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(54) Electrical connector with a contact pin and an interconnection pin

(57) The invention relates to an electrical connector (1), being provided with a signal path (4, 13), between a front signal port (2, 12) and a rear signal port (7, 16) for transmitting electrical signals in the Gigahertz range, and with a contact pin (3, 11), which protrudes from the front signal port (2, 12) along the signal path (4, 13). In order to provide an electrical connector (1) that can easily be assembled, the invention provides that the electrical connector (1) is shaped with an interconnection pin (6, 15), that extends from the rear signal port (7, 16) along the signal path (4, 13) and that rests on the contact pin (3, 11).

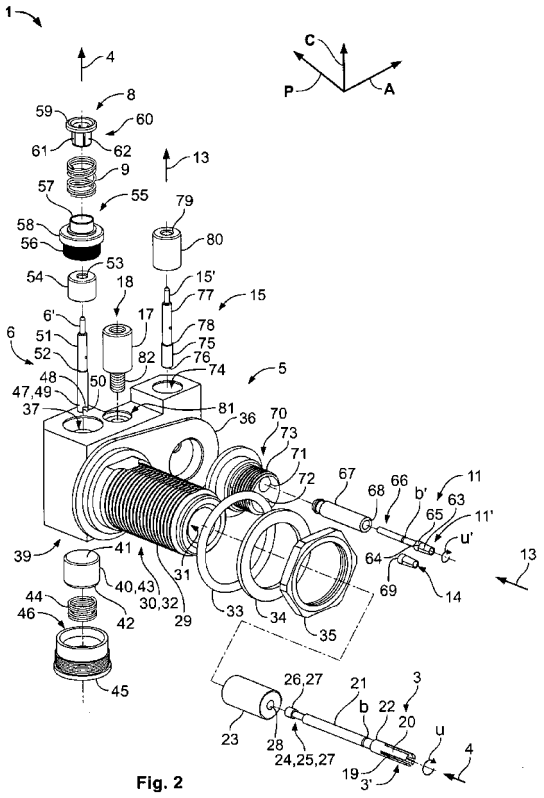

Fig. 2

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Description

[0001] The present invention relates to an electrical connector housing at least one signal path for a transmission of electrical signals in the Gigahertz range, wherein at one, front, end of the signal path a front signal port is arranged, the front signal port being adapted to be connected to a mating electrical connector in a plug direction, and, at the other, rear, end of the signal path, the other end opposing the front end with respect to the signal path, a rear signal port is arranged, and wherein the signal path comprises a contact pin, which projects into the front signal port against the plug direction.

[0002] Electrical connectors with two signal ports and a contact pin projecting into at least one of the signal ports are known. For connecting the contact pin to the other signal port, cables are used. The cable can be connected to the contact pin by soldering it directly to the contact pin, or by adding adapter elements to the contact pin and to at least one end of the wire. At the other signal port, a further contact element has to be connected to the wire and the same arrangements have to be provided.

[0003] Preparing the contact element, the wire and the contact pin as well as mounting the electrical connector is complex and costly when the above-mentioned procedure of the state of the art is followed. In view of these disadvantages of the known electrical connectors, an object underlying the invention is to provide electrical connectors that can more easily be assembled.

[0004] The object is achieved according to the invention for the electrical connector mentioned in the beginning in that the signal path further comprises an interconnection pin which extends from the rear signal port and rests on the contact pin. The rigid interconnection pin can be handled with less effort compared to a flexible wire and no separate adapter elements are needed. Such a connector cannot only be assembled more easily by hand, but also at least semi-automatically, resulting in decreased assembling costs.

[0005] The solutions according to the invention can be combined as desired and further improved by the further following embodiments that are advantageous on their own, in each case.

[0006] According to a first possible embodiment, the electrical connector can comprise a second signal path for connecting the signal source or drain, or another signal source or drain to a further mating connector. This second signal path can include a second front end with a second front signal port that is accessible in the plug direction. Furthermore, the second signal path can include a second rear end opposite of the second front end along the signal path. This second rear end can be adapted to be connected to the signal source or drain in a contact direction. The second rear end can comprise a second rear signal port. The signal path can be designed with a second interconnection pin, which extends from the second rear signal port, and which rests on the second contact pin. Naturally, the electrical connector can be formed with only one or with more than two signal paths that can be shaped according to the below.

[0007] In the following, the embodiment of the electrical connector along one of the signal paths is described. Elements arranged along each of the signal paths of the electrical connector can be shaped similarly or in a different way according to the following embodiments. Therefore, only embodiments of elements arranged along one signal are described in the following. The elements are introduced in the order of their arrangement along the signal path.

[0008] The contact pin and the interconnection pin can have an essentially cylindrical shape with a circular foot print. Along a longitudinal axis of each of the pins, the diameter of the pin may, however, vary. Each pin can have a length parallel to its longitudinal axis that is larger than its diameter normal to the longitudinal axis and the pins can essentially be stiff perpendicular to their longitudinal axis. Such a pin can easily be inserted along its longitudinal axis when assembling the electrical connector, still providing structures for positioning or fixing the pin.

[0009] In order to further improve the assembling of the electrical connector, the extreme ends of the pins can be adapted for the connection to mating contact pins and to the respective other pin in the signal path. The contact pin can be shaped with a plug end that may be insertable into a mating contact pin. Alternatively, the plug end may at least sectionwise have a hollow cylindrical shape and allows for inserting the mating contact pin into the plug end.

[0010] For facilitating a connection between the mating pin and the contact pin, especially the hollow cylindrical part of the plug end may be slotted, the slots extending along the plug direction and the longitudinal axis of the respective pin. The slots can separate side wall sections of the plug end from each other, the side wall sections thus being elastically deflectable perpendicular to the longitudinal axis. These elastic side wall sections can also be designated as spring contacts. Due to the elastic features of the plug end, mechanical vibrations or dimensional tolerances do not lead to an unsecure connection.

[0011] In the plug direction behind the plug end, the contact pin is shaped with a middle section, whose diameter can be reduced compared to the plug end. In a transition zone between the plug end and the middle section, the contact pin can be provided with an edge-like stop. This edge-like stop can limit the insertion depths of the contact pin in the electrical connector in the plug direction.

[0012] The middle section of the contact pin can be formed with a bead, which extends in a circumferential direction of the contact pin and which protrudes from the middle section normal to the plug direction.

[0013] In plug direction behind the middle section, the contact pin concludes with a coupling end. The coupling end may be shaped with a connection section, which comprises a circumferential retaining groove, whose di-

ameter is reduced compared to the middle section. The retaining groove can at least sectionwise extend around the contact pin in its circumferential direction. In the plug direction behind the retaining groove, the diameter of the contact pin can again be increased, this extreme end of the contact pin forming a retaining end.

[0014] Alternatively, the coupling end may be shaped without the retaining groove and without the retaining end and may in particular be formed with a constant diameter. Yet, a form deviating from the cylindrical base form and especially a form that is at least sectionwise complementary to the interconnection pin can improve the mechanical and electrical connection between the contact pin and the interconnection pin.

[0015] Also the interconnection pin may be shaped with an extreme end that is directed towards the contact pin in the assembled state, the extreme end forming a fastening end. The fastening end can at least sectionwise be shaped complementary to the coupling end and with a connection recess that extends along the plug direction and the longitudinal direction of the interconnection pin. This recess can be flanked by two legs, the legs being arranged opposite of each other and extending along the longitudinal direction of the interconnection pin.

[0016] The legs can be arranged in the retaining groove of the contact pin and the distance between the legs can be dimensioned such that the connection section can be arranged at least sectionwise in the connection recess. In the plug direction, borders of the retaining groove can be pushed against the legs, if the contact pin shall move during a plugging or unplugging procedure along the plug direction. Thus, the positioning of the contact pin along the plug direction is secured by the interconnection pin. It goes without saying, that the ends of the contact pin can be formed according to the ends of the interconnection pin and vice versa.

[0017] In an assembled state, a longitudinal axis of the interconnection pin can extend along a contact direction, in which the electrical connector can be brought into contact with a signal source or drain. In this contact direction, a middle section of the interconnection pin follows the fastening end. The diameter of this middle section is reduced compared to the fastening end, resulting in an edge-like stop. In contrast to the edge-like stop of the contact pin, which is facing in the plug direction and towards the housing, the edge-like stop of the interconnection pin is facing in the contact direction and away from the housing.

