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(54) Titre : RACCORD D'APPAREIL DE PLOMBERIE ELECTRONIQUE AVEC SOUPAPE ELECTRONIQUE AYANT UNE FAIBLE FORCE DE FERMETURE, UNE FAIBLE FORCE D'ETANCHEITE, UN FONCTIONNEMENT SEQUENTIEL, ET PLUSIEURS MODES DE FONCTIONNEMENT

(54) Title: ELECTRONIC PLUMBING FIXTURE FITTING WITH ELECTRONIC VALVE HAVING LOW CLOSING FORCE, LOW SEAL FORCE, SEQUENTIAL OPERATION, AND OPERATION MODES

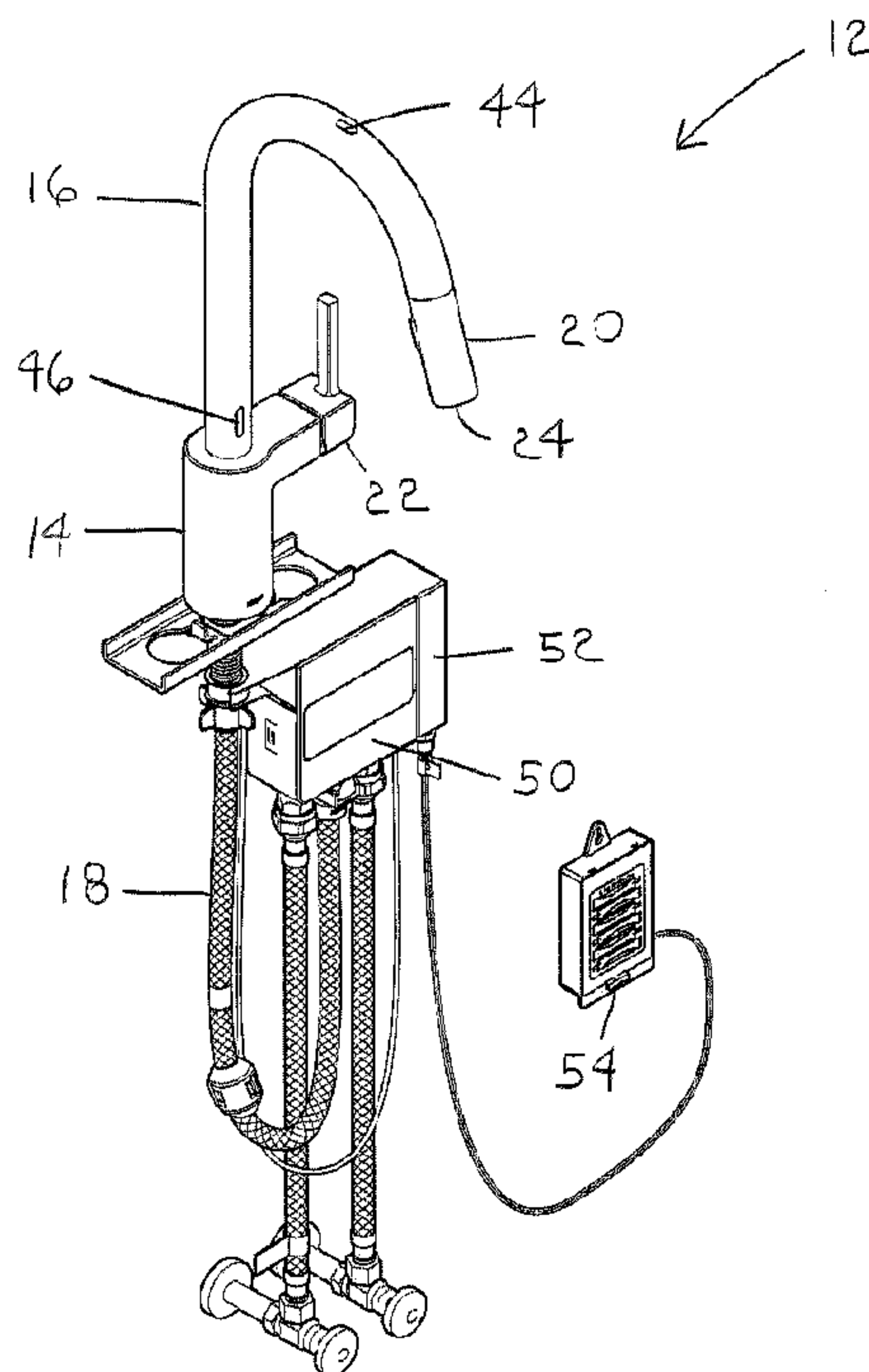


Figure 2

(57) Abrégé/Abstract:

The present invention provides an electronic plumbing fixture fitting with an electronic valve having a low closing force, a low seal force, sequential operation, and operation modes, such as an electronic faucet with an electronic valve having a low closing force, a low seal force, sequential operation, and operation modes.

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[Continued on next page]

(54) Title: ELECTRONIC PLUMBING FIXTURE FITTING WITH ELECTRONIC VALVE HAVING LOW CLOSING FORCE, LOW SEAL FORCE, SEQUENTIAL OPERATION, AND OPERATION MODES

(57) Abstract: The present invention provides an electronic plumbing fixture fitting with an electronic valve having a low closing force, a low seal force, sequential operation, and operation modes, such as an electronic faucet with an electronic valve having a low closing force, a low seal force, sequential operation, and operation modes.

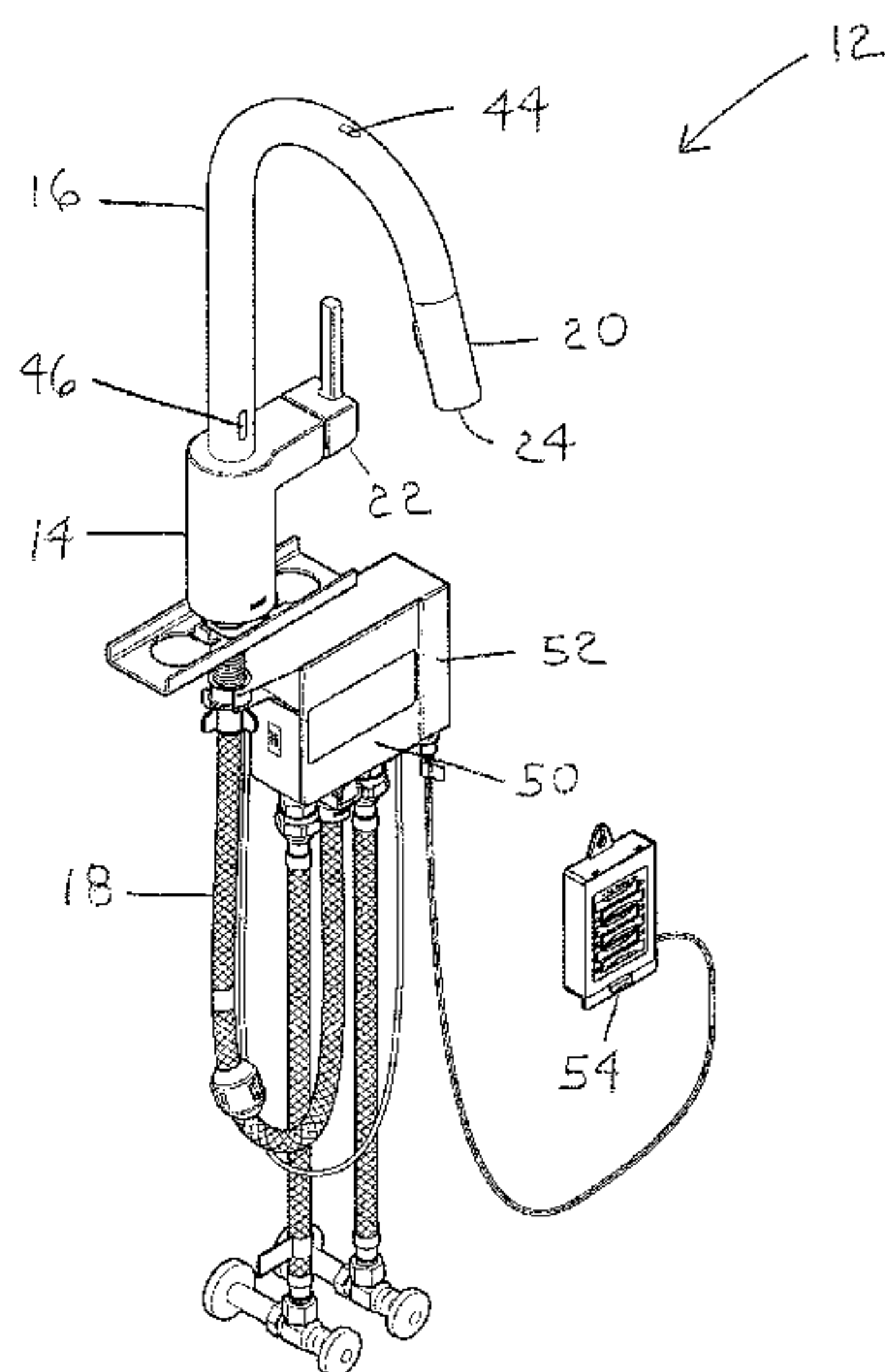


Figure 2

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**ELECTRONIC PLUMBING FIXTURE FITTING WITH
ELECTRONIC VALVE HAVING LOW CLOSING FORCE,
LOW SEAL FORCE, SEQUENTIAL OPERATION,
AND OPERATION MODES**

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application Nos. 62/105,170, 62/105,171, 62/105,173, and 62/105,177, filed January 19, 2015, the entire disclosures of which are hereby incorporated by reference.

FIELD

[0002] The present invention relates generally to an electronic plumbing fixture fitting with an electronic valve having a low closing force, a low seal force, sequential operation, and operation modes, such as an electronic faucet with an electronic valve having a low closing force, a low seal force, sequential operation, and operation modes.

BACKGROUND

[0003] Electronic plumbing fixture fittings, such as electronic faucets, are well known. Such electronic plumbing fixture fittings are used in residential and commercial applications, such as in kitchens, bathrooms, and various other locations.

SUMMARY

[0004] The present invention provides an electronic plumbing fixture fitting with an electronic valve having a low closing force, a low seal force, sequential operation, and operation modes.

[0005] In an exemplary embodiment, the electronic plumbing fixture fitting comprises a discharge outlet and an electronic valve. The discharge outlet is operable to deliver water. The electronic valve is operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated. The electronic valve includes a valve inlet, a valve outlet, a shaft, a shaft sealing member, a piston, a piston sealing member, and a seat. The shaft is operable to attach to the piston. The shaft sealing member is operable to be received on the shaft. The shaft sealing member has an inner diameter and an outer diameter. When received on the shaft, the shaft sealing member is located upstream of the valve outlet. The piston is operable to interface with the seat. The piston includes a body and a nose. The piston sealing member is operable to be received on the nose of the piston. The piston sealing member has an inner diameter and an outer diameter. When received on the nose of the piston, the piston sealing member is located upstream of the valve outlet. The seat includes a body. The body includes a central opening extending therethrough. A ratio of the outer diameter of the piston sealing member to the inner diameter of the shaft sealing member is between approximately one and four tenths and three and nine tenths.

[0006] In an exemplary embodiment, the electronic plumbing fixture fitting comprises a discharge outlet and an electronic valve. The discharge outlet is operable to deliver water. The electronic valve is operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when

the electronic valve is deactivated. The electronic valve includes a valve inlet, a valve outlet, a shaft, a shaft sealing member, a piston, a piston sealing member, and a seat. The shaft is operable to attach to the piston. The shaft sealing member is operable to be received on the shaft. The shaft sealing member has an inner diameter and an outer diameter. During operation of the electronic valve, the shaft sealing member is under pressure from a supply line. The piston is operable to interface with the seat. The piston includes a body and a nose. The piston sealing member is operable to be received on the nose of the piston. The piston sealing member has an inner diameter and an outer diameter. During operation of the electronic valve, the piston sealing member is under pressure from the supply line. The seat includes a body. The body includes a central opening extending therethrough. A ratio of the outer diameter of the piston sealing member to the inner diameter of the shaft sealing member is between approximately one and four tenths and three and nine tenths.

[0007] In an exemplary embodiment, the electronic plumbing fixture fitting comprises a discharge outlet and an electronic valve. The discharge outlet is operable to deliver water. The electronic valve is operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated. The electronic valve includes a valve inlet, a valve outlet, a shaft, a shaft sealing member, a piston, a piston sealing member, and a seat. The shaft is operable to attach to one of the piston and the seat. The shaft sealing member is operable to be received on the shaft. The shaft sealing member has an inner diameter and an outer diameter. The piston is operable to interface with the seat. The piston includes a body and a nose. The piston sealing member is operable to be received on the nose of the piston. The piston sealing member has an inner diameter and an outer diameter. The seat includes a body. The body

includes a central opening extending therethrough. With a supply line pressure of approximately sixty pounds per square inch, a force required to close the electronic valve is between approximately five tenths pounds and eleven pounds.

[0008] In an exemplary embodiment, the electronic plumbing fixture fitting comprises a discharge outlet and an electronic valve. The discharge outlet is operable to deliver water. The electronic valve is operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated. The electronic valve includes a motor, a piston, a seat, and a sealing member. One of the piston and the seat is operable to move relative to the other of the piston and the seat. The sealing member is operable to be received on one of the piston and the seat. The motor is operable to move one of the piston and the seat relative to the other of the piston and the seat so that the piston is out of the seat to open the electronic valve. The motor is operable to move one of the piston and the seat relative to the other of the piston and the seat so that the piston is in the seat to close the electronic valve. Upon startup of the electronic valve, the motor is actuated a predetermined number of startup open steps causing the piston to be out of the seat. The predetermined number of startup open steps is greater than a maximum number of open steps required for the electronic valve to be in a completely open position. After the motor has been actuated the predetermined number of startup open steps, the motor is actuated a predetermined number of startup close steps causing the piston to be in sealing contact with the seat. The predetermined number of startup close steps is greater than a maximum number of close steps required for the electronic valve to be in a completely closed position.

[0009] In an exemplary embodiment, the electronic plumbing fixture fitting comprises a discharge outlet and an electronic valve. The discharge outlet is operable to deliver water. The

electronic valve is operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated. The electronic valve includes a motor, a piston, a seat, and a sealing member. One of the piston and the seat is operable to move relative to the other of the piston and the seat. The sealing member is operable to be received on one of the piston and the seat. The motor is operable to move one of the piston and the seat relative to the other of the piston and the seat so that the piston is out of the seat to open the electronic valve. The motor is operable to move one of the piston and the seat relative to the other of the piston and the seat so that the piston is in the seat to close the electronic valve. During a full opening operation of the electronic valve, the motor is actuated a predetermined number of full open steps causing the piston to be out of the seat. The predetermined number of full open steps is at least a maximum number of open steps required for the electronic valve to be in a completely open position. During a full closing operation of the electronic valve, the motor is actuated a predetermined number of full close steps causing the piston to be in sealing contact with the seat. The predetermined number of full close steps is at least a maximum number of close steps required for the electronic valve to be in a completely closed position. After the motor has been actuated the predetermined number of full close steps, the motor is actuated a predetermined number of seal compression steps to ensure that the sealing member is compressed.

[0010] In an exemplary embodiment, the electronic plumbing fixture fitting comprises a discharge outlet and an electronic valve. The discharge outlet is operable to deliver water. The electronic valve is operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated. The electronic valve includes a motor, a piston, a seat, and a

sealing member. One of the piston and the seat is operable to move relative to the other of the piston and the seat. The sealing member is operable to be received on one of the piston and the seat. The motor is operable to move one of the piston and the seat relative to the other of the piston and the seat so that the piston is out of the seat to open the electronic valve. The motor is operable to move one of the piston and the seat relative to the other of the piston and the seat so that the piston is in the seat to close the electronic valve. Upon startup of the electronic valve, the motor is actuated a predetermined number of startup open steps causing the piston to be out of the seat. The predetermined number of startup open steps is greater than a maximum number of open steps required for the electronic valve to be in a completely open position. After the motor has been actuated the predetermined number of startup open steps, the motor is actuated a predetermined number of startup close steps causing the piston to be in sealing contact with the seat. The predetermined number of startup close steps is greater than a maximum number of close steps required for the electronic valve to be in a completely closed position. After the motor has been actuated the predetermined number of startup close steps, the motor is actuated a predetermined number of seal compression steps to ensure that the sealing member is compressed. During a full opening operation of the electronic valve, the motor is actuated a predetermined number of full open steps causing the piston to be out of the seat. The predetermined number of full open steps is at least the maximum number of open steps required for the electronic valve to be in the completely open position. During a full closing operation of the electronic valve, the motor is actuated a predetermined number of full close steps causing the piston to be in sealing contact with the seat. The predetermined number of full close steps is at least the maximum number of close steps required for the electronic valve to be in the completely closed position. After the motor has been actuated the predetermined number of full

close steps, the motor is actuated the predetermined number of seal compression steps to ensure that the sealing member is compressed.

[0011] In an exemplary embodiment, the electronic plumbing fixture fitting comprises a discharge outlet, a hot water electronic valve, a cold water electronic valve, and an actuation device. The discharge outlet is operable to deliver water. The water electronic valve and the cold water electronic valve are operable to permit flow of water through the discharge outlet when at least one of the hot water electronic valve and the cold water electronic valve is activated and to not permit flow of water through the discharge outlet when both of the hot water electronic valve and the cold water electronic valve are deactivated. The actuation device is operable to indicate a desired change to at least one parameter of water flowing through the discharge outlet. When the desired change to the water flowing through the discharge outlet requires activation of both the hot water electronic valve and the cold water electronic valve, the hot water electronic valve and the cold water electronic valve are alternately activated until desired positions of both the hot water electronic valve and the cold water electronic valve are reached.

[0012] In an exemplary embodiment, the electronic plumbing fixture fitting comprises a discharge outlet, a hot water electronic valve, a cold water electronic valve, and an actuation device. The discharge outlet is operable to deliver water. The water electronic valve and the cold water electronic valve are operable to permit flow of water through the discharge outlet when at least one of the hot water electronic valve and the cold water electronic valve is activated and to not permit flow of water through the discharge outlet when both of the hot water electronic valve and the cold water electronic valve are deactivated. The actuation device is operable to indicate a desired change to at least one parameter of water flowing through the

discharge outlet. When the desired change to the water flowing through the discharge outlet will result in an increasing volume through one of the hot water electronic valve and the cold water electronic valve and a decreasing volume through the other of the hot water electronic valve and the cold water electronic valve, whichever of the hot water electronic valve and the cold water electronic valve has the increasing volume is activated first and whichever of the hot water electronic valve and the cold water electronic valve has the decreasing volume is activated second.

[0013] In an exemplary embodiment, the electronic plumbing fixture fitting comprises a discharge outlet, a hot water electronic valve, a cold water electronic valve, and an actuation device. The discharge outlet is operable to deliver water. The water electronic valve and the cold water electronic valve are operable to permit flow of water through the discharge outlet when at least one of the hot water electronic valve and the cold water electronic valve is activated and to not permit flow of water through the discharge outlet when both of the hot water electronic valve and the cold water electronic valve are deactivated. The actuation device is operable to indicate a desired change to at least one parameter of water flowing through the discharge outlet. When the actuation device is moved quickly, each of the hot water electronic valve and the cold water electronic valve is alternately activated a single time to desired positions of both the hot water electronic valve and the cold water electronic valve. When the actuation device is moved slowly, the hot water electronic valve and the cold water electronic valve are alternately activated multiple times until desired positions of both the hot water electronic valve and the cold water electronic valve are reached.

[0014] In an exemplary embodiment, the electronic plumbing fixture fitting comprises a discharge outlet, an electronic valve, an activation sensor, an actuation device, and a parameter

sensor. The discharge outlet is operable to deliver water. The electronic valve is operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated. The activation sensor is operable to activate and deactivate the electronic valve. The actuation device is operable to activate and deactivate the electronic valve. The actuation device is operable to indicate a desired change to a parameter of water flowing through the discharge outlet. The parameter sensor is operable to detect the desired activation and deactivation of the electronic valve by the actuation device. The parameter sensor is operable to detect the desired change to the parameter of water flowing through the discharge outlet. The parameter sensor includes an emitter and a detector. When the activation sensor activates and deactivates the electronic valve, the electronic plumbing fixture fitting is in a sensor mode. When the actuation device activates and deactivates the electronic valve, the electronic plumbing fixture fitting is in a manual mode. In the sensor mode, energy is transmitted from the emitter at a first rate of transmission, and energy is detected by the detector at a first rate of detection. In the manual mode, energy is transmitted from the emitter at a second rate of transmission, and energy is detected by the detector at a second rate of detection. The first rate of transmission is less frequent than the second rate of transmission. The first rate of detection is less frequent than the second rate of detection.

[0015] In an exemplary embodiment, the electronic plumbing fixture fitting comprises a discharge outlet, an electronic valve, an activation sensor, an actuation device, and a parameter sensor. The discharge outlet is operable to deliver water. The electronic valve is operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated.

The activation sensor is operable to activate and deactivate the electronic valve. The actuation device is operable to activate and deactivate the electronic valve. The actuation device is operable to indicate a desired change to a parameter of water flowing through the discharge outlet. The parameter sensor is operable to detect the desired activation and deactivation of the electronic valve by the actuation device. The parameter sensor is operable to detect the desired change to the parameter of water flowing through the discharge outlet. The parameter sensor includes a first emitter, a second emitter, a first detector, and a second detector. When the activation sensor activates and deactivates the electronic valve, the electronic plumbing fixture fitting is in a sensor mode. When the actuation device activates and deactivates the electronic valve, the electronic plumbing fixture fitting is in a manual mode. In the sensor mode, energy is transmitted from the first emitter and the second emitter at a first rate of transmission, and energy is detected by the first detector and the second detector at a first rate of detection. In the manual mode, energy is transmitted from the first emitter and the second emitter at a second rate of transmission, and energy is detected by the first detector and the second detector at a second rate of detection. The first rate of transmission is less frequent than the second rate of transmission. The first rate of detection is less frequent than the second rate of detection.

[0016] In an exemplary embodiment, the electronic plumbing fixture fitting comprises a discharge outlet, an electronic valve, an activation sensor, an actuation device, and a parameter sensor. The discharge outlet is operable to deliver water. The electronic valve is operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated. The activation sensor is operable to activate and deactivate the electronic valve. The actuation device is operable to activate and deactivate the electronic valve. The actuation device is

operable to indicate a desired change to a parameter of water flowing through the discharge outlet. The parameter sensor is operable to detect the desired activation and deactivation of the electronic valve by the actuation device. The parameter sensor is operable to detect the desired change to the parameter of water flowing through the discharge outlet. The parameter sensor includes a first emitter, a second emitter, a first detector, and a second detector. When the activation sensor activates and deactivates the electronic valve, the electronic plumbing fixture fitting is in a sensor mode. When the actuation device activates and deactivates the electronic valve, the electronic plumbing fixture fitting is in a manual mode. In the sensor mode, energy is alternately transmitted from the first emitter and the second emitter, and energy is alternately detected by the first detector and the second detector. In the manual mode, energy is simultaneously transmitted from the first emitter and the second emitter, and energy is simultaneously detected by the first detector and the second detector.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Figure 1 is a schematic illustration of an electronic plumbing fixture fitting according to an exemplary embodiment of the present invention;

[0018] Figure 2 is a perspective view of an electronic faucet according to an exemplary embodiment of the present invention;

[0019] Figures 3a and 3b include views of an electronic mixing valve, including a hot water electronic valve, a cold water electronic valve, and a housing, according to an exemplary embodiment of the present invention - Figure 3a is an exploded perspective view, and Figure 3b is a central cross-sectional view;

[0020] Figures 4a-4f include views of the hot/cold water electronic valve of Figures 3a and 3b, including a piston and a seat, according to an exemplary embodiment of the present

invention - Figure 4a is a perspective view, Figure 4b is an exploded perspective view, Figure 4c is a front view, Figure 4d is a top view, Figure 4e is a bottom view, and Figure 4f is a central cross-sectional view;

[0021] Figures 5a-5g include views of the housing of Figures 3a and 3b, according to an exemplary embodiment of the present invention - Figure 5a is a perspective view, Figure 5b is a front view, Figure 5c is a left view, Figure 5d is a right view, Figure 5e is a top view, Figure 5f is a bottom view, and Figure 5g is a central cross-sectional view;

[0022] Figures 6a-6e include views of the piston of Figures 4a-4f, including a body and a nose, according to an exemplary embodiment of the present invention - Figure 6a is a perspective view, Figure 6b is a front view, Figure 6c is a left view, Figure 6d is a central cross-sectional view, and Figure 6e is a detailed front view of the nose;

[0023] Figures 7a-7e include views of the seat of Figures 4a-4f, including a body and projections, according to an exemplary embodiment of the present invention - Figure 7a is a perspective view, Figure 7b is a front view, Figure 7c is a top view, Figure 7d is a central cross-sectional view, and Figure 7e is a detailed central cross-sectional view of a portion of the body;

[0024] Figures 8a-8e include central cross-sectional views of the piston and the seat of Figures 6a-6e and 7a-7e during various phases of operation of the hot/cold water electronic valve of Figures 4a-4f incorporating the piston and the seat of Figures 6a-6e and 7a-7e - Figure 8a shows a completely closed position, Figure 8b shows a cracked open position, Figure 8c shows an open position in which flow begins to increase, Figure 8d shows a half open position, and Figure 8e shows a completely open position;

[0025] Figures 9a-9d include views of another embodiment of a piston, including a body and a nose, according to another exemplary embodiment of the present invention - Figure 9a is a

perspective view, Figure 9b is a front view, Figure 9c is a left view, and Figure 9d is a central cross-sectional view;

[0026] Figures 10a-10d include views of another embodiment of a seat, including a body and projections, according to another exemplary embodiment of the present invention - Figure 10a is a perspective view, Figure 10b is a front view, Figure 10c is a top view, and Figure 10d is a central cross-sectional view;

[0027] Figures 11a-11e include central cross-sectional views of the piston and the seat of Figures 9a-9d and 10a-10d during various phases of operation of the hot/cold water electronic valve of Figures 4a-4f incorporating the piston and the seat of Figures 9a-9d and 10a-10d - Figure 11a shows a completely closed position, Figure 11b shows a cracked open position, Figure 11c shows an open position in which flow begins to increase, Figure 11d shows a half open position, and Figure 11e shows a completely open position;

[0028] Figure 12 includes data for the hot/cold water electronic valve of Figures 4a-4f incorporating the piston and the seat of Figures 6a-6e and 7a-7e, including piston sealing member data, shaft sealing member data, and closing force data; and

[0029] Figures 13a and 13b include views of portions of the electronic faucet of Figure 2, including a parameter sensor, according to an exemplary embodiment of the present invention - Figure 13a is an exploded perspective view including the parameter sensor, and Figure 13b is a schematic illustration of the parameter sensor.

