

readily attached to or detached from the fixed injection needle. In this injection device, an injection operation is performed at a predetermined pace by an internal drive system and a retraction system.

5 PRIOR ART DOCUMENTS

PATENT DOCUMENTS

Patent Document 1: Published Japanese Translation of PCT International Application No. 2015-505487

10 SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

 However, in the technique of Patent Document 1, since the injection needle is fixed in the interior, in the case of performing injection using this device for multiple patients or subjects, there is a high risk of infection due to contagious diseases and infectious diseases, and of needling pain due to abrasion or the like of the injection needle. Therefore, the injection device itself needs to be discarded once used.

20 Furthermore, the structure of the targeted injection device, which is integrated with an injection needle for a syringe that is not attachable and detachable, may necessitate the device to be handled as a rather highly sophisticated medical device, and may impose strict cares in delivery and conveyance of the device.

 In addition, when a substance having a highly viscous, gel-like structure is used as the contents to be injected by injection, high pressure is applied at the time of use, and in some cases, the injection cylinder is detached from the fixed injection needle.

 Thereupon, in view of the above circumstances, ~~it is an object of the present invention to embody~~ embodiments of the present disclosure provide an

injection device that can prevent the injection needle from falling out of the injection cylinder when being used, and can have the syringe detached and attached.

- 5 According to an aspect, there is provided an injection device to inject a content into a test object by a syringe that includes a plunger, an injection cylinder into which the plunger is inserted, and an injection needle including
 10 a needle base connected to the injection cylinder and a needle tube to be punctured into the test object, the injection device comprising:
 a contact head configured to contact the test object and to have an opening formed through which the needle tube passes;
 15 a movable holder configured to hold the injection cylinder and the injection needle;
 a support mechanism configured to be fixed to the contact head; and
 20 a content injection control mechanism configured to push the plunger into the injection cylinder,
 wherein the movable holder moving along the support mechanism moves the injection cylinder and
 25 the injection needle with respect to the contact head,
 wherein the syringe is attachable to and detachable from the injection device,
 wherein the content injection control mechanism includes a pressing part configured to push the
 30 plunger into the injection cylinder,
 wherein the movable holder moving in a forward direction approaching the contact head causes the needle tube to puncture the test object and to enter an
 inside of the test object,
 35 wherein the movable holder moving in a backward direction away from the contact head causes the needle tube to move backward with respect to the test object, and causes the movable holder to approach the pressing part and

to push the plunger into the injection cylinder to inject the content into the test object,

wherein the injection cylinder includes an outer cylinder part to contain the content, and a flange provided at a rear end of the outer cylinder part,

wherein at an upper part of the movable holder is provided with a flange fitting portion to hold the flange and to restrict a movement of the flange in the backward direction with respect to the movable holder, and an outer cylinder part holding portion to restrict displacement of the outer cylinder part in a sideward direction with respect to the movable holder,

wherein the flange fitting portion holds, in a front-end direction and in a rear-end direction, a part extending in the sideward direction from the outer cylinder part,

wherein the outer cylinder part holding portion has linear protrusions standing on an upper surface of the movable holder, to sandwich and hold the outer cylinder part, and

wherein the outer cylinder part holding portion and the flange fitting portion are open upward, and a central part and a lower part of the flange fitting portion are open, the central part and the lower part corresponding to a part of the outer cylinder part in the rear-end direction.

MEANS FOR SOLVING THE PROBLEM

According to one aspect of the present invention an embodiment, an injection device is provided to inject a content into a test object by a syringe that includes a plunger, an injection cylinder into which the plunger is inserted, and an injection needle including a needle base connected to the injection cylinder and a needle tube to be punctured into the test object. The injection device includes a contact head configured to contact the test object and to have an opening formed

through which the needle tube passes; a movable holder configured to hold the injection cylinder and the injection needle; a support mechanism configured to be fixed to the contact head; and a content injection control mechanism configured to push the plunger into the injection cylinder. The movable holder moving along the support mechanism moves the injection cylinder and the injection needle with respect to the contact head. The syringe is attachable to and detachable from the injection device.