[0018] The extreme end of the interconnection pin opposite of the fastening end can be provided with a terminal end that can be shaped as a deflection section, being elastically deflectable along the longitudinal axis of the interconnection pin. For instance, the interconnection pin can be shaped as a so-called pogo-pin. Furthermore, contact pins or interconnection pins with at least one end being elastically deflectable with respect to a middle section of the respective pin may improve electrical contacts between the two pins or between one of the pins and a signal source or drain, if mechanical vibrations or dimensional tolerances occur. Moreover, a mechanical overload of the signal source or drain can be avoided. Yet, also the fastening end or the plug end or the coupling end of the contact pin can be designed to be elastically deflectable with respect to the middle section of the respective pin.

[0019] When inserting the pins into the housing, a first pin, e.g. the contact pin, can be inserted until it reaches a final position, which may be defined by a stop. The end of this pin points into the housing and can now be used as an end stop for the second pin, e.g. the interconnection pin, when the second pin is inserted into the housing along its longitudinal axis. In the completely inserted state of the two pins, one of the pins can abut on the respective other pin. Thus, the pins can be brought in direct contact with each other in a point of contact, which forms an electrical close-fitting contact by simply inserting the pins.

[0020] This insertion process can easily be done by hand or by a machine, as a force acting against the insertion process rises abruptly as soon as the contact pins are in contact with each other. Hence, when in direct contact, one of the contact pin and the interconnection pin can support the other respective pin. This increase of the force can easily be detected by the operator or by the machine inserting the pins. The point of contact can be located at a free end of at least one of the respective contact pin or interconnection pin.

[0021] It can be sufficient if the contact pin abuts on the interconnection pin without a further fixation. Yet, if this close-fitting contact shall be improved or protected against mechanical vibrations, the two pins can be affixed to each other. For instance, the contact pin and the interconnection pin can be shaped with threads and one pin can be screwed to the other pin or the pins can be connected via an additional screw. Alternatively, the pins can be soldered to each other.

[0022] The interconnection pin can bridge a gap between the contact pin and the respective rear signal port. Hence, the contact pin is connected to the rear signal port by the interconnection pin only, such that no further connecting means are necessary.

[0023] The contact pin and the interconnection pin can be arranged perpendicular to each other, if this is required by the installation conditions for the electrical connector.

[0024] In order to electrically isolate the pins from the housing or from other components of the electrical connector, each of the pins can be inserted into a central aperture of a dielectric tube. The dielectric tube can be arranged at least on the middle sections of the respective pin. The depth of insertion of the pin into the dielectric tube can be limited by the edge-like stop interacting with a front of the dielectric tube. As soon as the respective pin reaches its assembled state in the dielectric tube, the front of the dielectric tube abuts on the edge-like stop, preventing a further insertion of the pin.

[0025] A simple and secure connection between the dielectric tube and the respective pin can be achieved

by a force-fit between the pin and the tube. Therefore, the diameter of the central aperture can be adapted to the diameter of the middle section.

[0026] In order to facilitate an easy insertion of at least the contact pin into the dielectric tube, the retaining end of the contact pin can have a diameter that is about the same size as the diameter of the middle section. The beads can be arranged on the middle section of each of the pins can further improve the force-fit.

[0027] In order to correctly position the dielectric tubes, the electrical connector can be formed with insertion stop surfaces, against which a front of a respective dielectric tube facing in the plug direction abuts when it is inserted into the electrical connector.

[0028] The front port can be provided with a hollow cylindrical mating section that houses at least the contact pin and possibly also the dielectric tube. The cylindrical mating section can be shaped with an outer thread, e.g. for fixing the mating connector. It can be formed as a separate part that can be affixed to the housing e.g. by screwing it to the housing. Alternatively, it can be forced into fixing bowl of the housing. Yet, at least one of the cylindrical mating sections of the electrical connector can be formed in one piece with the housing.

[0029] The cylindrical mating section can comprise at least one holding opening, in which the contact pin or the dielectric tube can be pressed and thereby be positioned. Also, the contact pin or the dielectric tube can be affixed in the holding opening by screwing the said component into the opening or by affixing it by gluing.

[0030] In the course of the holding opening along the plug direction, its diameter can decrease excursively, forming the insertion stop surface. A correct insertion of the pin and/or the dielectric tube is made easier by this insertion stop surface.

[0031] The holding opening can extend into the housing and can either be formed as a blind hole or as a continuous channel extending completely through the housing. If the holding opening is formed as a channel, the free ends of the contact pin protruding into the housing can be accessed, even if the contact pin is completely inserted. This may be necessary for affixing the two pins to each other or for checking their connection.

[0032] For the interconnection pin, the housing can comprise a tube acceptance opening, that extends against the contact direction. Also, the tube acceptance opening can be formed as a blind hole or as a channel extending completely through the housing. The tube acceptance opening or the holding opening can be formed with a bottleneck that can be formed as a narrowed section, in which the inner diameter is reduced. For instance, this bottleneck can be arranged at an end abutting the contact volume. The dielectric tube can be shaped with a circumferential groove in its shell. In particular, the dielectric tube can be formed complementary to the opening that is inserted into and be held in the opening by the bottleneck engaging the circumferential groove.

[0033] Furthermore, the tube acceptance opening can be provided with a diameter that excursively decreases against the contact direction. Thus, if the interconnection pin is inserted into the housing against the contact direction, the dielectric tube pressed upon the pin towards the fastening end can rest on an insertion stop surface formed by this change of diameter. The holding opening and the tube acceptance opening can overlap each other in a contact volume, into which both pins extend and the point of contact is arranged.

[0034] Especially if the tube acceptance opening is provided with an open end facing against the contact direction, the contact volume can be accessible in the contact direction. Again, this can be necessary for checking or improving the connection between the two pins.

[0035] The electrical connector can be equipped with an electrical overload protection that is electrically connected to at least one of the contact pins and that can at least sectionwise be arranged in the contact volume. The electric overload protection can be in electrical contact with the housing, i.e. the ground, and can comprise a gas discharge tube, which interconnects the contact element to the ground when too high voltages are applied, which, for instance, can be caused by a lightening strike. In order to assure the connection even when mechanical vibrations or dimensional tolerances occur, the overload protection can be clamped between the housing and the at least one contact pin. To prevent at least the electrical overload protection from mechanical damage, a contact assurance spring can be provided that presses against the electrical overload protection and whose spring force acts towards the contact pin.

[0036] A ground sleeve for connecting the electrical connector to a ground, especially the ground of the signal source or drain, can be provided that is electrically connected to the housing of the electrical connector. The ground sleeve can have an essentially hollow cylindrical shape, and the interconnection pin can protrude into the ground sleeve. The ground sleeve and the interconnection pin can end in the connection direction in the rear contact port at the same level or the ground sleeve or the interconnection pin can lead in the connection direction. Thus, both the interconnection pin and the ground sleeve can be connected to the signal source or drain, which can provide for a signal and a ground connection. Furthermore, the ground sleeve can electrically shield the signal path towards the signal source or drain, the signal path also extending along the interconnection pin.

[0037] The ground sleeve can be mounted to the housing to be elastically deflectable parallel to the interconnection pin that it surrounds. Thus, not only the terminal end of the interconnection pin but also the ground sleeve can evade especially contrary to the contact direction, providing for protection against damage by mechanical overload and against instable connection when mechanical vibrations or dimensional tolerances occur.

[0038] For elastically mounting the ground sleeve, a ground spring can be provided between the ground sleeve and the housing. The ground spring can be a hel-

ical spring, into which a hollow cylindrical contact tube of the ground sleeve is arranged. In the contact direction after the contact tube the contact sleeve can be formed with a collar that protrudes normal to the contact direction and rests on the ground spring against the contact direction.

[0039] Furthermore, the electrical connector can comprise a ground adapter. The ground adapter can be shaped with a housing contact organ for affixing the ground adapter to the housing and with a ground sleeve acceptance, into which the ground sleeve can at least sectionwise be pushed against the elastic force of the ground spring. Between the housing contact organ and the ground sleeve acceptance the ground adapter is formed with an assembly ring. The assembly ring protrudes perpendicular to the contact direction. The dielectric tube for the interconnection pin can be pushed into the housing contact organ. Against the contact direction, the ground sleeve can be pushed into the ground adapter, wherein side walls of its contact tube can be in electrical contact with the ground sleeve acceptance. The maximum insertion depth of the ground sleeve can either be defined by the ground spring, the ground sleeve acceptance interacting with its collar. As a preassembled element, the interconnection pin, the ground sleeve, the ground spring, the ground adapter and the dielectric tube can very easily be handled.

[0040] The ground adapter can be affixed to the housing. For instance, the housing contact organ can be pressed into the tube acceptance opening resulting in a force-fit between the housing and the ground adapter. Alternatively, the ground adapter can be screwed into the tube acceptance opening, if both components are provided with a thread, or can e.g. be fixed by glue. The maximum depth of insertion of the ground adapter can be limited by the insertion stop surface of the tube acceptance opening or by the assembling ring.