DETAILED DESCRIPTION

[0030] The present invention provides an electronic plumbing fixture fitting. In an exemplary embodiment, the electronic plumbing fixture fitting is an electronic faucet. However, one of ordinary skill in the art will appreciate that the electronic plumbing fixture fitting could be

an electronic showering system, an electronic showerhead, an electronic handheld shower, an electronic body spray, an electronic side spray, or any other electronic plumbing fixture fitting.

[0031] An exemplary embodiment of an electronic plumbing fixture fitting 10, such as an electronic faucet 12, is illustrated in Figure 1. An exemplary embodiment of the electronic faucet 12 is illustrated in Figure 2.

[0032] In the illustrated embodiment, as best shown in Figure 2, the faucet 12 includes a hub 14, a spout 16, a flexible hose 18, a wand 20, and a handle 22. An upstream end of the hub 14 is connected to a mounting surface (such as a counter or sink). An upstream end of the spout 16 is connected to a downstream end of the hub 14. The spout 16 is operable to rotate relative to the hub 14. The flexible hose 18 extends through the hub 14 and the spout 16 and is operable to move within the hub 14 and the spout 16. An upstream end of the wand 20 is mounted in a downstream end of the spout 16 and is connected to a downstream end of the flexible hose 18. A downstream end of the wand 20 includes a discharge outlet 24 through which water is delivered from the faucet 12. The wand 20 is operable to be pulled away from the spout 16. The handle 22 covers a side opening in the hub 14 and is operable to be moved relative to the hub 14. Although the faucet 12 has been described as having a rotatable spout 16, a pull-out or pull-down wand 20, and a handle 22 mounted on the hub 14, one of ordinary skill in the art will appreciate that the spout 16 could be fixed relative to the hub 14, the faucet 12 may not include a wand 20, the handle 22 may be mounted on other locations on the faucet 12 or remote from the faucet 12, the faucet 12 could include more than one handle 22, the handle 22 may be any mechanical actuation device or user interface, and/or the faucet 12 may not include a handle 22.

[0033] Additionally, in the illustrated embodiment, as best shown in Figure 1, the fitting 10 includes a hot water line 26, a cold water line 28, a mixed water line 30, and an electronic

mixing valve 32. The electronic mixing valve 32 includes a hot water electronic valve 34 and a cold water electronic valve 36. An upstream end of the hot water line 26 connects to a hot water supply 38, and an upstream end of the cold water line 28 connects to a cold water supply 40. A downstream end of the hot water line 26 connects to the electronic mixing valve 32, and more specifically, the hot water electronic valve 34. A downstream end of the cold water line 28 connects to the electronic mixing valve 32 and, more specifically, the cold water electronic valve 36. An upstream end of the mixed water line 30 connects to the electronic mixing valve 32. A downstream end of the mixed water line 30 connects to the discharge outlet 24. In the illustrated embodiments, at least a portion of the mixed water line 30 is the flexible hose 18. As stated above, the downstream end of the flexible hose 18 connects to the upstream end of the wand 20. Although the faucet 12 has been described as including a hot water electronic valve 34 and a cold water electronic valve 36, one of ordinary skill in the art will appreciate that the faucet 12 could include one or more electronic valves and/or the faucet 12 could include one or more mechanical valves in series or in parallel with the electronic valve(s).

[0034] In an exemplary embodiment, the hot water electronic valve 34 and the cold water electronic valve 36 are proportional valves and, more specifically, stepper motor actuated valves. However, one of ordinary skill in the art will appreciate that, in some embodiments, the electronic valves could be any type of electronic valves.

[0035] Further, in the illustrated embodiments, as best shown in Figures 1 and 2, the fitting 10 includes an activation sensor 42, such as a toggle sensor 44 and a presence sensor 46 of the faucet 12.

[0036] In an exemplary embodiment, the toggle sensor 44 is a proximity sensor and, in particular, an infrared sensor. The toggle sensor 44 is also referred to as a latching sensor and a

sustained-flow sensor. In the illustrated embodiment, the toggle sensor 44 is mounted on an apex of the spout 16. The toggle sensor 44 defines a toggle zone. In an exemplary embodiment, the toggle sensor 44 is operable to activate the hot water electronic valve 34 and the cold water electronic valve 36 when an object enters the toggle zone and to deactivate the hot water electronic valve 34 and the cold water electronic valve 36 when the object exits and reenters the toggle zone. As used herein, an “object” can be any portion of a user’s body or any item used by the user to trigger the toggle sensor 44. In an exemplary embodiment, the toggle zone extends generally upwardly from the toggle sensor 44. Additionally, in an exemplary embodiment, the toggle zone has a generally cone-like shape.

[0037] In an exemplary embodiment, the presence sensor 46 is a proximity sensor, and, in particular, an infrared sensor. The presence sensor 46 is also referred to as a quick-strike sensor. In the illustrated embodiment, the presence sensor 46 is mounted on the upstream end of the spout 16. The presence sensor 46 defines a presence zone. In an exemplary embodiment, the presence sensor 46 is operable to activate the hot water electronic valve 34 and the cold water electronic valve 36 when an object enters the presence zone and to deactivate the hot water electronic valve 34 and the cold water electronic valve 36 when the object exits the presence zone. Again, as used herein, an “object” can be any portion of a user’s body or any item used by the user to trigger the presence sensor 46. In an exemplary embodiment, the presence zone extends generally horizontally from the presence sensor 46. Additionally, in an exemplary embodiment, the presence zone has a generally cone-like shape.

[0038] As described above, the toggle sensor 44 and the presence sensor 46 are proximity sensors and, in particular, infrared sensors. Proximity sensors are sensors that detect the presence of an object without any physical contact. However, one of ordinary skill in the art will

appreciate that the toggle sensor 44 and the presence sensor 46 could be any type of electronic sensors that can be triggered, including, but not limited to, other proximity sensors, touch sensors, and image sensors. Exemplary electronic sensors include, but are not limited to, electromagnetic radiation sensors (such as optical sensors and radar sensors), capacitance sensors, inductance sensors, piezo-electric sensors, and multi-pixel optical sensors (such as camera sensors). Moreover, the toggle sensor 44 and the presence sensor 46 may not be the same type of sensor. As further described above, the toggle sensor 44 is mounted on the apex of the spout 16 and the presence sensor 46 is mounted on the upstream end of the spout 16. However, one of ordinary skill in the art will appreciate that the toggle sensor 44 and the presence sensor 46 could be mounted in any location on the faucet 12 or in a location remote from the faucet 12. Furthermore, the toggle sensor 44 and the presence sensor 46 may be located in close proximity to each other or fairly remote from each other.

[0039] Similarly, as described above, the sensors are a toggle sensor 44 and a presence sensor 46. However, one of ordinary skill in the art will appreciate that the toggle sensor 44 and the presence sensor 46 could be any type of sensors that provide information useful in determining whether to activate or deactivate the hot water electronic valve 34 and the cold water electronic valve 36, including, but not limited to, flow sensors, pressure sensors, temperature sensors, and position sensors. Moreover, the toggle sensor 44 and the presence sensor 46 may be the same type of sensor.

[0040] Further, in the illustrated embodiment, as best shown in Figure 1, the fitting 10 includes a parameter sensor 48. In an exemplary embodiment, the parameter sensor 48 is operable to detect movement of the handle 22 and to provide information to set at least one parameter of water flowing through the hot water electronic valve 34 and the cold water

electronic valve 36 based on the movement of the handle 22. The parameter sensor 48 is operable to detect movement of the handle 22 either directly or indirectly. In an exemplary embodiment, based on the movement of the handle 22, the parameter sensor 48 provides information to set a temperature and/or a volume of water flowing through the hot water electronic valve 34 and the cold water electronic valve 36.

[0041] In the illustrated embodiments, the handle 22 operates as it would with a standard faucet. In other words, the handle 22 can be moved between various positions to indicate a desired temperature and volume of water discharged from the faucet 12.

[0042] More specifically, with regard to the temperature of water, the handle 22 can be rotated about a longitudinal axis of the side opening in the hub 14. At one extent of a range of rotation, the position of the handle 22 indicates all hot water (a full hot position). At the other extent of the range of rotation, the position of the handle 22 indicates all cold water (a full cold position). In between the extents of the range of rotation, the position of the handle 22 indicates a mix of hot and cold water (mixed temperature positions) with hotter temperature water as the position nears the full hot extent of the range of rotation and colder temperature water as the position nears the full cold extent of the range of rotation.

[0043] With regard to the volume of water, the handle 22 can be moved toward and away from the side opening in the hub 14. At one extent of a range of movement, the position of the handle 22 indicates no volume of water (a full closed position). At the other extent of the range of movement, the position of the handle 22 indicates full volume of water (a full open position). In between the extents of the range of movement, the position of the handle 22 indicates an intermediate volume of water (less than full open positions) with reduced volume water as the

position nears the full closed extent of the range of movement and increased volume water as the position nears the full open extent of the range of movement.

[0044] Additionally, in the illustrated embodiment, as best shown in Figure 2, the electronic faucet 12 includes a flow module 50, an electronics module 52, and a power module 54. The flow module 50 includes a number of inlets and outlets and a number of flow passages. These inlets/outlets and flow passages enable the easy management of the flow between the incoming supplies (i.e., the hot water supply 38 and the cold water supply 40) and the wand 20. In the illustrated embodiment, the hot water electronic valve 34 and the cold water electronic valve 36 are located inside the flow module 50. The electronics module 52 includes a number of electronic components. These components enable the activation and deactivation of the hot water electronic valve 34 and the cold water electronic valve 36. In the illustrated embodiment, the electronics module 52 is connected to the flow module 50. The power module 54 provides electrical power to electronic components of the faucet 12.

[0045] Further, in the illustrated embodiment, as best shown in Figure 1, the fitting 10 includes an electronic control 56. The electronic control 56 receives information (such as signals) from the toggle sensor 44 and the presence sensor 46 to activate and deactivate the hot water electronic valve 34 and the cold water electronic valve 36. Moreover, the electronic control 56 receives information (such as signals) from the parameter sensor 48 to set parameters (such as the temperature and the volume) of water flowing through the hot water electronic valve 34 and the cold water electronic valve 36. In an exemplary embodiment, at least a portion of the electronic control 56 is located inside the electronics module 52. Although the fitting 10 has been described as having a separate electronic control 56, one of ordinary skill in the art will

appreciate that the electronic control 56 could be incorporated into the toggle sensor 44, the presence sensor 46, and/or the parameter sensor 48.

[0046] In an exemplary embodiment, as best shown in Figures 3a-3b and 5a-5g, the electronic mixing valve 32 includes the hot water electronic valve 34, the cold water electronic valve 36, and a housing 58. The housing 58 includes a hot water inlet 60, a cold water inlet 62, a hot water electronic valve chamber 64, a cold water electronic valve chamber 66, a mixing chamber 68, and an outlet 70. The hot water electronic valve 34 is operable to be received in the hot water electronic valve chamber 64, and the cold water electronic valve 36 is operable to be received in the cold water electronic valve chamber 66.

[0047] In an exemplary embodiment, the hot water electronic valve 34 and the cold water electronic valve 36 are the same type of valve, i.e., a proportional valve and, more specifically, a stepper motor actuated valve. The following description of the electronic valve applies to both the hot water electronic valve 34 and the cold water electronic valve 36.

[0048] In an exemplary embodiment, as best shown in Figures 3a-5g, the hot/cold water electronic valve 34/36 includes a stepper motor 72, an upper housing 74, a lower housing 76h/76c, a piston 78, a seat 80, and various sealing members 82, such as O-rings. The motor 72 includes a shaft 84.

[0049] In an exemplary embodiment, as best shown in Figures 5a-5g, the lower housing 76h/76c of the hot/cold water electronic valve 34/36 is integral with the housing 58 of the electronic mixing valve 32. However, one of ordinary skill in the art will appreciate that the lower housing 76h/76c of the hot/cold water electronic valve 34/36 could be separate from the housing 58 of the electronic mixing valve 32.

[0050] In an exemplary embodiment, as best shown in Figures 6a-6e, the piston 78 includes a body 86 and a nose 88. In the illustrated embodiment, the body 86 is generally cylindrical shaped. More specifically, the body 86 is a hexagonal prism. The body 86 includes a recess 90 that is operable to receive a portion of the shaft 84. In the illustrated embodiment, the nose 88 includes a sealing member groove 92, a first conical portion 94, a cylindrical portion 96, and a second conical portion 98. The sealing member groove 92 is operable to receive the sealing member 82, such as an O-ring. Although the nose 88 of the piston 78 has been described as including specific portions, one of ordinary skill in the art will appreciate that the nose 88 of the piston 78 does not need to include each of these portions. For example, the nose 88 of the piston 78 may not include a second conical portion 98.

[0051] In an exemplary embodiment, as best shown in Figures 7a-7e, the seat 80 includes a body 100 and a plurality of projections 102 extending therefrom. In the illustrated embodiment, the body 100 is generally cylindrical shaped. In the illustrated embodiment, the seat 80 includes four projections 102 extending from the body 100. The projections 102 are operable to connect the seat 80 to the lower housing 76h/76c. The body 100 includes a central opening 104 extending therethrough. In the illustrated embodiment, the central opening 104 in the body 100 includes an inlet portion 106, a first cylindrical portion 108, a conical portion 110, a second cylindrical portion 112, and an outlet portion 114. The nose 88 of the piston 78 is operable to be received in and move in and out of the central opening 104 in the seat 80. Although the central opening 104 in the seat 80 has been described as including specific portions, one of ordinary skill in the art will appreciate that the central opening 104 in the seat 80 does not need to include each of these portions. For example, the central opening 104 in the seat 80 may not include a first cylindrical portion 112 and an outlet portion 114.

[0052] During operation of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, as best shown in Figures 8a-8e, the hot/cold water electronic valve 34/36 moves from a completely closed position to a completely open position. In the completely closed position, no fluid flows through the hot/cold water electronic valve 34/36. In the completely open position, a maximum amount of fluid flows through the hot/cold water electronic valve 34/36. Between the completely closed position and the completely open position, an increasing amount of fluid flows through the hot/cold water electronic valve 34/36.

[0053] In the completely closed position, the sealing member 82 on the piston 78 is in sealing contact with the inlet portion 106 of the seat 80. Additionally, the first conical portion 94 and the cylindrical portion 96 of the piston 78 interface with the conical portion 110 and the second cylindrical portion 112 of the seat 80. As a result of the sealing contact between the sealing member 82 on the piston 78 and the inlet portion 106 of the seat 80, no fluid flows through the hot/cold water electronic valve 34/36.

[0054] As the piston 78 starts to move out of the seat 80, the sealing member 82 on the piston 78 loses sealing contact with the inlet portion 106 of the seat 80. Additionally, the first conical portion 94 and the cylindrical portion 96 of the piston 78 move away from the conical portion 110 and the second cylindrical portion 112 of the seat 80. As a result of the sealing member 82 on the piston 78 losing sealing contact with the inlet portion 106 of the seat 80, fluid starts to flow through the hot/cold water electronic valve 34/36.

[0055] As the piston 78 moves further out of the seat 80, the sealing member 82 on the piston 78 moves further away from the inlet portion 106 of the seat 80. Additionally, the first conical portion 94 and the cylindrical portion 96 of the piston 78 move further away from the

conical portion 110 and the second cylindrical portion 112 of the seat 80. As a result, an increasing amount of fluid flows through the hot/cold water electronic valve 34/36.

[0056] In the completely open position, the sealing member 82 on the piston 78 is furthest away from the inlet portion 106 of the seat 80. Additionally, the first conical portion 94 and the cylindrical portion 96 of the piston 78 are furthest away from the conical portion 110 and the second cylindrical portion 112 of the seat 80. As a result, the maximum amount of fluid flows through the hot/cold water electronic valve 34/36.

[0057] Although the hot/cold water electronic valve 34/36 has been described with the sealing member 82 on the piston 78 interfacing with the inlet portion 106 of the seat 80, one of ordinary skill in the art will appreciate that the sealing member 82 could be on the seat 80 and interface with the nose 88 of the piston 78. Additionally, although the hot/cold water electronic valve 34/36 has been described as including a sealing member 82, such as an O-ring, in the sealing member groove 92 on the piston 78, one of ordinary skill in the art will appreciate that the sealing member 82 could be integrally formed with the piston 78 (or the seat 80 if the sealing member 82 is on the seat 80). Further, one of ordinary skill in the art will appreciate that the piston 78 (or the seat 80 if the sealing member 82 is on the seat 80) does not need to include a sealing member groove 92.

[0058] In another exemplary embodiment, as best shown in Figures 9a-9d, the piston 78' includes a body 86' and a nose 88'. In the illustrated embodiment, the body 86' is generally cylindrical shaped. More specifically, the body 86' is a hexagonal prism. The body 86' includes a recess 90' that is operable to receive a portion of the shaft 84. In the illustrated embodiment, the nose 88' includes a sealing member groove 92' and a dome-shaped portion 122. The sealing member groove 92' is operable to receive the sealing member 82, such as an O-ring.

[0059] In another exemplary embodiment, as best shown in Figures 10a-10d, the seat 80' includes a body 100' and a plurality of projections 102' extending therefrom. In the illustrated embodiment, the body 100' is generally cylindrical shaped. In the illustrated embodiment, the seat 80' includes four projections 102' extending from the body 100'. The projections 102' are operable to connect the seat 80' to the lower housing 76h/76c. The body 100' includes a central opening 104' extending therethrough. In the illustrated embodiment, the central opening 104' in the body 100' includes an inlet portion 106', a rounded portion 124, and an outlet portion 114'. The nose 88' of the piston 78' is operable to be received in and move in and out of the central opening 104' in the seat 80'. Although the central opening 104' in the seat 80' has been described as including specific portions, one of ordinary skill in the art will appreciate that the central opening 104' in the seat 80' does not need to include each of these portions. For example, the central opening 104' in the seat 80' may not include an outlet portion 114'.

[0060] During operation of the hot/cold water electronic valve 34/36 including the piston 78' and the seat 80', as best shown in Figures 11a-11e, the hot/cold water electronic valve 34/36 moves from a completely closed position to a completely open position. In the completely closed position, no fluid flows through the hot/cold water electronic valve 34/36. In the completely open position, a maximum amount of fluid flows through the hot/cold water electronic valve 34/36. Between the completely closed position and the completely open position, an increasing amount of fluid flows through the hot/cold water electronic valve 34/36.

[0061] In the completely closed position, the sealing member 82 on the piston 78' is in sealing contact with the inlet portion 106' of the seat 80'. Additionally, the dome-shaped portion 122 of the piston 78' interfaces with the rounded portion 124 of the seat 80'. As a result of the

sealing contact between the sealing member 82 on the piston 78' and the inlet portion 106' of the seat 80', no fluid flows through the hot/cold water electronic valve 34/36.

[0062] As the piston 78' starts to move out of the seat 80', the sealing member 82 on the piston 78' loses sealing contact with the inlet portion 106' of the seat 80'. Additionally, the dome-shaped portion 122 of the piston 78' moves along the rounded portion 124 of the seat 80'. As a result of the sealing member 82 on the piston 78' losing sealing contact with the inlet portion 106' of the seat 80', fluid starts to flow through the hot/cold water electronic valve 34/36.

[0063] As the piston 78' moves further out of the seat 80', the sealing member 82 on the piston 78' moves further away from the inlet portion 106' of the seat 80'. Additionally, the dome-shaped portion 122 of the piston 78' moves further away from the rounded portion 124 of the seat 80'. As a result, an increasing amount of fluid flows through the hot/cold water electronic valve 34/36.

[0064] In the completely open position, the sealing member 82 on the piston 78' is furthest away from the inlet portion 106' of the seat 80'. Additionally, the dome-shaped portion 122 of the piston 78' is furthest away from the rounded portion 124 of the seat 80'. As a result, the maximum amount of fluid flows through the hot/cold water electronic valve 34/36.

[0065] Although the hot/cold water electronic valve 34/36 has been described with the sealing member 82 on the piston 78' interfacing with the inlet portion 106' of the seat 80', one of ordinary skill in the art will appreciate that the sealing member 82 could be on the seat 80' and interface with the nose 88' of the piston 78'. Additionally, although the hot/cold water electronic valve 34/36 has been described as including a sealing member 82, such as an O-ring, in the sealing member groove 92' on the piston 78', one of ordinary skill in the art will appreciate that the sealing member 82 could be integrally formed with the piston 78' (or the seat 80' if the

sealing member 82 is on the seat 80'). Further, one of ordinary skill in the art will appreciate that the piston 78' (or the seat 80' if the sealing member 82 is on the seat 80') does not need to include a sealing member groove 92'.

[0066] Although the electronic plumbing fixture fitting 10 has been described as including an electronic mixing valve 32 and the electronic mixing valve 32 has been described as including a hot water electronic valve 34 and a cold water electronic valve 36, one of ordinary skill in the art will appreciate that the electronic valve could be used as a shutoff valve in addition to or in place of the mixing valve. Additionally, when the electronic valve is used as a shutoff valve, the seat 80/80' could be integrated into the valve housing.

[0067] As stated above, during operation of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the hot/cold water electronic valve 34/36 moves between a completely closed position and a completely open position. In the completely closed position, the sealing member 82 on the piston 78 is in sealing contact with the inlet portion 106 of the seat 80. In order to move the hot/cold water electronic valve 34/36 to an open position, the shaft 84 moves the piston 78 out of the seat 80. A lower portion of the shaft 84 and an upper portion of the piston 78 are in a pressurized fluid chamber 176 (see Figure 4f). The pressure in the fluid chamber 176 affects an amount of force needed to move the shaft 84 and, in turn, the piston 78. A lower amount of force to move the shaft 84 and the piston 78 is desired because it requires a lower amount of power.

[0068] As also stated above, in an exemplary embodiment, the sealing member groove 92 is operable to receive the piston sealing member, specifically referenced as 82a (see Figure 4f), such as an O-ring. In an exemplary embodiment, the shaft 84 is operable to receive a shaft sealing member, specifically referenced as 82b (see Figure 4f), such as an O-ring. In an

exemplary embodiment, the upper housing 74 is operable to receive an upper housing sealing member, specifically referenced as 82c (see Figure 4f), such as an O-ring. In an exemplary embodiment, the seat 80 is operable to receive a seat sealing member, specifically referenced as 82d (see Figure 4f), such as an O-ring. The pressurized fluid chamber 176 is created by the piston sealing member 82a, the shaft sealing member 82b, the upper housing sealing member 82c, and the seat sealing member 82d.

[0069] The piston sealing member 82a has an inner diameter. The inner diameter of the piston sealing member 82a for various standard size O-rings is provided in column P2 of Figure 12. The piston sealing member 82a has an outer diameter. The outer diameter of the piston sealing member 82a for various standard size O-rings is provided in column P1 of Figure 12. The piston sealing member 82a has a cross-section that is equal to one-half the difference between the outer diameter and the inner diameter ($1/2 (OD - ID)$). The cross-section of the piston sealing member 82a for various standard size O-rings is provided in column P3 of Figure 12. The piston sealing member 82a has a seal area that is equal to pi times one-half the outer diameter squared ($\pi * ((1/2 OD) \text{ squared})$). The seal area of the piston sealing member 82a for various standard size O-rings is provided in column P4 of Figure 12.

[0070] The shaft sealing member 82b has an inner diameter. The inner diameter of the shaft sealing member 82b is provided in column S2 of Figure 12. The shaft sealing member 82b has an outer diameter. The outer diameter of the shaft sealing member 82b is provided in column S1 of Figure 12. The shaft sealing member 82b has a cross-section that is equal to one-half the difference between the outer diameter and the inner diameter ($1/2 (OD - ID)$). The cross-section of the shaft sealing member 82b is provided in column S3 of Figure 12. The shaft sealing member 82b has a seal area that is equal to pi times one-half the inner diameter squared

($\pi * ((1/2 \text{ ID})^2)$). The seal area of the shaft sealing member 82b is provided in column S4 of Figure 12.

[0071] The hot/cold water electronic valve 34/36 has a force to close at a specified line pressure that is equal to the line pressure times the difference between the seal area of the piston sealing member 82a and the seal area of the shaft sealing member 82b ($\text{line pressure} * (\text{piston seal area} - \text{shaft seal area})$). The force to close at a line pressure of one-hundred fifty pounds per square inch (150 psi) for various standard size O-rings is provided in column F1 of Figure 12. The force to close at a line pressure of sixty pounds per square inch (60 psi) for various standard size O-rings is provided in column F2 of Figure 12.

[0072] The hot/cold water electronic valve 34/36 has a ratio of the seal area of the piston sealing member 82a to the seal area of the shaft sealing member 82b. The ratio of the seal area of the piston sealing member 82a to the seal area of the shaft sealing member 82b for various standard size O-rings is provided in column R1 of Figure 12. The hot/cold water electronic valve 34/36 has a ratio of the outer diameter of the piston sealing member 82a to the inner diameter of the shaft sealing member 82b. The ratio of the outer diameter of the piston sealing member 82a to the inner diameter of the shaft sealing member 82b for various standard size O-rings is provided in column R2 of Figure 12. The hot/cold water electronic valve 34/36 has a ratio of the outer diameter of the piston sealing member 82a to the outer diameter of the shaft sealing member 82b. The ratio of the outer diameter of the piston sealing member 82a to the outer diameter of the shaft sealing member 82b for various standard size O-rings is provided in column R3 of Figure 12.

[0073] In an exemplary embodiment, the piston sealing member 82a and the shaft sealing member 82b are upstream of the outlet 70 of the hot/cold water electronic valve 34/36. In an

exemplary embodiment, the piston sealing member 82a and the shaft sealing member 82b are under pressure from a supply line, such as hot water line 26 or cold water line 28.

[0074] In an exemplary embodiment, as best shown in column F2 of Figure 12, with a supply line pressure of approximately sixty pounds per square inch (60 psi), a force required to close the hot/cold water electronic valve 34/36 is between approximately five tenths pounds and eleven pounds (0.5 lbs.-11 lbs.). In an exemplary embodiment, as best shown in column F2 of Figure 12, with a supply line pressure of approximately sixty pounds per square inch (60 psi), a force required to close the hot/cold water electronic valve 34/36 is between approximately nine tenths pounds and six pounds (0.9 lbs.-6 lbs.). In an exemplary embodiment, as best shown in column F2 of Figure 12, with a supply line pressure of approximately sixty pounds per square inch (60 psi), a force required to close the hot/cold water electronic valve 34/36 is between approximately nine tenths pounds and two and one-half pounds (0.9 lbs.-2.5 lbs.). In an exemplary embodiment, as best shown in column F2 of Figure 12, with a supply line pressure of approximately sixty pounds per square inch (60 psi), a force required to close the hot/cold water electronic valve 34/36 is approximately one and forty-seven hundredths pounds (1.47 lbs.).

