DESCRIPTION

SYRINGE

TECHNICAL FIELD

[0001]

The present invention relates to a syringe that injects an injection objective substance into an injection target area of a living body.

BACKGROUND ART

[0002]

Needleless syringes which perform injection without using an injection needle generally have a configuration in which an injection component is injected by applying pressure to an injection liquid including a medicine or the like with the aid of a propellant, a pressurized gas, a spring, or the like. Moreover, the pressure applied to the injection liquid is adjusted so that the injection liquid is delivered to a desired area inside a living body. In a technique illustrated in Patent Document 1, a configuration in which an injection liquid and a gas generating agent for applying pressure are formed as one unit, and the unit is loaded into a syringe body before using the syringe is disclosed. In this configuration, the unit inserted in the syringe body enters a get-ready state when a lid that covers the unit is blocked. A new unit is loaded after use, whereby subsequent injection can be performed.

[0003]

Patent Document 2 discloses a configuration in which a portion that retains an injection liquid is separated from a pressurizing portion that applies pressure to the injection liquid. In this configuration, the injection liquid holding portion and a driving source of the pressurizing portion are replaced after the injection liquid is injected, whereby subsequent injection can be performed.

[0004]

Patent Document 1: US Patent Specification No. 6258063

Patent Document 2: Japanese Translation of PCT Application No. 2003-535654

Patent Document 3: US Patent Application Publication No. 2003/0114789

DISCLOSURE

[0005]

Regardless of presence of an injection needle, when an injection liquid is injected into an injection target area, injection conditions such as the kind and amount of injection liquid, the magnitude of load applied to the injection liquid in order to deliver the injection liquid to an injection target area changes depending on the subject person and the purpose of injection. Thus, in order to realize injection under intended conditions, the syringe needs to have a configuration corresponding to the conditions and it cannot be said that such a syringe provides good user's convenience.

[0006]

The present disclosure has been made in view of the problem and an object thereof is to provide a syringe capable of facilitating injection of injection liquid ideal for various purposes and improving user's convenience.

[0007]

In order to solve the problem, a syringe of the present disclosure includes a configuration for regulating an order of constituent portions of the syringe, which is loaded into a housing thereof. With this configuration, when respective constituent portions are loaded into the syringe in order to perform injection, even if there is an error in the order of loading the constituent portions, a user can recognize the error immediately with the regulating configuration. Thus, it is possible to improve the convenience of the syringe.

[0008]

In one aspect, the present disclosure provides a syringe that injects an injection objective substance into an injection target area of a living body, the syringe comprising: a housing; a holding portion that accommodates the injection objective substance; a driving portion that applies injection energy toward the injection objective substance accommodated in the holding portion, from the holding portion; and a nozzle portion that includes a passage, through which the injection objective substance injected from the holding portion flows, and injects the injection objective substance from an open end of the passage to the injection target area, wherein the holding portion, the driving portion, and the nozzle portion are loaded into the

housing independently, whereby a state where the injection objective substance can be injected is established, the syringe further comprising: regulating means for regulating a loading position of the holding portion and the driving portion within the housing so that a loading state where the holding portion and the driving portion are always loaded in the same order into the housing is established for injection of the injection objective substance.

[0009]

In the syringe according to the present disclosure, preparation for injection of the injection objective substance is made when the holding portion, the driving portion, and the nozzle portion which are constituent portions thereof are loaded into the housing in an independent manner. In the syringe, when the driving portion applies injection energy to the injection objective substance accommodated in the holding portion, the injection objective substance flows through the passage of the nozzle portion and is injected to the injection target area from the open end of the passage. The injection objective substance contains a component which is expected to exhibit effects inside the injection target area. As described above, the injection energy applied by the driving portion is the driving source when the injection objective substance is injected. Therefore, an accommodation state of the injection objective substance in the syringe and a specific physical form of the injection objective substance such fluid in a liquid or gel form, powder, granular solid is not particularly limited as long as that the injection objective

substance can be injected by the driving portion.

[0010]

For example, the injection objective substance is a liquid and may be solid in a gel form, provided that the solid has such fluidity that the solid can be injected. Further, the injection objective substance may be in a powder state. The injection objective substance may contain a component which is to be delivered to the injection target area of the living body. The component may exist in a state of being dissolved in the injection objective substance or may exist in a simply mixed state without being dissolved. Examples of the component to be delivered include vaccines for enhancing antibody, proteins for cosmetic treatments, and cultured cells for regenerating hair. These components are contained in fluid in a liquid or gel form so that the components can be injected, whereby the injection objective substance is formed.

[0011]

Further, various energy sources can be used for allowing the driving portion to apply the injection energy to the injection objective substance as long as the injection objective substance can be injected. Examples of the injection energy source include an energy source which uses the pressure of gas generated with combustion of ignition charge and an energy source which uses an electric actuator (for example, a motor, a piezoelectric device, and the like) for applying pressure.

[0012]

When the injection objective substance is supplied to a living body using the syringe according to the present invention, the kind of the injection objective substance used is different since the effects change depending on a size, an age, and a gender of the living body. Moreover, the thickness of the injection target area is different depending on the layer of biological tissues such as the epidermis layer, the intracutaneous layer, the subcutaneous layer, and the muscle layer, and the load applied to the injection objective substance needs to be adjusted so that the injection objective substance reaches the respective depths. Thus, in the syringe, the holding portion that accommodates the injection objective substance, the driving portion that applies the injection energy to the injection objective substance, and the nozzle portion having a passage for injecting the injection objective substance are configured to be independent from each other and are loaded into the housing in an independent manner.