[0041] The contact tube can as the contact end of the contact pin be slotted such that side wall sections of the contact tube that are separated by the slots can act as contact springs, being elastically deflected normal to the contact direction towards the interior of the contact tube.

[0042] The front port can be equipped with a ground contact element neighbouring the contact pin, the ground contact element being electrically connected to the ground via the housing. With such a ground contact element, the ground can be provided to the mating connector in a defined way and not only via the cylindrical mating section.

[0043] The electrical connector can comprise a spacer element which is adapted to fix the electrical connector to the signal source or drain. The spacer element can be located between the rear ports and extend parallel to at least one of the interconnection pins. For instance, the spacer element can be screwed into the housing, and can be provided with an inner thread. The signal source or drain can comprise a printed circuit board that can be clamped between a screw head and the spacer element, the screw being affixed to the spacer element.

[0044] At least one of the front ports can be shaped as a type N connector; the other front port can be shaped as a test port for connecting test probes.

[0045] The invention will be described hereinafter, in more detail and in an exemplary manner using advantageous embodiments and with reference to the drawings. The described embodiments are only possible configurations in which, however, the individual features as described above can be provided independent of one another or can be omitted in the drawings:

Fig. 1 is a schematic prospective view of an exemplary embodiment of an electrical connector;

Fig. 2 shows the connector shown in Fig. 1 in a schematic exploded view;

Fig. 3 shows the electrical connector of Fig. 1 in a schematic cross-sectional view;

Fig. 4 shows the electrical connector of Fig. 1 in a schematic cross-sectional view;

Fig. 5 shows the electrical connector of Fig. 1 is a schematic cross-sectional view connected to a signal source or drain;

Fig. 6 shows the electrical connector of Fig. 1 in a schematic cross-sectional view connected to a signal source or drain.

[0046] First, an electrical connector 1 with four signal ports will be described with reference to Fig. 1. A front signal port 2 is adapted to be connected to a mating electrical connector in a plug direction P. Inside of the front signal port 2, a contact pin 3 is arranged along at least a section of a signal path 4. A plug end 3' of the contact pin 3 faces against the plug direction P.

[0047] In the plug direction P, a housing 5 of the electrical connector 1 is arranged behind the front signal port 2. The signal path 4 and the contact pin 3 extend from the front signal port 2 into the housing 5. Inside the housing 5, the contact pin 3 is connected to an interconnection pin 6, the interconnection pin 6. The interconnection pin 6 is arranged along the signal path 4 and a contact direction C, which runs perpendicular to the plug direction P. A terminal end 6' of the interconnection pin 6 points towards the contact direction C, sticks out of the housing 5 and ends in a rear signal port 7.

[0048] An essentially hollow cylindrically shaped ground sleeve 8 of an electrically conductive material is placed around the terminal end 6' of the interconnection pin 6. A longitudinal axis of the ground sleeve 8 runs parallel to the contact direction C. A ground spring 9 is arranged between the ground sleeve 8 and the housing 5. The ground spring 9 is of an essentially helical shape and due to its resilient properties, the ground sleeve 8

can be elastically deflected along the contact direction C. Moreover, the ground spring 9 can also electrically connect the ground sleeve 8 to the housing 5.

[0049] In a lateral direction A, which extends perpendicular to the plug direction P and the contact direction C, behind the front signal port 2, the electrical connector 1 comprises a second front signal port 10. The second front signal port 10 is equipped with a second contact pin 11 that extends from a second front signal port 12 of a second signal path 13 along the plug direction P. A contact end 11' of the second contact pin 11 faces against the plug direction P. From its contact end 11', the second contact pin 11 extends along the second signal path 13 and in the plug direction P towards the housing 5.

[0050] In the contact direction C, a ground contact element 14 is arranged before the second contact pin 11.

[0051] The second signal path 13 extends from the contact end 11' towards a terminal end 15' of a second interconnection pin 15, which protrudes from the housing 5 in the contact direction C A second rear signal port 16 is arranged adjacent the terminal end 15'.

[0052] The contact pins 3, 11 and the interconnection pins 6, 15 are essential of a cylindrical shape, at least sectionwise having a circular foot print.

[0053] A spacer element 17 is affixed to the housing 5 and arranged between the rear signal ports 7, 16. The spacer element 17 is formed with an inside thread 18 and extends parallel to at least one of the interconnection ends 6, 15. In the shown embodiment, the interconnection pins 6, 15 and the spacer element 17 with the inside thread 18 all extend along the contact direction C.

[0054] Fig. 2 shows the exemplary embodiment of Fig. 1 in a schematic perspective exploded view.

[0055] In the following, elements arranged along signal path 4 are described, starting from the front signal port 2.

[0056] Signal path 4 begins with the plug end 3' of contact pin 3. The plug end 3' is of a hollow cylindrical shape and comprises expansion slots 19. The expansion slots 19 extends parallel to the plug direction P and can start at the most extreme point of the plug end 3' against the plug direction P or at a distance to the most extreme point. Due to the expansion slots 19, side walls 20 of the plug end 3' can be elastically deflected perpendicular to the plug direction P. Due to the elastic deflectability, plug end 3' can adapt to mating contacts with different diameters, the mating contacts being insertable into or around the plug end 3'.

[0057] In plug direction P behind the plug end 3' the contact pin 3 comprises a middle section 21 with a smaller diameter compared to the plug end 3'. In a transition zone between the plug end 3' and the middle section 21, the contact pin 3 is shaped with an edge-like stop 22 for a dielectric tube 23.

[0058] In plug direction P, the contact pin 3 continues behind the middle section 21 in a coupling end 24 that is adapted to be directly connected to the interconnection pin 6. In the shown embodiment, the coupling end 24 comprises a connection section 25, whose diameter is further reduced. In plug direction P after the connection section 25, the diameter of the contact pin 3 increases excursively up to the same size as the middle section 21 in a retaining end 26. The connection section 25 can also be described as a circumferential retaining groove 27 that extends at least sectionwise around the contact pin 3 along its circumferential direction U.

[0059] The dielectric tube 23 is shown at a distance to the contact pin 3. Yet, in an assembled state of the electrical connector 1, the contact pin 3 is pushed into a central aperture 28 of the dielectric tube 23. The contact pin 3 and the dielectric tube 23 are then connected via a force-fit, which is increased by a bead b protruding from the middle section 21 normal to the middle section 21 and at least sectionwise extending around the contact pin 3 in its circumferential direction U. As the diameter of the central aperture 28 is about the size of the diameter of the middle section 21 of the contact pin 3, the maximum depth of insertion is limited by the border-like stop 22, against which a front of the dielectric tube 23 abuts in the assembled state.

[0060] The contact pin 3 and the dielectric tube 23 can one after the other or in a pre-assembled state together be pushed in the plug direction P into a plug section 29 of the electrical connector 1. The plug section 29 comprises a hollow cylindrical mating section 30 with a holding opening 31, whose inner diameter is dimensioned in order for receiving the dielectric tube 23. It can be connected to the dielectric tube 23 via a force-fit. An outer shell 32 of the plug section 29 is formed with a thread.

[0061] Onto the plug section 29, a gasket ring 33, a washer 34 and a ring nut 35 can be placed. The gasket ring 33 can in the plug direction P be pressed towards the housing 5 and e.g. onto a clamp 36, that is arranged between the gasket ring 33 and the housing 5 in order to seal the connection between the cylindrical mating section 30 and the housing 5 or the clamp 36. The washer 34 and the ring nut 35 are used for fixing the gasket ring 33 and for applying sealing pressure.

[0062] Inside the housing 5, the signal path 4 bends towards the contact direction C. A tube acceptance opening 37 extends against the contact direction C into the housing 5. The tube acceptance opening 37 is at least sectionwise dimensioned in order to accommodate a dielectric tube 38 for the interconnection pin 6. The tube acceptance opening 37 can, if shaped as a blind hole, end inside the housing 5 or can be shaped as a continuous channel extending completely through the housing 5 parallel to the contact direction C. If the tube acceptance opening 37 completely extends through the housing 5, the coupling end 24 of the contact pin 3 can be accessed in the coupling direction C, even if both pins 3, 6 are mounted into the electrical connector 1. On the one hand, this may be useful to fix the contact pin 3 to the interconnection pin 6 via the tube acceptance opening 37 and especially via its lower end 39 facing against the contact direction C e.g. by soldering. In the shown embodiment, the tube acceptance opening begins at the lower end 39

and extends in the contact direction C completely through the housing 5.