[0075] In an exemplary embodiment, as best shown in column P1 of Figure 12, the outer diameter of the piston sealing member 82a is between approximately fifteen hundredths inches and fifty-five hundredths inches (0.15 in.-0.55 in.). In an exemplary embodiment, as best shown in column P1 of Figure 12, the outer diameter of the piston sealing member 82a is between approximately two tenths inches and four tenths inches (0.2 in.-0.4 in.). In an exemplary embodiment, as best shown in column P1 of Figure 12, the outer diameter of the piston sealing member 82a is between approximately two tenths inches and twenty-five hundredths inches (0.2 in.-0.25 in.). In an exemplary embodiment, as best shown in column P1 of Figure 12, the

outer diameter of the piston sealing member 82a is approximately seven thirty-seconds inches (0.21875 in.).

[0076] In an exemplary embodiment, as best shown in columns P1 and S2 of Figure 12, the outer diameter of the piston sealing member 82a is approximately equal to the inner diameter of the shaft sealing member 82b. In an exemplary embodiment, as best shown in columns P1 and S2 of Figure 12, the outer diameter of the piston sealing member 82a is slightly greater than the inner diameter of the shaft sealing member 82b. In an exemplary embodiment, as best shown in columns P1 and S2 of Figure 12, the outer diameter of the piston sealing member 82a is greater than the inner diameter of the shaft sealing member 82b. In an exemplary embodiment, as best shown in columns P1 and S2 of Figure 12, the outer diameter of the piston sealing member 82a is approximately two times the inner diameter of the shaft sealing member 82b.

[0077] In an exemplary embodiment, as best shown in column R2 of Figure 12, a ratio of the outer diameter of the piston sealing member 82a to the inner diameter of the shaft sealing member 82b is between approximately one and four tenths and three and nine tenths (1.4-3.9). In an exemplary embodiment, as best shown in column R2 of Figure 12, a ratio of the outer diameter of the piston sealing member 82a to the outer diameter of the shaft sealing member 82b is between approximately one and one half and three (1.5-3.0). In an exemplary embodiment, as best shown in column R2 of Figure 12, a ratio of the outer diameter of the piston sealing member 82a to the inner diameter of the shaft sealing member 82b is between approximately one and one half and two (1.5-2.0). In an exemplary embodiment, as best shown in column R2 of Figure 12, a ratio of the outer diameter of the piston sealing member 82a to the inner diameter of the shaft sealing member 82b is approximately one and seven tenths (1.7).

[0078] In an exemplary embodiment, as best shown in column R3 of Figure 12, a ratio of the outer diameter of the piston sealing member 82a to the outer diameter of the shaft sealing member 82b is between approximately six tenths and one and nine tenths (0.6-1.9). In an exemplary embodiment, as best shown in column R3 of Figure 12, a ratio of the outer diameter of the piston sealing member 82a to the outer diameter of the shaft sealing member 82b is between approximately seven tenths and one and six tenths (0.7-1.6). In an exemplary embodiment, as best shown in column R3 of Figure 12, a ratio of the outer diameter of the piston sealing member 82a to the outer diameter of the shaft sealing member 82b is between approximately seven tenths and one (0.7-1.0). In an exemplary embodiment, as best shown in column R3 of Figure 12, a ratio of the outer diameter of the piston sealing member 82a to the outer diameter of the shaft sealing member 82b is approximately eight-one hundredths (0.81).

[0079] In an exemplary embodiment, as best shown in column R1 of Figure 12, a ratio of the seal area of the piston sealing member 82a to the seal area of the shaft sealing member 82b is between approximately two and sixteen (2.0-16.0). In an exemplary embodiment, as best shown in column R1 of Figure 12, a ratio of the seal area of the piston sealing member 82a to the seal area of the shaft sealing member 82b is between approximately two and four tenths and nine (2.4-9). In an exemplary embodiment, as best shown in column R1 of Figure 12, a ratio of the seal area of the piston sealing member 82a to the seal area of the shaft sealing member 82b is between approximately two and four tenths and four (2.4-4). In an exemplary embodiment, as best shown in column R1 of Figure 12, a ratio of the seal area of the piston sealing member 82a to the seal area of the shaft sealing member 82b is approximately two and eighty-eight hundredths (2.88).

[0080] Although the hot/cold water electronic valve 34/36 has been described with the shaft 84 attached to the piston 78 and the shaft 84 moving the piston 78 relative to the seat 80, one of ordinary skill in the art will appreciate that the shaft 84 could be attached to the seat 80 and move the seat 80 relative to the piston 78.

[0081] As stated above, the electronic control 56 receives information (such as signals) from the toggle sensor 44 and the presence sensor 46 to activate and deactivate the hot water electronic valve 34 and the cold water electronic valve 36. Moreover, the electronic control 56 receives information (such as signals) from the parameter sensor 48 to set parameters (such as the temperature and the volume) of water flowing through the hot water electronic valve 34 and the cold water electronic valve 36. In an exemplary embodiment, the electronic control 56 activates and deactivates the hot/cold water electronic valve 34/36 and sets parameters of water flowing through the hot/cold water electronic valve 34/36 by actuating the motor 72 of the hot/cold water electronic valve 34/36.

[0082] Upon startup of the hot/cold water electronic valve 34/36, the motor 72 is actuated a predetermined number of startup open steps causing the piston 78/78' to move out of the seat 80/80'. The predetermined number of startup open steps is greater than a maximum number of open steps required to move the piston 78/78' as far away from the seat 80/80' as possible and ensures that the hot/cold water electronic valve 34/36 is in a completely open position with a maximum flow. In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the predetermined number of startup open steps is two hundred (200) steps and the maximum number of open steps is eighty (80) steps.

[0083] After the motor 72 has been actuated the predetermined number of startup open steps, the motor 72 is actuated a predetermined number of startup close steps causing the piston

78/78' to move into sealing contact with the seat 80/80'. The predetermined number of startup close steps is greater than a maximum number of close steps required to move the piston 78/78' into sealing contact with the seat 80/80' and ensures that the hot/cold water electronic valve 34/36 is in a completely closed position with no flow. In an exemplary embodiment, the predetermined number of startup close steps is one hundred eighty (180) steps and the maximum number of close steps is eighty (80) steps.

[0084] In an exemplary embodiment, during the predetermined number of startup close steps, while the piston 78/78' is moving from the completely open position to the completely closed position, the motor 72 starts at a minimum speed, is accelerated to a maximum speed, and is decelerated to the minimum speed. In an exemplary embodiment, prior to the piston 78/78' moving into sealing contact with the seat 80/80', the motor 72 reaches the minimum speed. The motor 72 is accelerated and decelerated at a predetermined rate of acceleration and deceleration. In an exemplary embodiment, the predetermined rate of acceleration and deceleration is a rate of acceleration and deceleration per step and is measured as a percentage of the minimum speed when the motor 72 starts.

[0085] In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the motor 72 starts at two hundred fifty (250) steps per second, is accelerated to five hundred (500) steps per second, and is decelerated to two hundred fifty (250) steps per second. In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the predetermined rate of acceleration and deceleration is between approximately one percent and one hundred percent (1%-100%). In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the predetermined rate of acceleration and declaration is between approximately

three percent and eighty percent (3%-80%). In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the predetermined rate of acceleration and deceleration is approximately six percent (6%). In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, at the predetermined rate of acceleration and deceleration of approximately six percent (6%), the motor 72 is accelerated and decelerated fifteen (15) steps per step (six percent (6%) of two hundred fifty (250) steps).

[0086] In an exemplary embodiment, during the predetermined number of startup close steps, while the piston 78/78' is moving from the completely open position to the completely closed position, the motor 72 is actuated at a first power level. In an exemplary embodiment, the first power level is determined by specifications for the motor 72.

[0087] After the motor 72 has been actuated the predetermined number of startup close steps, the motor 72 is actuated a predetermined number of seal compression steps to ensure that the piston sealing member 82 is compressed. The predetermined number of seal compression steps is large enough to ensure that the piston sealing member 82 is compressed. In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the predetermined number of seal compression steps is four (4) steps.

[0088] In an exemplary embodiment, during the predetermined number of seal compression steps, the motor 72 is actuated at the minimum speed. In an exemplary embodiment, the minimum speed is two hundred fifty (250) steps per second.

[0089] In an exemplary embodiment, during the predetermined number of seal compression steps, the motor 72 is actuated at a second power level. The second power level is less than the first power level.

[0090] During a full opening operation of the hot/cold water electronic valve 34/36 after startup, the motor 72 is actuated a predetermined number of full open steps causing the piston 78/78' to move out of the seat 80/80'. In an exemplary embodiment, the predetermined number of full open steps is at least the maximum number of open steps required to move the piston 78/78' as far away from the seat 80/80' as possible and ensures that the hot/cold water electronic valve 34/36 is in the completely open position with the maximum flow. In an exemplary embodiment, the predetermined number of full open steps is the maximum number of open steps required to move the piston 78/78' as far away from the seat 80/80' as possible and ensures that the hot/cold water electronic valve 34/36 is in the completely open position with the maximum flow. In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the predetermined number of full open steps and the maximum number of open steps are eighty (80) steps.

[0091] During a full closing operation of the hot/cold water electronic valve 34/36 after startup, the motor 72 is actuated a predetermined number of full close steps causing the piston 78/78' to move into sealing contact with the seat 80/80'. In an exemplary embodiment, the predetermined number of full close steps is at least the maximum number of close steps required to move the piston 78/78' into sealing contact with the seat 80/80' and ensures that the hot/cold water electronic valve 34/36 is in the completely closed position with no flow. In an exemplary embodiment, the predetermined number of full close steps is the maximum number of close steps required to move the piston 78/78' into sealing contact with the seat 80/80' and ensures that the hot/cold water electronic valve 34/36 is in the completely closed position with no flow. In an exemplary embodiment, the predetermined number of full close steps and the maximum number of close steps are eighty (80) steps.

[0092] In an exemplary embodiment, during the predetermined number of full close steps, while the piston 78/78' is moving from the completely open position to the completely closed position, the motor 72 starts at the minimum speed, is accelerated to the maximum speed, and is decelerated to the minimum speed. In an exemplary embodiment, prior to the piston 78/78' moving into sealing contact with the seat 80/80', the motor 72 reaches the minimum speed. The motor 72 is accelerated and decelerated at the predetermined rate of acceleration and deceleration. In an exemplary embodiment, the predetermined rate of acceleration and deceleration is a rate of acceleration and deceleration per step and is measured as a percentage of the minimum speed when the motor 72 starts.

[0093] In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the motor 72 starts at two hundred fifty (250) steps per second, is accelerated to five hundred (500) steps per second, and is decelerated to two hundred fifty (250) steps per second. In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the predetermined rate of acceleration and deceleration is between approximately one percent and one hundred percent (1%-100%). In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the predetermined rate of acceleration and deceleration is between approximately three percent and eighty percent (3%-80%). In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the predetermined rate of acceleration and deceleration is approximately six percent (6%). In an exemplary embodiment of the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, at the predetermined rate of acceleration and deceleration of approximately six percent (6%), the motor

72 is accelerated and decelerated fifteen (15) steps per step (six percent (6%) of two hundred fifty (250) steps).

[0094] In an exemplary embodiment, during the predetermined number of full close steps, while the piston 78/78' is moving from the completely open position to the completely closed position, the motor 72 is actuated at the first power level. In an exemplary embodiment, the first power level is determined by specifications for the motor 72.

[0095] After the motor 72 has been actuated the predetermined number of full close steps, the motor 72 is actuated the predetermined number of seal compression steps to ensure that the piston sealing member 82 is compressed. The predetermined number of seal compression steps is large enough to ensure that the piston sealing member 82 is compressed. In an exemplary embodiment the hot/cold water electronic valve 34/36 including the piston 78 and the seat 80, the predetermined number of seal compression steps is four (4) steps.

[0096] In an exemplary embodiment, during the predetermined number of full close steps, the motor 72 is actuated at the minimum speed. In an exemplary embodiment, the minimum speed is two hundred fifty (250) steps per second.

[0097] In an exemplary embodiment, during the predetermined number of full close steps, the motor 72 is actuated at the second power level. The second power level is less than the first power level.

[0098] Since the motor 72 is actuated at a decelerated speed and/or at a reduced power level during the steps that cause the piston 78/78' to move into sealing contact with the seat 80/80' (i.e., a portion of the predetermined number of startup close steps and a portion of the predetermined number of full close steps) and the steps that cause the piston sealing member to compress (i.e., the predetermined number of seal compression steps), the force exerted on the

piston 78/78' when the piston 78/78' is moving into sealing contact with the seat 80/80' and the piston sealing member is compressed is reduced.

[0099] In an exemplary embodiment, the force exerted on the piston 78/78' when the piston 78/78' is moving into sealing contact with the seat 80/80' and the piston sealing member is compressed is between approximately one-half pound and thirty pounds (0.5 lbs.-30 lbs.). In an exemplary embodiment, the force exerted on the piston 78/78' when the piston 78/78' is moving into sealing contact with the seat 80/80' and the piston sealing member is compressed is between approximately two pounds and twenty pounds (2 lbs.-20 lbs.). In an exemplary embodiment, the force exerted on the piston 78/78' when the piston 78/78' is moving into sealing contact with the seat 80/80' and the piston sealing member is compressed is between approximately three pounds and ten pounds (3 lbs.-10 lbs.). In an exemplary embodiment, the force exerted on the piston 78/78' when the piston 78/78' is moving into sealing contact with the seat 80/80' and the piston sealing member is compressed is approximately four pounds (4 lbs.).

[00100] Again, although the hot/cold water electronic valve 34/36 has been described with the shaft 84 attached to the piston 78 and the shaft 84 moving the piston 78 relative to the seat 80, one of ordinary skill in the art will appreciate that the shaft 84 could be attached to the seat 80 and move the seat 80 relative to the piston 78.

[00101] Again, as stated above, the electronic control 56 receives information (such as signals) from the toggle sensor 44 and the presence sensor 46 to activate and deactivate the hot water electronic valve 34 and the cold water electronic valve 36. Moreover, the electronic control 56 receives information (such as signals) from the parameter sensor 48 to set parameters (such as the temperature and the volume) of water flowing through the hot water electronic valve 34 and the cold water electronic valve 36. In an exemplary embodiment, the electronic control

56 activates and deactivates the hot/cold water electronic valve 34/36 and sets parameters of water flowing through the hot/cold water electronic valve 34/36 by actuating the motor 72 of the hot/cold water electronic valve 34/36.

[00102] During operation of the electronic faucet 12, the handle 22 is moved to indicate a desired change to at least one parameter of water flowing through the hot water electronic valve 34 and/or the cold water electronic valve 36 and eventually discharged from the faucet 12. In an exemplary embodiment, the handle 22 is moved to indicate a desired change to a temperature and/or a volume of water flowing through the hot water electronic valve 34 and/or the cold water electronic valve 36 and eventually discharged from the faucet 12.

[00103] When a desired change to the water requires opening and/or closing of only one of the hot water electronic valve 34 and the cold water electronic valve 36, the appropriate hot/cold water electronic valve 34/36 is activated to accomplish the desired change. An exemplary desired change to the water that would require opening and/or closing of only one of the hot water electronic valve 34 and the cold water electronic valve 36 is a change in a volume of the water when a temperature of the water is all hot or all cold.

[00104] When a desired change to the water requires opening and/or closing of both the hot water electronic valve 34 and the cold water electronic valve 36, both the hot water electronic valve 34 and the cold water electronic valve 36 need to be activated to accomplish the desired change. Exemplary desired changes to the water that would require opening and/or closing of both the hot water electronic valve 34 and the cold water electronic valve 36 are a change in a volume of the water when a temperature of the water is mixed and constant and a change in a temperature of the water when a volume of the water is constant. A temperature of the water is mixed when the water is not all hot and not all cold.

[00105] When both the hot water electronic valve 34 and the cold water electronic valve 36 need to be activated to accomplish the desired change, both the hot water electronic valve 34 and the cold water electronic valve 36 are not activated at the same time. Rather, the hot water electronic valve 34 and the cold water electronic valve 36 are alternately activated until desired positions of both the hot water electronic valve 34 and the cold water electronic valve 36 are reached and the desired change is accomplished.

[00106] In an exemplary embodiment, when activation of the hot water electronic valve 34 and the cold water electronic valve 36 will result in an increasing volume through one of the hot water electronic valve 34 and the cold water electronic valve 36 and a decreasing volume through the other of the hot water electronic valve 34 and the cold water electronic valve 36, whichever of the hot/cold water electronic valve 34/36 has the increasing volume is activated first and whichever of the hot/cold water electronic valve 34/36 has the decreasing volume is activated second.

[00107] In an exemplary embodiment, when the handle 22 is moved quickly, each of the hot water electronic valve 34 and the cold water electronic valve 36 is alternately activated a single time to desired positions of both the hot water electronic valve 34 and the cold water electronic valve 36. In an exemplary embodiment, when the handle 22 is moved slowly, the hot water electronic valve 34 and the cold water electronic valve 36 are alternately activated multiple times until desired positions of both the hot water electronic valve 34 and the cold water electronic valve 36 are reached.

[00108] In an exemplary embodiment, when a speed of rotation of the handle 22 is more than fifty degrees per second ($50^{\circ}/s$), the handle 22 is considered to be moved quickly. In an exemplary embodiment, when a speed of rotation of the handle 22 is more than seventy-five

degrees per second ($75^{\circ}/s$), the handle 22 is considered to be moved quickly. In an exemplary embodiment, when a speed of rotation of the handle 22 is more than one-hundred degrees per second ($100^{\circ}/s$), the handle 22 is considered to be moved quickly. In an exemplary embodiment, when a speed of rotation of the handle 22 is more than one-hundred twenty-five degrees per second ($125^{\circ}/s$), the handle 22 is considered to be moved quickly.

[00109] Conversely, in an exemplary embodiment, when a speed of rotation of the handle 22 is less than or equal to fifty degrees per second ($50^{\circ}/s$), the handle 22 is considered to be moved slowly. In an exemplary embodiment, when a speed of rotation of the handle 22 is less than or equal to seventy-five degrees per second ($75^{\circ}/s$), the handle 22 is considered to be moved slowly. In an exemplary embodiment, when a speed of rotation of the handle 22 is less than or equal to one-hundred degrees per second ($100^{\circ}/s$), the handle 22 is considered to be moved slowly. In an exemplary embodiment, when a speed of rotation of the handle 22 is less than or equal to one-hundred twenty-five degrees per second ($125^{\circ}/s$), the handle 22 is considered to be moved slowly.

[00110] When the power module 54 includes a battery, steps should be taken to extend a life of the battery. Simultaneously activating the hot water electronic valve 34 and the cold water electronic valve 36 creates a higher peak current draw on the battery than alternately activating the hot water electronic valve 34 and the cold water electronic valve 36. Since a higher peak current draw on the battery reduces the life of the battery, alternately activating the hot water electronic valve 34 and the cold water electronic valve 36 extends the life of the battery.

[00111] Again, as stated above, the electronic control 56 receives information (such as signals) from the toggle sensor 44 and the presence sensor 46 to activate and deactivate the hot

water electronic valve 34 and the cold water electronic valve 36. Moreover, the electronic control 56 receives information (such as signals) from the parameter sensor 48 to set parameters (such as the temperature and the volume) of water flowing through the hot water electronic valve 34 and the cold water electronic valve 36. In an exemplary embodiment, the electronic control 56 activates and deactivates the hot/cold water electronic valve 34/36 and sets parameters of water flowing through the hot/cold water electronic valve 34/36 by actuating the motor 72 of the hot/cold water electronic valve 34/36.

[00112] During operation of the electronic faucet 12, the toggle sensor 44 and the presence sensor 46 can be used to activate and deactivate the hot water electronic valve 34 and the cold water electronic valve 36. When the toggle sensor 44 and/or the presence sensor 46 are used to activate and deactivate the hot water electronic valve 34 and the cold water electronic valve 36, the electronic faucet 12 is in a sensor mode.

[00113] Additionally, the handle 22 can be used to activate and deactivate the hot water electronic valve 34 and the cold water electronic valve 36. When the handle 22 is used to activate and deactivate the hot water electronic valve 34 and the cold water electronic valve 36, the electronic faucet 12 is in a manual mode.

[00114] In an exemplary embodiment, in the sensor mode, the handle 22 can be used to control a temperature of water flowing through the hot water electronic valve 34 and/or the cold water electronic valve 36. However, the handle 22 cannot be used to control a volume of water flowing through the hot water electronic valve 34 and/or the cold water electronic valve 36.

[00115] In an exemplary embodiment, in the manual mode, the handle 22 can be used to control both the temperature and the volume of water flowing through the hot water electronic valve 34 and/or the cold water electronic valve 36.

[00116] As stated above, the parameter sensor 48 is operable to detect movement of the handle 22 and to provide information to set at least one parameter of water flowing through the hot water electronic valve 34 and/or the cold water electronic valve 36 based on the movement of the handle 22. In an exemplary embodiment, based on the movement of the handle 22, the parameter sensor 48 provides information to set the temperature and/or the volume of water flowing through the hot water electronic valve 34 and the cold water electronic valve 36. An exemplary embodiment of a parameter sensor is disclosed in U.S. Patent App. No. 13/889,186 filed on May 7, 2013, which was published as U.S. Patent App. Pub. No. 2013/0291978 A1 on November 7, 2013, and which issued as U.S. Patent No. 9,212,473 B2 on December 15, 2015, for Electronic Plumbing Fixture Fitting, the entire disclosures of which are hereby incorporated by reference.

[00117] In the illustrated embodiment, as best shown in Figure 13a, the parameter sensor 48 and at least a portion of the electronic control 56 are located in a portion of the hub 14 to which the handle 22 is mounted. In an exemplary embodiment, as best shown in Figure 13b, the parameter sensor 48 includes a first emitter 178, a second emitter 180, a first detector 182, and a second detector 184. In an exemplary embodiment, the first emitter 178 and the second emitter 180 emit infrared light, and the first detector 182 and the second detector 184 detect the infrared light. However, one of ordinary skill in the art will appreciate that the first emitter 178 and the second emitter 180 could emit any type of energy, including, but not limited to, visible light, acoustic energy (both ultrasonic and audible), and compressed air. Moreover, one of ordinary skill in the art will appreciate that the first detector 182 and the second detector 184 would detect whatever type of energy is emitted from the first emitter 178 and the second emitter 180. In an exemplary embodiment, the parameter sensor 48 is operable to detect an intensity of energy

transmitted from the first emitter 178 and the second emitter 180 to the first detector 182 and the second detector 184.

[00118] In an exemplary embodiment, in the sensor mode, energy is transmitted from the first emitter 178 and the second emitter 180 at a first rate of transmission, and energy is detected by the first detector 182 and the second detector 184 at a first rate of detection. In an exemplary embodiment, in the manual mode, energy is transmitted from the first emitter 178 and the second emitter 180 at a second rate of transmission, and energy is detected by the first detector 182 and the second detector 184 at a second rate of detection. In an exemplary embodiment, the first rate of transmission is less frequent than the second rate of transmission, and the first rate of detection is less frequent than the second rate of detection.

[00119] In an exemplary embodiment, in the sensor mode, energy is alternately transmitted from the first emitter 178 and the second emitter 180, and energy is alternately detected by the first detector 182 and the second detector 184. In an exemplary embodiment, in the manual mode, energy is simultaneously transmitted from the first emitter 178 and the second emitter 180, and energy is simultaneously detected by the first detector 182 and the second detector 184.

[00120] Since the first rate of transmission and the first rate of detection in the sensor mode is less frequent than the second rate of transmission and the second rate of detection in the manual mode, less power is required in the sensor mode and more power is required in the manual mode. Similarly, since energy is alternately transmitted and alternately detected in the sensor mode and simultaneously transmitted and simultaneously detected in the manual mode, less power is required in the sensor mode and more power is required in the manual mode.

[00121] Although the parameter sensor 48 has been described as including a first emitter 178, a second emitter 180, a first detector 182, and a second detector 184, one of ordinary skill in the art will appreciate that the parameter sensor 48 could include any number of emitters and any number of detectors and/or the parameter sensor 48 could include a different number of emitters and detectors.

[00122] One of ordinary skill in the art will now appreciate that the present invention provides an electronic plumbing fixture fitting with an electronic valve having a low closing force, a low seal force, sequential operation, and operation modes, such as an electronic faucet with an electronic valve having a low closing force, a low seal force, sequential operation, and operation modes. Although the present invention has been shown and described with reference to particular embodiments, equivalent alterations and modifications will occur to those skilled in the art upon reading and understanding this specification. The present invention includes all such equivalent alterations and modifications and is limited only by the scope of the following claims in light of their full scope of equivalents.

What is claimed is:

1. An electronic plumbing fixture fitting, comprising:

a discharge outlet, the discharge outlet being operable to deliver water; and

an electronic valve, the electronic valve being operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated, the electronic valve including a valve inlet, a valve outlet, a shaft, a shaft sealing member, a piston, a piston sealing member, and a seat;

the shaft being operable to attach to the piston;

the shaft sealing member being operable to be received on the shaft, the shaft sealing member have an inner diameter and an outer diameter, when received on the shaft, the shaft sealing member being located upstream of the valve outlet;

the piston being operable to interface with the seat, the piston including a body and a nose;

the piston sealing member being operable to be received on the nose of the piston, the piston sealing member having an inner diameter and an outer diameter, when received on the nose of the piston, the piston sealing member being located upstream of the valve outlet; and

the seat including a body, the body including a central opening extending therethrough;

wherein, a ratio of the outer diameter of the piston sealing member to the inner diameter of the shaft sealing member is between approximately one and four tenths and three and nine tenths.

2. The electronic plumbing fixture fitting of claim 1, wherein, with a supply line pressure of approximately sixty pounds per square inch, a force required to close the electronic valve is between approximately five tenths pounds and eleven pounds.
3. The electronic plumbing fixture fitting of claim 1, wherein the outer diameter of the piston sealing member is between approximately fifteen hundredths inches and fifty-five hundredths inches.
4. The electronic plumbing fixture fitting of claim 1, wherein a ratio of the outer diameter of the piston sealing member to the outer diameter of the shaft sealing member is between approximately six tenths and one and nine tenths.
5. The electronic plumbing fixture fitting of claim 1, wherein a ratio of the seal area of the piston sealing member to the seal area of the shaft sealing member is between approximately two and sixteen.
6. The electronic plumbing fixture fitting of claim 1, wherein:
during operation of the electronic valve, the shaft sealing member is under pressure from a supply line; and
during operation of the electronic valve, the piston sealing member is under pressure from the supply line.

