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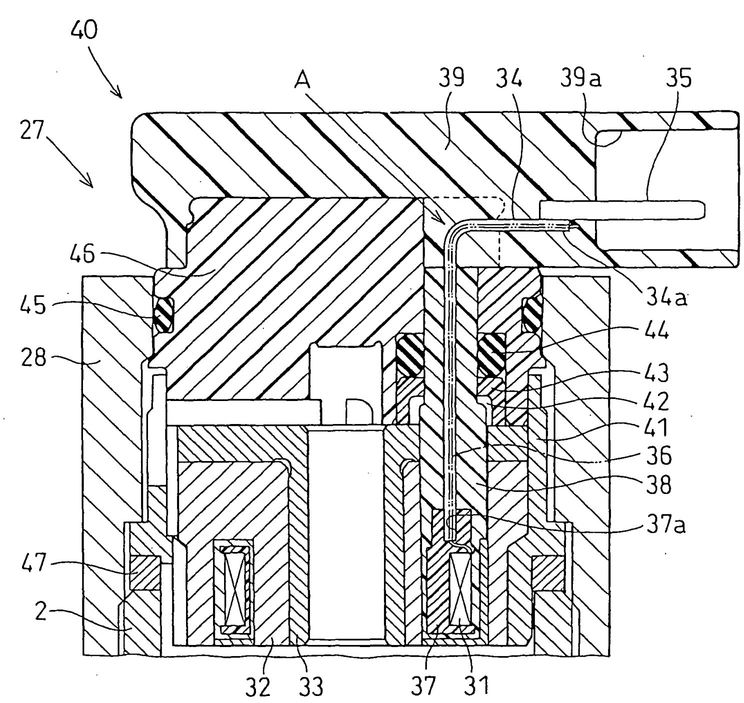
(54) **Coil device, method of manufacturing the same and fuel injection valve**

(57) A wire (36) is drawn outside of a coil (31), and is passed through a whole length of a pipe-shaped terminal (34). A tip end (34a) of the pipe-shaped terminal (34) is crimped, so that an insulating coating of a wire (36) can be broken, and the tip end (34a) of the pipe-shaped terminal (34) is electrically connected with the wire (36). The tip end (34a) of the pipe-shaped terminal (34) is once welded with the external terminal (35). Thereby, the wire (36), a pipe-shaped terminal (34), and an external terminal (35) can be electrically connected, and are steadily joined together. Thus, it is possible to reduce joining of the wire (36) in the vicinity of the coil (31), so that productivity can be enhanced. Besides, a region of joining is distant from the coil (31), so that heat generated at the time of welding is hard to be conducted to the coil (31).

FIG. 2



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Description

[0001] The present invention relates to a coil device, a method of manufacturing the coil device, and a fuel injection valve. More particular, the present invention relates to a method of electric connection between a coil and an external terminal in the coil device.

[0002] With conventional coil devices according to JP-A-5-38583, a coil is electrically and mechanically connected with a terminal for external connection (external terminal) via an intermediate terminal (intermediate conductive part). A wire of a coil is joined with one end of the intermediate terminal in the vicinity of the coil. Thereafter, the other end of the intermediate terminal is joined with the external terminal.

[0003] Conventionally, a short wire is partially drawn outside of a coil, and an intermediate terminal is joined with the short wire. However, the wire, which is partially drawn outside of the coil, is short. Accordingly, it is not easy to peel an insulating coating away from a portion of the wire, which is to be joined, prior to joining the wire with the intermediate terminal. Therefore, it is conventionally common to use a joining method, such as fusing welding, in which the insulating coating is melted and peeled off simultaneously with joining.

[0004] Besides, the wire, which is partially drawn outside of the coil, is short, and the coil is located in the vicinity of that portion of the wire, which is to be joined to the intermediate terminal. Accordingly, the joining work becomes difficult, and setting and control of joining conditions become difficult.

[0005] Besides, heat generated in the joining work is apt to be conducted to the coil, and the heat may likely affect the coil or a bobbin of the coil.

[0006] Further, a coil need to be assembled to a body device such as a solenoid of a solenoid valve, after the wire of the coil is joined with the intermediate terminal. Therefore, a concentrated load is apt to arise in an assembling process, and the concentrated load may be applied to the region, in which the wire of the coil is joined with the intermediate terminal. Besides, the concentrated load may be applied to the short wire drawn outside of the coil. Accordingly, the wire may be broken due to the concentrated load.

[0007] Conventionally, surface treatment is applied to an intermediate terminal using plating tin (Sn) or the like, in order to ensure the quality of joining and to ensure conductivity between a wire of a coil and an external terminal. As a result, the manufacturing cost of a coil device increases.

[0008] Conventionally, an intermediate terminal is located between a coil and an external terminal. Therefore, it is necessary to perform joining at both respective ends of the intermediate terminal. Accordingly, manhour for joining twice causes an increase in manufacturing cost of a coil device.

[0009] An intermediate terminal may be bent by 90° midway, so that an orientation of the intermediate terminal may be changed, in order to decrease the height of a body device such as a solenoid valve, on which a coil device is mounted, and to improve the quality of mount of the body device. However, a failure in conduction will be caused when the bent portion of the intermediate terminal is broken.

[0010] In view of the foregoing problems, it is an object of the present invention to produce a coil device that has a structure, in which joining work is capable of being reduced in the vicinity of a coil. It is another object of the present invention to produce a method of manufacturing the coil device. It is another object of the present invention to produce a fuel injection valve.