[0013]

That is, a plurality of types of holding portions for accommodating a plurality of kinds and amounts of injection objective substances is prepared, a plurality of types of driving portions for applying a plurality of types of energy sources for supplying the injection energy to the injection objective substance is prepared, and these constituent portions are combined appropriately for the injection purposes and are assembled into the housing of the syringe. Further, a plurality of types of nozzle portions having various shapes may be prepared and included in the

combination. By doing so, it becomes easy to adjust a mode of injection of the injection objective substance (for example, diameters of the passages for the injection objective substance injected into a plurality of positions of the injection target area). In this manner, by enabling the respective constituent portions of the syringe to be combined appropriately for injection purposes, the usability and convenience of the syringe according to the present invention are improved.

[0014]

The plurality of types of driving portions may be driving portions having different amounts, shapes, dimensions, and the like when the energy source is an ignition charge or a gas generating agent and may be driving portions in which different amounts of gas are filled when the energy source is pressurized gas. Further, the driving portions may have different spring constants when the energy source is a spring. Moreover, the plurality of types of holding portions may be holding portions in which different kinds, amounts, and the like of injection objective substances are filled.

[0015]

Although it is possible to facilitate injection of the injection objective substance ideal for various injection purposes by appropriately combining the holding portion, the driving portion, and the nozzle portion and loading the same into the housing, the syringe may not function properly if there is an error in the order of loading the respective constituent portions in relation to the housing. In such a case, it may be desirable that users can

recognize the error in the loading order immediately, which may enhance the convenience of the syringe. Moreover, by allowing users to load the respective constituent portions in a proper order, the syringe can exhibit stable performance and perform injection with satisfactory reproducibility. Therefore, it can be said that the use of the syringe according to the present invention is desirable.

[0016]

Thus, the syringe according to the present invention includes the regulating means that regulates the loading position of at least the holding portion and the driving portion in relation to the housing. When the holding portion and the driving portion are loaded into the housing, the loading position of the holding portion and the driving portion in relation to the housing is determined at a predetermined position based on a configuration that the injection energy supplied from the driving portion is applied to the injection objective substance accommodated in the holding portion, whereby the injection objective substance is injected. Thus, when the holding portion and the like are loaded at a position different from the predetermined position, the syringe cannot inject the injection objective substance appropriately. However, in the syringe according to the present invention, since the loading position of the holding portion and the like to the housing is regulated uniquely by the regulating means, that is, a state where the holding portion and the driving portion are loaded in the housing at a position other than the regulated loading position does not

happen, if there is an error in the order of loading the holding portion and the like, the user can recognize the loading error immediately. Due to this, it is possible to realize various injection modes by appropriately combining the respective constituent portions without impairing the user's convenience.

[0017]

The holding portion may be disposed after used once and a new holding portion may be assembled to perform injection. In this case, the driving portion and the nozzle portion may be configured such that the portions are to be disposed after used once and a new driving portion and the like may be used. Alternatively, the driving portion and the nozzle portion may be used repeatedly or several times continuously if the portions can be used repeatedly. Since the housing of a syringe basically can be used repeatedly, it is not necessary to prepare a plurality of housings for various injection purposes and maintenance of constituent components of the syringe is easy.

[0018]

The holding portion and the driving portion for which the loading position is regulated by the regulating means may be loaded into the housing in a state of being temporarily fixed to each other by an adhesive tape or a paste, for example, before the holding portion and the driving portion are loaded into the housing. Alternatively, the holding portion and the driving portion may be loaded into the housing individually. Moreover, the loading position of the nozzle portion may also be regulated by the

regulating means. Since a nozzle portion includes a passage through which the injection objective substance is injected, although users may relatively rarely make an error in the loading order, the regulating means of the present invention may also regulate the loading position of the nozzle portion.

[0019]

In the syringe, the driving portion may include an ignition charge or a gas generating agent that combusts with a voltage applied from a power source portion and may apply the injection energy to the injection objective substance with pressure of a combustion gas that is generated by combustion of the ignition charge or the gas generating agent. In this case, the regulating means may regulate a loading position of the power source portion, the holding portion, and the driving portion in relation to the housing so that a loading state where the power source portion, the holding portion, and the driving portion are always loaded in the same order into the housing is established for injection of the injection objective substance. That is, since the loading position of the respective constituent portions including the power source portion in relation to the housing is regulated by the regulating means, it is possible to realize various injection modes by appropriately combining the respective constituent portions without impairing the user's convenience.

[0020]

In the above aspect, although the loading position of the power source portion is regulated by the regulating means, the

loading position of the power source portion may not be regulated by the regulating means. That is, when the power source portion is included in the syringe, the regulating means may regulate a loading position of the holding portion and the driving portion in relation to the housing so that a loading state where the holding portion and the driving portion are always loaded in the same order into the housing is established for injection of the injection objective substance, and a loading position of the power source portion may not be regulated by the regulating means when the power source portion is loaded into the housing. A voltage required for combustion of the ignition charge or the like may be applied to the driving portion a plurality of number of times depending on a storage capacity of the power source portion. In such a case, since it is not necessary to detach the power source portion from the housing whenever the injection objective substance is injected, the loading position of the power source portion may not be regulated by the regulating means. Moreover, depending on the storage capacity, when the power source portion is configured to be removed from the housing independently from the driving portion and the holding portion, the convenience during replacement or the like is improved.

[0021]

The driving portion, the holding portion, and the nozzle portion may be formed so as to be superimposed in an axial direction of the housing when loaded into the housing, and the driving portion, the holding portion, and the nozzle portion are sequentially loaded

from one direction into the housing through an opening of the housing. In this case, the regulating means includes: a first tapered surface which is a continuous outer peripheral surface formed so as to extend from the driving portion toward the holding portion when the driving portion, the holding portion, and the nozzle portion are superimposed on each other and which is formed so that a radius of the continuous outer peripheral surface increases as the outer peripheral surface advances from the driving portion toward the holding portion; and a second tapered surface which is a continuous inner peripheral surface on the housing and corresponds to the first tapered surface.