ADVANTAGEOUS EFFECT OF THE INVENTION

According to ~~one aspect of the present invention~~embodiments of the present disclosure, the injection device can prevent the injection needle from falling out of the injection cylinder when being used, and can have the syringe detached and attached.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 includes explanatory diagrams of an

CLAIMS

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1. An injection device to inject a content into a test object by a syringe that includes a plunger, an injection cylinder into which the plunger is inserted, and an injection needle including a needle base connected
10 to the injection cylinder and a needle tube to be punctured into the test object, the injection device comprising:

a contact head configured to contact the test object and to have an opening formed through which the
15 needle tube passes;

a movable holder configured to hold the injection cylinder and the injection needle;

a support mechanism configured to be fixed to the contact head; and

20 a content injection control mechanism configured to push the plunger into the injection cylinder,

wherein the movable holder moving along the support mechanism moves the injection cylinder and the
25 injection needle with respect to the contact head, and

wherein the syringe is attachable to and detachable from the injection device.

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2. The injection device as claimed in claim 1,
~~wherein the content injection control mechanism includes~~

a pressing part configured to push the plunger into the injection cylinder,

wherein the movable holder moving in a forward direction approaching the contact head causes the needle tube to puncture the test object and to enter an inside
5 of the test object,

wherein the movable holder moving in a backward direction away from the contact head causes the needle tube to move backward with respect to the test
10 object, and causes the movable holder to approach the pressing part and to push the plunger into the injection cylinder to inject the content into the test object.

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3. The injection device as claimed in claim 2, wherein the injection cylinder includes an outer cylinder part to contain the content, and a flange provided at a
20 rear end of the outer cylinder part,

wherein the movable holder includes a flange fitting portion to hold the flange by engagement, and the flange fitting portion restricts a movement of the flange in the backward direction with respect to the movable
25 holder.

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4. The injection device as claimed in claim 3, wherein the movable holder includes an outer cylinder part holding portion to sandwich and hold the outer
cylinder part by protrusions standing along both sides of

a side portion of the outer cylinder part, and the outer cylinder part holding portion restricts displacement of the outer cylinder part in a sideward direction with respect to the movable holder.

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5. The injection device as claimed in claim 2,
10 wherein the movable holder includes a needle base stopper to stop a movement of the injection needle by a protrusion to contact a vicinity of a front end of the needle base so as to hold the needle base, and the needle base stopper restricts a movement of the needle base in
15 the forward direction with respect to the movable holder.

20 6. The injection device as claimed in claim 2, wherein the movable holder includes a circumferential surface holding portion to hold the needle base in a circumferential shape, and the circumferential surface holding portion restricts displacement of the needle base
25 in a sideward direction with respect to the movable holder.

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7. The injection device as claimed in claim 2,
wherein the content injection control mechanism includes
~~a guide rod movably engaged with the movable~~

holder and the pressing part,

an interlocking rod fastened to the movable holder and movably engaged with the pressing part, and

a connecting rod that extends on a same

5 straight line as the interlocking rod, and has a rear end facing a front end of the interlocking rod, wherein the rear end is capable of coming into contact with or being separated from the front end of the interlocking rod and is located inside the movable holder.

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8. The injection device as claimed in claim 7,
15 wherein each of the interlocking rod and the guide rod has an engaging rack with inclination on a part of a circumferential surface that is allowed to face the pressing part,

wherein the pressing part includes a pawl to
20 engage with the engaging rack of the interlocking rod and the guide rod, and

wherein the pressing part constitutes a ratchet mechanism that is movable relative to the interlocking rod and the guide rod in a direction in
25 which the plunger is pushed into the injection cylinder to approach the movable holder, and is locked to be immovable in a direction away from the movable holder.

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9. The injection device as claimed in claim 7,

~~wherein first elastic members are provided in the movable~~

holder,

wherein the movable holder includes a movement support portion in which a first through hole through which the guide rod slidably passes is formed, and a
5 second through hole through which the connecting rod is slidably inserted at a front end, and the interlocking rod is fastened to a rear end on a same straight line as the front end, is formed,

wherein when the movable holder moves in the
10 forward direction approaching the contact head, respective compressive forces are applied to the first elastic members from the guide rod and the connecting rod with respect to the first elastic members; and

wherein restoring forces of the first elastic
15 members move the movable holder in a direction away from the support mechanism.