[0011] According to the present invention, a coil device includes a coil, a pipe-shaped terminal, and an external terminal. The coil includes a wire provided with an electrically insulating coating. The wire is wound in the coil. The wire has a start portion and an end portion that are drawn outside of the coil. The start portion of the wire and the end portion of the wire are inserted into a pipe-shaped terminal. The start portion of the wire and the end portion of the wire are electrically connected with the pipe-shaped terminal on a side that is different from the side of the coil. The external terminal is conductive. The external terminal is electrically connected with the pipe-shaped terminal for external connection.

[0012] The coil includes a bobbin. The wire is wound around the bobbin. The pipe-shaped terminal has one end that is inserted into the bobbin.

[0013] The pipe-shaped terminal is arranged in a bent state. The start portion of the wire and the end portion of the wire are electrically connected with the pipe-shaped terminal on a substantially opposite side of the coil with respect to a location, in which the pipe-shaped terminal is in the bent state. Specifically, the start portion of the wire and the end portion of the wire are crimped with the pipe-shaped terminal on the substantially opposite side of the coil with respect to the location, in which the pipe-shaped terminal is in the bent state. Besides, the external terminal is welded with the pipe-shaped terminal on the substantially opposite side of the coil with respect to the location, in which the pipe-shaped terminal is in the bent state.

[0014] The wire is equal to 0.5 mm or less in diameter.

[0015] A fuel injection valve defines a pressure control chamber connected with an inflow passage, through which the pressure control chamber is supplied with high-pressure fuel. The pressure control chamber defines a discharge passage, through which high-pressure fuel in the pressure control chamber is discharged. The fuel injection valve includes a valve, a spring, a needle, a nozzle body, and a solenoid valve.

[0016] The valve is capable of opening and closing the discharge passage to control pressure in the pressure control chamber. The spring biases the valve in a direction in which the valve closes the discharge passage. The needle displaces in accordance with pressure in the pressure control chamber. The nozzle body defines a fuel jet nozzle. The fuel jet nozzle is opened and closed by the needle. The solenoid valve is capable of attracting the valve with magnetomotive force to open the discharge passage. The solenoid valve is provided with the coil device.

[0017] A method of manufacturing the coil device includes following processes.

[0018] The pipe-shaped terminal is electrically connected with the external terminal after the wire drawn outside of the coil is inserted into the pipe-shaped terminal.

[0019] The pipe-shaped terminal has a substantially C-shaped cross section. The wire drawn outside of the coil is inserted into the pipe-shaped terminal through the substantially C-shaped gap.

[0020] A region, into which the wire is inserted, is at least partially crimped after the wire drawn outside of the coil is inserted into the pipe-shaped terminal.

[0021] An end of the pipe-shaped terminal is welded with the external terminal while the end of the pipe-shaped terminal is pressed against the external terminal, after the wire drawn outside of the coil is inserted into a whole region of the pipe-shaped terminal.

[0022] The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:

FIG. 1 is a cross sectional view showing a fuel injection valve according to a first embodiment of the present invention; and

FIG. 2 is a cross sectional view showing a solenoid mounted on the fuel injection valve according to the first embodiment.

(First Embodiment)

[0023] A coil device 40 is applied to a solenoid of a fuel injection valve (injector) for jetting and supplying fuel to respective cylinders of an internal combustion engine.

[0024] A shown in FIG. 1, a fuel injection valve 1 is used in a pressure-accumulating type fuel injection device for diesel engines. The fuel injection valve 1 jets high-pressure fuel supplied from a common rail (not shown) to a combustion chamber of the engine, for example.

[0025] The fuel injection valve 1 includes a nozzle (described later), a lower body 2, a control piston 3, an orifice plate 4, a solenoid valve 5, and the like.

[0026] The nozzle includes a nozzle body 6 having a jet nozzle 6a at a tip end thereof, and a needle 7 inserted slidably into the nozzle body 6. The nozzle is clamped to a lower portion of the lower body 2 by a retaining nut 8.

[0027] A cylinder 9, a fuel passage 11, a fuel passage 12, a low-pressure passage 13, and the like are formed in the lower body 2. The control piston 3 is inserted into the cylinder 9. High-pressure fuel supplied from the common rail is conducted to the nozzle through the fuel passage 11. The high-pressure fuel is conducted to the orifice plate through the fuel passage 12. The high-pressure fuel is discharged to a low-pressure side through the low-pressure passage 13.

[0028] The control piston 3 is inserted slidably into the cylinder 9 of the lower body 2, and is connected to the needle 7 through a tip end 3a thereof.

[0029] A pressure rod 14 is arranged around a connection between the control piston 3 and the needle 7. The pressure rod 14 is biased by a spring 15, which is connected to the top of the pressure rod 14, to push the needle 7 downward, in which the fuel injection valve 1 is closed.

[0030] The orifice plate 4 is arranged on an end surface of the lower body 2, which is opened to the upper end of the cylinder 9, to form a pressure control chamber 16 communicated to the cylinder 9.

[0031] The orifice plate 4 is provided with an inlet orifice 17 and an outlet orifice 18. The inlet orifice 17 is arranged on the upstream side, and the outlet orifice 18 is arranged on the downstream side of the pressure control chamber 16.

[0032] The inlet orifice (inflow passage) 17 is provided in an inflow passage. High-pressure fuel is supplied from the fuel passage 12 to the pressure control chamber 16 through the inflow passage. The outlet orifice 18 is formed above the pressure control chamber 16, and is provided in a discharge passage, through which the fuel in the pressure control chamber 16 is discharged toward a low-pressure side of the solenoid valve 5. The discharge passage is formed in the outlet orifice 18.