7. An electronic plumbing fixture fitting, comprising:

a discharge outlet, the discharge outlet being operable to deliver water; and

an electronic valve, the electronic valve being operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated, the electronic valve including a valve inlet, a valve outlet, a shaft, a shaft sealing member, a piston, a piston sealing member, and a seat;

the shaft being operable to attach to the piston;

the shaft sealing member being operable to be received on the shaft, the shaft sealing member have an inner diameter and an outer diameter, during operation of the electronic valve, the shaft sealing member being under pressure from a supply line;

the piston being operable to interface with the seat, the piston including a body and a nose;

the piston sealing member being operable to be received on the nose of the piston, the piston sealing member having an inner diameter and an outer diameter, during operation of the electronic valve, the piston sealing member being under pressure from the supply line; and

the seat including a body, the body including a central opening extending therethrough;

wherein, a ratio of the outer diameter of the piston sealing member to the inner diameter of the shaft sealing member is between approximately one and four tenths and three and nine tenths.

8. The electronic plumbing fixture fitting of claim 7, wherein, with a supply line pressure of approximately sixty pounds per square inch, a force required to close the electronic valve is between approximately five tenths pounds and eleven pounds.
9. The electronic plumbing fixture fitting of claim 7, wherein the outer diameter of the piston sealing member is between approximately fifteen hundredths inches and fifty-five hundredths inches.
10. The electronic plumbing fixture fitting of claim 7, wherein a ratio of the outer diameter of the piston sealing member to the outer diameter of the shaft sealing member is between approximately six tenths and one and nine tenths.
11. The electronic plumbing fixture fitting of claim 7, wherein a ratio of the seal area of the piston sealing member to the seal area of the shaft sealing member is between approximately two and sixteen.
12. The electronic plumbing fixture fitting of claim 7, wherein:
when received on the shaft, the shaft sealing member is located upstream of the valve outlet; and
when received on the nose of the piston, the piston sealing member is located upstream of the valve outlet.

13. An electronic plumbing fixture fitting, comprising:

a discharge outlet, the discharge outlet being operable to deliver water; and

an electronic valve, the electronic valve being operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated, the electronic valve including a valve inlet, a valve outlet, a shaft, a shaft sealing member, a piston, a piston sealing member, and a seat;

the shaft being operable to attach to one of the piston and the seat;

the shaft sealing member being operable to be received on the shaft, the shaft sealing member have an inner diameter and an outer diameter;

the piston being operable to interface with the seat, the piston including a body and a nose;

the piston sealing member being operable to be received on the nose of the piston, the piston sealing member having an inner diameter and an outer diameter; and

the seat including a body, the body including a central opening extending therethrough;

wherein, with a supply line pressure of approximately sixty pounds per square inch, a force required to close the electronic valve is between approximately five tenths pounds and eleven pounds.

14. The electronic plumbing fixture fitting of claim 13, wherein the outer diameter of the piston sealing member is approximately two times the inner diameter of the shaft sealing member.

15. The electronic plumbing fixture fitting of claim 13, wherein a ratio of the outer diameter of the piston sealing member to the inner diameter of the shaft sealing member is between approximately one and four tenths and three and nine tenths.

16. The electronic plumbing fixture fitting of claim 13, wherein the outer diameter of the piston sealing member is between approximately fifteen hundredths inches and fifty-five hundredths inches.

17. The electronic plumbing fixture fitting of claim 13, wherein a ratio of the outer diameter of the piston sealing member to the outer diameter of the shaft sealing member is between approximately six tenths and one and nine tenths.

18. The electronic plumbing fixture fitting of claim 13, wherein a ratio of the seal area of the piston sealing member to the seal area of the shaft sealing member is between approximately two and sixteen.

19. The electronic plumbing fixture fitting of claim 13, wherein:

during operation of the electronic valve, the shaft sealing member is under pressure from a supply line; and

during operation of the electronic valve, the piston sealing member is under pressure from the supply line.

20. The electronic plumbing fixture fitting of claim 13, wherein:

when received on the shaft, the shaft sealing member is located upstream of the valve outlet; and

when received on the nose of the piston, the piston sealing member is located upstream of the valve outlet.

21. An electronic plumbing fixture fitting, comprising:

a discharge outlet, the discharge outlet being operable to deliver water; and

an electronic valve, the electronic valve being operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated, the electronic valve including a motor, a piston, a seat, and a sealing member;

one of the piston and the seat being operable to move relative to the other of the piston and the seat;

the sealing member being operable to be received on one of the piston and the seat; and

the motor being operable to move one of the piston and the seat relative to the other of the piston and the seat so that the piston is out of the seat to open the electronic valve, the motor being operable to move one of the piston and the seat relative to the other of the piston and the seat so that the piston is in the seat to close the electronic valve;

wherein, upon startup of the electronic valve, the motor is actuated a predetermined number of startup open steps causing the piston to be out of the seat;

wherein the predetermined number of startup open steps is greater than a maximum number of open steps required for the electronic valve to be in a completely open position;

wherein, after the motor has been actuated the predetermined number of startup open steps, the motor is actuated a predetermined number of startup close steps causing the piston to be in sealing contact with the seat; and

wherein the predetermined number of startup close steps is greater than a maximum number of close steps required for the electronic valve to be in a completely closed position.

22. The electronic plumbing fixture fitting of claim 21, wherein, during the predetermined number of startup close steps, the motor starts at a minimum speed, is accelerated to a maximum speed, and is decelerated to the minimum speed.

23. The electronic plumbing fixture fitting of claim 22, wherein, prior to the piston being in sealing contact with the seat, the motor reaches the minimum speed.

24. The electronic plumbing fixture fitting of claim 22, wherein, the motor is accelerated and decelerated at a predetermined rate of acceleration and deceleration.

25. The electronic plumbing fixture fitting of claim 21, wherein, after the motor has been actuated the predetermined number of startup close steps, the motor is actuated a predetermined number of seal compression steps to ensure that the sealing member is compressed.

26. The electronic plumbing fixture fitting of claim 25, wherein, during the predetermined number of seal compression steps, the motor is actuated at a minimum speed.

27. The electronic plumbing fixture fitting of claim 25, wherein:

during the predetermined number of startup close steps, the motor is actuated at a first power level;

during the predetermined number of seal compression steps, the motor is actuated at a second power level; and

the second power level is less than the first power level.

28. The electronic plumbing fixture fitting of claim 21, wherein:

during a full opening operation of the electronic valve, the motor is actuated a predetermined number of full open steps causing the piston to be out of the seat;

the predetermined number of full open steps is at least the maximum number of open steps required for the electronic valve to be in the completely open position;

during a full closing operation of the electronic valve, the motor is actuated a predetermined number of full close steps causing the piston to be in sealing contact with the seat;

the predetermined number of full close steps is at least the maximum number of close steps required for the electronic valve to be in the completely closed position; and

after the motor has been actuated the predetermined number of full close steps, the motor is actuated a predetermined number of seal compression steps to ensure that the sealing member is compressed.

29. The electronic plumbing fixture fitting of claim 28, wherein, during the predetermined number of full close steps, the motor starts at the minimum speed, is accelerated to a maximum speed, and is decelerated to the minimum speed.

30. The electronic plumbing fixture fitting of claim 29, wherein, prior to the piston being in sealing contact with the seat, the motor reaches the minimum speed.
31. The electronic plumbing fixture fitting of claim 29, wherein, the motor is accelerated and decelerated at a predetermined rate of acceleration and deceleration.
32. The electronic plumbing fixture fitting of claim 28, wherein, during the predetermined number of seal compression steps, the motor is actuated at a minimum speed.
33. The electronic plumbing fixture fitting of claim 28, wherein:
during the predetermined number of full close steps, the motor is actuated at a first power level;
during the predetermined number of seal compression steps, the motor is actuated at a second power level; and
the second power level is less than the first power level.
34. An electronic plumbing fixture fitting, comprising:
a discharge outlet, the discharge outlet being operable to deliver water; and
an electronic valve, the electronic valve being operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated, the electronic valve including a motor, a piston, a seat, and a sealing member,

one of the piston and the seat being operable to move relative to the other of the piston and the seat;

the sealing member being operable to be received on one of the piston and the seat; and

the motor being operable to move one of the piston and the seat relative to the other of the piston and the seat so that the piston is out of the seat to open the electronic valve, the motor being operable to move one of the piston and the seat relative to the other of the piston and the seat so that the piston is in the seat to close the electronic valve;

wherein, during a full opening operation of the electronic valve, the motor is actuated a predetermined number of full open steps causing the piston to be out of the seat;

wherein the predetermined number of full open steps is at least a maximum number of open steps required for the electronic valve to be in a completely open position;

wherein, during a full closing operation of the electronic valve, the motor is actuated a predetermined number of full close steps causing the piston to be in sealing contact with the seat;

wherein the predetermined number of full close steps is at least a maximum number of close steps required for the electronic valve to be in a completely closed position; and

wherein, after the motor has been actuated the predetermined number of full close steps, the motor is actuated a predetermined number of seal compression steps to ensure that the sealing member is compressed.

35. The electronic plumbing fixture fitting of claim 34, wherein, during the predetermined number of full close steps, the motor starts at a minimum speed, is accelerated to a maximum speed, and is decelerated to the minimum speed.

36. The electronic plumbing fixture fitting of claim 35, wherein, prior to the piston being in sealing contact with the seat, the motor reaches the minimum speed.
37. The electronic plumbing fixture fitting of claim 35, wherein, the motor is accelerated and decelerated at a predetermined rate of acceleration and deceleration.
38. The electronic plumbing fixture fitting of claim 34, wherein, during the predetermined number of seal compression steps, the motor is actuated at a minimum speed.
39. The electronic plumbing fixture fitting of claim 34, wherein:
during the predetermined number of full close steps, the motor is actuated at a first power level;
during the predetermined number of seal compression steps, the motor is actuated at a second power level; and
the second power level is less than the first power level.
40. An electronic plumbing fixture fitting, comprising:
a discharge outlet, the discharge outlet being operable to deliver water; and
an electronic valve, the electronic valve being operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated, the electronic valve including a motor, a piston, a seat, and a sealing member,

one of the piston and the seat being operable to move relative to the other of the piston and the seat;

the sealing member being operable to be received on one of the piston and the seat; and

the motor being operable to move one of the piston and the seat relative to the other of the piston and the seat so that the piston is out of the seat to open the electronic valve, the motor being operable to move one of the piston and the seat relative to the other of the piston and the seat so that the piston is in the seat to close the electronic valve;

wherein, upon startup of the electronic valve, the motor is actuated a predetermined number of startup open steps causing the piston to be out of the seat;

wherein the predetermined number of startup open steps is greater than a maximum number of open steps required for the electronic valve to be in a completely open position;

wherein, after the motor has been actuated the predetermined number of startup open steps, the motor is actuated a predetermined number of startup close steps causing the piston to be in sealing contact with the seat;

wherein the predetermined number of startup close steps is greater than a maximum number of close steps required for the electronic valve to be in a completely closed position;

wherein, after the motor has been actuated the predetermined number of startup close steps, the motor is actuated a predetermined number of seal compression steps to ensure that the sealing member is compressed;

wherein, during a full opening operation of the electronic valve, the motor is actuated a predetermined number of full open steps causing the piston to be out of the seat;

wherein the predetermined number of full open steps is at least the maximum number of open steps required for the electronic valve to be in the completely open position;

wherein, during a full closing operation of the electronic valve, the motor is actuated a predetermined number of full close steps causing the piston to be in sealing contact with the seat;

wherein the predetermined number of full close steps is at least the maximum number of close steps required for the electronic valve to be in the completely closed position; and

wherein, after the motor has been actuated the predetermined number of full close steps, the motor is actuated the predetermined number of seal compression steps to ensure that the sealing member is compressed.

41. An electronic plumbing fixture fitting, comprising:

a discharge outlet, the discharge outlet being operable to deliver water;

a hot water electronic valve and a cold water electronic valve, the hot water electronic valve and the cold water electronic valve being operable to permit flow of water through the discharge outlet when at least one of the hot water electronic valve and the cold water electronic valve is activated and to not permit flow of water through the discharge outlet when both of the hot water electronic valve and the cold water electronic valve are deactivated; and

an actuation device, the actuation device being operable to indicate a desired change to at least one parameter of water flowing through the discharge outlet;

wherein, when the desired change to the water flowing through the discharge outlet requires activation of both the hot water electronic valve and the cold water electronic valve, the hot water electronic valve and the cold water electronic valve are alternately activated until desired positions of both the hot water electronic valve and the cold water electronic valve are reached.

42. The electronic plumbing fixture fitting of claim 41, wherein, when the desired change to the water flowing through the discharge outlet will result in an increasing volume through one of the hot water electronic valve and the cold water electronic valve and a decreasing volume through the other of the hot water electronic valve and the cold water electronic valve, whichever of the hot water electronic valve and the cold water electronic valve has the increasing volume is activated first and whichever of the hot water electronic valve and the cold water electronic valve has the decreasing volume is activated second.

43. The electronic plumbing fixture fitting of claim 41, wherein the hot water electronic valve and the cold water electronic valve are alternately activated a single time to desired positions of both the hot water electronic valve and the cold water electronic valve.

44. The electronic plumbing fixture fitting of claim 41, wherein the hot water electronic valve and the cold water electronic valve are alternately activated multiple times until desired positions of both the hot water electronic valve and the cold water electronic valve are reached.

45. The electronic plumbing fixture fitting of claim 41, wherein the actuation device is a handle.

46. The electronic plumbing fixture fitting of claim 41, wherein the actuation device is a user interface.

47. The electronic plumbing fixture fitting of claim 41, wherein the desired change to at least one parameter of water flowing through the discharge outlet is a change in a volume of the water when a temperature of the water is mixed and constant.

48. The electronic plumbing fixture fitting of claim 41, wherein the desired change to at least one parameter of water flowing through the discharge outlet is a change in a temperature of the water when a volume of the water is constant

49. An electronic plumbing fixture fitting, comprising:

a discharge outlet, the discharge outlet being operable to deliver water;

a hot water electronic valve and a cold water electronic valve, the hot water electronic valve and the cold water electronic valve being operable to permit flow of water through the discharge outlet when at least one of the hot water electronic valve and the cold water electronic valve is activated and to not permit flow of water through the discharge outlet when both of the hot water electronic valve and the cold water electronic valve are deactivated; and

an actuation device, the actuation device being operable to indicate a desired change to at least one parameter of water flowing through the discharge outlet;

wherein, when the desired change to the water flowing through the discharge outlet will result in an increasing volume through one of the hot water electronic valve and the cold water electronic valve and a decreasing volume through the other of the hot water electronic valve and the cold water electronic valve, whichever of the hot water electronic valve and the cold water electronic valve has the increasing volume is activated first and whichever of the hot water

electronic valve and the cold water electronic valve has the decreasing volume is activated second.

50. The electronic plumbing fixture fitting of claim 49, wherein the hot water electronic valve and the cold water electronic valve are alternately activated a single time to desired positions of both the hot water electronic valve and the cold water electronic valve.

51. The electronic plumbing fixture fitting of claim 49, wherein the hot water electronic valve and the cold water electronic valve are alternately activated multiple times until desired positions of both the hot water electronic valve and the cold water electronic valve are reached.

52. The electronic plumbing fixture fitting of claim 49, wherein the actuation device is a handle.

53. The electronic plumbing fixture fitting of claim 49, wherein the actuation device is a user interface.

54. An electronic plumbing fixture fitting, comprising:

a discharge outlet, the discharge outlet being operable to deliver water;

a hot water electronic valve and a cold water electronic valve, the hot water electronic valve and the cold water electronic valve being operable to permit flow of water through the discharge outlet when at least one of the hot water electronic valve and the cold water electronic

valve is activated and to not permit flow of water through the discharge outlet when both of the hot water electronic valve and the cold water electronic valve are deactivated; and

an actuation device, the actuation device being operable to indicate a desired change to at least one parameter of water flowing through the discharge outlet;

wherein, when the actuation device is moved quickly, each of the hot water electronic valve and the cold water electronic valve is alternately activated a single time to desired positions of both the hot water electronic valve and the cold water electronic valve; and

wherein, when the actuation device is moved slowly, the hot water electronic valve and the cold water electronic valve are alternately activated multiple times until desired positions of both the hot water electronic valve and the cold water electronic valve are reached.

55. The electronic plumbing fixture fitting of claim 54, wherein:

the actuation device is moved quickly when a speed of rotation of the actuation device is more than fifty degrees per second; and

the actuation device is moved slowly when the speed of rotation of the actuation device is less than or equal to fifty degrees per second.

56. The electronic plumbing fixture fitting of claim 54, wherein:

the actuation device is moved quickly when a speed of rotation of the actuation device is more than seventy-five degrees per second; and

the actuation device is moved slowly when the speed of rotation of the actuation device is less than or equal to seventy-five degrees per second.

57. The electronic plumbing fixture fitting of claim 54, wherein:

the actuation device is moved quickly when a speed of rotation of the actuation device is more than one-hundred degrees per second; and

the actuation device is moved slowly when the speed of rotation of the actuation device is less than or equal to one-hundred degrees per second.

58. The electronic plumbing fixture fitting of claim 54, wherein:

the actuation device is moved quickly when a speed of rotation of the actuation device is more than one-hundred twenty-five degrees per second; and

the actuation device is moved slowly when the speed of rotation of the actuation device is less than or equal to one-hundred twenty-five degrees per second.

59. The electronic plumbing fixture fitting of claim 54, wherein the actuation device is a handle.

60. The electronic plumbing fixture fitting of claim 54, wherein the actuation device is a user interface.

61. An electronic plumbing fixture fitting, comprising:

a discharge outlet, the discharge outlet being operable to deliver water;

an electronic valve, the electronic valve being operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated;

an activation sensor, the activation sensor being operable to activate and deactivate the electronic valve;

an actuation device, the actuation device being operable to activate and deactivate the electronic valve, the actuation device being operable to indicate a desired change to a parameter of water flowing through the discharge outlet; and

a parameter sensor, the parameter sensor being operable to detect the desired activation and deactivation of the electronic valve by the actuation device, the parameter sensor being operable to detect the desired change to the parameter of water flowing through the discharge outlet, the parameter sensor including an emitter and a detector;

wherein, when the activation sensor activates and deactivates the electronic valve, the electronic plumbing fixture fitting is in a sensor mode;

wherein, when the actuation device activates and deactivates the electronic valve, the electronic plumbing fixture fitting is in a manual mode;

wherein, in the sensor mode, energy is transmitted from the emitter at a first rate of transmission, and energy is detected by the detector at a first rate of detection;

wherein, in the manual mode, energy is transmitted from the emitter at a second rate of transmission, and energy is detected by the detector at a second rate of detection; and

wherein the first rate of transmission is less frequent than the second rate of transmission, and the first rate of detection is less frequent than the second rate of detection.

62. The electronic plumbing fixture fitting of claim 61, wherein the activation sensor includes a toggle sensor.

63. The electronic plumbing fixture fitting of claim 61, wherein the activation sensor includes a presence sensor.

64. The electronic plumbing fixture fitting of claim 61, wherein the actuation device is a handle.

65. The electronic plumbing fixture fitting of claim 64, wherein the parameter sensor is located in a portion of a hub to which the handle is mounted.

66. The electronic plumbing fixture fitting of claim 61, wherein the actuation device is a user interface.

67. An electronic plumbing fixture fitting, comprising:

a discharge outlet, the discharge outlet being operable to deliver water;

an electronic valve, the electronic valve being operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated;

an activation sensor, the activation sensor being operable to activate and deactivate the electronic valve;

an actuation device, the actuation device being operable to activate and deactivate the electronic valve, the actuation device being operable to indicate a desired change to a parameter of water flowing through the discharge outlet; and

a parameter sensor, the parameter sensor being operable to detect the desired activation and deactivation of the electronic valve by the actuation device, the parameter sensor being operable to detect the desired change to the parameter of water flowing through the discharge outlet, the parameter sensor including a first emitter, a second emitter, a first detector, and a second detector;

wherein, when the activation sensor activates and deactivates the electronic valve, the electronic plumbing fixture fitting is in a sensor mode;

wherein, when the actuation device activates and deactivates the electronic valve, the electronic plumbing fixture fitting is in a manual mode;

wherein, in the sensor mode, energy is transmitted from the first emitter and the second emitter at a first rate of transmission, and energy is detected by the first detector and the second detector at a first rate of detection;

wherein, in the manual mode, energy is transmitted from the first emitter and the second emitter at a second rate of transmission, and energy is detected by the first detector and the second detector at a second rate of detection; and

wherein the first rate of transmission is less frequent than the second rate of transmission, and the first rate of detection is less frequent than the second rate of detection.

68. The electronic plumbing fixture fitting of claim 67, wherein:

in the sensor mode, energy is alternately transmitted from the first emitter and the second emitter, and energy is alternately detected by the first detector and the second detector; and

in the manual mode, energy is simultaneously transmitted from the first emitter and the second emitter, and energy is simultaneously detected by the first detector and the second detector.

69. The electronic plumbing fixture fitting of claim 67, wherein the activation sensor includes a toggle sensor.

70. The electronic plumbing fixture fitting of claim 67, wherein the activation sensor includes a presence sensor.

71. The electronic plumbing fixture fitting of claim 67, wherein the actuation device is a handle.

72. The electronic plumbing fixture fitting of claim 71, wherein the parameter sensor is located in a portion of a hub to which the handle is mounted.

73. The electronic plumbing fixture fitting of claim 67, wherein the actuation device is a user interface.

74. An electronic plumbing fixture fitting, comprising:
a discharge outlet, the discharge outlet being operable to deliver water;

an electronic valve, the electronic valve being operable to permit flow of water through the discharge outlet when the electronic valve is activated and to not permit flow of water through the discharge outlet when the electronic valve is deactivated;

an activation sensor, the activation sensor being operable to activate and deactivate the electronic valve;

an actuation device, the actuation device being operable to activate and deactivate the electronic valve, the actuation device being operable to indicate a desired change to a parameter of water flowing through the discharge outlet; and

a parameter sensor, the parameter sensor being operable to detect the desired activation and deactivation of the electronic valve by the actuation device, the parameter sensor being operable to detect the desired change to the parameter of water flowing through the discharge outlet, the parameter sensor including a first emitter, a second emitter, a first detector, and a second detector;

wherein, when the activation sensor activates and deactivates the electronic valve, the electronic plumbing fixture fitting is in a sensor mode;

wherein, when the actuation device activates and deactivates the electronic valve, the electronic plumbing fixture fitting is in a manual mode;

wherein, in the sensor mode, energy is alternately transmitted from the first emitter and the second emitter, and energy is alternately detected by the first detector and the second detector; and

wherein, in the manual mode, energy is simultaneously transmitted from the first emitter and the second emitter, and energy is simultaneously detected by the first detector and the second detector.

75. The electronic plumbing fixture fitting of claim 74, wherein:

in the sensor mode, energy is transmitted from the first emitter and the second emitter at a first rate of transmission, and energy is detected by the first detector and the second detector at a first rate of detection;

in the manual mode, energy is transmitted from the first emitter and the second emitter at a second rate of transmission, and energy is detected by the first detector and the second detector at a second rate of detection; and

the first rate of transmission is less frequent than the second rate of transmission, and the first rate of detection is less frequent than the second rate of detection.

76. The electronic plumbing fixture fitting of claim 74, wherein the activation sensor includes a toggle sensor.

77. The electronic plumbing fixture fitting of claim 74, wherein the activation sensor includes a presence sensor.

78. The electronic plumbing fixture fitting of claim 74, wherein the actuation device is a handle.

79. The electronic plumbing fixture fitting of claim 78, wherein the parameter sensor is located in a portion of a hub to which the handle is mounted.