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10. The injection device as claimed in claim 9, wherein a spring holding member protruding from an inner wall of each of the first through hole and the second through hole is provided on the inner wall,

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wherein each of the guide rod and the connecting rod provides a small diameter portion and a large diameter portion, the small diameter portion is located around a center of the movable holder in an extending direction of the guide rod and the connecting
30 rod, and the large diameter portion is located on a front end side of the movable holder, and

wherein each of the first elastic members has
a front end held by a side surface of the guide rod or

the connecting rod located where a diameter is reduced from the large diameter portion to the small diameter portion, and has a rear end held by the spring holding member.

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11. The injection device as claimed in claim 10, wherein a side wall on a rear end side of the support mechanism has an opening into which a part of the movable holder is inserted, has a front end of the guide rod and a front end of the connecting rod fixed,

15 wherein when the movable holder moves in the forward direction approaching the contact head, the side wall of the supporting mechanism coming into contact with the part of the movable holder stops the movement of the movable holder in the forward direction approaching the contact head, and

20 wherein when the restoring forces of the first elastic members move the movable holder in the backward direction away from the contact head, the content is injected into the test object, and simultaneously, the needle tube is moved backward from a desired depth to a
25 surface of the test object to pull out the needle tube.

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12. The injection device as claimed in claim 11, wherein the support mechanism includes a cover to cover at least the injection needle and a portion of the movable holder to hold the injection needle on a top side

and lateral sides in a circumferential direction, and the movable holder is inserted inside the support mechanism.

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13. The injection device as claimed in claim 2, further comprising:

10 a control mechanism of pulling out the needle tube,

wherein the content injection control mechanism controls a first stage of a needle-tube backing operation to move the needle tube backward to a desired position with respect to the test object, and to have the
15 movable holder approach the pressing part so as to push the plunger into the injection cylinder to inject the content into the test object, and

wherein the content injection control mechanism controls a second stage of the needle-tube
20 backing operation to move the needle tube backward from the predetermined position to at least a surface of the test object without injecting the content into the test object, so as to pull out the needle tube.

25

14. The injection device as claimed in claim 13, wherein the control mechanism of pulling out the
30 needle tube includes a control plate that includes a top plate to cover at least a part of an upper surface of the support mechanism, and a side plate to cover a side wall on a rear end side distant from the contact head, and

includes

two position adjustment pins having a large-diameter head portion and inserted into the side plate of the control plate,

5 second elastic members provided to be fitted on outsides of the position adjustment pins, and to contact the side plate of the control plate and the support mechanism, and

10 two elastic pins provided on the upper surface of the support mechanism, wherein each of the two elastic pins has one end held on a side surface of a part of the circumferential surface holding portion of the movable holder, and extends in a substantially vertical direction with respect to the injection cylinder,

15 wherein the support mechanism includes the upper surface and a side surface, and has a guide path formed for guiding a movement of the movable holder,

wherein on the upper surface of the support mechanism, two grooves to which the elastic pins are
20 fitted are formed, respectively, and

wherein on the side surface of the support mechanism, the position adjustment pins to which the second elastic members are fitted outside are inserted, and an insertion hole as an entrance of the guide path is
25 formed.

30 15. The injection device as claimed in claim 14, wherein the content injection control mechanism includes:

~~a guide rod movably engaged with the movable~~

holder and the pressing part,

an interlocking rod fastened to the movable holder and movably engaged with the pressing part, and

a connecting rod that extends on a same
5 straight line as the interlocking rod, has a rear end facing a front end of the interlocking rod, wherein the rear end is capable of coming into contact with or being separated from the front end of the interlocking rod and is located inside the movable holder,