[0033] The solenoid valve 5 opens and closes the outlet orifice 18 (discharge passage). The solenoid valve 5 accommodates a ball valve 23, a moving valve (armature) 24, a valve body 25, a spring 26, a solenoid 27, and the like. The ball valve 23 is mounted at a lower end of the moving valve 24. The valve body 25 holds the moving valve 24 slidably in a vertical direction. The valve body 25 positions the orifice plate 4 at the top of the lower body 2. The spring 26 biases the moving valve 24 downward in a direction in which the fuel injection valve 1 is closed. The solenoid 27 operates the moving valve 24 upward in a direction in which the fuel injection valve 1 is opened.

[0034] The solenoid valve is assembled to the top of the lower body 2, and fixedly joined to the top of the lower body 2 by an upper body 28.

[0035] As shown in FIG. 2, the solenoid 27 includes a coil device 40 provided with a coil 31, a stator core 32, and a stopper 33. The coil 31 generates magnetomotive force by energization. The stator core 32 attracts the moving valve 24 with the magnetomotive force generated by the coil 31. The stopper 33 abuts against the moving valve 24 when the moving valve 24 is attracted, and sets an upper limit of lift of the moving valve 24. The stator core 32 and the stopper 33 construct a stator. The stator core 32 and the stopper 33 may be provided as a unitary body.

[0036] The moving valve 24 is integrally constructed of a disk magnetically attracted by the stator core 32 and a shaft axially slidably supported by the valve body 25.

[0037] As referred to FIG. 1, high-pressure is fuel supplied from the common rail to the fuel injection valve 1, and is introduced into both an internal passage 29 of the nozzle and the pressure control chamber 16.

[0038] When the coil 31 is put in an OFF state, the moving valve 24 is pushed downward by bias of the spring 26, so that the ball valve 23 is seated onto an upper surface of the orifice plate 4 in a manner to plug the outlet orifice 18. Thereby, the pressure control chamber 16 is maintained high in pressure. High pressure in the pressure control chamber 16 is applied onto the needle 7 through the control piston 3, and cooperates with the spring 15 to strongly bias the needle 7 downward in the direction, in which the fuel injection valve 1 is closed.

[0039] On the contrary, the high-pressure fuel supplied to the internal passage 29 of the nozzle is applied onto a pressure-receiving surface of the needle 7 to exert force that pushes the needle 7 upward in the direction, in which the fuel injection valve 1 is opened. Pressure-receiving surface of the needle 7 serves as an effective seat area of the nozzle. However, when the ball valve 23 is put in a state to plug the outlet orifice 18, force pushing the needle 7 downward becomes dominant, so that the needle 7 does not lift but closes the jet nozzle 6a. Thereby, the fuel is not jetted through the jet nozzle 6a.

[0040] When the coil 31 is turned ON, the moving valve 24 is moved upward against the bias of the spring 26, so that the ball valve 23 lifts upward from the upper surface of the orifice plate 4. In this situation, the outlet orifice 18 is opened, and the outlet orifice 18 is put in communication with the low-pressure passage 13. Thereby, fuel in the pressure control chamber 16 passes through the outlet orifice 18 to be discharged from the low-pressure passage 13, so that pressure in the pressure control chamber 16 drops.

[0041] When pressure in the pressure control chamber 16 drops to a predetermined valve-opening pressure, force that upwardly pushes the needle 7 becomes dominant. Thereby, the needle 7 lifts to open the jet nozzle 6a, and fuel injection starts.

[0042] When the coil 31 is turned OFF, the moving valve 24 is pushed downward by bias of the spring 26, so that the ball valve 23 is seated onto the upper surface of the orifice plate 4 in a manner to plug the outlet orifice 18. Since the ball valve 23 plugs the outlet orifice 18, the fuel pressure in the pressure control chamber 16 rises again.

[0043] When pressure in the pressure control chamber 16 rises to a predetermined valve-closing pressure, force that downwardly pushes the needle 7 becomes dominant. Thereby, the needle 7 is pushed downward to close the jet nozzle 6a, and fuel injection is terminated.

[0044] A description will be given to the coil device 40. The coil device 40 includes a pipe-shaped terminal 34 and a terminal (external terminal) 35 for external connection, in addition to the coil 31.

[0045] The coil 31 is constructed of a wire 36, which is wound around a resin bobbin 37 for a large number of turns. An insulating coating is provided on the surface of the wire 36. The start of winding of the wire 36 and the end of winding of the wire 36 is drawn outside for a length corresponding to a length of the pipe-shaped terminal 34. The wire 36 constructing the coil 31 includes a thin wire having a diameter of 0.5 mm or less. Specifically, the thin wire has a diameter of 0.1 to 0.3 mm. The insulating coating is a resin film that is excellent in fuel resistance and is excellent in high-temperature resistance.

[0046] The pipe-shaped terminal 34 is a cylinder member, which is made of a thin metallic material such as copper, aluminum being excellent in conductivity and flexibility. The wire 36, which is drawn outside of the coil 31, passes through an interior of the pipe-shaped terminal 34. The wire 36 of the coil 31 is inserted throughout the whole length of the pipe-shaped terminal 34. An end of the pipe-shaped terminal 34 is inserted into a terminal insertion hole 37 formed in the bobbin 37.

[0047] The pipe-shaped terminal 34 is in a form of a thin metallic plate having a substantially C-shaped cross section, and a substantially C-shaped gap is formed in the pipe-shaped terminal 34 to be slightly larger than the diameter of the wire 36 of the coil 31, prior to insertion of the wire 36 of the coil 31 into the pipe-shaped terminal 34. After the wire 36 of the coil 31 is inserted into the pipe-shaped terminal 34 from the substantially C-shaped gap, the terminal is crimped over substantially the whole length of the pipe-shaped terminal 34 from the outside, so that the substantially C-shaped gap is closed.