80. The electronic plumbing fixture fitting of claim 74, wherein the actuation device is a user interface.

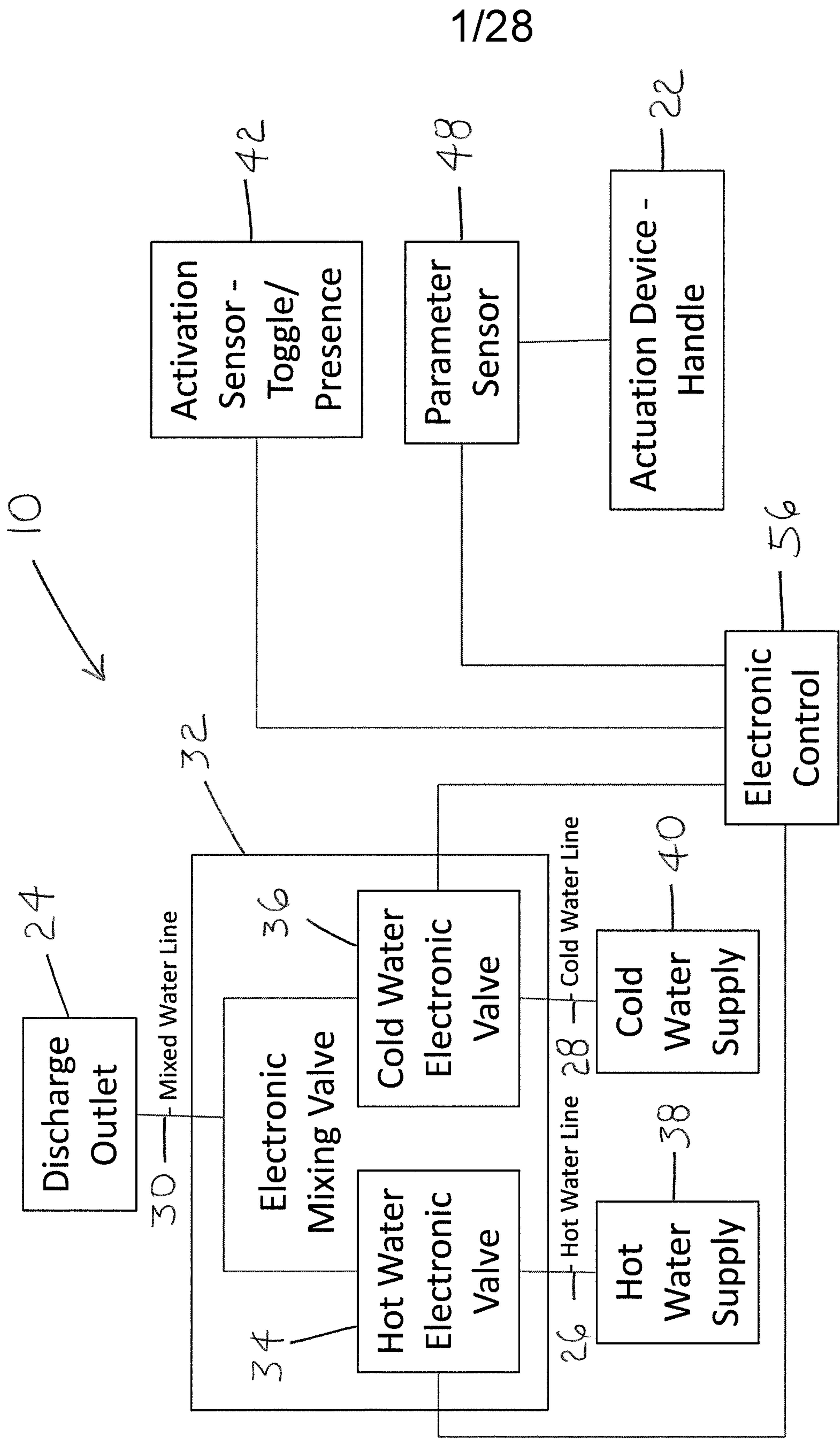


Figure 1

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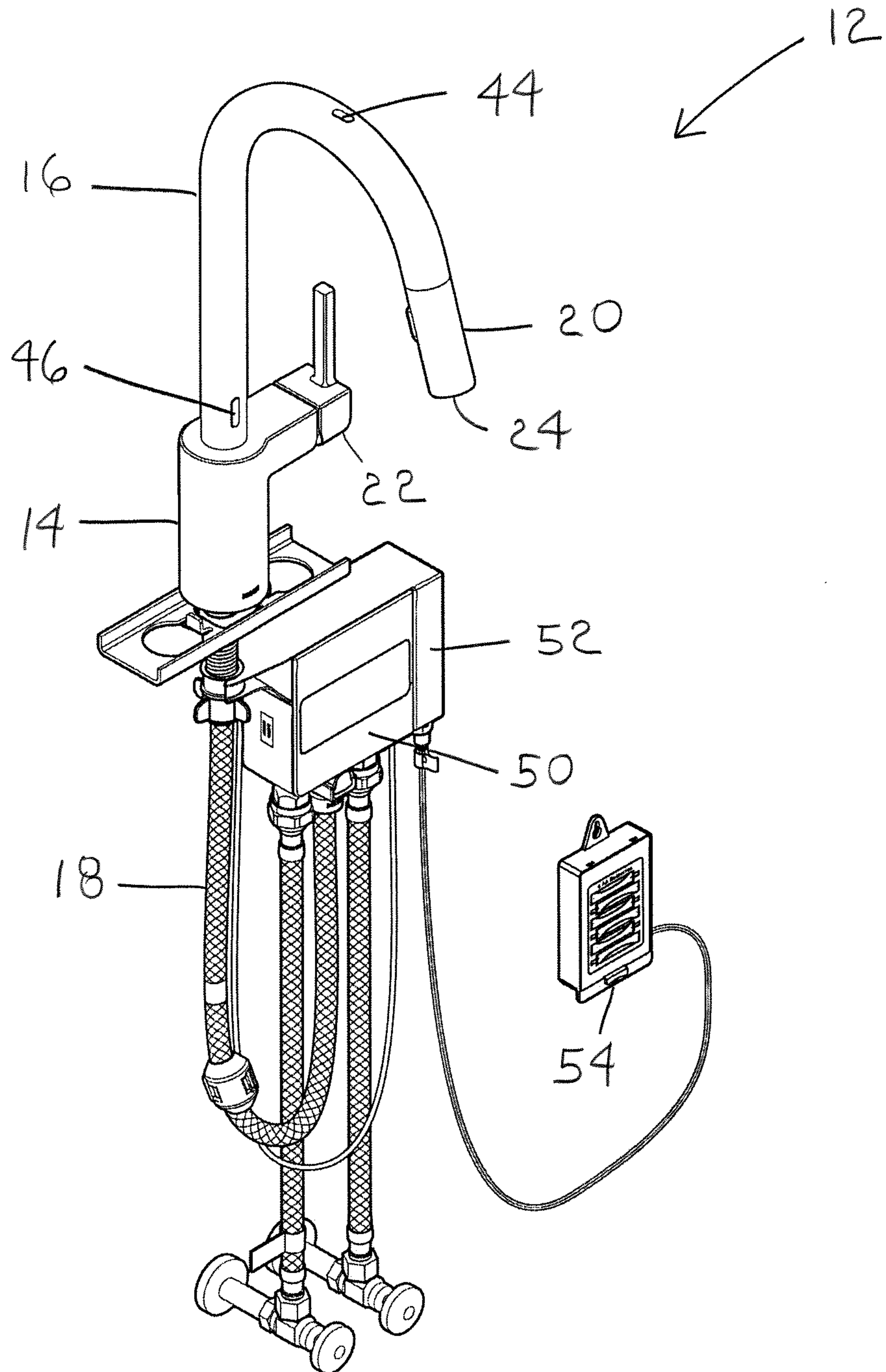


Figure 2

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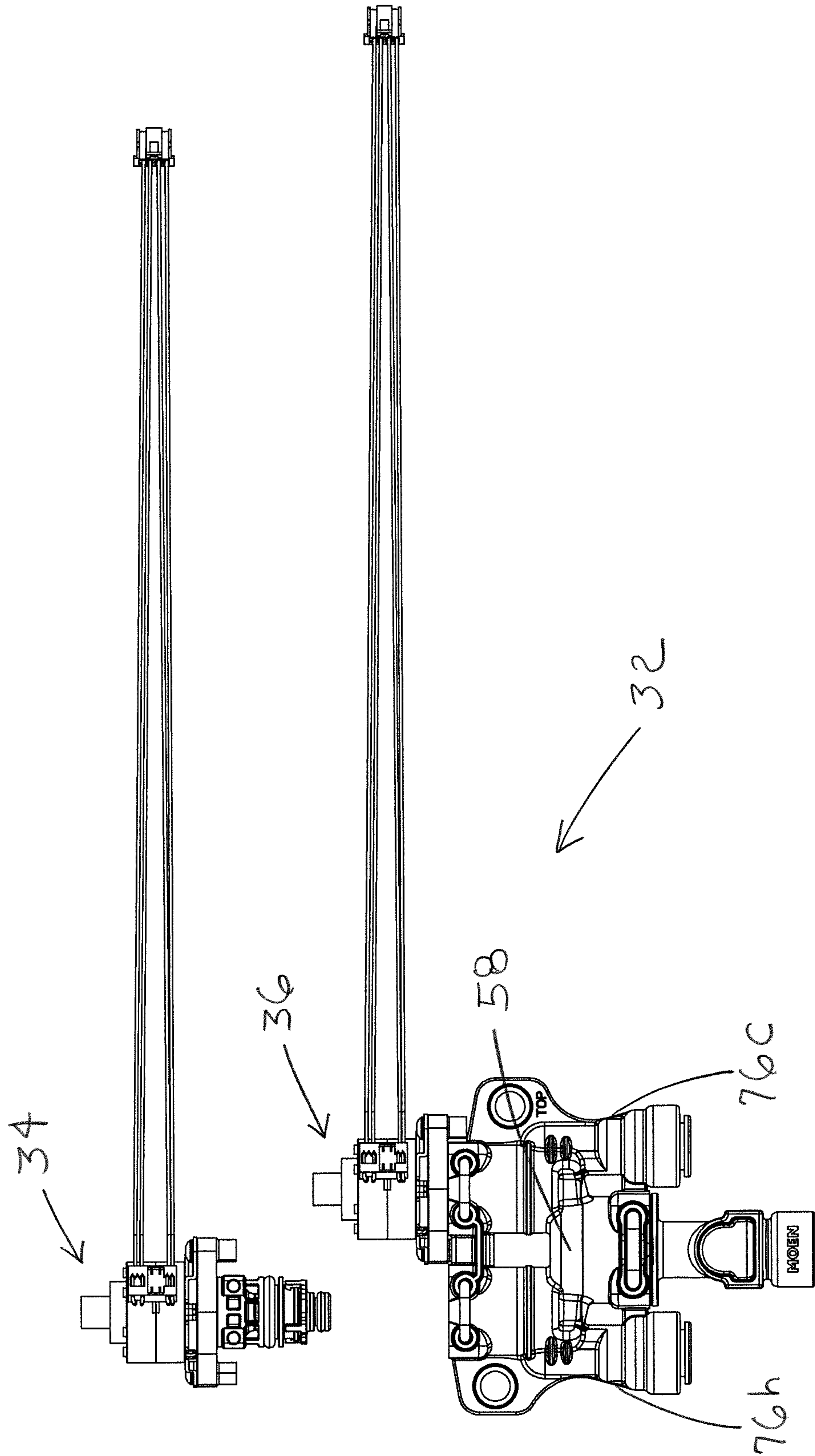


Figure 3a

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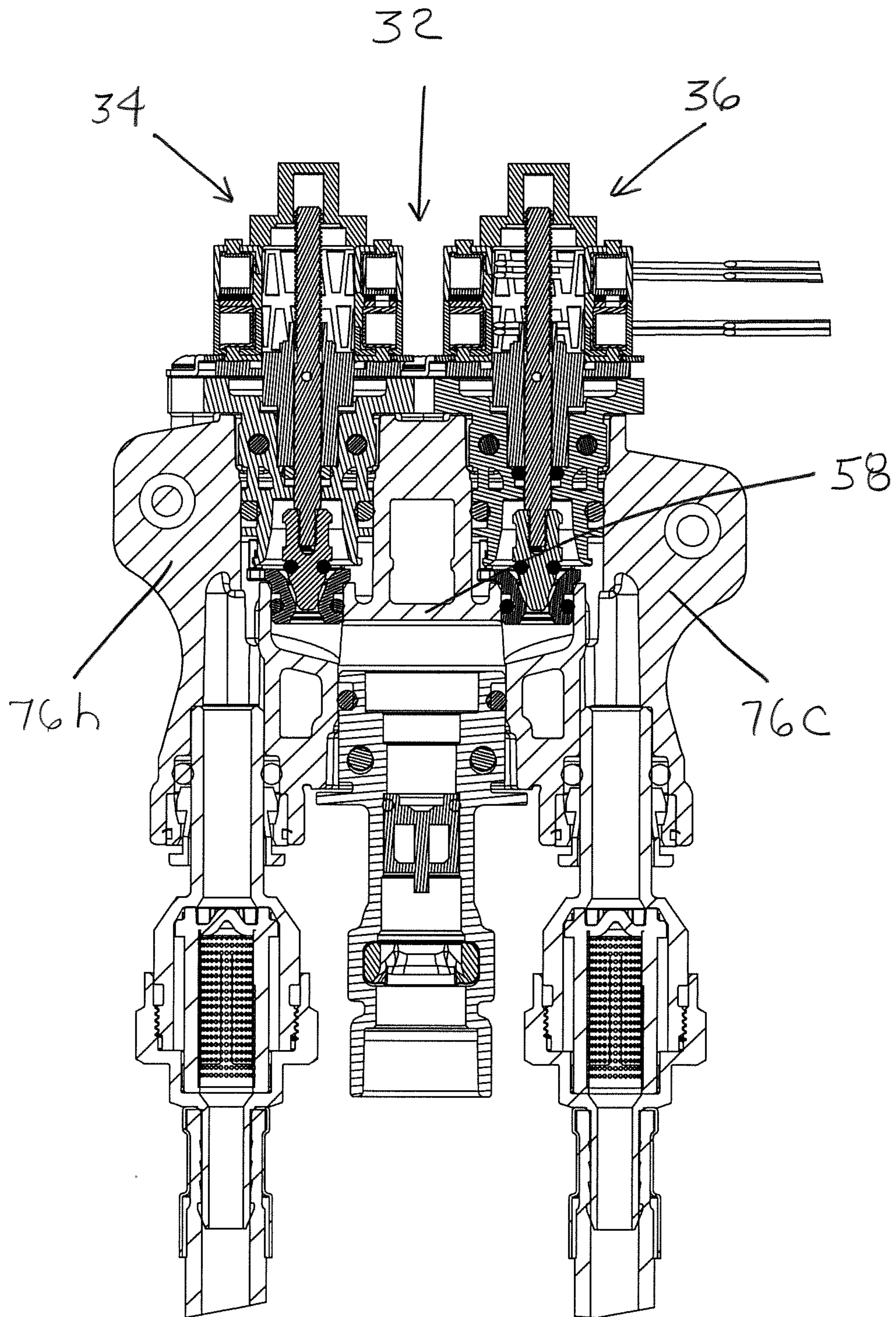


Figure 3b

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Figure 4a

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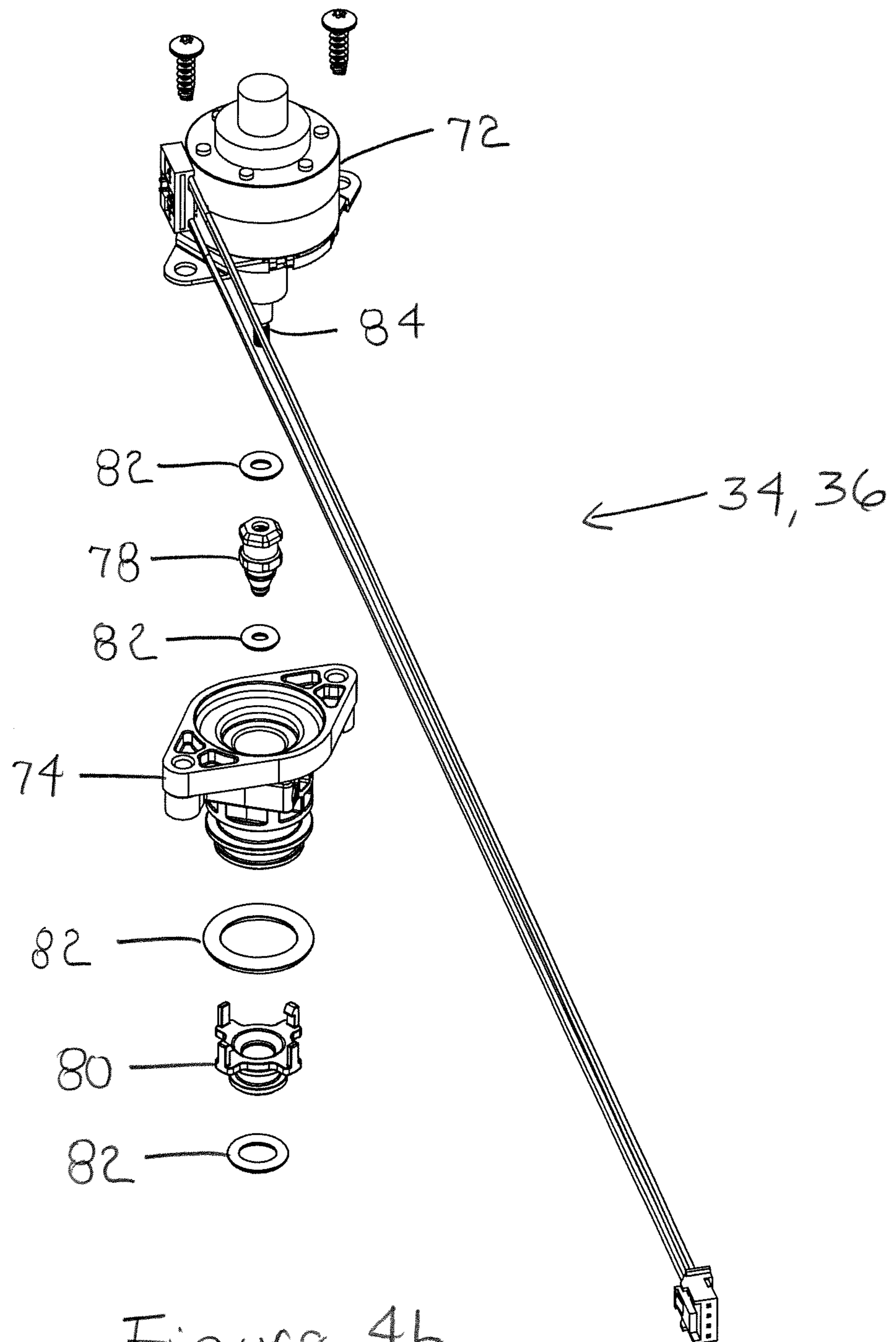


Figure 4b

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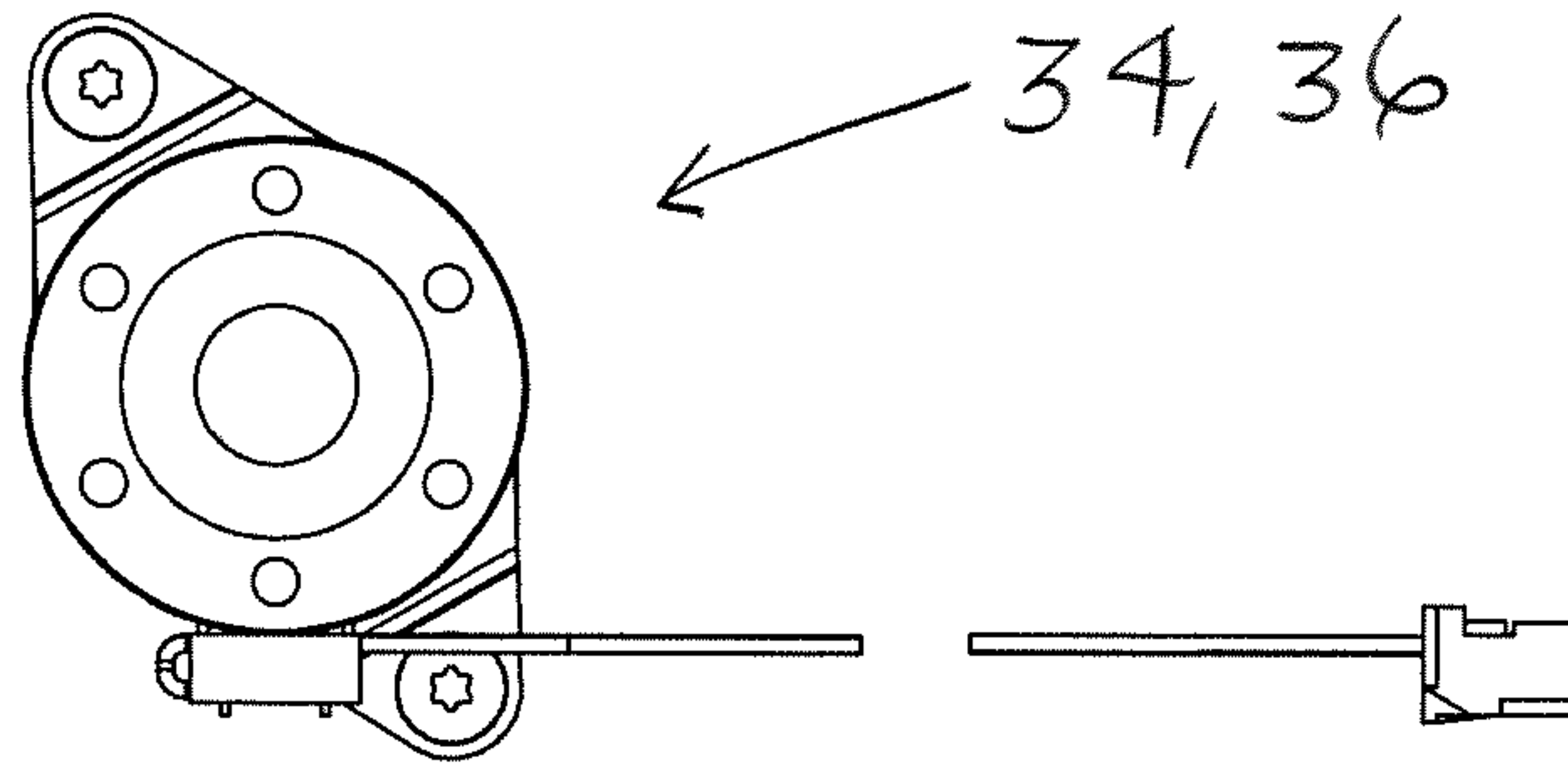