[0063] Moreover, further functional elements can be added to the housing 5 via the lower end 39. For instance, an electrical overload protection 40 can be placed in the housing 5 via the lower end 39 of the tube acceptance opening or channel 37. The electrical overload protection 40 is shown with electrical contact surfaces 41, 42, which are facing in an against the contact direction C. Between the electrical contact faces 41, 42, the electrical overload protection 40 can be equipped with a gas discharge tube 43, which can discharge too high currents or voltages that may be caused by a lightning strike. The electrical contact surface 41 faces into the contact direction C and is in the assembled state of the electrical connector 1 electrically connected to the contact pin 3. In order to ensure the connection between the electrical overload protection 40 and the contact pin 3, a contact assurance spring 44 can cause an elastic force that is directed towards the contact pin 3. For instance and as displayed, the contact assurance spring 44 can be arranged between the electrical overload protection 40 and a cap 45. The cap 45 can be fixed to the housing 5 and especially be screwed into the lower end 39 of the tube acceptance opening 37. It can at least sectionwise accommodate the contact assurance spring 44 and the electrical overload protection 40 in its free volume 46. Via the cap 45, the contact assurance spring 44 and the electrical contact surface 42 are electrically connected to the housing 5.

[0064] The interconnection pin 6 rests on the coupling end 24, which is thus shaped as a support bearing.

[0065] A fastening end 47 of the interconnection pin 6 points against the contact direction C an is shaped with a connection recess 48 that extends from the fastening end 47 parallel to the contact direction C and the plug direction P. The connection recess 48 is shaped with a clearance that is adapted to the diameter of the retaining groove 27 of the contact pin 3. In other words, the coupling end 24 of the contact pin 3 and the fastening end 47 of the interconnection pin 6 are at least sectionwise shaped complementary to each other. The retaining groove 27 can at least sectionwise be inserted into the connection recess 48. Legs 49, 50 are flanking the connection recess 48 and are dimensioned such that they can be placed into the retaining groove 27. In particular, the legs 49, 50 have the same or lower dimension as the retaining groove 27 in the plug direction P.

[0066] In the contact direction C, a middle section 51 of the interconnection pin 6 follows the fastening end 47. Again, the middle section 51 is of a smaller diameter than the fastening end 57. In a transition zone between the fastening end 47 and the middle section 51, also the interconnection pin 6 is formed with an edge-like stop 52, that faces away from the fastening end 47 and in the contact direction C. The diameter of the middle section 51 is dimensioned in order to be accommodated by a central aperture 53 of a further dielectric tube 54. When the further dielectric tube 54 is mounted onto the middle section 51 it is fixed to the interconnection pin 6 by a force-fit and abuts on the edge-like stop 5.

[0067] In the exploded view of this figure, a ground adapter 55 follows the further dielectric tube 54 in the contact direction C. The ground adapter 55 is shaped with a housing contact organ 56 and a ground sleeve acceptance 57. The housing contact organ 56 and the ground sleeve acceptance section 57 are interconnected by an assembling ring 58.

[0068] The ground adapter 55 can be superimposed onto the further dielectric tube 54, the interconnection pin 6 extending through the further dielectric tube 54 and the ground adapter 55. The further dielectric tube 54 electrically isolates the interconnection pin 6 from the ground adapter 55 and can be connected to the housing contact organ 56 via a force-fit.

[0069] The housing contact organ 56 can at least sectionwise be inserted into the tube acceptance opening 37 and is then electrically connected to the housing 5. The assembling ring 58 is formed as a flange and can assure that the ground adapter 55 can not be pressed too far into the tube acceptance opening 37. In the mounted condition, it can rest on the housing 5.

[0070] The hollow cylindrical ground sleeve acceptance 57 is formed with an outer diameter that is small enough so that the ground spring 9 can be placed upon the ground sleeve acceptance 57. Yet, the inner diameter of the ground sleeve acceptance 57 is large enough, such that the ground sleeve 8 can at least sectionwise be inserted.

[0071] The ground sleeve 8 has a T-shaped cross section, the horizontal bar of the T being formed by a collar 59 protruding perpendicular to the contact direction C. Against the contact direction C a contact tube 60 follows the collar 59. The contact tube 60 is slotted along the contact direction C. Each slot 61 extends from the collar 59 against the contact direction C and may extend towards the extreme end of the contact tube 60 or end in a distance of this end. Side walls 62 of the contact tube 60 are at least sectionwise separated by the slots 61 and are due to the slots 61 resiliently deflectable perpendicular to the contact direction C. Each side wall 62 can be designated as a contact spring, which, when the contact tube 60 is inserted into the ground sleeve acceptance section 57 is slightly deflected towards the center of the contact tube 60 and presses against inner walls of the ground sleeve acceptance section 57. In this way, the electrical connection between the ground sleeve 8 and the housing 5 via the ground adapter 55 as well as the deflectability of the ground sleeve 8 are ensured. The width of the collar 59 is so dimensioned that it rests on the ground spring 9.

[0072] Now, elements arranged along the second signal path 13 are described.

[0073] The second contact pin 11 of the second front signal port 10 is shown with a contact end 11'. The contact end 11' is shaped analogue to the plug end 3' of the contact pin 3 and comprises extension slots 63 and re-

silient side walls 64 separated by the extension slots 63 in a circumferential direction U' of the second contact pin 11. In the plug direction P behind the contact end 11', an edge-like stop 65 follows. In plug direction P behind the edge-like stop 65 the second contact pin 11 extends having an essentially constant diameter. An extreme end of the second contact pin 11 pointing in the plug direction P is shaped as a coupling end 66. Alternatively to the shown embodiment, the second contact pin 11 can also be equipped with a coupling end 66 that is alike the coupling end 24 of contact pin 3.

[0074] The next element in plug direction P is a further dielectric tube 67 with a central aperture 68 for the second contact pin 11. Similar to the dielectric tube 23 and the contact pin 3, the second contact pin 11 can be pressed into the central aperture 68 and is then connected to the further dielectric tube 67 by a force-fit assisted by bead b.

[0075] In the contact direction C, the ground contact element 14 is shown before the second contact pin 11. It can also be pressed into a dielectric tube before being mounted to the electrical connector 1. However, as the ground contact element 14 is meant for being electrically connected to the ground via the housing 5, mounting the ground contact element 14 with a dielectric tube would require installing an additional electrical connection between the ground contact element 14 and the housing 5. A direct connection of the ground contact element 14 to the electrical connector 1 without a dielectric tube 67 is therefore advantageous, as an additional electrical connection is then unnecessary.

[0076] The ground contact element 14 has essentially the same shape as the contact end 11' of the second contact pin 11. In plug direction P, the ground contact element 14 is equipped with a base 69 that enables a force-fit connection between the ground contact element 14 and the electrical connector 1. For instance, the base 69 can have a solid structure.

[0077] For accommodation of the second contact pin 11 and the ground contact element 14, a second cylindrical mating section 70 is provided behind the further dielectric tube 67 in the plug direction P. The second cylindrical mating section 70 is shaped with two holding openings 71, 72 that are arranged one after the other in the contact direction C and that extend along the plug direction P. The holding opening 71 is dimensioned such that the further dielectric tube 67 can be pressed into the holding opening 71 and be connected to it via a force-fit or via a form-fit. The ground contact element 14 can be pressed into the holding opening 72 so that at least its base 69 can be fastened by the force- or form-fit.

[0078] Further, the second cylindrical mating section 70 is shaped with an outer shell 73 that is threaded. Both cylindrical mating sections 30, 70 can be formed separate from the housing 5 or together with the housing 5 as one piece, e.g. by dye casting.

[0079] In the lateral direction A behind the tube acceptance opening 37, a second tube acceptance opening 74 extends into the housing 5 against the contact direction C. Comparable to the tube acceptance opening 37, also the second tube acceptance opening 74 can end inside the housing 5 or can continuously extend through the housing 5. In the shown embodiment, the second tube acceptance opening 74 is formed as a blind hole that opens towards the contact direction C.

[0080] The second interconnection pin 15 is arranged such that its terminal end 15' points into the contact direction C. Its end opposite the terminal end 15' is shaped as a fastening end 75 for connecting to the second contact pin 11. In the shown embodiment, the fastening end 75 concludes in a connection plane 76 that runs parallel to the plug direction P and the lateral direction A and that faces against the contact direction C.

[0081] In the contact direction C behind the connection plane 76, the second interconnection pin 15 is shaped similar to the interconnection pin 6. In particular, it is provided with a middle section 77, whose diameter is smaller than the diameter of the fastening end 75. In a transition zone of the fastening end 75 and the middle section 77, also the second interconnection pin 15 is formed with an edge-like stop 78 for limiting the maximum insertion depth of the second interconnection pin 15 into a central aperture 79 of another dielectric tube 80 that is displayed behind the second interconnection pin 15 in the contact direction C.