[0048] The pipe-shaped terminal 34 is crimped over substantially the whole length thereof to close the substantially C-shaped gap in order to prevent a secondary mold resin 38 and a third mold resin 39 from entering into the pipe-shaped terminal 34, when the secondary mold resin 38 and the third mold resin 39 are molded around the pipe-shaped terminal 34. However, the substantially C-shaped gap may not be closed, when the secondary mold resin 38 and the third mold resin 39 are allowed to enter into the pipe-shaped terminal 34.

[0049] The pipe-shaped terminal 34 is electrically connected with the wire 36 of the coil 31, which is disposed in the pipe-shaped terminal 34, at least at a joint between the pipe-shaped terminal 34 and the external terminal 35, that is, at a tip end 34a of the pipe-shaped terminal 34.

[0050] The tip end 34a of the pipe-shaped terminal 34 and the external terminal 35 are mechanically and electrically connected to each other by welding. At the time of welding, the pipe-shaped terminal 34 and the external terminal 35 are strongly pressed against each other. Thereby, the tip end 34a of the pipe-shaped terminal 34 is mashed, so that the insulating coating of the wire 36 is broken in the mashed pipe-shaped terminal 34 to achieve electric connection of the wire 36 of the coil 31 with the pipe-shaped terminal 34.

[0051] The pipe-shaped terminal 34 is laterally bent by 90° at a predetermined midway height A in order to decrease the height of the solenoid valve 5 and in order to improve the quality of mount thereof. The pipe-shaped terminal 34 may be bent by 90°, prior to or after welding of the pipe-shaped terminal 34 with the external terminal 35.

[0052] A portion of the external terminal 35, which is joined to the pipe-shaped terminal 34, is molded into the third mold resin 39, so that the external terminal 35 is supported by the third mold resin 39. The external terminal 35 is supported at a bottom of a recess 39a. The recess 39a is formed in the third mold resin 39 to be directed in a direction, in which the connector is socketed. The recess 39a serves as a socket for a connector (not shown). The external terminal 35 is electrically connected to a terminal, which is held in the connector, by socketing the connector into the recess 39a.

[0053] Subsequently, a method of manufacturing the coil device 40 and an assembling method of the solenoid 27 are described.

[0054] The pipe-shaped terminal 34 having a substantially C-shaped cross section is inserted into a terminal insertion hole 37a of the bobbin 37 in a first process.

[0055] The wire 36 (thin wire) provided with the insulating coating is wound around the bobbin 37 for predetermined turns in a second process. In the second process, the start of winding of the coil 31 and the end of winding of the coil 31 are drawn outside of the coil 31 for at least a length corresponding to the length of the pipe-shaped terminal 34. The first process and the second process may be replaced in order.

[0056] The wire 36 drawn outside of the coil 31 is inserted into the pipe-shaped terminal 34 through the substantially C-shaped gap of the pipe-shaped terminal 34, such that the wire 36 of the coil 31 is placed in a whole region of the pipe-shaped terminal 34 in a third process.

[0057] The pipe-shaped terminal 34 is crimped over a whole length thereof to close the substantially C-shaped gap over a whole length thereof in a fourth process, so that resin is restricted from entering into the pipe-shaped terminal 34 when the secondary mold resin 38 is molded. When resin is allowed to enter into the pipe-shaped terminal 34, the fourth process (crimping process) may be reduced.

[0058] The secondary mold resin 38 is molded in a manner to mold the whole surfaces of the coil 31 including the bobbin 37 and the pipe-shaped terminal 34 on the side of the coil 31 in a fifth process. Thus, fluid such as fuel is restricted from intruding into the coil 31, and the coil 31 is mechanically protected.

[0059] The secondary mold resin 38 is assembled into other components of the solenoid 27 in a sixth process. A specific example of the sixth process is described.

[0060] The stator, which is constructed of the stator core 32 and the stopper 33, is assembled into a stator case 41. The secondary mold resin 38, in which the coil 31 and the like are molded, is assembled into the stator.

[0061] Subsequently, a resin bush 43 is provided to cover the secondary mold resin 38, which projects from the stator. A resin 42 is filled around the secondary mold resin 38 to restrict movement of the secondary mold resin 38. The resin 42 may be molded around a base of the secondary mold resin 38, and thereafter the resin bush 43 may be provided to cover the outer periphery of the secondary mold resin 38.

[0062] Subsequently, an O-ring 44 is mounted on the outer periphery of the secondary mold resin 38 to seal against fuel entering from a fuel path formed around the outer periphery of the secondary mold resin 38.

[0063] Subsequently, an O-ring 45 is mounted on the outer periphery of a plug housing 46, and the plug housing 46 is assembled to the secondary mold resin 38. An upper body (retaining nut) 28 is succeedingly mounted to the plug housing 46.

[0064] The pipe-shaped terminal 34 exposed outside the secondary mold resin 38 is bent outward by 90° at the predetermined height A in a seventh process.

[0065] The tip end 34a of the pipe-shaped terminal 34 is welded with the external terminal 35 in an eighth process.