Figure 4d

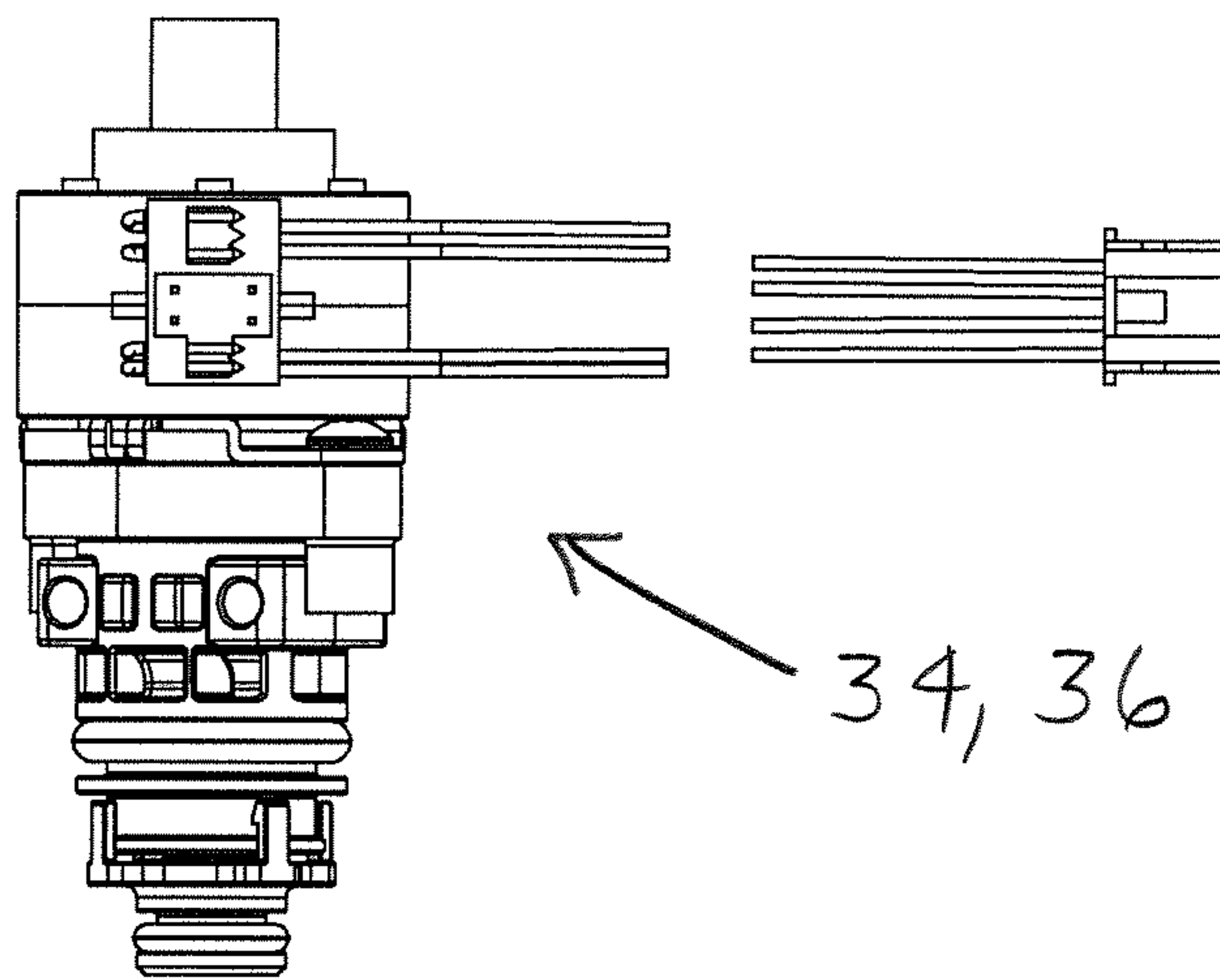


Figure 4c

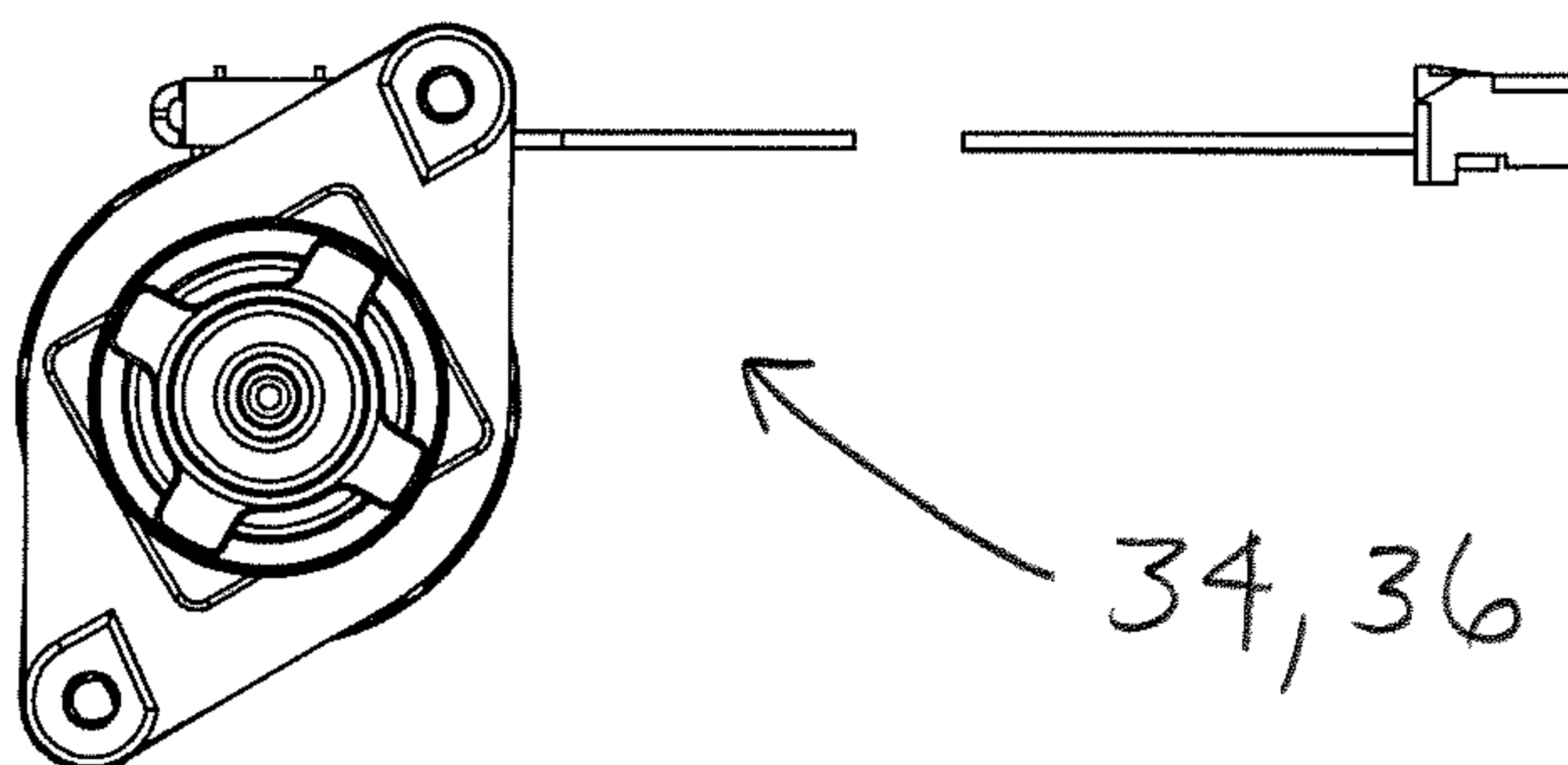


Figure 4e

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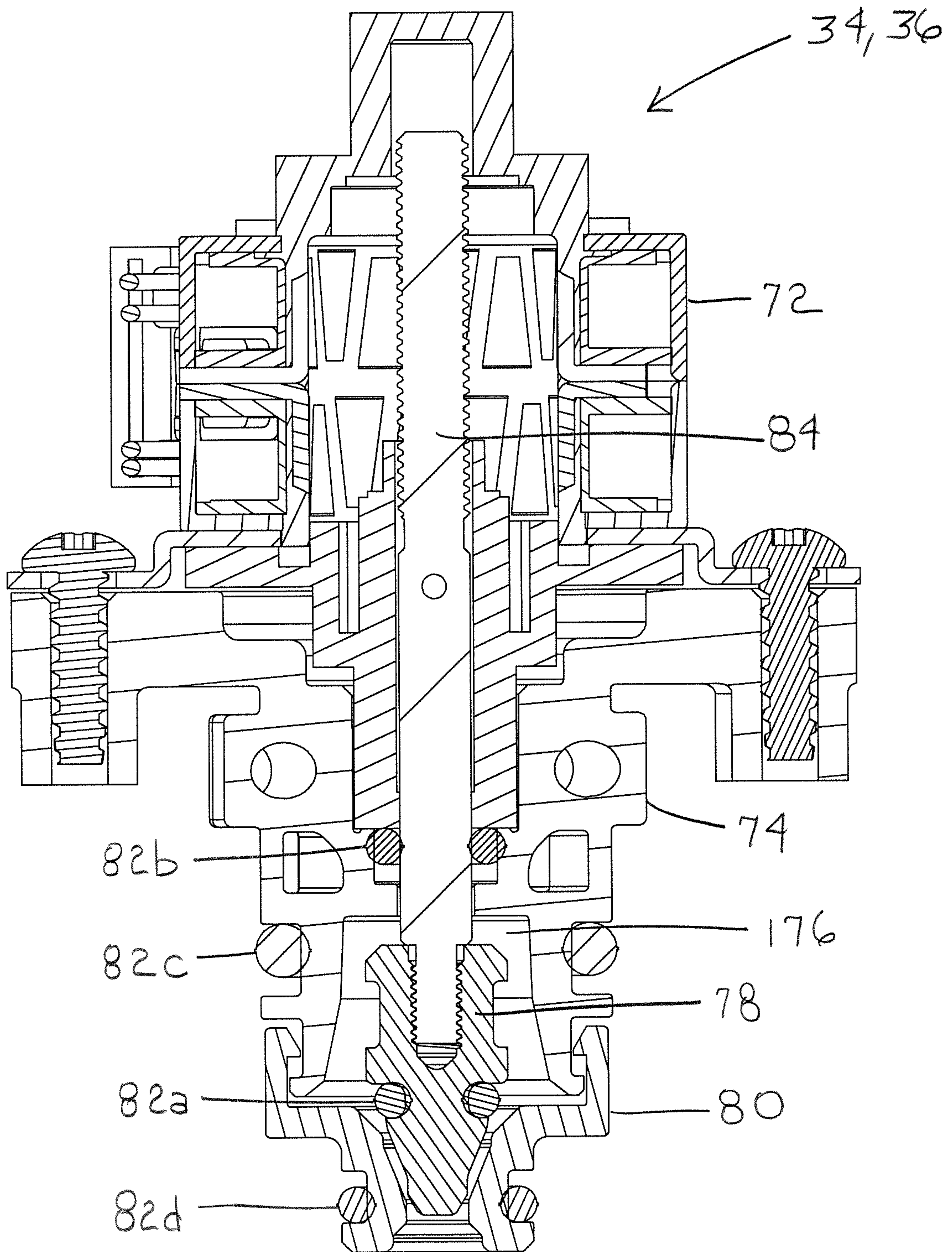


Figure 4f

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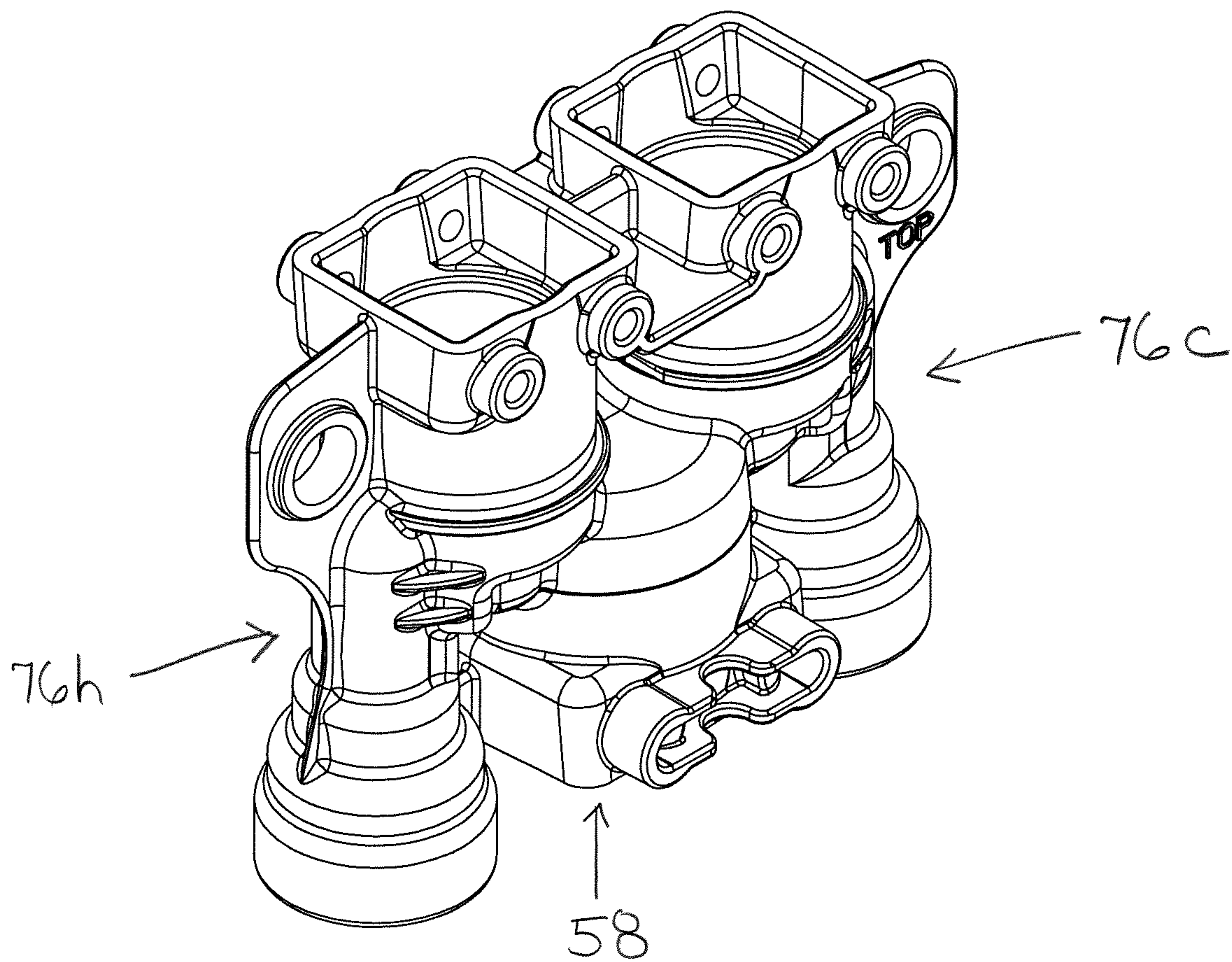


Figure 5a

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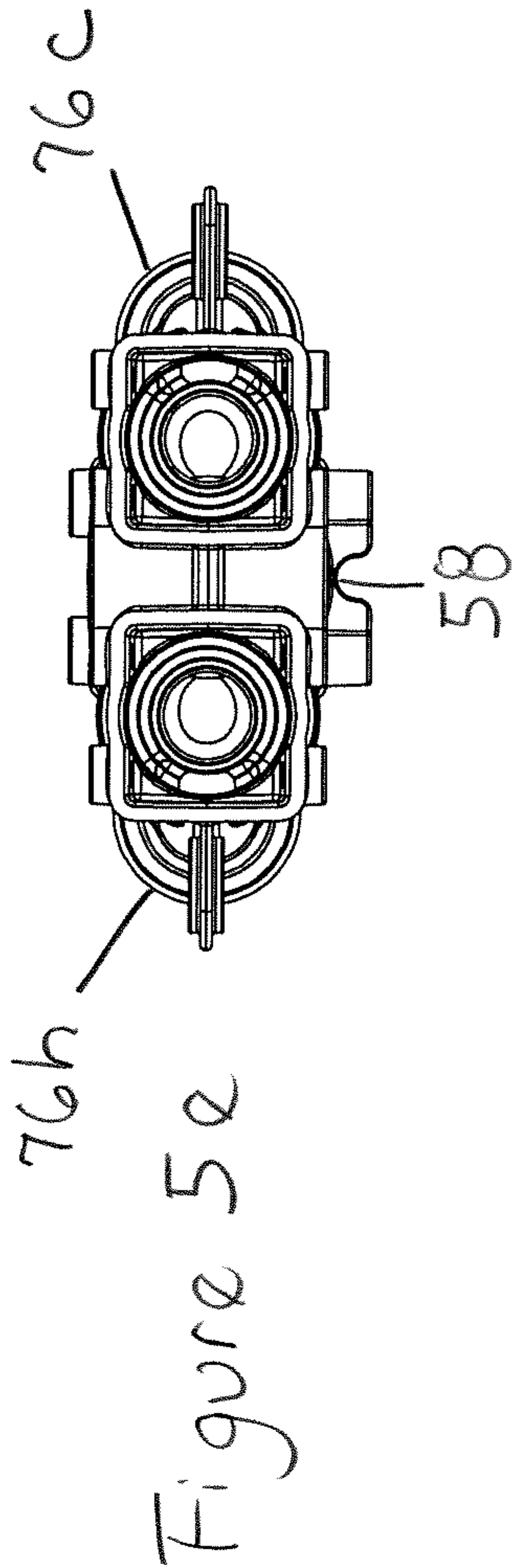