10 wherein a side wall on the rear end side of the support mechanism has an opening into which a part of the movable holder is inserted,

wherein the side plate of the control plate has an opening into which the part of the movable holder
15 is inserted, and a front end of the guide rod and a front end of the connecting rod are fixed in the opening,

wherein when the movable holder moves in the forward direction approaching the contact head, after the side plate of the control plate has come into contact
20 with the part of the movable holder, the side plate of the control plate contacting the side surface of the support mechanism stops the movement of the movable holder in the forward direction approaching the contact head,

25 wherein in the first stage of the needle-tube backing operation, in a state where the side plate of the control plate is in contact with the side surface of the support mechanism, while the movable holder approaches the pressing part, the movable holder moves in the
30 backward direction,

wherein in the second stage of the needle-tube backing operation, the side plate of the control plate moves away from the side surface of the support mechanism,

and while the movable holder keeps a predetermined distance from the pressing part, the movable holder moves in the backward direction.

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16. The injection device as claimed in claim 15, wherein in the control mechanism of pulling out the needle tube, first elastic members are provided in the movable holder,

wherein when the movable holder moves by a predetermined distance in the direction approaching the contact head, with respect to the first elastic members, respective compressive forces are applied from the guide rod and the connecting rod to the first elastic members provided inside the movable holder, and then,

the elastic pins move together with the movable holder in the direction approaching the contact head, and reach a predetermined position to be engaged with the grooves, and then,

in a state where the elastic pins are fitted in the grooves of the support mechanism, the position adjustment pins and the control plate move in the direction toward the contact head, and compressive forces are applied to the second elastic members.

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17. The injection device as claimed in claim 16, wherein when a force in the direction toward the

~~contact head is no longer applied to the movable holder,~~

as a first step, the positions of the position adjustment pins and the elastic pins remain unchanged owing to the restoring forces of the first elastic members, and the movable holder moving in a direction
5 away from the support mechanism and approaching the pressing part causes the content to be injected into the test object, and causes the needle tube to move backward from a desired depth to a predetermined position,

as a second step, when the elastic pins are
10 disengaged, and the positions of the position adjustment pins and the control plate are moved, the restoring forces of the second elastic members move the movable holder and the pressing part fitted to the guide rod, and thereby, the needle tube is moved backward from a desired
15 depth to a predetermined position.

20 18. The injection device as claimed in claim 1, wherein a lower surface of the contact head is configured such that a surrounding surface of the opening is positioned inward relative to a rest of the lower surface, and when injecting the content into the test object, the
25 lower surface is partially in contact with the test object, and the surrounding surface of the opening part does not contact the test object.

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19. The injection device as claimed in claim
~~18, wherein a protrusion protruding in a surface~~

direction of the lower surface is formed continuously or discontinuously on an edge of the lower surface of the contact head, and an upper surface of the protrusion comes into contact with the test object as if to surround
5 the opening.

10 20. The injection device as claimed in claim 18, wherein before starting a needling operation and after having completed a needle-pulling-out operation, a tip of the needle tube is positioned higher than a portion of the lower surface of the contact head
15 contacting the test object.

20 21. The injection device as claimed in claim 1, wherein with respect to the lower surface of the contact head, the opening of the contact head penetrates in bifurcating directions of a direction in which the needle tube passes along with the movement of the movable holder,
25 and a vertical direction of the contact head,

 wherein on the upper surface of the contact head, the opening has an elongated hole shape that is open and elongated from a position corresponding to the injection point toward the support mechanism.

22. The injection device as claimed in claim 1, wherein the support mechanism is provided with a movement guide rail having a circumferential shape to slidably support at least a part of the movable holder.

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23. The injection device as claimed in claim 10 22, wherein a lower part of the movement guide rail of the support mechanism is open to prevent a contact of the needle tube when attaching or detaching the syringe, wherein on the lower surface of the contact head, a cut shape is provided as the opening in a 15 direction in which the needle tube passes along with the movement of the movable holder, from a portion penetrating in the vertical direction toward the support mechanism to reach an edge of the lower surface of the contact head.