[0022]

That is, the first tapered surface provided on the constituent portions, formed when the driving portion, the holding portion, and the nozzle portion are superimposed on each other, and the second tapered surface provided on the housing to which the constituent portions are loaded, form the regulating means. These tapered surfaces are formed so that the radii thereof increase as the tapered surfaces advance toward the opening of the housing through which the constituent portions are loaded. Due to this, since the radii increase in the order of the driving portion, the holding portion, and the nozzle portion, if a user tries to load the holding portion and the nozzle portion into the housing earlier than the driving portion, the nozzle portion cannot advance toward the deeper side than the loading position of the nozzle portion. As a result, it is not possible to load the driving portion, and the user can

recognize an error in the loading order of the constituent portions of the syringe.

[0023]

Instead of the aspect where the tapered surfaces are used, the regulating means may be configured to include: a first outer peripheral surface which is a step-shaped outer peripheral surface and includes an outer peripheral surface of the driving portion and an outer peripheral surface of the holding portion, having a larger radius than a radius of the outer peripheral surface of the driving portion; and a second inner peripheral surface which is a step-shaped inner peripheral surface formed on the housing and corresponds to the first outer peripheral surface. In this manner, by using the step-shaped outer peripheral surface and inner peripheral surface having different radii, that is, the outer peripheral surface which is not continuous to the driving portion and the holding portion and the inner peripheral surface of the housing corresponding thereto, it is possible to regulate the loading position of the driving portion and the holding portion. In the above invention, the driving portion and the holding portion may be disposed on the same axis in relation to the housing, and the power source portion and the nozzle portion may be disposed on the same axis.

[0024]

The syringe according to the present invention may employ another regulating means as long as the regulating means is configured such that, when there is an error in the order of loading

a certain constituent portion into the housing, the constituent portion reaches its original loading position and the loading of the other constituent portions is inhibited, whereby users can recognize an error in the loading order.

[0025]

In the syringe, the driving portion may have a driving-side opening which is an opening for applying the injection energy to the holding portion, and the holding portion may have an accommodation hole in which the injection objective substance is accommodated and the accommodation hole may have an accommodation hole-side end portion that receives the injection energy applied from the driving-side opening. In this case, an annular projection which surrounds the driving-side opening or the accommodation hole-side end portion and deforms in the loading state to seal a space between the driving-side opening and the accommodation hole-side end portion is formed on any one of the driving portion and the holding portion. Alternatively, an annular groove which surrounds the driving-side opening or the accommodation hole-side end portion and engages with the annular projection in the loading state to seal a space between the driving-side opening and the accommodation hole-side end portion is formed on any one of the driving portion and the holding portion.

[0026]

The injection energy applied from the driving-side opening of the driving portion is transmitted to the accommodation hole-side end portion of the holding portion, whereby the injection energy

is applied to the injection objective substance accommodated in the accommodation hole. As described above, in the syringe according to the present invention, the driving portion and the holding portion are configured to be independent from each other and are loaded into the housing. Due to this, if the injection energy is not appropriately applied between the driving portion and the holding portion, the injection objective substance is not appropriately injected to the injection target area. Thus, as described above, by providing the deformable annular projection on the driving portion or the holding portion or providing the annular projection and the annular groove configured to engage with each other on the driving portion and the holding portion, respectively, it is possible to enhance the sealing of the space between the driving-side opening and the accommodation hole-side end portion and to suppress the injection transmitted from the driving portion from leaking outside. Due to this, it is possible to inject the injection objective substance to the injection target area satisfactorily.

EFFECT OF THE INVENTION

[0027]

It is possible to provide a syringe capable of facilitating injection of an injection liquid in various purposes and improving user's convenience.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028]

FIG. 1 is a cross-sectional view illustrating a schematic configuration in an assembled state, of a syringe according to a first embodiment of the present invention.

FIG. 2 is a diagram illustrating the order of loading constituent portions of the syringe illustrated in FIG. 1 and a relative relationship of the respective constituent portions.

FIG. 3 is a diagram for describing an embodiment in which the order of loading a power source portion of the syringe illustrated in FIG. 1 is different from the order of loading illustrated in FIG. 1.

FIG. 4 is a first diagram illustrating a detailed relative relationship between a driving portion and a holding portion of the syringe illustrated in FIG. 1.

FIG. 5 is a second diagram illustrating a detailed relative relationship between a driving portion and a holding portion of the syringe illustrated in FIG. 1.

FIG. 6 is a diagram illustrating the order of loading constituent portions of a syringe according to a second embodiment of the present invention and a relative relationship of the respective constituent portions.

BEST MODE FOR CARRYING OUT THE INVENTION

[0029]

Hereinafter, a syringe 70 according to an embodiment of the present invention will be described with reference to the drawings.

Although the syringe 70 according to an embodiment of the present invention is a so-called needleless syringe having no injection needle, the present invention can be applied regardless of presence of an injection needle without departing from the spirit of the present invention. Moreover, the configuration of the following embodiment is an example, and the present invention is not limited to the configuration of the embodiment.

FIRST EMBODIMENT

[0030]

FIG. 1 is a cross-sectional view illustrating a schematic configuration of the syringe 70 in a state where assembling of the syringe 70 according to the present invention is substantially completed. FIG. 2 is a diagram illustrating the order of loading the constituent portions thereof to assemble the syringe 70. As illustrated in FIG. 2, the syringe 70 has a housing 5 which serves as a main body thereof and in which a power source portion 1, a driving portion 2, a holding portion 3, and a nozzle portion 4, which are constituent portions of the syringe 70 are sequentially loaded, and finally, these constituent portions are fixed to the housing 5 by a fixing ring 6. In this way, the syringe 70 is assembled.