[0066] When welding is carried out in the eighth process, the tip end 34a of the pipe-shaped terminal 34 is pressed against the external terminal 35. At this time, the pipe-shaped terminal 34 is mashed in a region between the tip end 34a and the external terminal 35 as pressed, so that the insulating coating of the wire 36 is broken in the mashed pipe-shaped terminal 34. Thereby, electric connection of the wire 36 with the tip end 34a of the pipe-shaped terminal 34 is produced. Besides, welding is performed in the region between the tip end 34a and the external terminal 35 as pressed in the state, in which the wire 36 is electrically connected with the tip end 34a. Thereby, the tip end 34a of the pipe-shaped terminal 34 is joined with the external terminal 35.

[0067] The seventh process and the eighth process may be replaced in order.

[0068] The third mold resin 39 is molded around an upper portion of the plug housing 46, an upper portion of the pipe-shaped connector, and the base of the external terminal 35 in a ninth process, in order to fix the external terminal 35, and to form the recess 39a, which is to be a socket for the connector.

[0069] The solenoid 27 of the solenoid valve 5 is manufactured as an assembly part through the first to the ninth processes.

[0070] The orifice plate 4, the valve body 25, the moving valve 24, and the like are assembled to the upper end of the lower body 2. The upper body 28 is screwed into the lower body 2 with a spacer 47 that is interposed between the stator case 41 and the lower body 2. The spacer 47 serves to adjust lift of the moving valve 24. Thus, assembly of the solenoid valve 5 is completed.

[0071] The electric connection from the coil 31 to the external terminal 35 is achieved only by inserting the wire 36, which is drawn outside of the coil 31, through the whole length of the pipe-shaped terminal 34, and by once welding the tip end 34a of the pipe-shaped terminal 34 with the external terminal 35.

[0072] Thereby, it is possible to reduce joining of the wire 36 in the vicinity of the coil 31. Conventionally, the joining of the wire 36 is difficult. Thereby, productivity is capable of being enhanced by reducing the joining of the wire 36.

[0073] Besides, a location, in which the wire 36 of the coil 31 and the pipe-shaped terminal 34 are joined together, and a location, in which the pipe-shaped terminal 34 and the external terminal 35 are joined together, are distant from the coil 31. Thereby, heat generated in the welding is not conducted to the coil 31 or the bobbin 37.

[0074] Further, welding in a single location (once) affords joining of the wire 36 with the pipe-shaped terminal 34 simultaneously with joining of the pipe-shaped terminal 34 with the external terminal 35. Thereby, it is possible to decrease manhour in assembly, and it is possible to reduce the manufacturing cost of the solenoid 27, so that the fuel injection valve 1 is decreased in cost.

[0075] In the above structure, one end of the pipe-shaped terminal 34 is inserted into the terminal insertion hole 37a of the bobbin 37, in which the pipe-shaped terminal 34 is supported by the bobbin 37. Thereby, no load is applied to the wire 36 between the coil 31 and the pipe-shaped terminal 34, even when load is applied to the coil 31 and the pipe-shaped terminal 34.

[0076] Therefore, a portion of the wire 36, which is located between the coil 31 and the pipe-shaped terminal 34, can be restricted from being broken in a process, in which the coil 31 is assembled to the solenoid 27 after the wire 36 of the coil 31 is inserted into the pipe-shaped terminal 34.

[0077] In the above structure, the pipe-shaped terminal 34 is bent by 90°. The pipe-shaped terminal 34 is made of a thin metallic plate to be excellent in flexibility, so that bending can be readily carried out, and productivity can be enhanced.

[0078] The pipe-shaped terminal 34 replaces a conventional intermediate terminal. The pipe-shaped terminal 34 is bent midway to be changed in orientation in order to decrease the height of the solenoid valve 5 (body device), on which a coil 31 is mounted, and in order to improve the quality of mount thereof.

[0079] Besides, the wire 36 and the pipe-shaped terminal 34 are electrically connected together on the opposite side of the coil 31 with respect to the location of bending. Thereby, it is possible to prevent a failure in conduction between the external terminal 35 and the coil 31, even when the bent portion of the pipe-shaped terminal 34, in which the pipe-shaped terminal 34 is bent by 90° midway, breaks under a severe working condition. Therefore, it is possible to provide the fuel injection valve 1 with high reliability.

[0080] In the above structure, the wire 36 drawn outside of the coil 31 is protected within the pipe-shaped terminal 34, so that breakage of the wire 36 outside the coil 31 is prevented, even the wire 36 is a thin wire having a diameter of 0.5 mm or less.

[0081] In the above structure, the pipe-shaped terminal 34 has a substantially C-shaped cross section, in a state prior to insertion of the wire 36 of the coil 31 into the pipe-shaped terminal 34. The wire 36 drawn outside of the coil 31 is inserted into the pipe-shaped terminal 34 from the substantially C-shaped gap. Thereby, the wire 36 of the coil 31 can be readily inserted into the pipe-shaped terminal 34, so that the quality of assembly can be improved.

[0082] The pipe-shaped terminal 34 is crimped, so that the insulating coating of the wire 36 in the crimped portion is broken to enable electric connection of the wire 36 with the pipe-shaped terminal 34. That is, electric connection of the wire 36 and the pipe-shaped terminal 34 can be achieved by easy crimping.

[0083] Electric connection of the wire 36, which is drawn outside of the coil 31, and the pipe-shaped terminal 34 may be performed simultaneously with joining the pipe-shaped terminal 34 with the external terminal 35. Alternatively, electric connection of the wire 36 and the pipe-shaped terminal 34 may be performed by crimping the pipe-shaped terminal 34 separately from joining the pipe-shaped terminal 34 with the external terminal 35.