[0082] Between the tube acceptance openings 37, 74 an attachment opening 81 is formed into the housing 5. Via the attachment opening 81, the spacer element 17 can be affixed to the housing 5. Therefore, the attachment opening 81 is provided with an internal thread, into which a threaded attachment protrusion 82 of the spacer element 70 can be screwed.

[0083] Fig. 3 shows the exemplary embodiment of Figs. 1 and 2 in a cross-sectional side view, the sectional plane being arranged along the signal path 4.

[0084] The electrical connector 1 is shown in an assembled state. The contact pin 3 is, together with the dielectric tube 23, pressed into the holding opening 31 of the cylindrical mating section 30. The contact pin 3 extends in plug direction P and its coupling end 24 protrudes through the holding opening 31 into the tube acceptance opening 37 or a projection against the contact direction C thereof. A front of the dielectric tube 23 that faces in the plug direction P rests on an insertion stop surface 83.

[0085] Also, the interconnection pin 6 is assembled to the housing 5 and is together with the further dielectric tube 54 pressed into the housing contact organ 56 of the ground adapter 55. The ground adapter 55 is pressed into the tube acceptance opening 37 and rests on an insertion stop surface 83' of the tube acceptance opening 37. In the contact direction C behind the insertion stop surface 83', the diameter of the tube acceptance opening 37 is larger compared to the diameter before the insertion stop surface 83'. As the ground adapter 55 is pressed into the tube acceptance opening 37, it is not only in close contact to the insertion stop surface 83', but also to an

inner wall 84 of the tube acceptance opening 37 behind the insertion stop surface 83' in the contact direction C. Thus, an extensive and secure electrical contact between the housing 5 and the ground adapter 55 is assured by the chosen design. The contact pin 3 and the interconnection pin 6 both have a longitudinal axis, the longitudinal axis 85 of contact pin 3 being arranged perpendicular to the longitudinal axis 86 of the interconnection pin 6.

[0086] In a contact volume V, in which the holding opening 31 intersects the tube acceptance opening 37, the contact pin 3 is in direct contact with the interconnection pin 6 in a point of contact 87. In particular, the fastening end 47 of the interconnection pin 6 abuts on the coupling end 24 of the contact pin 3. The connection section 25 of the contact pin 3 is arranged in the connection recess 48 and is flanked by the legs 49, 50 in the lateral direction A. Due to the reduced diameter of the connection section 25 compared to the middle section 21 and the retaining end 26 of the contact pin 3, the contact pin 3 is secured against movements in or against the plug direction P. If the contact pin 3 would, despite the force-fit to the housing 5, be moved in or against the plug direction P during a plug procedure, the middle section 21 or the retaining end 26 would be pushed against the legs 49, 50, which would prevent a further movement of the contact pin 3.

[0087] For a secure electrical connection between the contact pin 3 and the interconnection pin 6, it is sufficient that the two pins 3, 6 are connected to each other by a close-fitting contact. In this case, no further connection means are necessary, and the contact volume V needs not to be accessible. If, however, the electrical connection between the two pins 3, 6 needs to be further secured, e.g. by soldering, the contact volume V can be accessible in the contact direction C via the tube acceptance opening 37, which, in this case, has to be shaped as a channel continuously extending through the housing 5.

[0088] Furthermore, the electrical overload protection 40 can be inserted into the tube acceptance opening 37 in the contact direction C when the tube acceptance opening 37 is of the continuous channel type. In the shown embodiment, the contact assurance spring 44 is placed inside the cap 45 and presses the electrical overload protection 40 in the contact direction C onto the contact pin 3. The cap 45 is screwed into the tube acceptance opening 37 and the contact assurance spring 44 is at least sectionwise compressed. The electrical contact surface 41 of the electrical overload protection 40 is arranged opposite of the interconnection pin 6 and rests on the contact pin 3. If the legs 94, 50 extend beyond the contact pin 3 against the contact direction C, the electrical overload protection can rest against the legs 49, 50 instead of the contact pin 3. In case of an electrical overload, the overload protection 40 electrically connects the contact pin 3, possibly via the interconnection pin 6, to the housing 5 which, in turn, can be connected to the ground via the ground adapter 55 and the ground sleeve 8.

[0089] In the contact direction C, the ground sleeve 8 and the terminal end 6' of the interconnection pin 6 both end at the same level. As can be best seen in this cross-sectional view, both the ground sleeve 8 and the terminal end 6' are elastically mounted and can be deflected against the contact direction C. The contact tube 60 of the ground sleeve 8 can be pushed into the ground sleeve acceptance section 57 of the ground adapter 55, to which it is electrically connected. The further the ground sleeve 8 is pushed into the ground adapter 55, the larger the contact surface between the two elements can be. The interconnection pin 6 is formed as a so-called pogo-pin with a spring arranged inside the pin 6 that interacts with the terminal end 6'.

[0090] The terminal end 6' ends in the rear signal port 7. Without the interconnection pin 6, a gap remains between the contact pin 3 and the rear signal port 7 in the contact direction C. The interconnection pin 6 bridges this gap mechanically and electrically and can directly transmit the signal between the contact pin 3 and the rear signal port 7.

[0091] Fig. 4 shows the electrical contact 1 of Figs. 1 to 3 in a cross-sectional view, the sectional plane being arranged along the second signal path 13.

[0092] The electrical connector 1 is shown in an assembled state and the second contact pin 11 is together with the further dielectric tube 67, and the ground contact element 14 pressed into the second cylindrical mating section 70. Also, the second interconnection pin 15 and the further dielectric tube 54 are mounted and pressed into the second tube acceptance opening 74. A longitudinal axis 85' of the second contact pin 11 runs along the plug direction P; a longitudinal axis 86' of the second interconnection pin 15 extends parallel to the contact direction C. The holding opening 71 for the second contact pin 11 intersects the second tube acceptance opening 74 in a second contact volume W.

[0093] The fastening end 75 and, in particular, its connection plane 76 of the second interconnection pin 15, rests on the second coupling end 66 of the second contact pin 11 and is electrically connected to the second contact pin 11 by this close-fitting contact 87. In the shown embodiment, the close-fitting contact 87 is sufficient for a secure electrical connection between the two pins 11 and 15. Thus, the second contact volume W needs not to be accessible from the outside when the electrical connector is assembled. If, however, the connection between the two pins shall be further secured, e.g. by soldering, at least one of the holding opening 71 and the second tube acceptance opening 74 can be shaped as a continuous channel, completely extending through the housing 5.

[0094] Like the interconnection pin 6, also the terminal end 15' of the second interconnection pin 15 can be elastically deflected against the contact direction C and can therefore also be shaped as so-called pogo-pin, the terminal ends 15' resting onto a spring arranged inside the

interconnection pins 15. All ends of the pins 3, 6, 11, 15 can be elastically deflectable and can, as the terminal end 6', 15', be designated as deflection sections 6', 15'.

[0095] The second cylindrical mating section 70 is shown as a separate part 88, which is shown inserted into a fixing bowl 89 of the housing 5, to which it is mechanically and electrically connected. Both cylindrical mating sections 30 and 70 can be shaped as separate parts and can each be affixed to the housing by a fixing bowl 89, e.g. by a force- or a form-fit. Alternatively, the cylindrical mating sections 30 and 70 can be formed as a single piece with the housing 5, e.g. by dye casting.

[0096] The diameter of the holding opening 71 of the second cylindrical mating section 70 is narrowed at its end 90, the narrowed end 90 being the extreme end of the holding opening 71 in the plug direction P. The further dielectric tube 67 is shaped with a circumferential groove 91 at its end facing in the plug direction P. In the assembled state of the second cylindrical mating section 70, the narrowed end 90 engages into the groove 91 and fixes the further dielectric tube 67 in an against the plug direction P.

[0097] The ground contact element 14 is directly pressed into the holding opening 72 and is in mechanical and electrical contact with the second cylindrical mating section 70.