[0031]

Specifically, the housing 5 has a hollow shape, and a loading opening 52 is formed at one end in an axial direction thereof so that the power source portion 1, the driving portion 2, the holding

portion 3, and the nozzle portion 4 can be loaded in the housing. On the other hand, an opening 53 is formed at the other end in the axial direction of the housing 5 so that an apex portion of a press button switch 11 (described later) provided in the power source portion 1 which is loaded first into the housing 5 is exposed outside. Moreover, a hollow portion in the housing 5 has an inner peripheral surface which is formed as a continuous tapered surface 50. The tapered surface 50 is formed so that the radius (the inner diameter of the housing 5) thereof increases as the tapered surface advances from the opening 53 to the loading opening 52 (that is, along the axis of the housing 5). In the syringe 70 of the present embodiment, a side of the housing 5 close to the opening 53 is referred to as an upstream side and the side close to the loading opening 52 is referred to as a downstream side. This is based on the flowing direction when an injection liquid 34 is injected in a state where the respective constituent portions are loaded into the housing 5 and assembling of the syringe 70 is completed.

[0032]

In the syringe 70, the power source portion 1, the driving portion 2, the holding portion 3, and the nozzle portion 4 as the constituent portions having individual functions and formed independently are sequentially loaded into the housing 5 through the loading opening 52, and the loading state illustrated in FIG. 1 is formed. The power source portion 1 is a power supply for supplying power to an igniter 22 provided in the driving portion 2 described later and generates a voltage between power source-side

electrodes 12 using the power of a battery included therein when a user presses the press button switch 11. The power source-side electrodes 12 are formed as a pair of electrodes including a first projecting electrode positioned on the central axis of the syringe 70 (the housing 5) and a second projecting electrode separated by a predetermined distance from the first electrode.

[0033]

The driving portion 2 has a gas generating agent 25 therein and applies the pressure of combustion gas generated when the gas generating agent 25 combusts as injection energy for the injection liquid accommodated in the holding portion 3 described later. Specifically, driving-side electrodes 21 corresponding to the power source-side electrodes 12 of the power source portion 1 are formed on an end surface of the driving portion 2. The driving-side electrodes 21 are formed as a pair of electrodes including a first small circular electrode positioned on the central axis of the syringe 70 (the housing 5) and a second electrode having the same radius as the predetermined distance, formed in a cylindrical form around the first electrode. Since the driving-side electrodes 21 are formed in this manner, it is possible to maintain satisfactory contact between the driving-side electrodes 21 and the power source-side electrodes 12 regardless of a relative position (the relative position in a rotation direction about the central axis of the syringe 70) of the power source portion 1 in relation to the driving portion 2.

[0034]

The driving-side electrodes 21 are connected to the igniter 22 provided in the driving portion 2. The igniter 22 is a known electric ignition device. When the power source portion 1 applies a voltage between the driving-side electrodes 21, current flows and an ignition charge provided in the igniter 22 combusts. In this case, products generated by combustion of the ignition charge flows toward the gas generating agent 25 disposed in a combustion chamber 24 adjacent to the igniter 22, and as a result, combustion of the gas generating agent 25 in the combustion chamber 24 starts. When a large amount of combustion gas is generated by combustion of the gas generating agent 25, pressure is applied to a metallic piston 23 provided adjacent to the combustion chamber 24, and the piston 23 is propelled toward the downstream side of the syringe 70. In FIG. 1, an end portion of the combustion chamber 24 close to the holding portion 3, which is blocked by the piston 23 is a driving-side opening.

[0035]

Examples of the ignition charge used in the igniter 22 preferably include a propellant (ZPP) containing zirconium and potassium perchlorate, a propellant (THPP) containing titanium hydride and potassium perchlorate, a propellant (TiPP) containing titanium and potassium perchlorate, a propellant (APP) containing aluminum and potassium perchlorate, a propellant (ABO) containing aluminum and bismuth oxide, a propellant (AMO) containing aluminum and molybdenum oxide, a propellant (ACO) containing aluminum and copper oxide, and a propellant (AFO) containing aluminum and iron

oxide, or a propellant composed of a combination of a plurality of the propellants. These propellants exhibit such characteristics that, although the propellants generate hot and high-pressure plasma during combustion immediately after ignition, when combustion products condense at a room temperature, the propellants do not contain gaseous components and the pressure generated decreases abruptly.

[0036]

Moreover, examples of the gas generating agent 25 disposed in the combustion chamber 24 preferably include a single base smokeless propellant including 98% by mass of nitrocellulose, 0.8% by mass of diphenylamine, and 1.2% by mass of potassium sulfate. Moreover, various gas generating agents used in a gas generator for airbags and a gas generator for seatbelt pretensioners may be used. A predetermined gas generated during combustion of the gas generating agent 25 contains gaseous components in a room temperature unlike the propellant. The gas generating agent 25 may not be used, and the igniter 22 and the piston 23 may form the driving portion 2.

[0037]

The holding portion 3 accommodates the injection liquid 34 which is an injection objective substance injected by the syringe 70. Specifically, a through-hole (accommodation hole) 33 is formed at the center of the holding portion 3 so as to follow the central axis of the housing 5 in a state where the holding portion 3 is loaded into the housing 5 as illustrated in FIG. 1. Moreover, the

injection liquid 34 is accommodated in the space of the through-hole 33 between an upstream plug 31 and a downstream plug 32. The upstream plug 31 and the downstream plug 32 are made from rubber, the surface of which is coated with a thin layer of silicon oil so that the injection liquid does not leak when accommodating the injection liquid 34 and the injection liquid 34 can move inside the through-hole 33 smoothly with sliding of the piston 23 which will be described later. Moreover, an end portion of the through-hole (accommodation hole) 33 close to the driving portion 2, which is blocked by the upstream plug 31 is an accommodation hole-side end portion.