(Modification)

[0084] In the above structure, the wire 36 drawn outside of the coil 31 is inserted throughout the pipe-shaped terminal 34, so that the electric connection from the coil 31 to the external terminal 35 is achieved by once welding of the tip end 34a of the pipe-shaped terminal 34 with the external terminal 35. However, an electric connection between the pipe-shaped terminal 34 and the wire 36 may be made further sure by crimping an intermediate portion of the pipe-shaped terminal 34 once or for multiple times to break the insulating coating of the wire 36.

[0085] Besides, an electric connection between the pipe-shaped terminal 34 and the wire 36 may be achieved by passing the wire 36, which is drawn outside of the coil 31, through an intermediate portion of the pipe-shaped terminal 34, and by crimping that portion of the pipe-shaped terminal 34, through which the wire 36 is passed, to break the insulating coating of the wire 36. In this structure, an electric connection from the coil 31 to the external terminal 35 cannot be achieved only by welding once. However, it is possible to reduce joining of the wire 36 in the vicinity of the coil 31, so that productivity is capable of being enhanced. Besides, an electric connection between the wire 36 and the pipe-shaped terminal 34 is achieved by crimping, so that heat is not conducted to the coil 31 or the bobbin 37.

[0086] As described above, the structure of the present invention is applied to the solenoid 27 of the fuel injection valve 1. However, the structure of the present invention may be applied to other valves such as valves for adjustment of a flow amount of fuel, valves for adjustment of a flow amount of oil, valves for adjustment of a flow amount of exhaust gas. Alternatively, the structure of the present invention can be applied to a coil device mounted on other electromagnetic actuators, such as an electric motor, than valves. Further, the structure of the present invention can be applied to coil devices, such as transducers, choke coils, other than actuators.

[0087] Various modifications and alternations may be diversely made to the above embodiments without departing from the spirit of the present invention.

[0088] A wire (36) is drawn outside of a coil (31), and is passed through a whole length of a pipe-shaped terminal (34). A tip end (34a) of the pipe-shaped terminal (34) is crimped, so that an insulating coating of a wire (36) can be broken, and the tip end (34a) of the pipe-shaped terminal (34) is electrically connected with the wire (36). The tip end (34a) of the pipe-shaped terminal (34) is once welded with the external terminal (35). Thereby, the wire (36), a pipe-shaped terminal (34), and an external terminal (35) can be electrically connected, and are steadily joined together. Thus, it is possible to reduce joining of the wire (36) in the vicinity of the coil (31), so that productivity can be enhanced. Besides, a region of joining is distant from the coil 31, so that heat generated at the time of welding is hard to be conducted to the coil 31.

Claims

1. A coil device (40) **characterized by** comprising:

    a coil (31) that includes a wire (36) provided with an electrically insulating coating, wherein the wire (36) is wound in the coil (31), wherein the wire (36) has a start portion and an end portion that are drawn outside of the coil (31);
    a pipe-shaped terminal (34), wherein the start portion of the wire (36) and the end portion of the wire (36) are inserted into the pipe-shaped terminal (34), wherein the start portion of the wire (36) and the end portion of the wire (36) are electrically connected with the pipe-shaped terminal (34) on a side that is different from a side of the coil (31); and
    an external terminal (35) that is conductive, wherein the external terminal (35) is electrically connected with the pipe-shaped terminal (34) for external connection.

2. The coil device (40) according to claim 1,
    wherein the coil includes a bobbin (37), wherein the wire (36) is wound around the bobbin (37), and
    the pipe-shaped terminal (34) has one end that is inserted into the bobbin (37).

3. The coil device (40) according to claim 1 or 2, wherein the pipe-shaped terminal (34) is arranged in a bent state.

4. The coil device (40) according to claim 3, wherein the start portion of the wire (36) and the end portion of the wire (36) are electrically connected with the pipe-shaped terminal (34) on a substantially opposite side of the coil (31) with respect to a location, in which the pipe-shaped terminal (34) is in the bent state.

5. The coil device (40) according to claim 3 or 4, wherein the start portion of the wire (36) and the end portion of the wire (36) are crimped with the pipe-shaped terminal (34) on a substantially opposite side of the coil (31) with respect to a location, in which the pipe-shaped terminal (34) is in the bent state.

6. The coil device (40) according to any one of claims 3 to 5, wherein the external terminal (35) is welded with the pipe-shaped terminal (34) on a substantially opposite side of the coil (31) with respect to a location, in which the pipe-shaped terminal (34) is in the bent state.

7. The coil device (40) according to any one of claims 1 to 6, wherein the wire (36) has a diameter that is equal to 0.5 mm or less.

8. A fuel injection valve (1) that defines a pressure control chamber (16) connected with an inflow passage (17) through which the pressure control chamber (16) is supplied with high-pressure fuel, the pressure control chamber (16) defining a discharge passage (18) through which high-pressure fuel in the pressure control chamber (16) is discharged, the fuel injection valve (1) **characterized by** comprising:

    a valve (23, 24) that is capable of opening and closing the discharge passage (18) to control pressure in the pressure control chamber (16);
    a spring (26) that biases the valve (23, 24) in a direction in which the valve (23, 24) closes the discharge passage (18);
    a needle (7) that displaces in accordance with pressure in the pressure control chamber (16);

a nozzle body (6) that defines a fuel jet nozzle (6a), the fuel jet nozzle (6a) being opened and closed by the needle (7); and
a solenoid valve (5) that attracts the valve (23, 24) with magnetomotive force to open the discharge passage (18), the solenoid valve (5) being provided with the coil device (40) according to any one of claims 1 to 7.