[0098] Fig. 5 shows the electrical connector 1 in the cross-sectional view of Fig. 3 with an additional signal source or drain 92. The signal source or drain 92 comprises a printed circuit board 93, which extends in the lateral direction A and the plug direction P. The electrical connector 1 is placed onto the printed circuit board 93 in the contact direction C. Due to the movement of the electrical connector 1 towards the printed circuit board 93, the ground sleeve 8 and the terminal end 6' of the interconnection pin 6 abut against the board 93 and are elastically deflected against the contact direction C. The terminal end 6' is electrically connected to a track of the printed circuit board 93, the track being shaped for conducting the signal. The ground sleeve 8 rests upon a ground track of the printed circuit board 93 and connects the housing 5, the cylindrical mating section 30 and the electrical overload protection 40 with the ground track. Furthermore, the ground sleeve 8 electrically shields the terminal end 6'. A screw 94, of which only the screw head 95 is visible, is screwed through the printed circuit board 93 into the inside thread 18 of the spacer element 17, fixing the electrical connector 1 to the printed circuit board 93. The electrical connector 1 and in particular the front signal port 2 can be shaped as a type N connector, transmitting electrical signals in the Gigahertz range.

[0099] Fig. 6 shows the electrical connector 1 in a cross-sectional view according to Fig. 4 with the signal source or drain 92 comprising the printed circuit board 93. As in Fig. 5, the electrical connector 1 is moved towards the signal source or drain 92 in the contact direction C until the terminal end 15' of the second interconnection pin 15 is connected to a track of the printed circuit board 93 and is at least partially resiliently deflected against the contact direction C. As the housing 5 is already connected to the ground via the ground sleeve 8, no further connection to the ground is necessary. Via the second signal path 13, a test circuit may temporarily be connected to the signal source or drain 92. As a constant contact to the test circuit is unnecessary, an overload protection does not need to be connected to the second contact pin 11, especially if the second front signal port 10 is used as a test port only.

Claims

1. Electrical connector (1) housing at least one signal path (4) for a transmission of electrical signals in the Gigahertz range, wherein at one, front, end of the signal path (4) a front signal port (2) is arranged, the front signal port (2) being adapted to be connected to a mating electrical connector in a plug direction (P), and at the other, rear, end of the signal path (4), the other end opposing the front end with respect to the signal path (4), a rear signal port (7) is arranged, and wherein the signal path (4) comprises a contact pin (3), which projects into the front signal port (2) against the plug direction (P), **characterized in that** the signal path (4) further comprises an interconnection pin (6), which extends from the rear signal port (7) and rests on the contact pin (3).

2. Electrical connector (1) according to claim 1, **characterized in that** the electrical connector (1) comprises a second signal path (13), which includes a second front end with a second front signal port (12) that is accessible in the plug direction (P) and which further includes a second rear end opposing the second front end along the signal path (13), the second rear end comprising a second rear signal port (16), the second signal path (13) further comprising a second interconnection pin (15), which extends from the second rear signal port (16) and which rests on the second contact pin (11).

3. Electrical connector (1) according to claim 1 or 2, **characterized in that** in at least one signal path (4, 13) the contact pin (3, 11) abuts on the interconnection pin (6, 15) in a point of contact (87, 87').

4. Electrical connector (1) according to claim 3, **characterized in that** the point of contact (87, 87') is located at a free end of at least one of the respective contact pin (3, 11) or interconnection pin (6, 15).

5. Electrical connector (1) according to any of claims 1 to 4, **characterized in that** in at least one signal path (4, 13), one of the contact pin (3, 11) and the interconnection pin (6, 15) supports the other one of the contact pin (3, 11) and the interconnection pin

(6, 15).

6. Electrical connector (1) according to any of claims 1 to 5, **characterized in that** in at least one signal path (4, 13), the contact pin (3, 11) and the interconnection pin (6, 15) are affixed to each other.

7. Electrical connector (1) according to any of claims 1 to 6, **characterized in that** in at least one signal path (4, 13), the contact pin (3, 11) or the interconnection pin (6, 15) comprises a deflection section (6', 15') that is elastically deflectable along a longitudinal axis (85, 85', 86, 86') of the respective pin (3, 6, 11, 15).

8. Electrical connector (1) according to any of claims 1 to 7, **characterized in that** in at least one signal path (4, 13), the contact pin (3, 11) extends perpendicular to the interconnection pin (6, 15).

9. Electrical connector (1) according to any of claims 1 to 8, **characterized in that** a ground sleeve (8) is provided that is electrically connected to a housing (5) of the electrical connector (1) and into which one of the interconnection pins (6, 15) protrudes.

10. Electrical connector (1) according to claim 9, **characterized in that** the ground sleeve (8) is mounted to the housing (5) to be elastically deflectable parallel to the interconnection pin (6, 15) that it surrounds.

11. Electrical connector (1) according to any of claims 1 to 10, **characterized in that** the electrical connector (1) is equipped with an electrical overload protection (40) that is electrically connected to at least one of the contact pins (3, 11).

12. Electrical connector (1) according to claim 11, **characterized in that** the overload protection (40) is clamped between the housing (5) and the at least one contact pin (3, 11).

13. Electrical connector (1) according to any of claims 1 to 12, **characterized in that** at least one of the front signal ports (2, 10) is equipped with a ground contact element (14) neighbouring the respective contact pin (3, 11), the ground contact element (14) being electrically connected to the housing (5).

14. Electrical connector (1) according to any of claims 1 to 13, **characterized in that** the electrical connector (1) comprises a spacer element (17), which is adapted to affix the electrical connector (1) to a signal source or drain (92), the spacer element (17) being located between the rear signal ports (7, 16) and extending parallel to at least one of the interconnection pins (6, 15).

15. Electrical connector (1) according to any of claims 1 to 14, **characterized in that** at least one of the front signal ports (2, 10) is shaped as a type N-connector.