[0038]

The nozzle portion 4 has a passage for injecting the injection liquid 34 accommodated in the holding portion 3 into an injection target (injection target area) outside the syringe 70. Specifically, a nozzle 43 for injecting the injection liquid 34 is formed in the nozzle portion 4, and a recess 41 configured to accommodate the downstream plug 32 is formed in a portion of the nozzle portion 4 facing the downstream plug 32 in a state where the nozzle portion 4 is loaded into the housing 5 as illustrated in FIG. 1. The recess 41 has substantially the same diameter as the downstream plug 32 and has a slightly larger depth than the length of the downstream plug 32. Due to this, when pressure is applied to the injection liquid 34 due to injection energy from the driving portion 2, the downstream plug 32 can be accommodated in the recess 41. When the downstream plug 32 is accommodated in

the recess 41, the pressurized injection liquid 34 is released from the space in the through-hole 33 of the holding portion 3. A passage 42 for guiding the released injection liquid 34 up to the nozzle 43 is formed so as to extend in a direction vertical to the central axis of the syringe 70. Due to this, the released injection liquid 34 is injected from the nozzle 43 into the injection target through the passage 42. Moreover, since the recess 41 has such a depth that the downstream plug 32 is accommodated therein, it is possible to prevent the injection of the injection liquid 34 from being inhibited by the downstream plug 32.

[0039]

A plurality of nozzles 43 or only one nozzle 43 may be formed in the nozzle portion 4. When a plurality of nozzles 43 is formed, passages 42 corresponding to the respective nozzles 43 are formed so that the released injection liquid is delivered to the respective nozzles 43. Further, when a plurality of nozzles 43 is formed, the respective nozzles 43 are preferably disposed at equal intervals around the central axis of the syringe 70. Moreover, the diameter of the nozzle 43 is set appropriately by taking injection pressure applied to the injection liquid 34, properties (viscosity) of the injection liquid and the like into consideration.

[0040]

As described above, in the syringe 70, the power source portion 1, the driving portion 2, the holding portion 3, and the nozzle portion 4 are formed independently from each other, and the respective constituent portions are sequentially loaded into the

housing 5 as illustrated in FIG. 2, whereby the loading state illustrated in FIG. 1 is created.

[0041]

In this manner, when the constituent portions of the syringe 70 are configured to be independent from each other, users can select constituent portions according to the purpose of injection and combine the constituent portions to assemble a final syringe 70. For example, a plurality of types of driving portions 2 having different kinds and amounts of gas generating agents 25 may be prepared so that an injection depth of the injection target can be adjusted while changing a pressure profile applied to the injection liquid 34. Moreover, a plurality of types of holding portions 3 corresponding to different kinds and amounts of injection liquid may be prepared so that the kinds and amount of the injection liquid 34 injected to an injection target can be adjusted according to the state or the like of the injection target (for example, the dose of injection liquid can be adjusted according to the injection target in such a way that the dose of injection liquid injected to the skin structure of adults is to be different from the dose of injection liquid injected to the skin structure of kids). Further, a plurality of types of nozzle portions 4 having different numbers of nozzles 43 and different nozzle diameters may be prepared so that an injection mode of the injection liquid 34 ideal for an injection target can be selected. A user selects one driving portion 2, one holding portion 3, and one nozzle portion 4 in order to attain an intended injection purpose and loads the respective

constituent portions into the housing 5 through the loading opening 52 as illustrated in FIG. 2 to create a state where the syringe 70 gets ready for use. In this way, it is possible to facilitate injection of injection liquid ideal for various purposes.

[0042]

The respective constituent portions are preferably configured such that a predetermined unified paint or design is applied to the external shape thereof so that users can easily select one driving portion 2, one holding portion 3, and one nozzle portion 4 to be loaded into the housing to be prepared for injection. For example, the driving portions 2 may be painted in blue, the holding portions 3 may be painted in yellow, and the nozzle portions 4 may be painted in red. In this way, users are prevented from selecting a plurality of driving portions 2 by mistake.

[0043]

As illustrated in FIGS. 1 and 2, the power source portion 1 is loaded first into the housing 5. When the power source portion 1 is loaded into the housing 5 with the surface of the press button switch 11 facing the inside of the housing 5, a stepped portion 13 provided around the press button switch 11 collides with a stepped portion 54 provided around the opening 53 of the housing 5, whereby a loading position of the power source portion 1 is determined. At this loading position, an apex surface of the press button switch 11 is flush with the end surface close to the opening 53, of the housing 5.

[0044]

The syringe 70 is configured such that a voltage applied from the power source portion 1 is applied to the driving portion 2 to combust the gas generating agent 25 to generate a combustion gas, the injection liquid 34 is pressurized by the combustion gas, and the pressurized injection liquid 34 is injected outside from the nozzle 43. Thus, the constituent portions have to be loaded into the housing 5 in the order of the power source portion 1, the driving portion 2, the holding portion 3, and the nozzle portion 4 as illustrated in FIG. 2. If the constituent portions are not loaded in this order, it is not possible to inject the injection liquid 34 using the syringe 70.

[0045]

Thus, the syringe 70 adopts a configuration for defining the loading position of the respective constituent portions in the housing 5 so that the respective constituent portions are loaded into the housing 5 in an appropriate order (that is, a user can recognize a loading error when the respective constituent portions are not loaded in an appropriate order). Specifically, the outer peripheral surfaces of the respective constituent portions are formed as a tapered surface (first tapered surface) so as to correspond to the tapered surface 50 (the second tapered surface) which is the inner peripheral surface of the housing 5. As described above, the tapered surface 50 is formed so that the radius (outer diameter) of the tapered surface 50 increases as the tapered surface advances from the upstream side to the downstream side. The outer peripheral surfaces 10, 20, 30, and 40 of the respective constituent

portions are formed so as to correspond to the tapered surface 50 in the order of loading the same into the housing 5 (that is, the outer peripheral surfaces of the power source portion 1, the driving portion 2, the holding portion 3, and the nozzle portion 4 form a continuous tapered surface (first tapered surface) so as to correspond to the tapered surface 50 close to the housing 5 in a state where the respective constituent portions are superimposed in the housing 5 in the axial direction as illustrated in FIG. 1).