9. A method of manufacturing the coil device (40) according to any one of claims 1 to 8, **characterized by** comprising the step of:

electrically connecting the pipe-shaped terminal (34) with the external terminal (35) after the wire (36) drawn outside of the coil (31) is inserted into the pipe-shaped terminal (34).

10. The method of manufacturing the coil device (40) according to claim 9, wherein the pipe-shaped terminal (34) has a substantially C-shaped cross section,

the method of manufacturing the coil device (40), **characterized by** further comprising the step of:

inserting the wire (36) drawn outside of the coil (31) into the pipe-shaped terminal (34) through the substantially C-shaped gap.

11. The method of manufacturing the coil device (40) according to claim 9 or 10, **characterized by** further comprising the step of:

crimping at least partially the pipe-shaped terminal (34), into which the wire (36) is inserted, after the wire (36) drawn outside of the coil (31) is inserted into the pipe-shaped terminal (34).

12. The method of manufacturing the coil device (40) according to any one of claims 9 to 11, **characterized by** further comprising the step of:

welding an end of the pipe-shaped terminal (34) with the external terminal (35), while the end of the pipe-shaped terminal (34) is pressed against the external terminal (35), after the wire (36) drawn outside of the coil (31) is inserted into a whole region of the pipe-shaped terminal (34).

FIG. 1

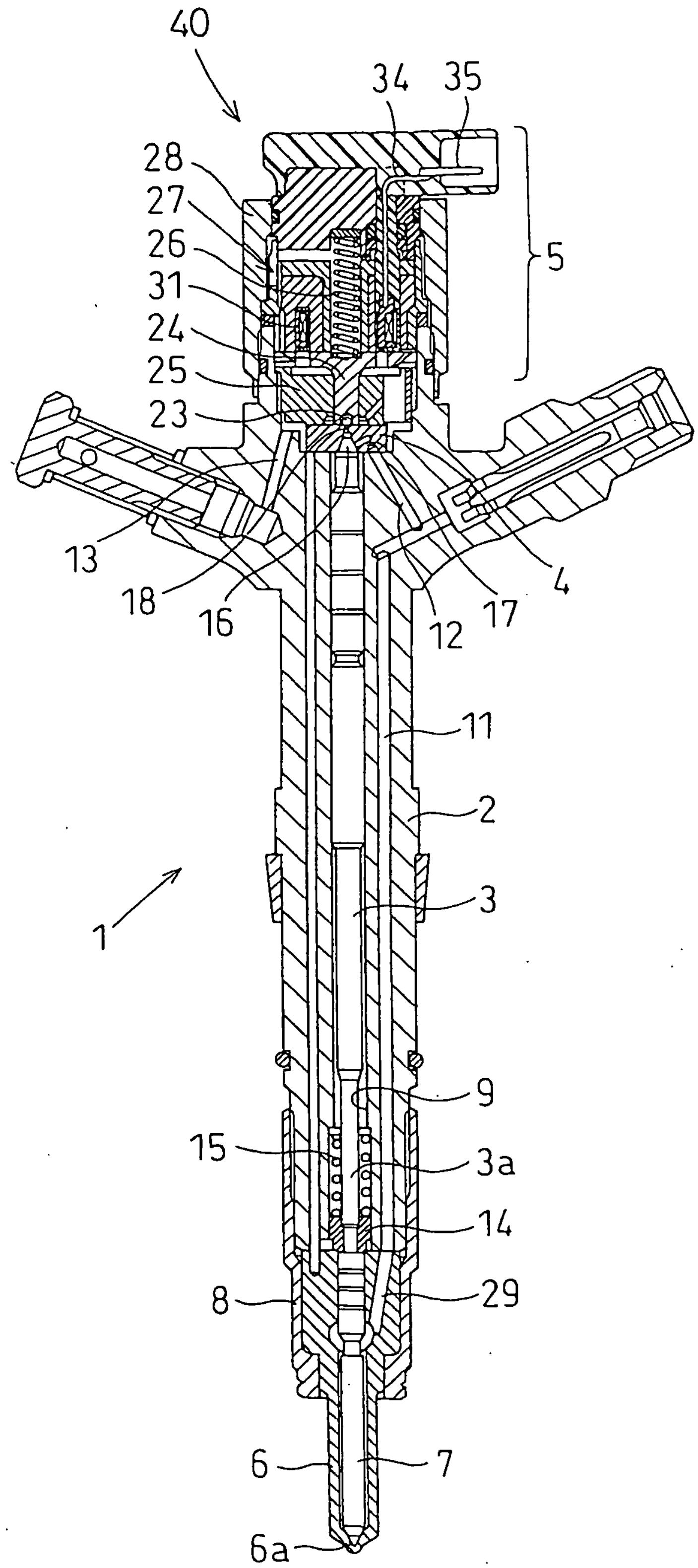
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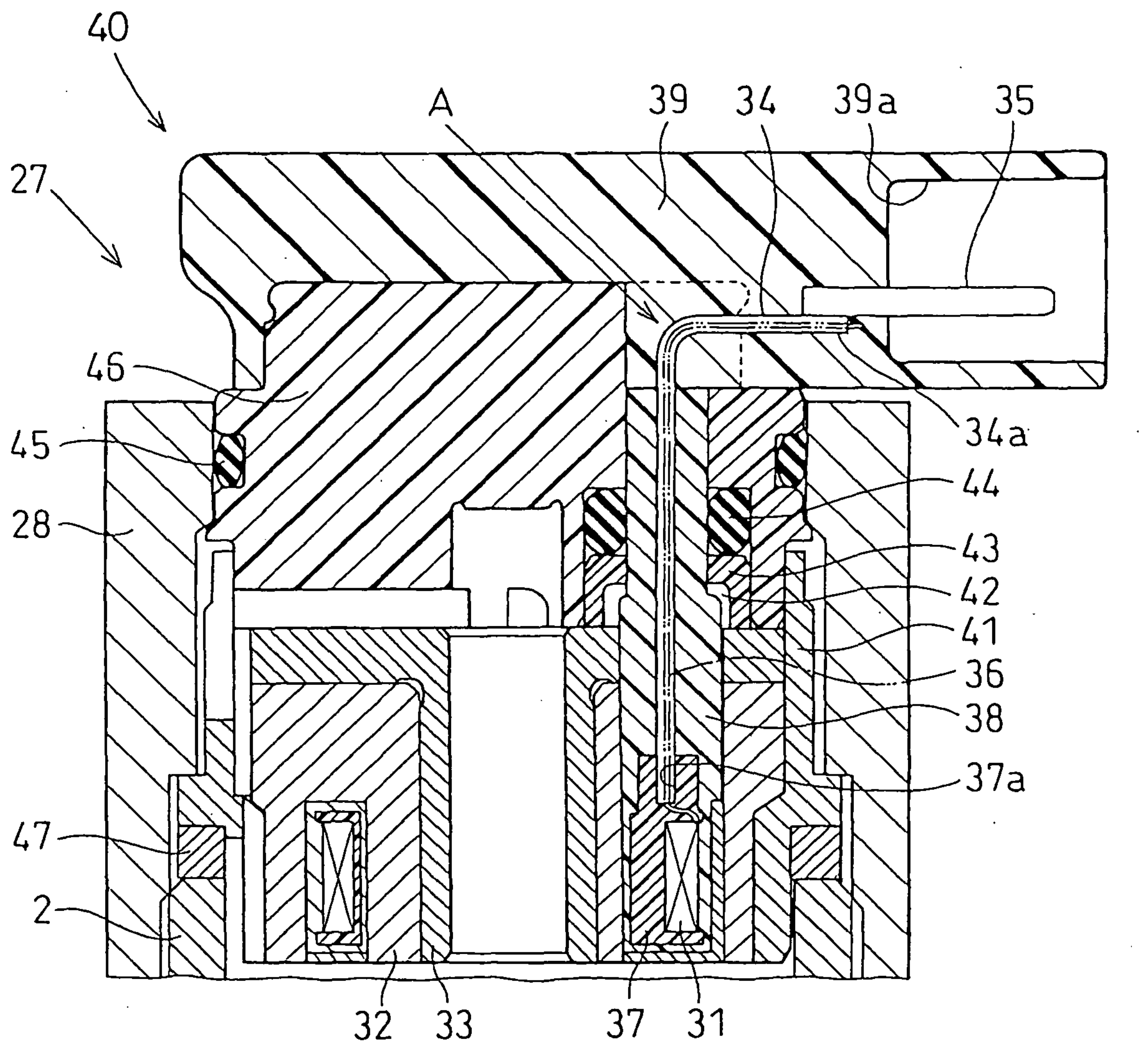
FIG. 2