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CLAIMS

1. An injection device to inject a content into a test object by a syringe that includes a plunger, an injection cylinder into which the plunger is inserted, and an injection needle including a needle base connected to the injection cylinder and a needle tube to be punctured into the test object, the injection device comprising:
 - a contact head configured to contact the test object and to have an opening formed through which the needle tube passes;
 - a movable holder configured to hold the injection cylinder and the injection needle;
 - a support mechanism configured to be fixed to the contact head; and
 - a content injection control mechanism configured to push the plunger into the injection cylinder,
- wherein the movable holder moving along the support mechanism moves the injection cylinder and the injection needle with respect to the contact head,
- wherein the syringe is attachable to and detachable from the injection device,
- wherein the content injection control mechanism includes a pressing part configured to push the plunger into the injection cylinder,
- wherein the movable holder moving in a forward direction approaching the contact head causes the needle tube to puncture the test object and to enter an inside of the test object,
- wherein the movable holder moving in a backward direction away from the contact head causes the needle tube to move backward with respect to the test object, and causes the movable holder to approach the pressing part and to push the plunger into the injection cylinder to inject the content into the test object,
- wherein the injection cylinder includes an outer cylinder part to contain the content, and a flange provided at a rear end of the outer cylinder part,
- wherein at an upper part of the movable holder is provided with a flange fitting portion to hold the flange and to restrict a movement of the flange in the backward direction with respect to the movable holder, and

an outer cylinder part holding portion to restrict displacement of the outer cylinder part in a sideward direction with respect to the movable holder,

wherein the flange fitting portion holds, in a front-end direction and in a rear-end direction, a part extending in the sideward direction from the outer cylinder part,

wherein the outer cylinder part holding portion has linear protrusions standing on an upper surface of the movable holder, to sandwich and hold the outer cylinder part, and

wherein the outer cylinder part holding portion and the flange fitting portion are open upward, and a central part and a lower part of the flange fitting portion are open, the central part and the lower part corresponding to a part of the outer cylinder part in the rear-end direction.

2. The injection device as claimed in claim 1, wherein on the upper surface of the movable holder, a plane portion is provided in which the protrusion is partially discontinuous at a part not including a front end and a rear end of the protrusion of the outer cylinder part holding portion.

3. The injection device as claimed in claim 1 or 2, wherein the movable holder includes a needle base stopper to stop a movement of the injection needle by a protrusion to contact a vicinity of a front end of the needle base so as to hold the needle base, and the needle base stopper restricts a movement of the needle base in the forward direction with respect to the movable holder.

4. The injection device as claimed in any one of claims 1 to 3, wherein the movable holder includes a circumferential surface holding portion to hold the needle base in a circumferential shape, and the circumferential surface holding portion restricts displacement of the needle base in a sideward direction with respect to the movable holder.

5. The injection device as claimed in claim 1 or 2, wherein the flange is a flange having a wing-like part extending in two directions,

wherein the flange fitting portion has a pair of U-shaped parts to hold the flange in a lateral direction and in a front-back direction by holding the wing-like extending part of the flange in a state of being virtually parallel with the upper surface of the movable holder, and

wherein when attaching the syringe to the injection device, in a state where the wing-like extending part of the flange is shifted to be virtually orthogonal to the upper surface of the movable holder, after the flange being pressed from a rear of an interval at an inside edge of a surface at the rear end of the flange fitting portion moves the injection cylinder in a forward direction on the movable holder along the outer cylinder part holding portion, the injection cylinder is rotated on the movable holder so as to have the wing-like extending part of the flange engaged with the flange fitting portion.

6. The injection device as claimed in any one of claims 1 to 5, wherein the content injection control mechanism includes

a guide rod movably engaged with the movable holder and the pressing part,

an interlocking rod fastened to the movable holder and movably engaged with the pressing part, and

a connecting rod that extends on a same straight line as the interlocking rod, and has a rear end facing a front end of the interlocking rod, wherein the rear end is capable of coming into contact with or being separated from the front end of the interlocking rod and is located inside the movable holder.

7. The injection device as claimed in claim 6, wherein each of the interlocking rod and the guide rod has an engaging rack with inclination on a part of a circumferential surface that is allowed to face the pressing part,

wherein the pressing part includes a pawl to engage with the engaging rack of the interlocking rod and the guide rod, and

wherein the pressing part constitutes a ratchet mechanism that is movable relative to the interlocking rod and the guide rod in a direction in which the plunger is pushed into the injection cylinder to

approach the movable holder, and is locked to be immovable in a direction away from the movable holder.