[0046]

Since the outer peripheral surfaces 10, 20, 30, and 40 of the respective constituent portions are formed so as to form a continuous tapered surface when the outer peripheral surfaces are superimposed, the loading positions of the constituent portions in the housing 5 are uniquely determined as illustrated in FIG. 1 in order to create a state where the syringe 70 can be used. If the holding portion 3 is loaded into the housing 5 prior to the driving portion 2, the holding portion 3 cannot advance toward the deeper side (the upstream side) than a position where the outer peripheral surface 30 makes contact with a portion of the corresponding tapered surface 50 (that is, a loading position where the holding portion 30 is to be loaded). Due to this, when the user tries to load the driving portion 2 subsequently, since a state where it is not possible to load the driving portion 2 is created, the user can immediately recognize where is an error in the loading order. Thus, the tapered surface 50 (second tapered surface) of the housing 5 and the continuous tapered surface (first tapered

surface) formed when the outer peripheral surfaces 10, 20, 30, and 40 of the constituent portions are superimposed on each other correspond to a regulating means according to the present invention.

[0047]

When the respective constituent portions are loaded into the housing 5 as illustrated in FIG. 1, the fixing ring 6 is inserted into the housing 5 so as to make contact with the end surface of the nozzle portion 4 located closest to the downstream side. An external thread formed on the outer circumference of the fixing ring 6 engages with an internal thread 51 formed near the end portion (the loading opening 52) of the inner peripheral surface of the housing 5. In this way, the constituent portions loaded into the housing 5 can be pressed and fixed with the nozzle portion 4 interposed.

[0048]

< MODIFIED EXAMPLE 1 >

In the embodiment, the power source portion 1 is also loaded into the housing 5 through the loading opening 52 together with the other constituent portions, but in place of such a configuration, the power source portion 1 may be loaded into the housing 5 from the upstream side separately from the driving portion 2 and the like. In this case, a stepped portion 14 is provided around an end surface of the power source portion 1 opposite the end surface where the press button switch 11 is provided. Moreover, a recess 55 in which the power source portion 1 is accommodated is formed in a portion of the housing 5 close to the opening 53, and a projection

56 is provided in a space connecting the recess 55 and the space in the housing 5 defined by the tapered surface 50. When the power source portion 1 is loaded in the recess 55, the stepped portion 14 close to the power source portion 1 collides with the projection 56 close to the housing 5, whereby the loading position of the power source portion 1 is determined. The loaded power source portion 1 is fixed to the housing 5 by known fixing means (for example, in a state where the power source portion 1 can be detachable from the housing by a snap-fit of the power source portion 1). When the power source portion 1 is loaded into the housing 5 in this manner, a state where the power source-side electrodes 12 are exposed to the space in the housing 5 defined by the tapered surface 50 is created, and a state where the power source-side electrodes 12 can come into contact with the driving-side electrodes 21 of the driving portion 2 loaded through the loading opening 52 as illustrated in FIG. 1 is created.

[0049]

The power source portion 1 can supply an electric power to the driving portion 2 several time depending on the storage capacity. In this case, as illustrated in FIG. 1, it may be inconvenient to load the power source portion 1 into the housing 5 together with the other constituent portions such as the driving portion 2 whenever the injection liquid 34 is injected. Thus, it is possible to diminish inconveniences associated with loading of the power source portion 1 when the power source portion 1 is loaded separately from the other constituent portions as illustrated in FIG. 3. That

is, the power source portion 1 does not have a tapered surface which is used for determining the loading position. After the power source portion 1 supplies electric power for a predetermined number of times corresponding to the storage capacity, the power source portion 1 may be detached from the housing and a new power source portion 1 may be loaded.

[0050]

< MODIFIED EXAMPLE 2 >

FIG. 4 illustrates a relative relationship between the driving portion 2 and the holding portion 3 according to the present modification. The gas generating agent 25 is disposed in the combustion chamber 24, and the gas generating agent 25 combusts with ignition of the igniter 22 to generate a combustion gas, whereby the piston 23 is pressed. In this case, the piston 23 moves from the opening (the driving-side opening) 24a close to the driving portion 3, of the combustion chamber 24 toward the holding portion 3. On the other hand, on the holding portion 3 side, the piston 23 advances into the end portion (the accommodation hole-side end portion) 33a of the through-hole 33 in which the upstream plug 31, the injection liquid 34, and the downstream plug 32 are disposed, whereby the injection energy due to the combustion gas of the gas generating agent 25 is transmitted to the injection liquid 34 with the upstream plug 31 interposed therebetween.

[0051]

Here, an annular projection 26 is formed on the end surface of the driving portion 2, close to the holding portion 3, so as

to surround the opening 24a. The annular projection 26 is formed from relatively soft metal such as aluminum, and when the respective constituent portions are loaded into the housing 5 and are fixed by the fixing ring 6 to generate pressing force as illustrated in FIG. 1, the projection 26 collapses and deforms between the driving portion 2 and the holding portion 3 with the pressing force. With this deformation, the transmission of injection energy from the piston 23 to the upstream plug 31 is not inhibited. As a result, since the deformed annular projection 26 surrounds and seals the space between the driving portion 2 and the holding portion 3 around the through-hole 33 and the combustion chamber 24, it is possible to suppress the combustion gas of the gas generating agent 25 from leaking outside from the space between the driving portion 2 and the holding portion 3 and to allow the injection energy to be effectively transmitted to the injection liquid 34.