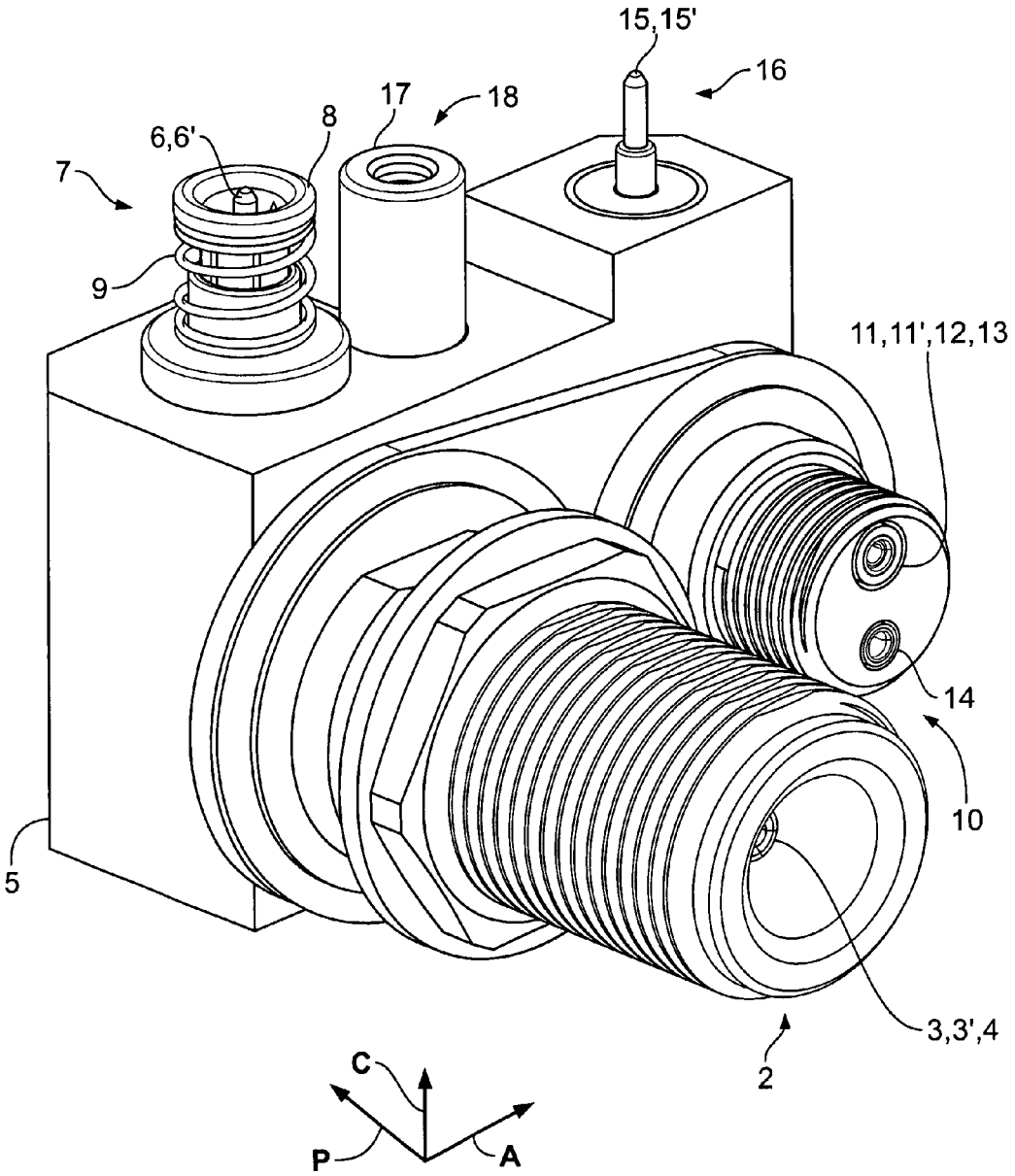

Fig. 1

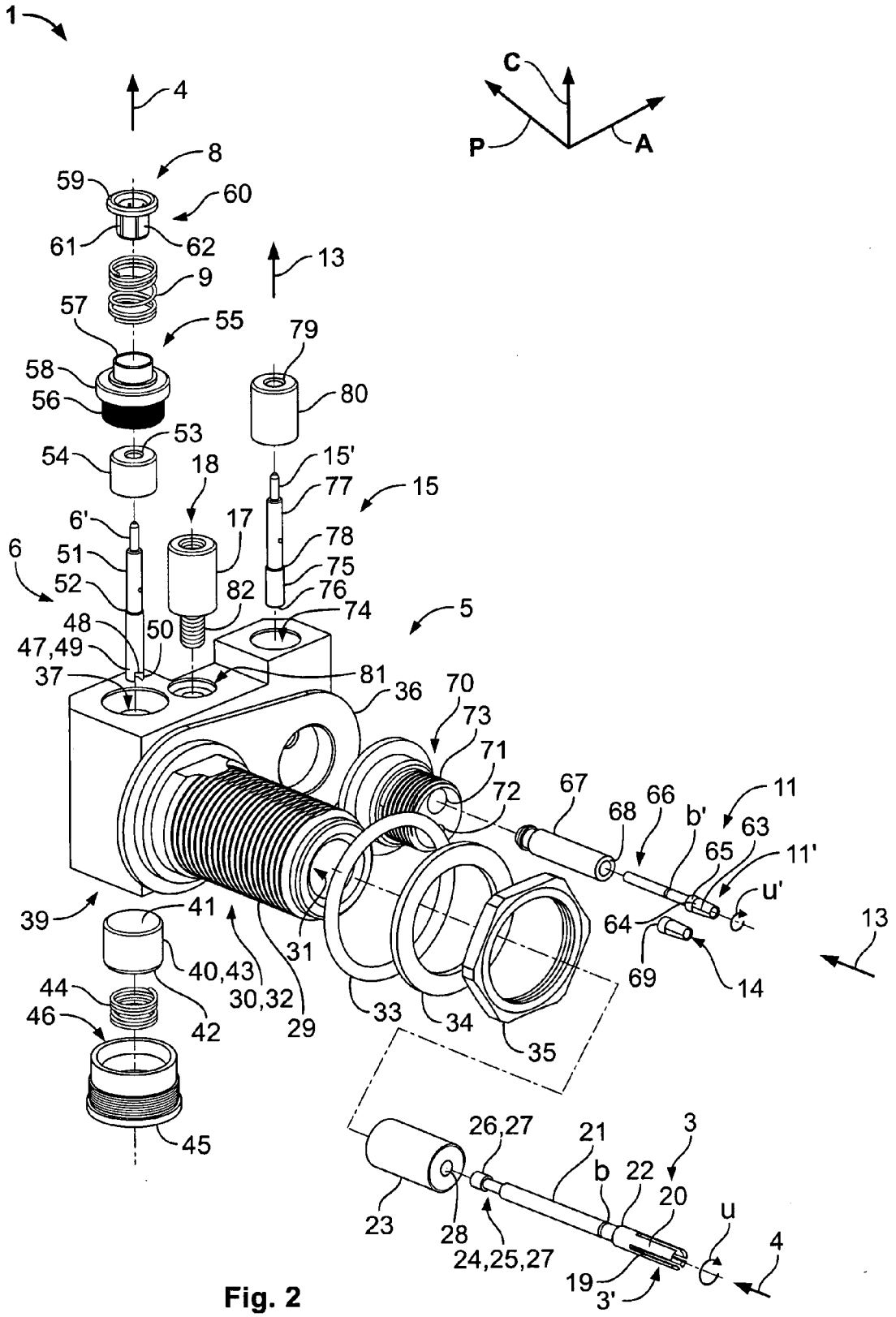
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Fig. 2

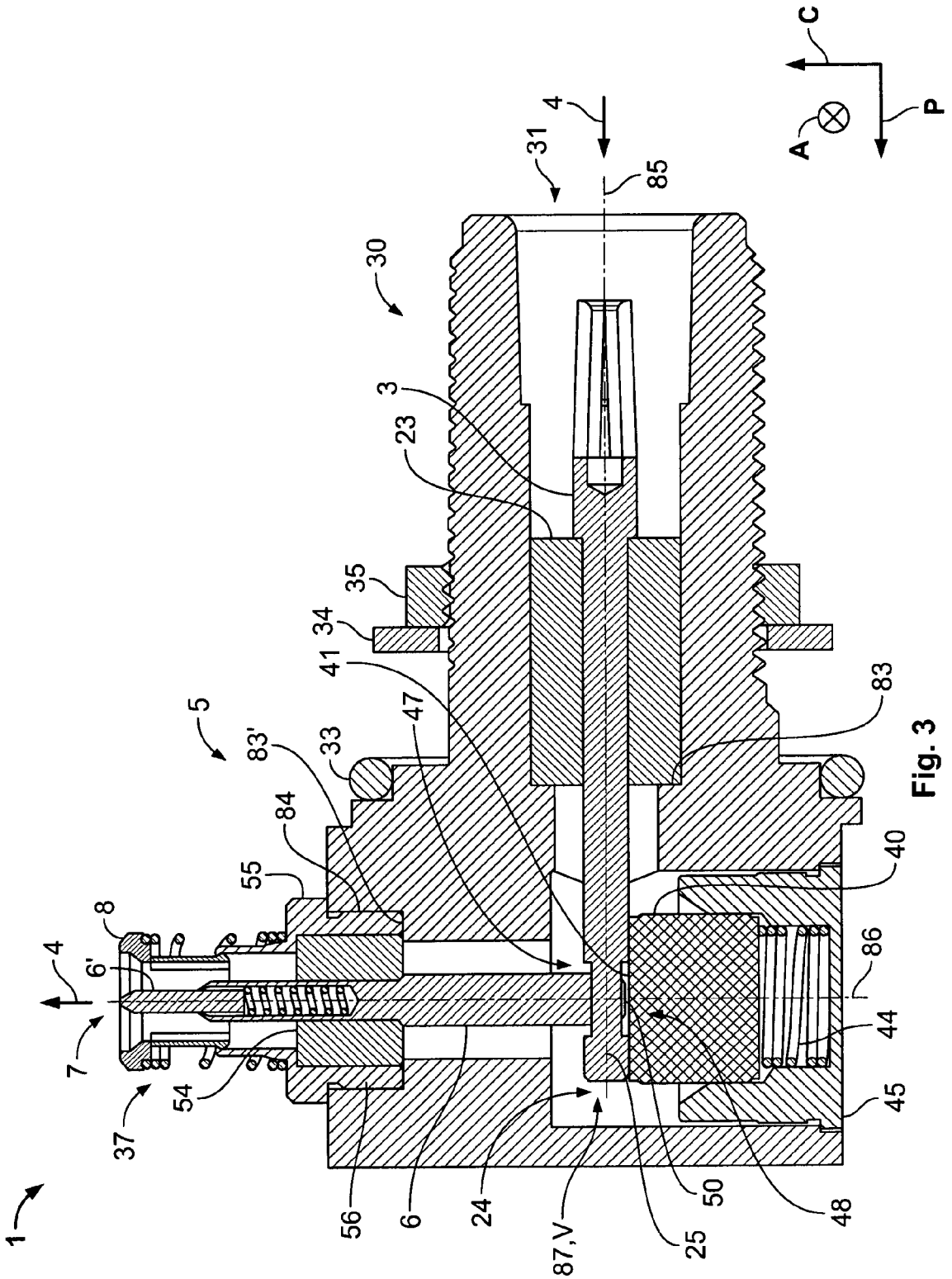
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Fig. 3