Figure 5c

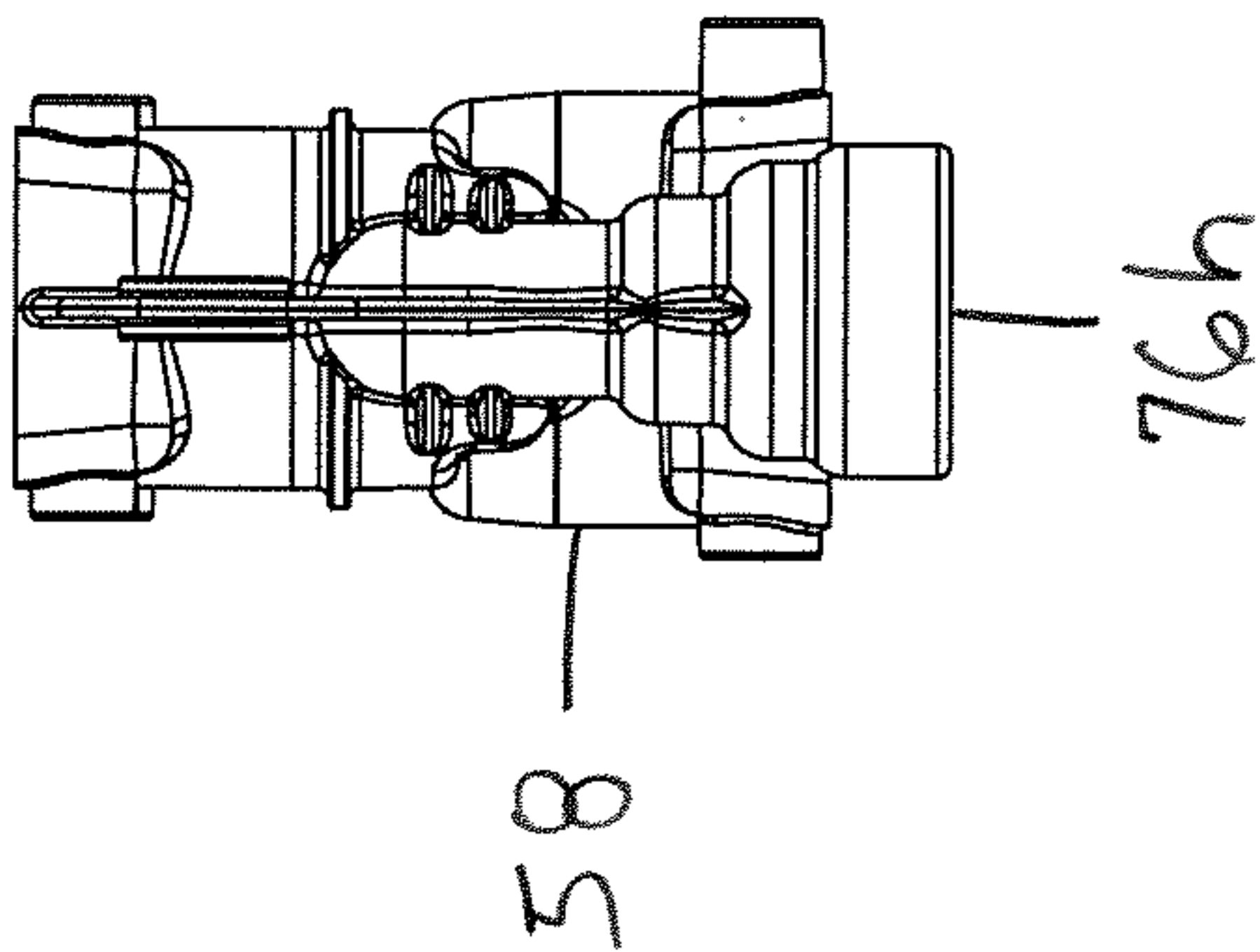


Figure 5b

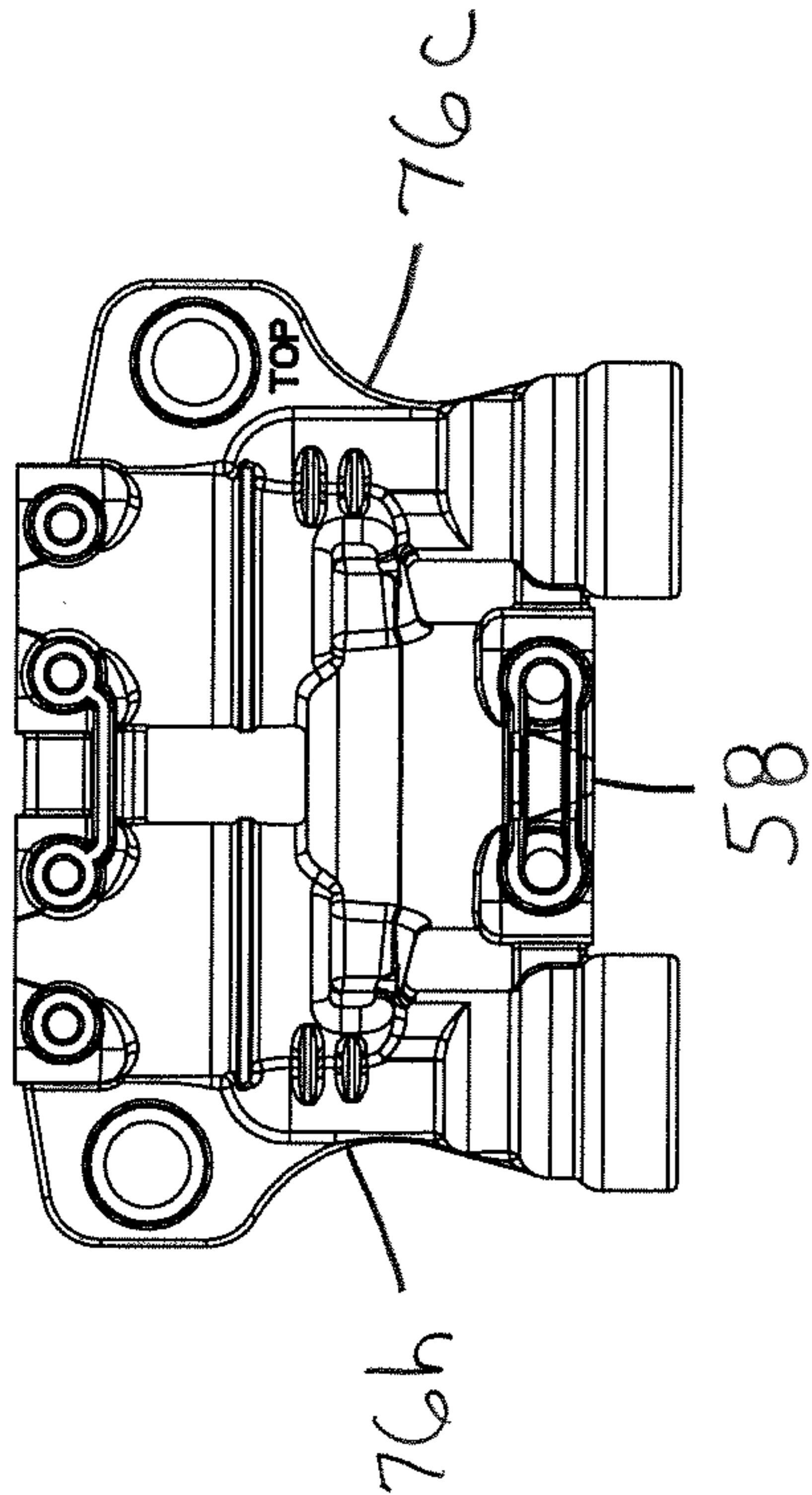
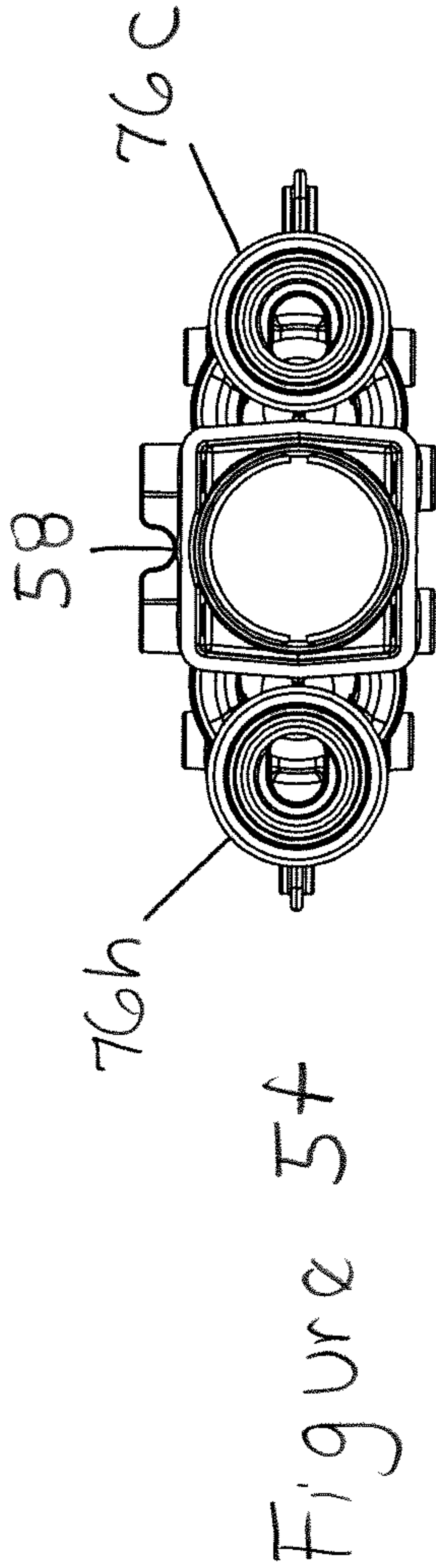
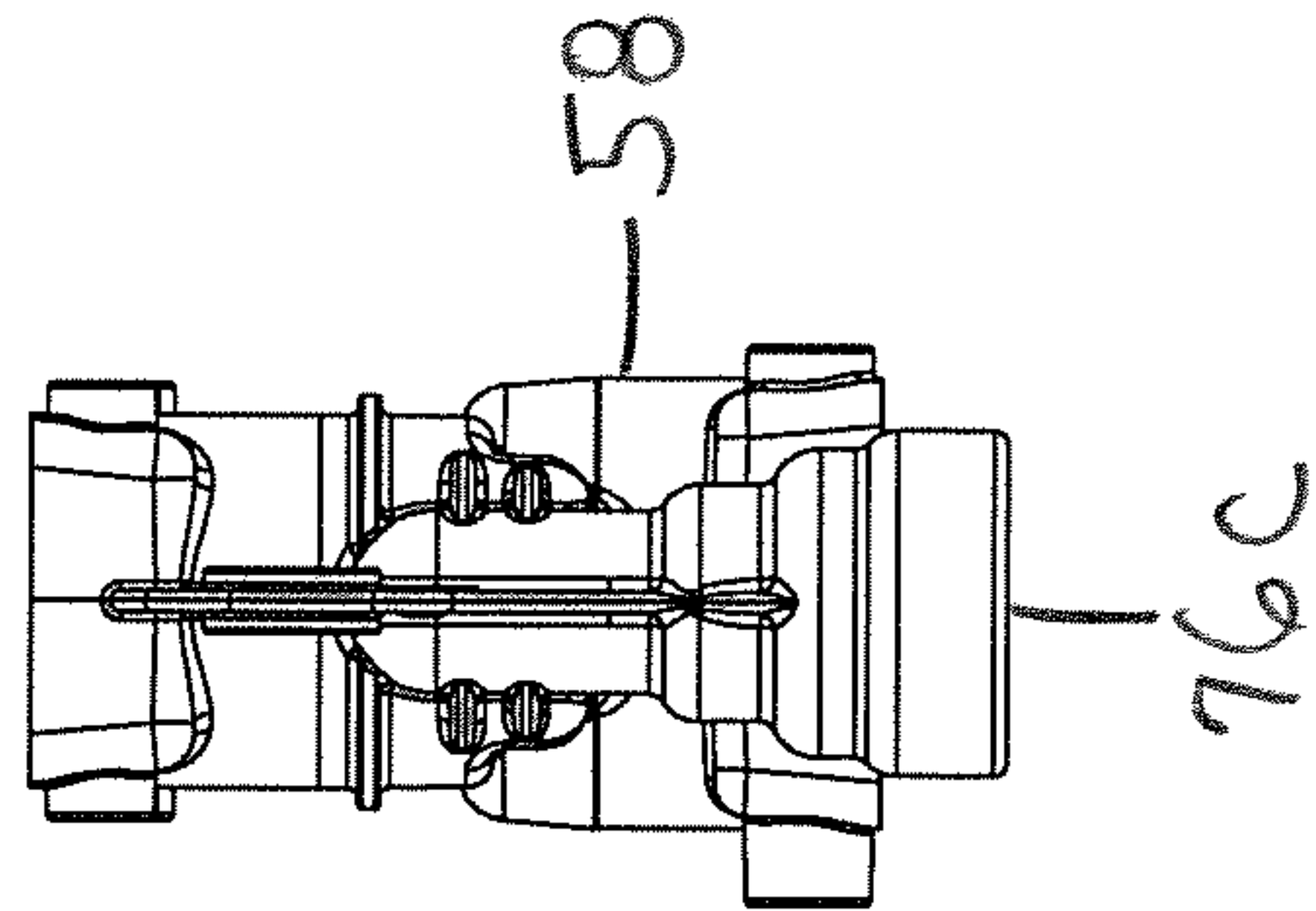
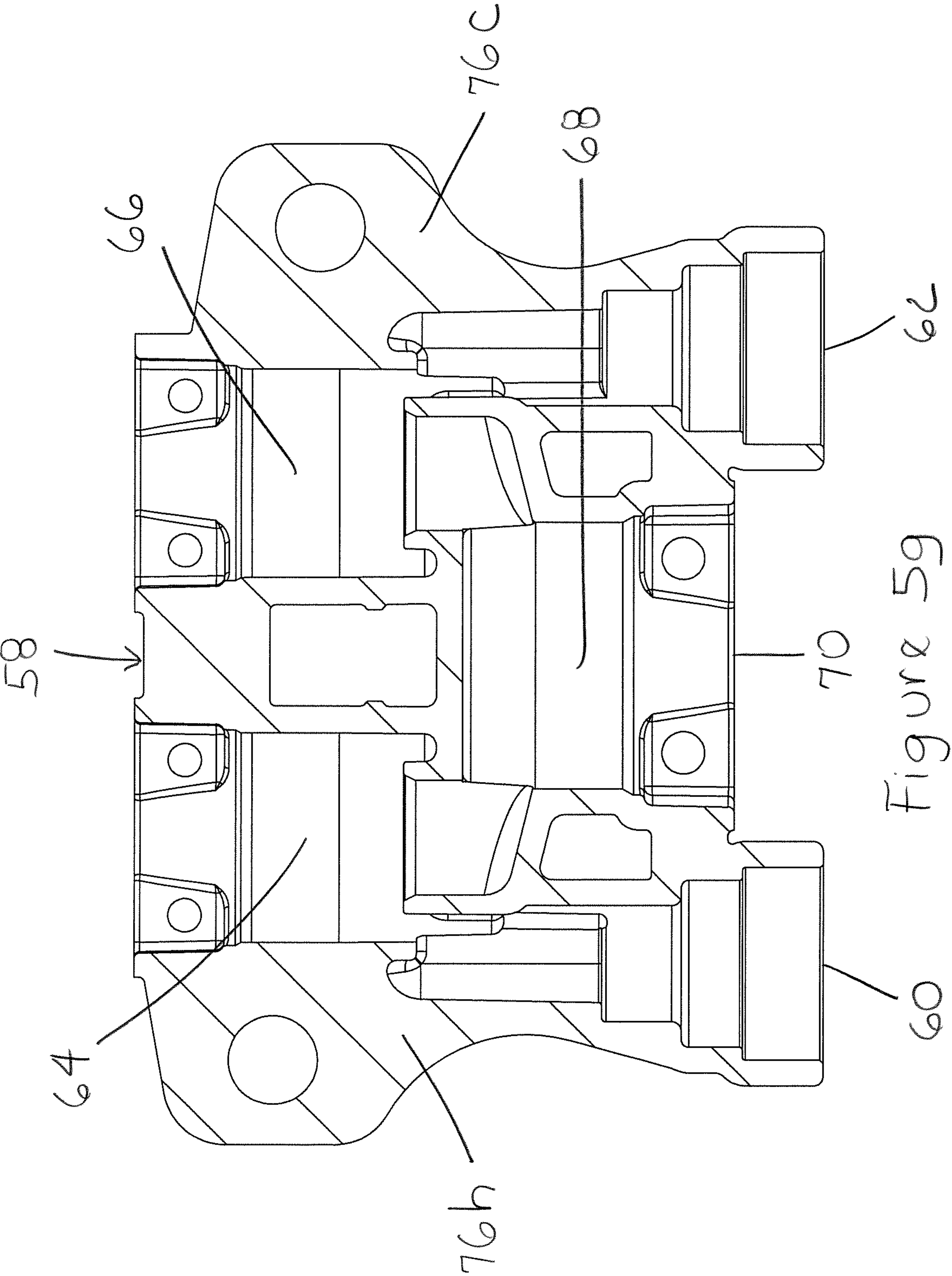
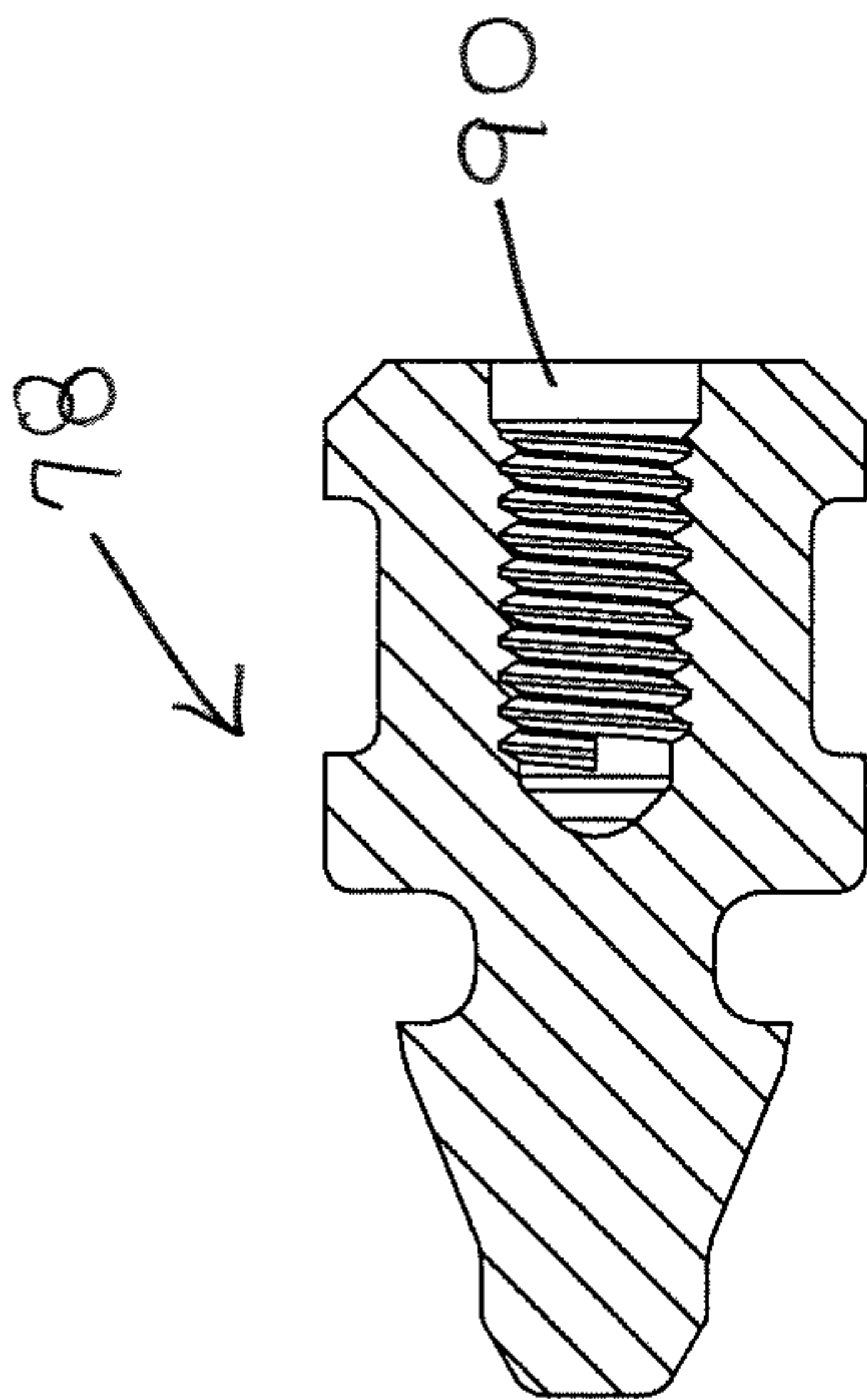
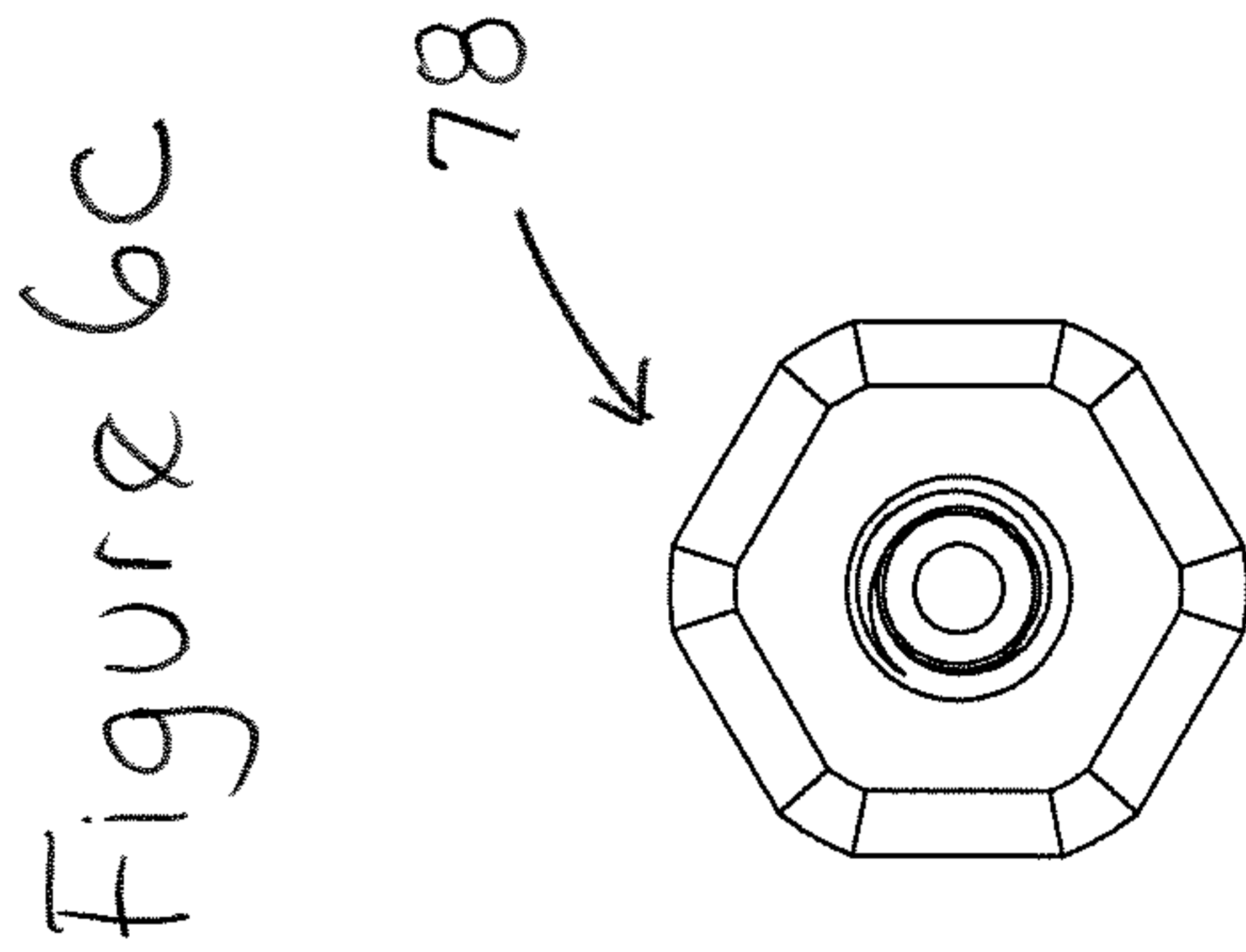
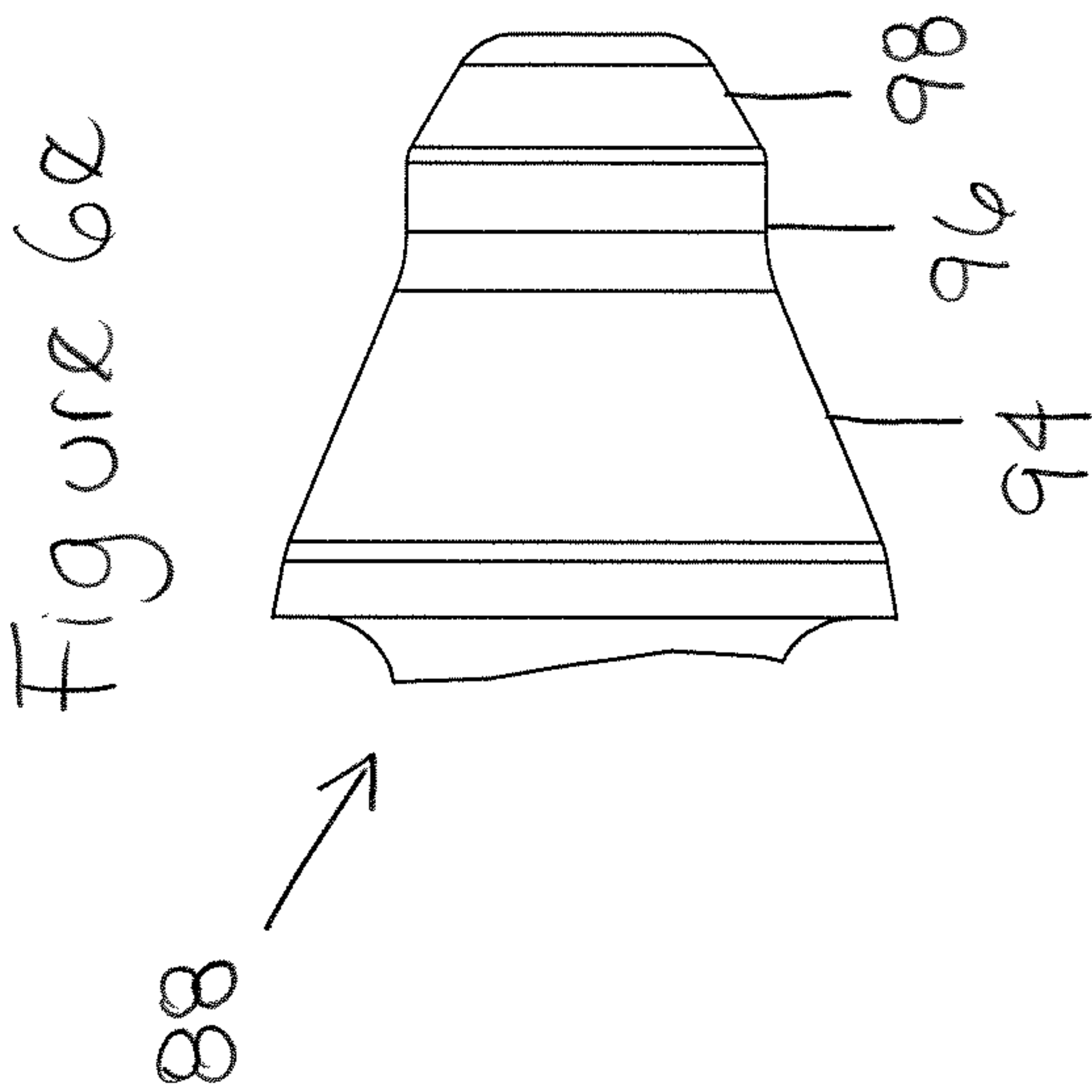
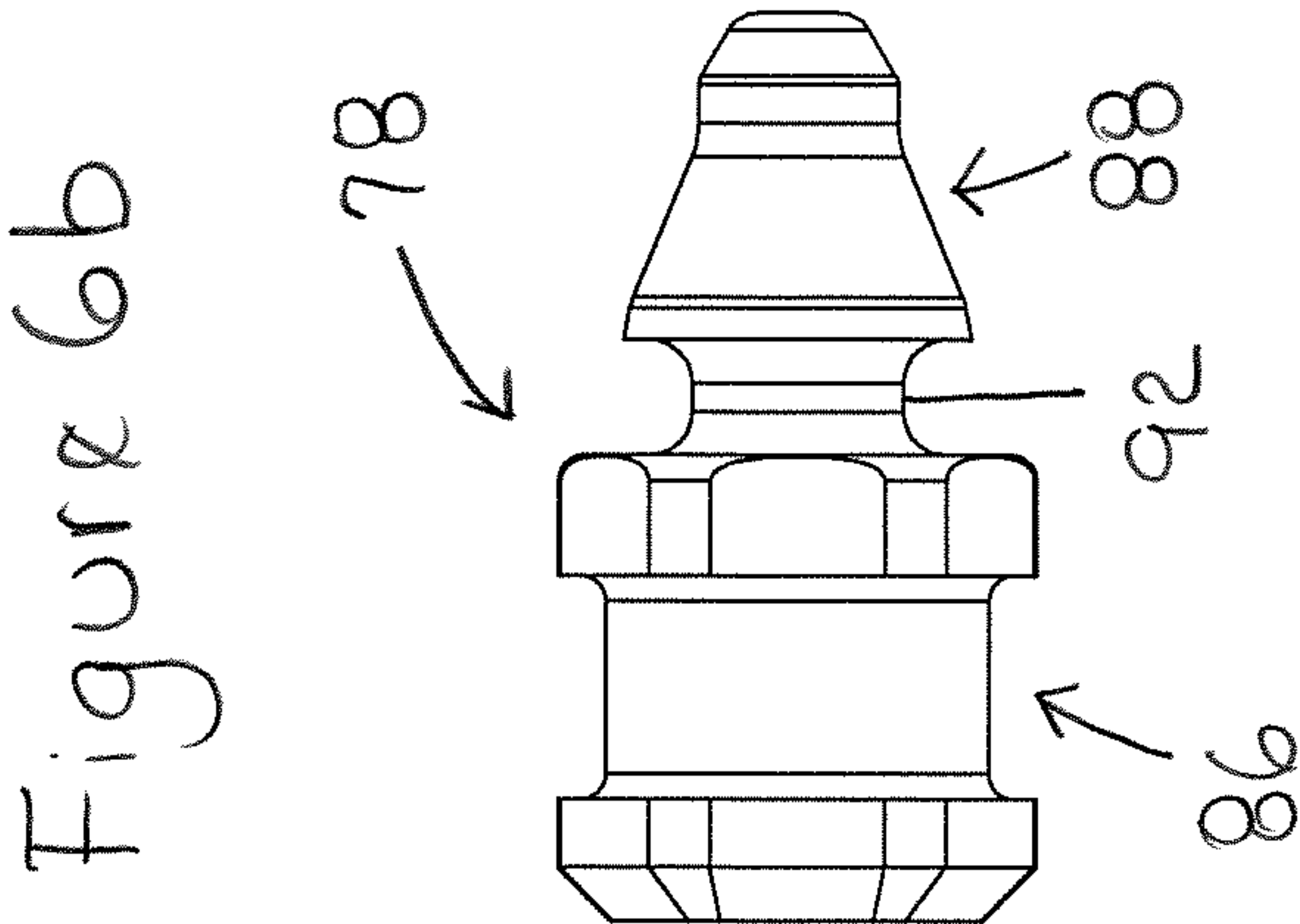
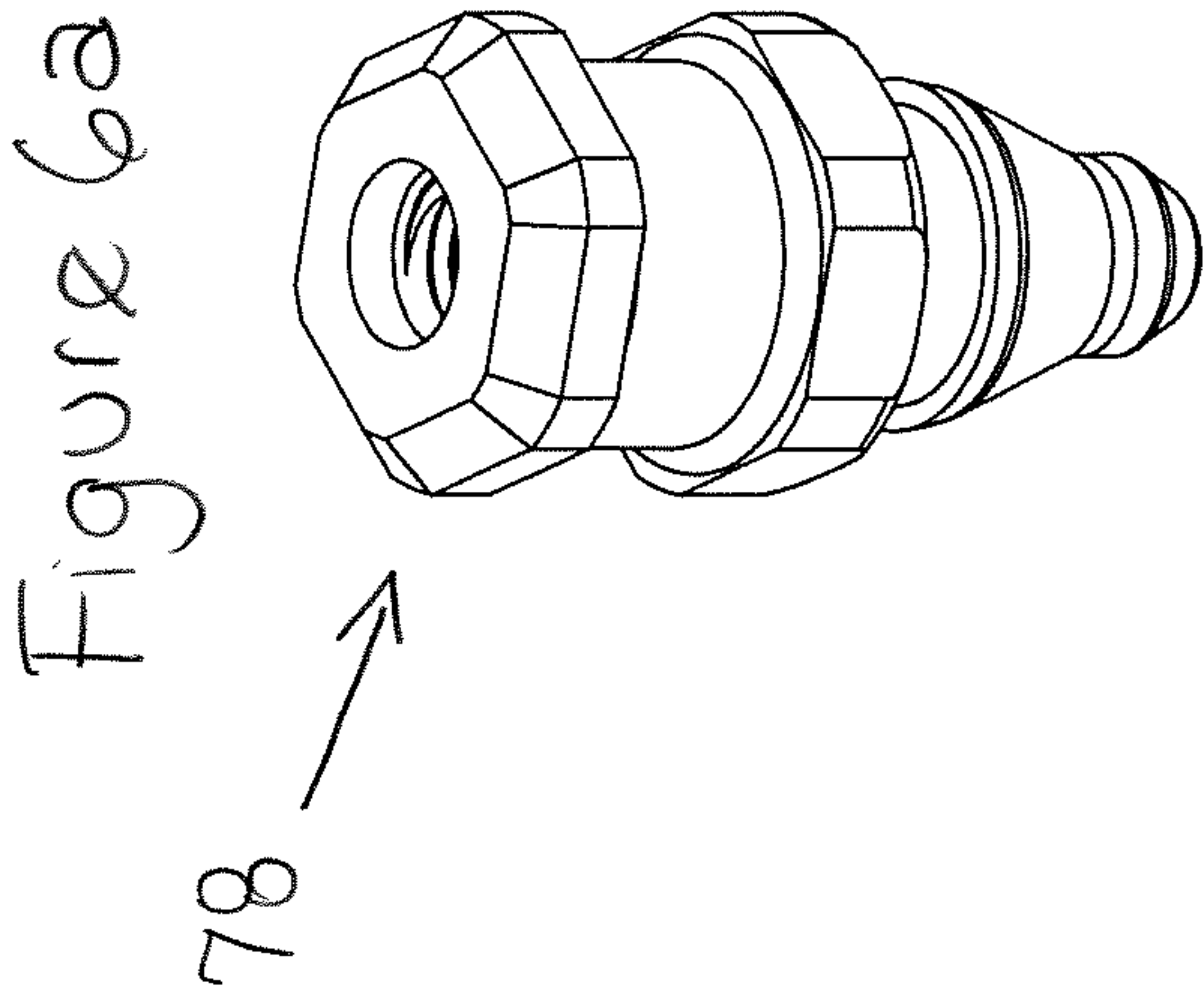
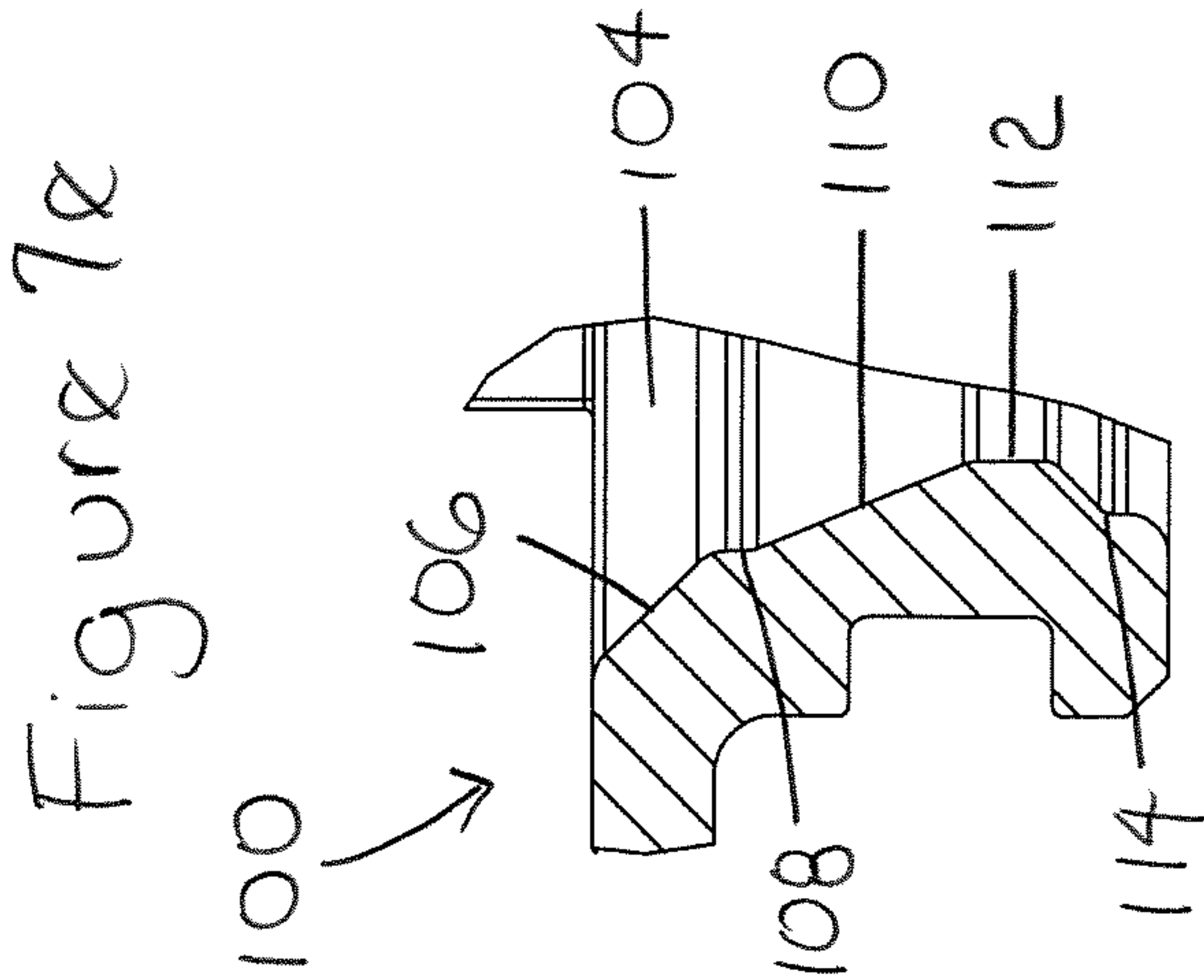
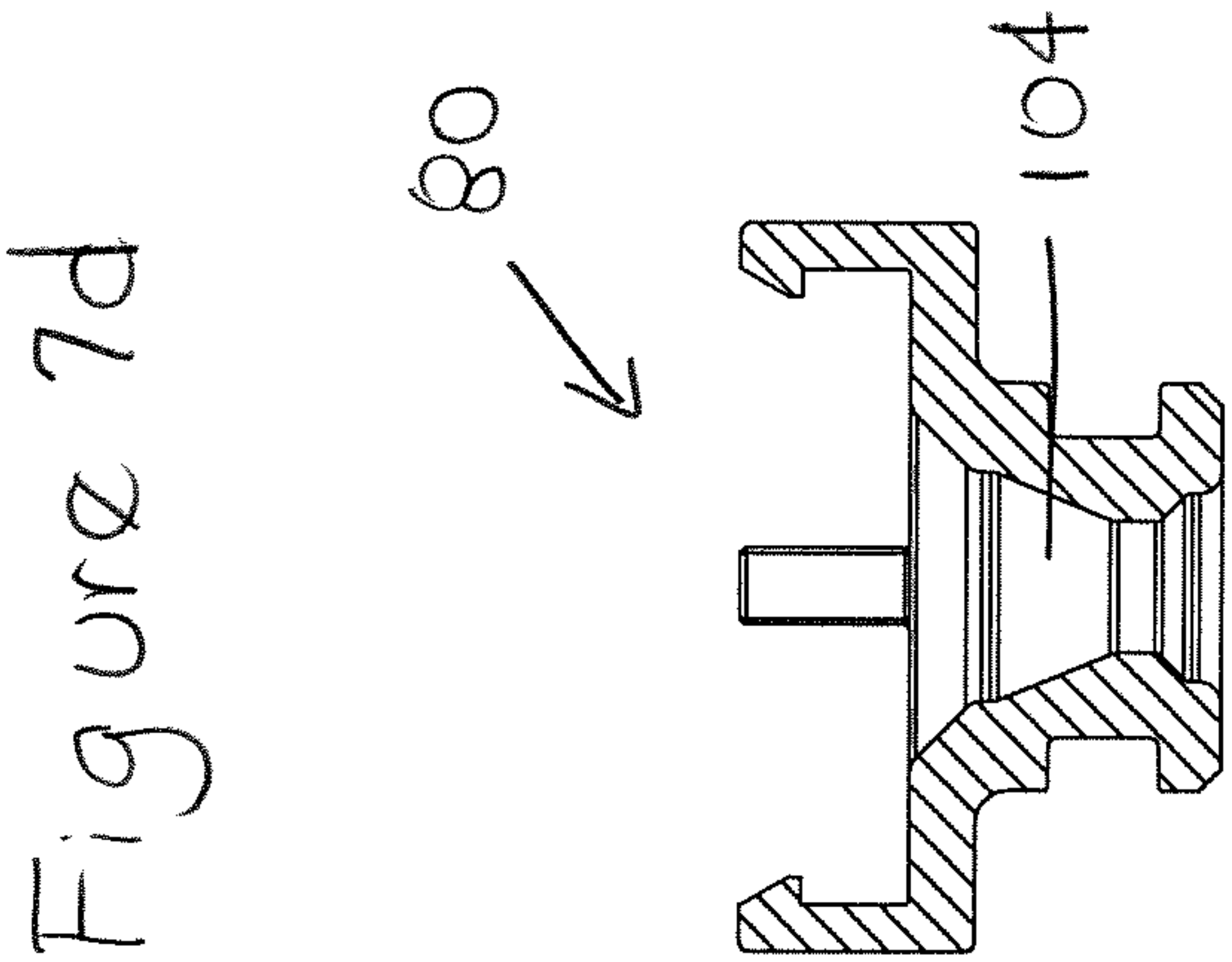
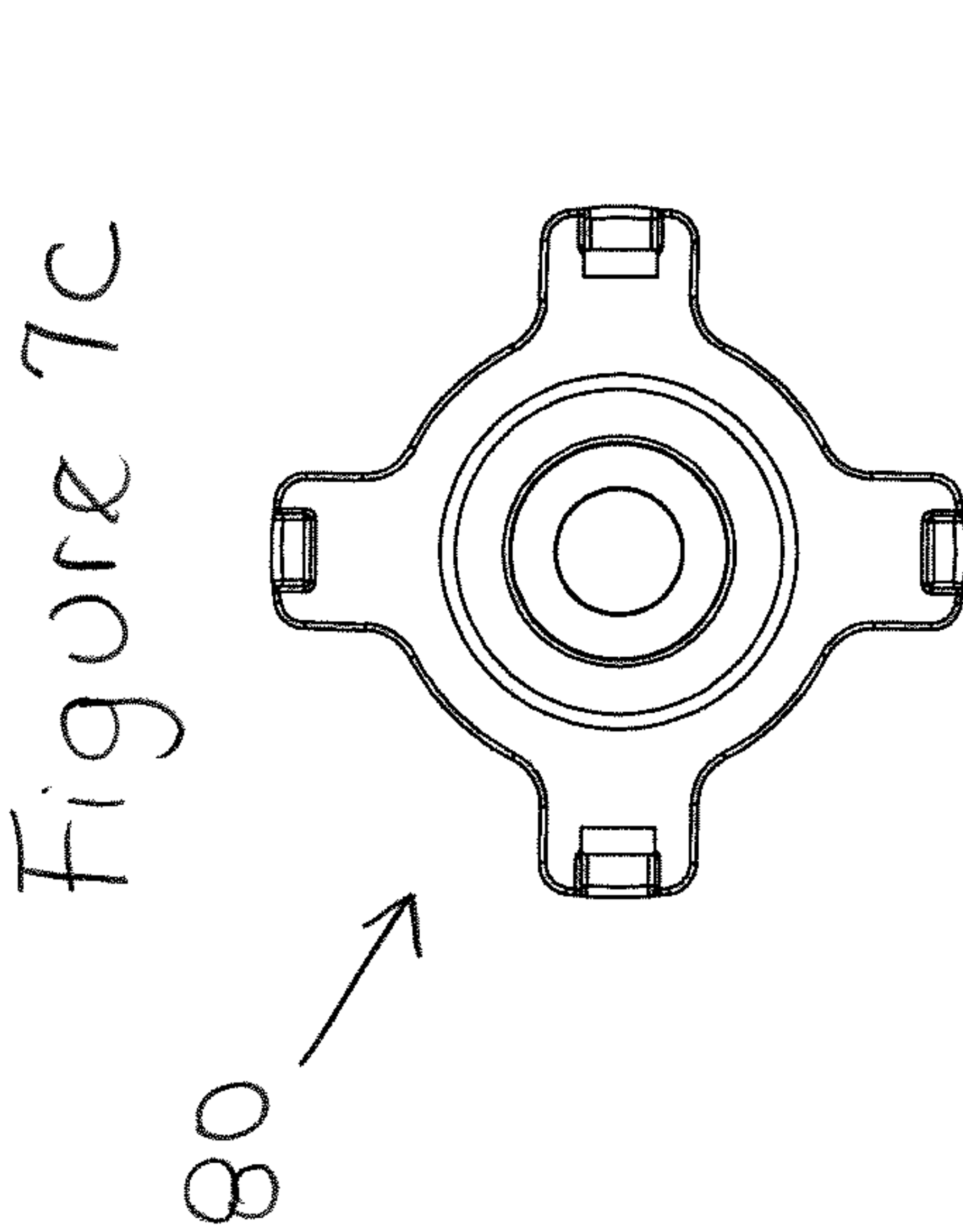
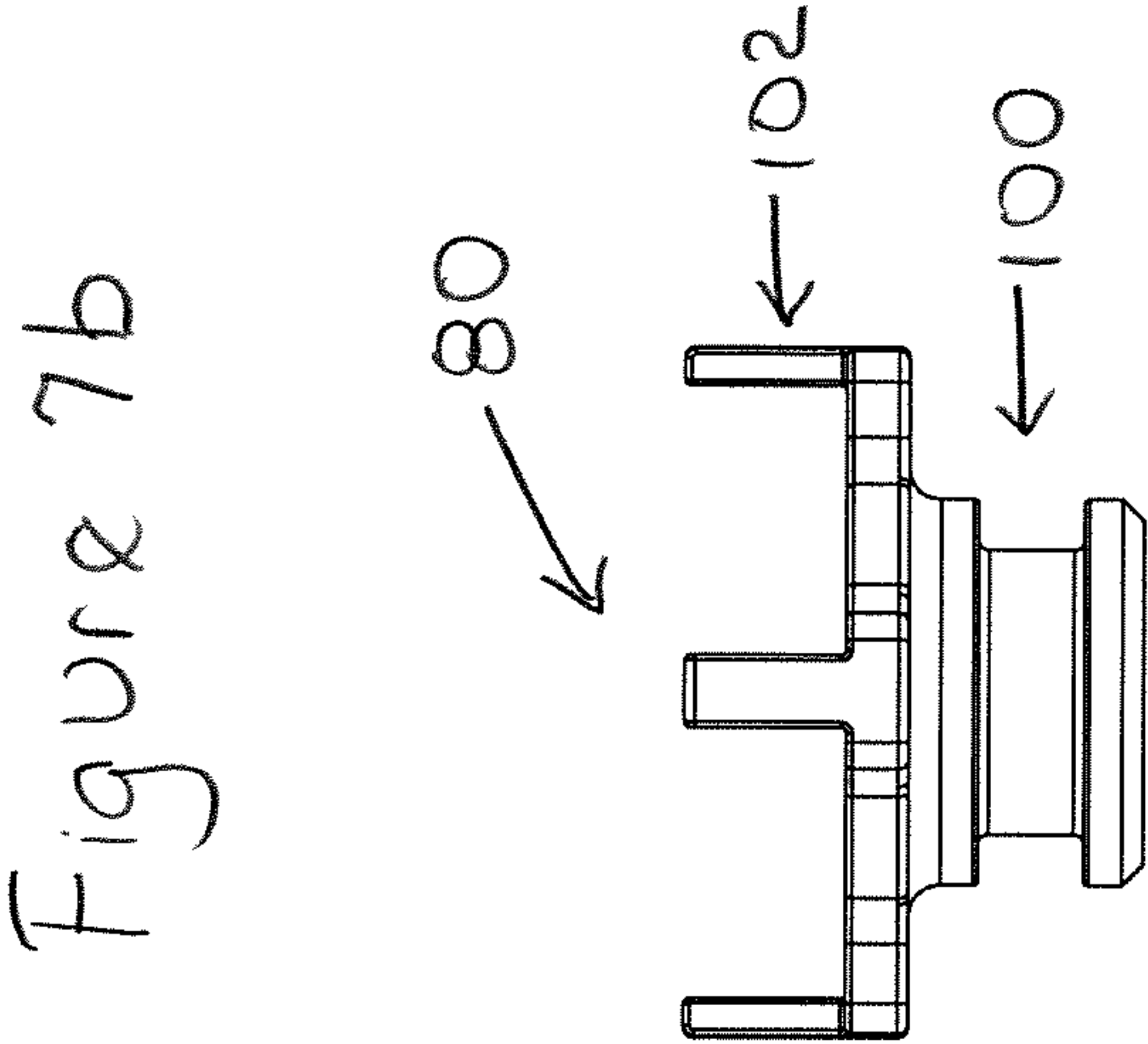
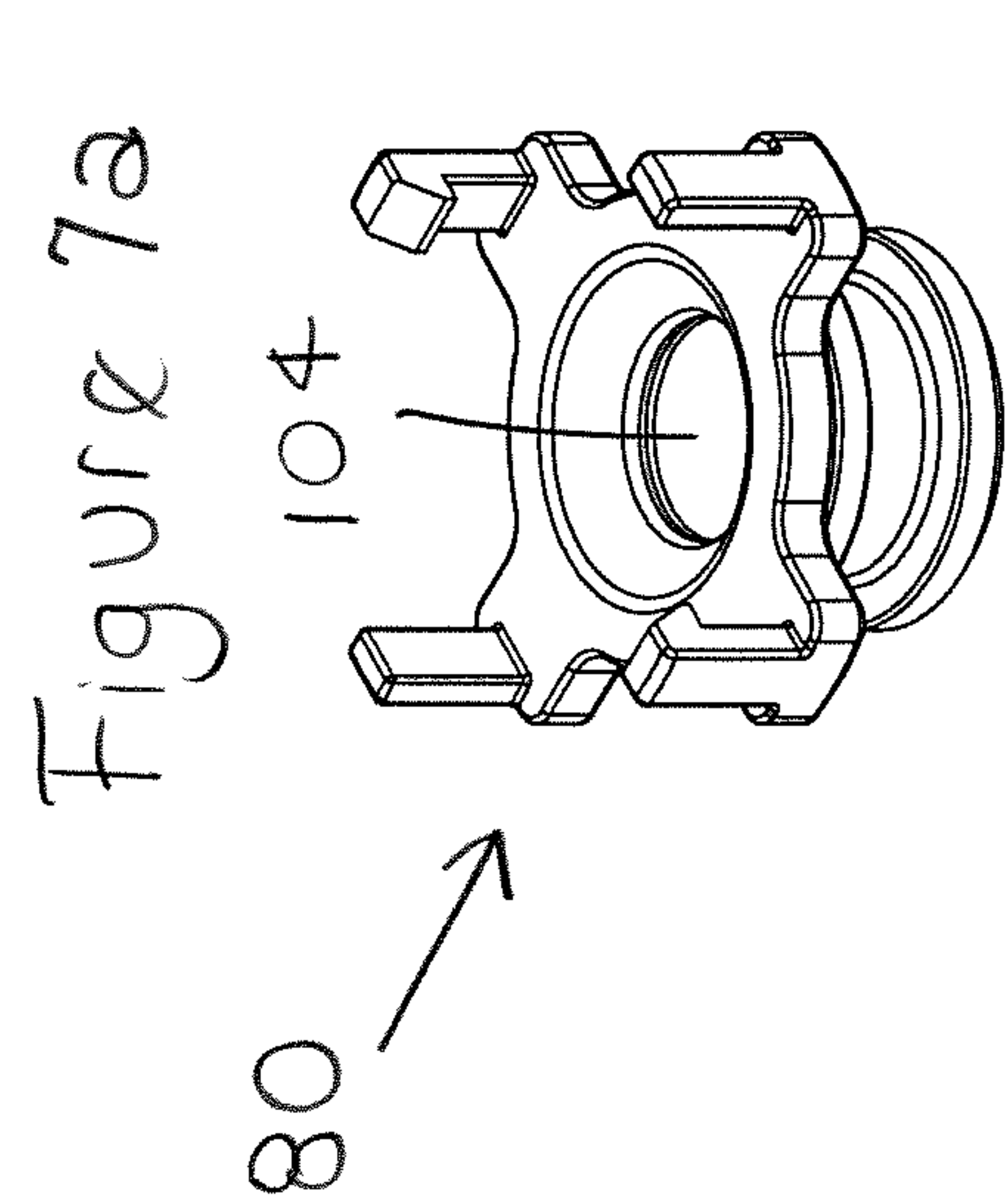