[0052]

< MODIFIED EXAMPLE 3 >

FIG. 5 illustrates a relative relationship between the driving portion 2 and the holding portion 3 according to the present modification. FIG. 5 illustrates a configuration in which an annular projection 27 and an annular groove 28 are formed instead of the annular projection 26 illustrated in FIG. 4 so as to allow injection energy to be effectively transmitted to the injection liquid 34. Specifically, the annular projection 27 is formed on an end surface of the driving portion 2, close to the holding portion 3, so as to surround the opening 24a. The annular projection 27

does not deform at the time of fixing to the housing 5 unlike the annular projection 26 but engages with the annular groove 28 formed on an end surface of the holding portion 3, close to the driving portion 2, so as to surround the end portion 33a. The depth of the annular groove 28 is set to be slightly larger than the height of the annular projection 27.

[0053]

As a result, when the annular projection 27 engages with the annular groove 28, the projection 27 and the groove 28 surround and seal the space between the driving portion 2 and the holding portion 3 around the through-hole 33 and the combustion chamber 24. Due to this, it is possible to suppress the combustion gas of the gas generating agent 25 from leaking outside from the space between the driving portion 2 and the holding portion 3 and to allow the injection energy to be effectively transmitted to the injection liquid 34.

SECOND EMBODIMENT

[0054]

A second embodiment of the syringe 70 (in particular, a regulating means that determines the loading position of the respective constituent portions loaded into the housing 5) will be described based on FIG. 6. Since the other constituent portions other than the regulating means, of the syringe 70 according to the second embodiment are the same as those of the syringe 70 according to the first embodiment, these constituent portions are

denoted by the same reference numerals, and description thereof will not be provided.

[0055]

In the present embodiment, the external shape of the power source portion 1, the driving portion 2, the holding portion 3, and the nozzle portion 4 loaded into the housing 5 are formed in an approximately cylindrical shape, and the radii (outer diameters) of the outer peripheral surface of the respective constituent portions are designed so as to increase in the order of the outer peripheral surface 100 of the power source portion 1, the outer peripheral surface 200 of the driving portion 2, the outer peripheral surface 300 of the holding portion 3, and the outer peripheral surface 400 of the nozzle portion 4. Thus, in the present embodiment, when the respective constituent portions are superimposed so as to face each other in the housing 5, the outer peripheral surfaces of the respective constituent portions do not form a continuous tapered surface unlike the first embodiment but form a step-shaped discontinuous outer peripheral surface. The inner peripheral surface of the housing 5 is formed so as to correspond to the outer peripheral surfaces of the respective constituent portions. Specifically, an inner peripheral surface 501 is formed so as to correspond to the outer peripheral surface 100 of the power source portion 1, an inner peripheral surface 502 is provided so as to correspond to the outer peripheral surface 200 of the driving portion 2, an inner peripheral surface 503 is provided so as to correspond to the outer peripheral surface 300

of the holding portion 3, and an inner peripheral surface 504 is provided so as to correspond to the outer peripheral surface 400 of the nozzle portion 4. The radii (inner diameters) of the inner peripheral surfaces 501, 502, 503, and 504 are set so as to increase in that order. Thus, the inner peripheral surface of the housing 5 is also formed as a step-shaped discontinuous surface.

[0056]

In this manner, since the outer peripheral surfaces 100, 200, 300, and 400 of the respective constituent portions are formed so as to form a step-shaped discontinuous outer peripheral surface when the constituent portions are superimposed and the inner peripheral surface of the housing 5 is formed so as to correspond to the outer peripheral surface, the loading positions of the constituent portions in the housing 5 are uniquely determined as illustrated in FIG. 1 in order to create a state where the syringe 70 can be used. Due to this, users can recognize an error in the loading order immediately. Thus, the step-shaped discontinuous inner peripheral surfaces 501, 502, 503, and 504 formed in the housing 5 and the step-shaped discontinuous outer peripheral surface formed when the outer peripheral surfaces 100, 200, 300, and 400 of the respective constituent portions are superimposed on each other correspond to a regulating means according to the present invention.

[0057]

Moreover, the external shape of the respective constituent portions may have a circular truncated external shape so that the

outer peripheral surface has a tapered surface instead of the cylindrical shape.

[0058]

According to the syringe 70 of the present invention, for example, cultured cells, stem cells, and the like may be seeded or inoculated into injection target cells or scaffold tissues (scaffolds) in the field of the regenerative medicine of human, in addition to the case where the injection liquid is injected into the skin structure. For example, as described in Japanese Patent Application Publication No. 2008-206477, the syringe 70 may inject cells which may be appropriately determined by those skilled in the art depending on a transplantation portion and the purpose of the cell regeneration, for example, endothelial cells, endothelial precursor cells, myeloid cells, preosteoblast, chondrocytes, fibroblast, skin cells, muscle cells, liver cells, kidney cells, intestinal tract cells, and stem cells, as well as all cells considered in the field of the regenerative medicine. More specifically, a liquid (cell suspension) containing the cells to be seeded or inoculated is accommodated in the holding portion 3, and the liquid pressurized with combustion of the gas generating agent 25. In this way, predetermined cells are injected and transplanted to the transplantation portion.

[0059]

Further, the syringe 70 according to the present invention may be also used for delivering DNA or the like to cells or scaffold tissues (scaffolds) as described in Japanese Patent Application

Publication No. 2007-525192. In this case, it is possible to suppress an adverse effect on cells themselves or scaffold tissues (scaffolds) themselves when the syringe 70 according to the present invention is used, as compared with when the delivery is performed using a needle. Therefore, it can be said that the use of the syringe 70 according to the present invention is more desirable.

[0060]

Further, the syringe 70 according to the present invention is ideally useful, for example, when various genes, cancer inhibiting cells, lipid envelops, and the like are directly delivered to target tissues and when antigen genes are administered to enhance the immunity against pathogens. In addition to the above, the syringe 70 can be also used, for example, in the field of medical treatment for various diseases (for example, see Japanese Translation of PCT Application No. 2008-508881 and Japanese Translation of PCT Application No. 2010-503616) and the field of immunological medical treatment (for example, see Japanese Translation of PCT Application No. 2005-523679). The field, in which the syringe 70 is usable, is not intentionally limited.