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EUROPEAN SEARCH REPORT

Application Number
EP 05 00 5904

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	GB 2 212 982 A (* WEBER S R L) 2 August 1989 (1989-08-02) * the whole document *	1,2,9,12 7,8	F02M63/02 F02M47/02 F02M51/00 F02M51/06 F02M59/46 H01F41/04 H01F5/04 H01F5/06 F02M61/16
Y	EP 0 890 730 A (ELASIS SISTEMA RICERCA FIAT NEL MEZZOGIORNO SOCIETA CONSORTILE PER AZI) 13 January 1999 (1999-01-13) * figure 1 *	8	
Y A	EP 1 270 926 A (HITACHI, LTD; HITACHI CAR ENGINEERING CO., LTD) 2 January 2003 (2003-01-02) * paragraph [0050]; figures 1a,3,4,10 *	7 1,3,10	
A	US 6 121 865 A (DUST ET AL) 19 September 2000 (2000-09-19) * figures *	1	
A	US 2003/151481 A1 (KOLARSKY JENS) 14 August 2003 (2003-08-14) * abstract *	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F02M H01F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 April 2005	Landriscina, V

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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....
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 00 5904

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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26-04-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2212982 A	02-08-1989	IT 213013 Z2	13-10-1989
		DE 3839692 A1	29-06-1989
		FR 2623567 A1	26-05-1989
		US 4988073 A	29-01-1991
EP 0890730 A	13-01-1999	IT TO970618 A1	11-01-1999
		CN 1205394 A ,C	20-01-1999
		DE 69813957 D1	05-06-2003
		DE 69813957 T2	13-05-2004
		EP 0890730 A2	13-01-1999
		ES 2197396 T3	01-01-2004
		JP 11082228 A	26-03-1999
		RU 2215177 C2	27-10-2003
		US 6152387 A	28-11-2000
EP 1270926 A	02-01-2003	WO 0166933 A1	13-09-2001
		EP 1270926 A1	02-01-2003
		US 6834844 B1	28-12-2004
US 6121865 A	19-09-2000	CA 2275227 A1	03-02-2000
		DE 19936425 A1	16-03-2000
		GB 2343303 A	03-05-2000
US 2003151481 A1	14-08-2003	DE 10014738 A1	11-10-2001
		WO 0173799 A1	04-10-2001
		EP 1269490 A1	02-01-2003
		JP 2003529214 T	30-09-2003
		TW 504718 B	01-10-2002

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82