8. The injection device as claimed in claim 6 or 7, wherein first elastic members are provided in the movable holder,

wherein the movable holder includes a movement support portion in which a first through hole through which the guide rod slidably passes is formed, and a second through hole through which the connecting rod is slidably inserted at a front end, and the interlocking rod is fastened to a rear end on a same straight line as the front end, is formed,

wherein when the movable holder moves in the forward direction approaching the contact head, respective compressive forces are applied to the first elastic members from the guide rod and the connecting rod with respect to the first elastic members; and

wherein restoring forces of the first elastic members move the movable holder in a direction away from the support mechanism.

9. The injection device as claimed in claim 8, wherein a spring holding member protruding from an inner wall of each of the first through hole and the second through hole is provided on the inner wall,

wherein each of the guide rod and the connecting rod provides a small diameter portion and a large diameter portion, the small diameter portion is located around a center of the movable holder in an extending direction of the guide rod and the connecting rod, and the large diameter portion is located on a front end side of the movable holder, and

wherein each of the first elastic members has a front end held by a side surface of the guide rod or the connecting rod located where a diameter is reduced from the large diameter portion to the small diameter portion, and has a rear end held by the spring holding member.

10. The injection device as claimed in claim 9, wherein a side wall on a rear end side of the support mechanism has an opening into which a part of the movable holder is inserted, has a front end of the guide rod and a front end of the connecting rod fixed,

wherein when the movable holder moves in the forward direction approaching the contact head, the side wall of the supporting mechanism coming into contact with the part of the movable holder stops the movement of the movable holder in the forward direction approaching the contact head, and

wherein when the restoring forces of the first elastic members move the movable holder in the backward direction away from the contact head, the content is injected into the test object, and simultaneously, the needle tube is moved backward from a desired depth to a surface of the test object to pull out the needle tube.

11. The injection device as claimed in claim 10, wherein the support mechanism includes a cover to cover at least the injection needle and a portion of the movable holder to hold the injection needle on a top side and lateral sides in a circumferential direction, and the movable holder is inserted inside the support mechanism.

12. The injection device as claimed in any one of claims 1 to 11, wherein a part close to an edge of the lower surface of the contact head is formed to continuously or discontinuously protrude in a surface direction of the lower surface with respect to a surface of surroundings of the opening part, and

wherein when injecting the content into the test object, the part close to the edge formed to continuously or discontinuously protrude contacts the test object so as to enclose the surroundings of the opening part, and the surroundings of the opening part do not contact the test object.

13. The injection device as claimed in claim 12, wherein the lower surface of the contact head has virtually a circular shape, and the part close to the edge formed to continuously or discontinuously protrude has virtually a ring shape.

14. The injection device as claimed in any one of claims 1 to

13, wherein before starting a needling operation and after having completed a needle-pulling-out operation, a tip of the needle tube is positioned higher than a portion of the lower surface of the contact head contacting the test object.

15. The injection device as claimed in any one of claims 1 to 14, wherein with respect to the lower surface of the contact head, the opening of the contact head penetrates in bifurcating directions of a direction in which the needle tube passes along with the movement of the movable holder, and a vertical direction of the contact head, wherein on the upper surface of the contact head, the opening has an elongated hole shape that is open and elongated from a position corresponding to the injection point toward the support mechanism.

16. The injection device as claimed in any one of claims 1 to 15, wherein the support mechanism is provided with a movement guide rail having a circumferential shape to slidably support at least a part of the movable holder.

17. The injection device as claimed in claim 16, wherein a lower part of the movement guide rail of the support mechanism is open to prevent a contact of the needle tube when attaching or detaching the syringe,

wherein on the lower surface of the contact head, a cut shape is provided as the opening in a direction in which the needle tube passes along with the movement of the movable holder, from a portion penetrating in the vertical direction toward the support mechanism to reach an edge of the lower surface of the contact head.