EXPLANATION OF REFERENCE NUMERALS

[0061]

1: Power source portion

2: Driving portion

3: Holding portion

4: Nozzle portion

5: Housing

6: Fixing ring

10, 20, 30, 40: Outer peripheral surface

12: Power-side electrode

21: Driving-side electrode

22: Igniter

23: Piston

24: Combustion chamber

24a: Opening

25: Gas generating agent

26: Annular projection

31: Upstream plug

32: Downstream plug

33: Through-hole

33a: End portion

34: Injection liquid

41: Recess

43: Nozzle

70: Syringe

100, 200, 300, 400: Outer peripheral surface

501, 502, 503, 504: Inner peripheral surface

CLAIMS:

1. A syringe that injects an injection objective substance into an injection target area of a living body,

the syringe comprising:

a housing;

a holding portion that accommodates the injection objective substance;

a driving portion that applies injection energy toward the injection objective substance accommodated in the holding portion, from the holding portion; and

a nozzle portion that includes a passage, through which the injection objective substance injected from the holding portion flows, and injects the injection objective substance from an open end of the passage to the injection target area, wherein

the holding portion, the driving portion, and the nozzle portion are loaded into the housing independently, whereby a state where the injection objective substance can be injected is established,

the syringe further comprising:

regulating means for regulating a loading position of the holding portion and the driving portion within the housing so that a loading state where the holding portion and the driving portion are always loaded in the same order into the housing is established for injection of the injection objective substance.

2. The syringe according to claim 1, wherein

the driving portion includes an ignition charge or a gas generating agent that combusts with a voltage applied from a power source portion and applies the injection energy to the injection objective substance with pressure of a combustion gas that is generated by combustion of the ignition charge or the gas generating agent, and

the regulating means regulates a loading position of the power source portion, the holding portion, and the driving portion within the housing so that a loading state, where the power source portion, the holding portion, and the driving portion are always loaded in the same order into the housing, is established for injection of the injection objective substance.

3. The syringe according to claim 1, wherein

the driving portion includes an ignition charge or a gas generating agent that combusts with a voltage applied from a power source portion and applies the injection energy to the injection objective substance with pressure of a combustion gas that is generated by combustion of the ignition charge or the gas generating agent,

the regulating means regulates a position of the holding portion and the driving portion within the housing so that a loading state, where the holding portion and the driving portion are always loaded in the same order into the housing, is established for injection of the injection objective substance, and

a loading position of the power source portion is not

regulated by the regulating means when loading into the housing is implemented.

4. The syringe according to any one of claims 1 to 3,

the driving portion, the holding portion, and the nozzle portion are formed so as to be superimposed in an axial direction of the housing when loaded into the housing, and the driving portion, the holding portion, and the nozzle portion are sequentially loaded from one direction into the housing through an opening of the housing,

the regulating means comprises:

a first tapered surface which is a continuous outer peripheral surface formed so as to extend from the driving portion toward the holding portion when the driving portion, the holding portion, and the nozzle portion are superimposed on each other, and which is formed so that a radius of the continuous outer peripheral surface increase gradually from the driving portion toward the holding portion; and

a second tapered surface which is a continuous inner peripheral surface on a side of the housing and corresponds to the first tapered surface.

5. The syringe according to any one of claims 1 to 3, wherein

the driving portion, the holding portion, and the nozzle portion are formed so as to be superimposed in an axial direction of the housing when loaded into the housing, and the driving portion,

the holding portion, and the nozzle portion are sequentially loaded from one direction into the housing through an opening of the housing,

the regulating means comprises:

a first outer peripheral surface which is a step-shaped outer peripheral surface and includes an outer peripheral surface of the driving portion and an outer peripheral surface of the holding portion, which has a larger radius than a radius of the outer peripheral surface of the driving portion; and

a second inner peripheral surface which is a step-shaped inner peripheral surface formed on the housing and corresponds to the first outer peripheral surface.

6. The syringe according to any one of claims 1 to 5, wherein

the driving portion has a driving-side opening which is an opening for applying the injection energy to the holding portion,

the holding portion has an accommodation hole in which the injection objective substance is accommodated and the accommodation hole has an accommodation hole-side end portion that receives the injection energy applied from the driving-side opening, and

an annular projection, which surrounds the driving-side opening or the accommodation hole-side end portion and deforms in the loading state to seal a space between the driving-side opening and the accommodation hole-side end portion, is formed on one of the driving portion and the holding portion.

7. The syringe according to any one of claims 1 to 6, wherein

the driving portion has a driving-side opening which is an opening for applying the injection energy to the holding portion,

the holding portion has an accommodation hole in which the injection objective substance is accommodated and the accommodation hole has an accommodation hole-side end portion that receives the injection energy applied from the driving-side opening,

an annular projection which surrounds the driving-side opening or the accommodation hole-side end portion is formed on one of the driving portion and the holding portion,

an annular groove, which surrounds the driving-side opening or the accommodation hole-side end portion and engages with the annular projection in the loading state to seal a space between the driving-side opening and the accommodation hole-side end portion, is formed on the other one of the driving portion and the holding portion.

SYRINGE

ABSTRACT

A syringe includes a holding portion that accommodates an injection objective substance, a driving portion that applies injection energy, and a nozzle portion that includes a passage for injection, with these portions being loaded into a housing independently, whereby a state where the injection objective substance can be injected is established. The syringe includes a regulating means for regulating a loading position of the holding portion and the driving portion within the housing so that a loading state, where the holding portion and the driving portion are always loaded in the same order into the housing, is established for injection of the injection objective substance. Due to this, it is possible to facilitate injection of injection liquid ideal for various purposes and to improve user's convenience.

[Fig. 2]