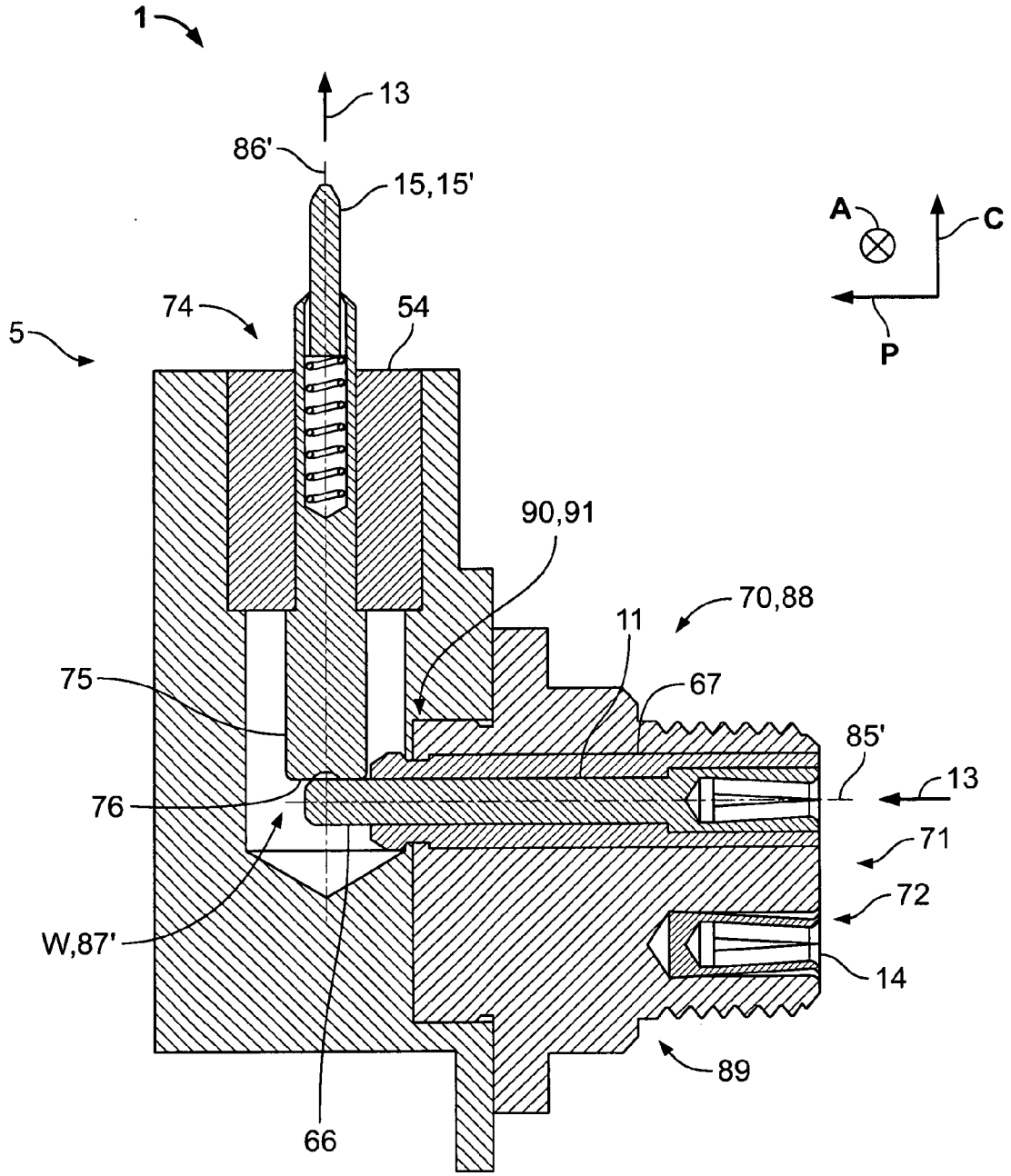
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Fig. 4

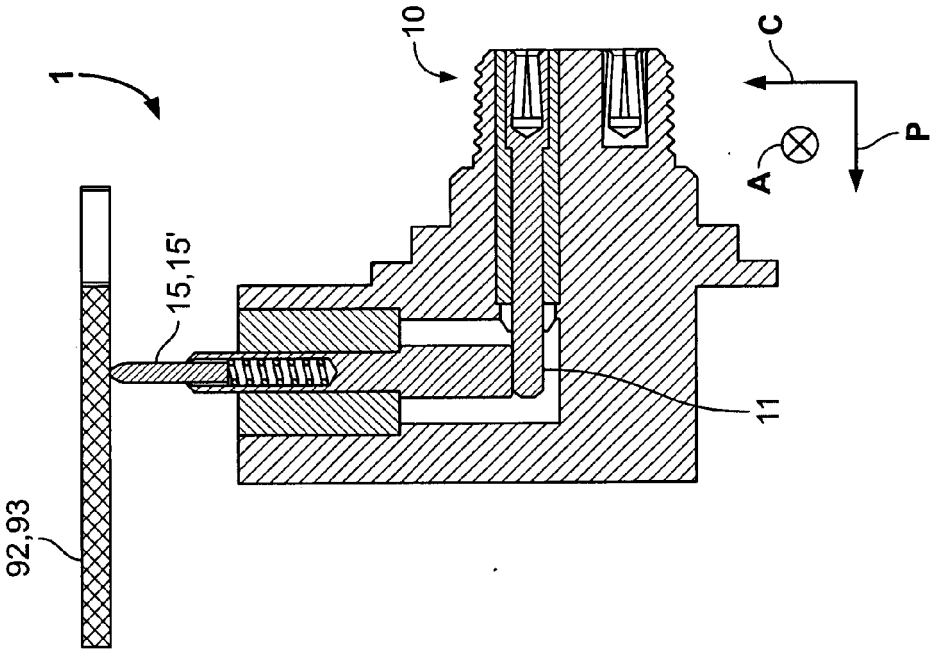

Fig. 6

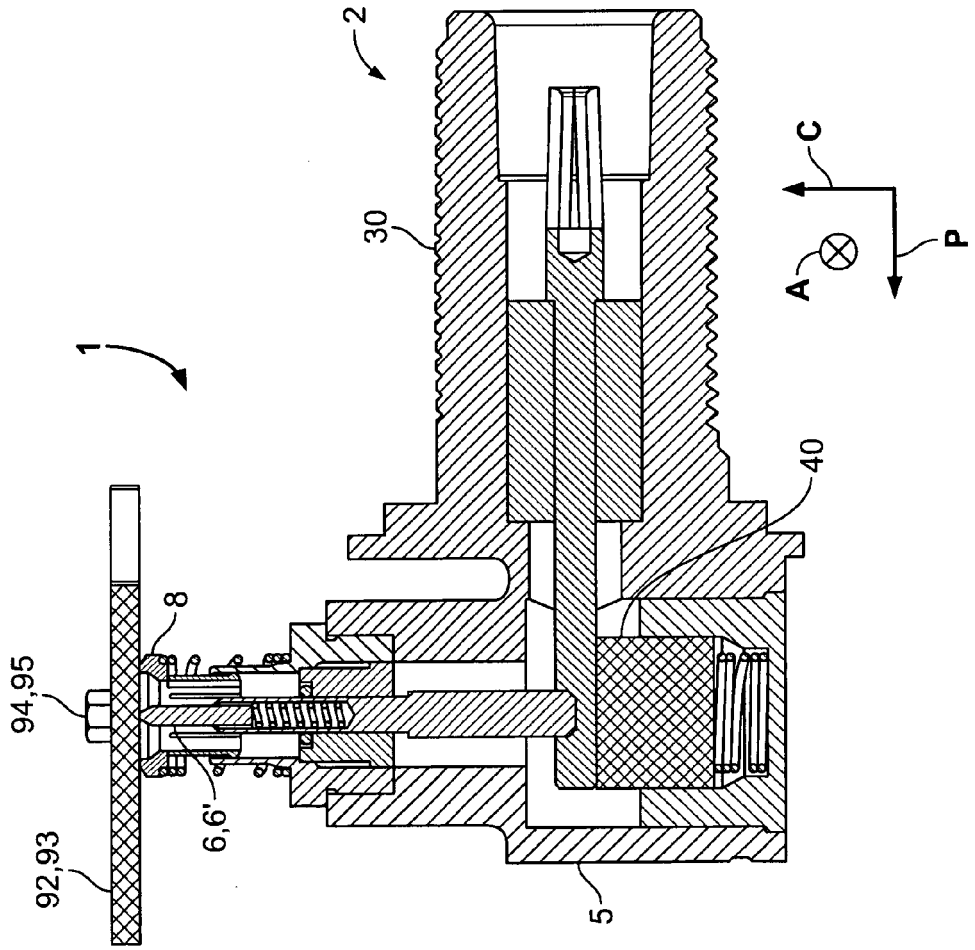

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 10 00 2742

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H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	1 July 2010	Vautrin, Florent

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