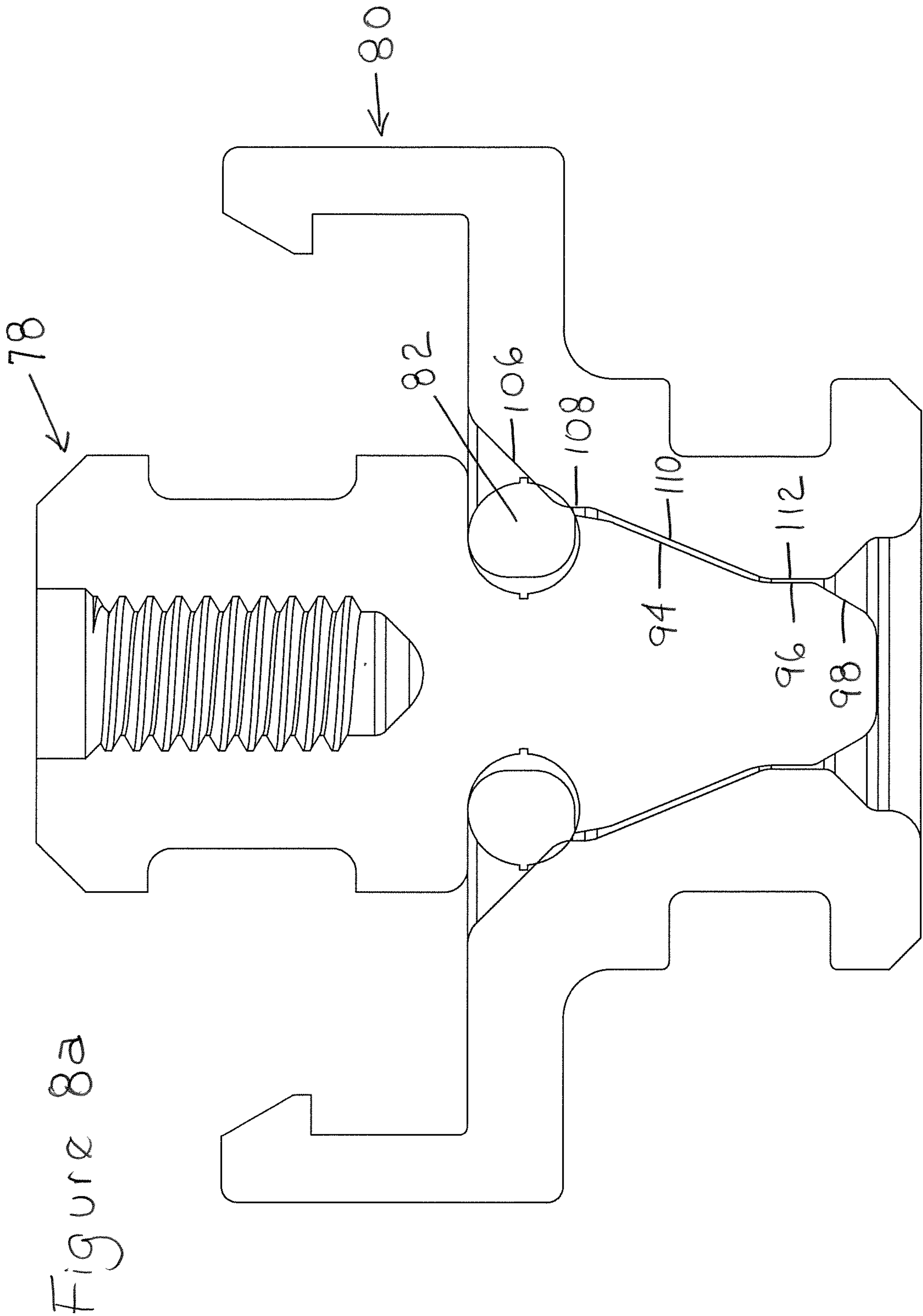
Figure 5d











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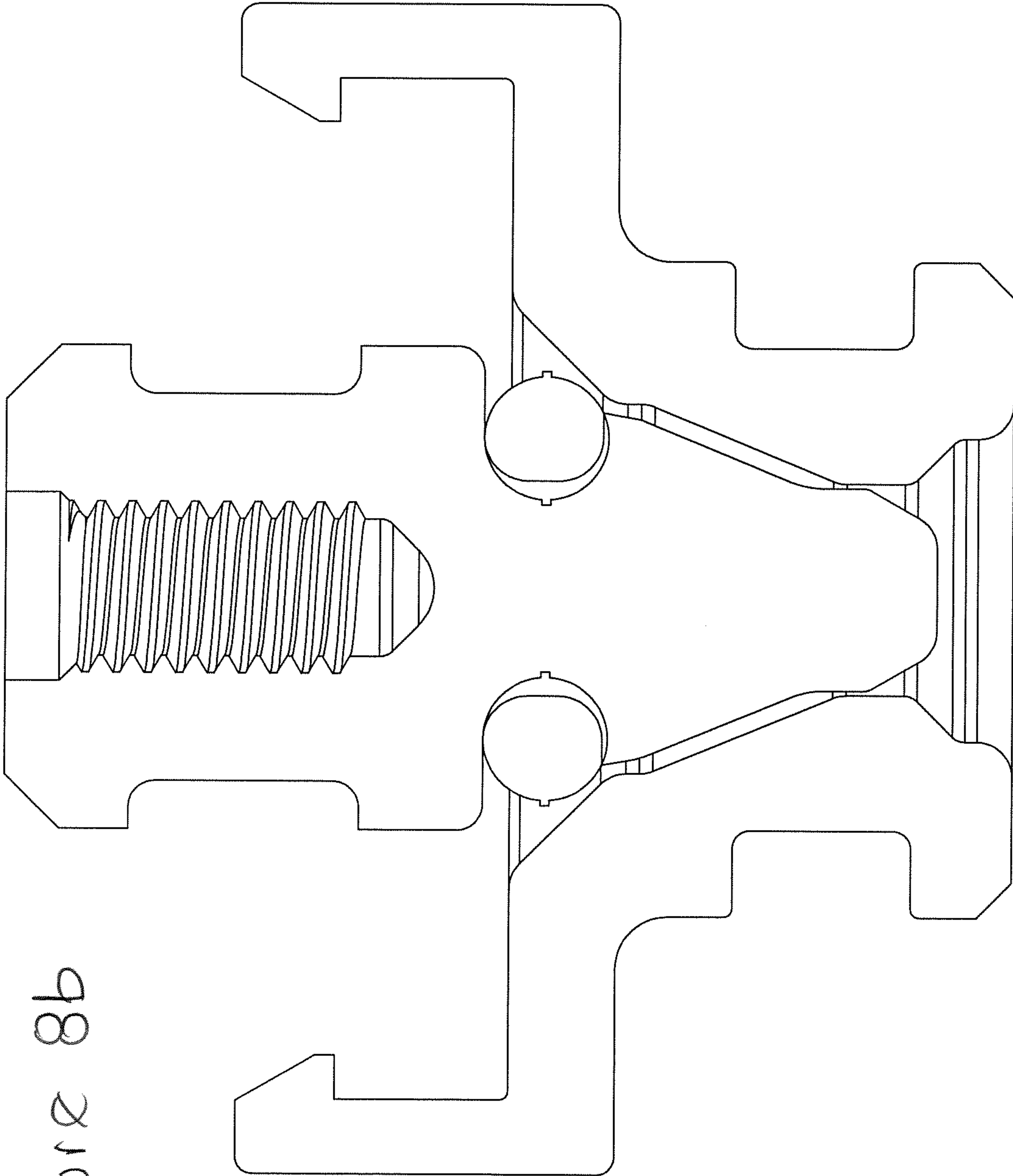


Figure 8b

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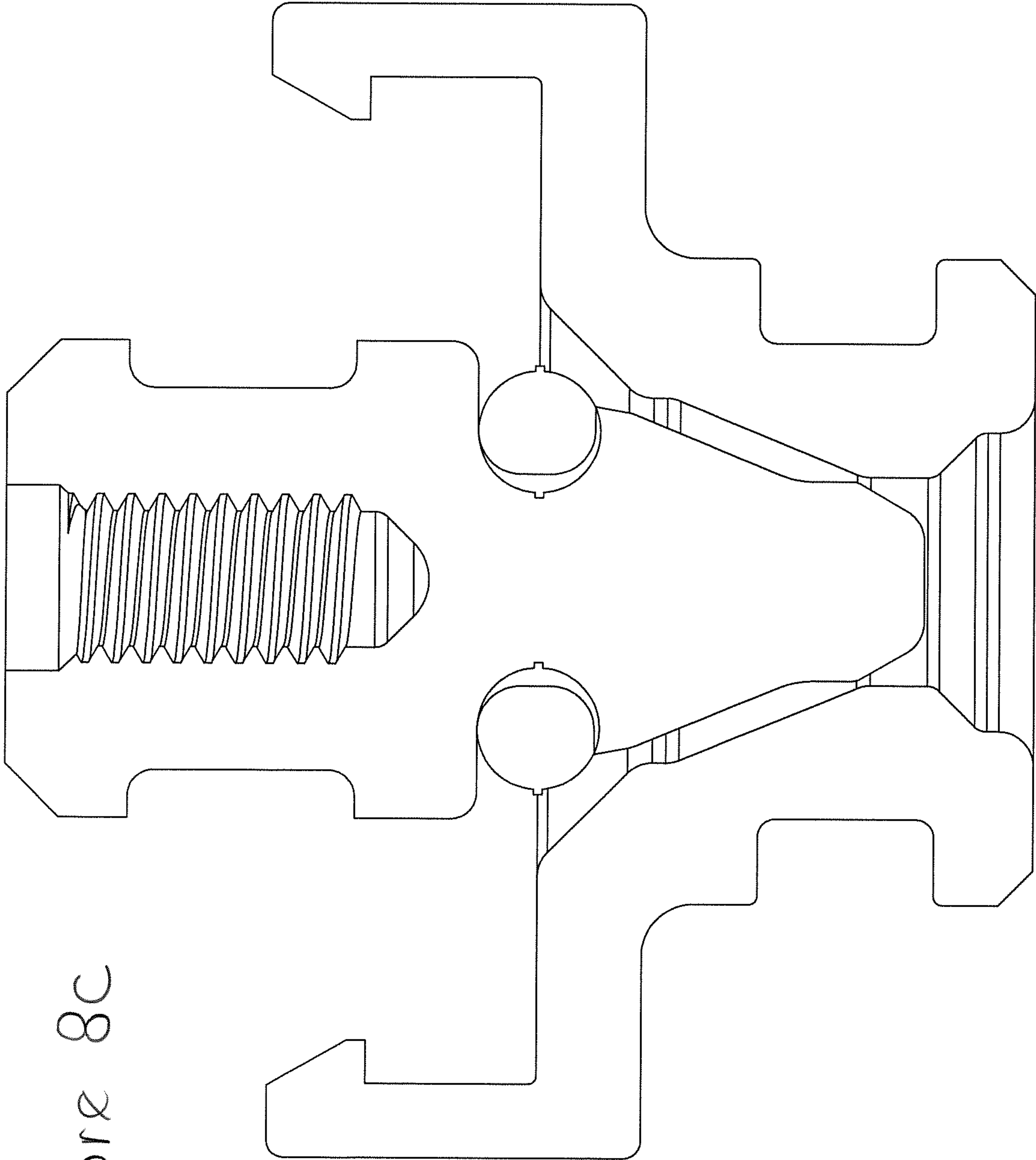


Figure 8c

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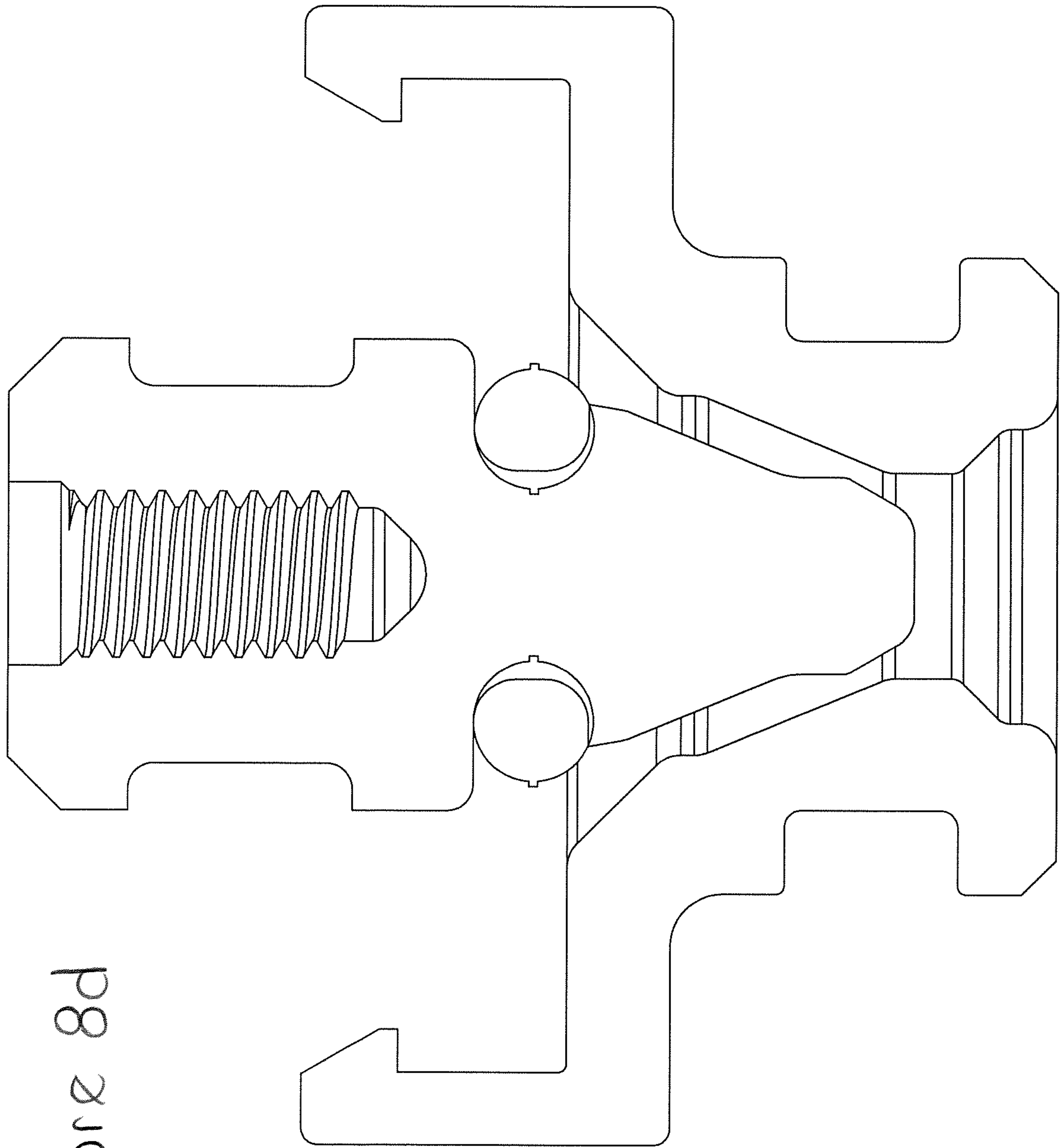


Figure 8d

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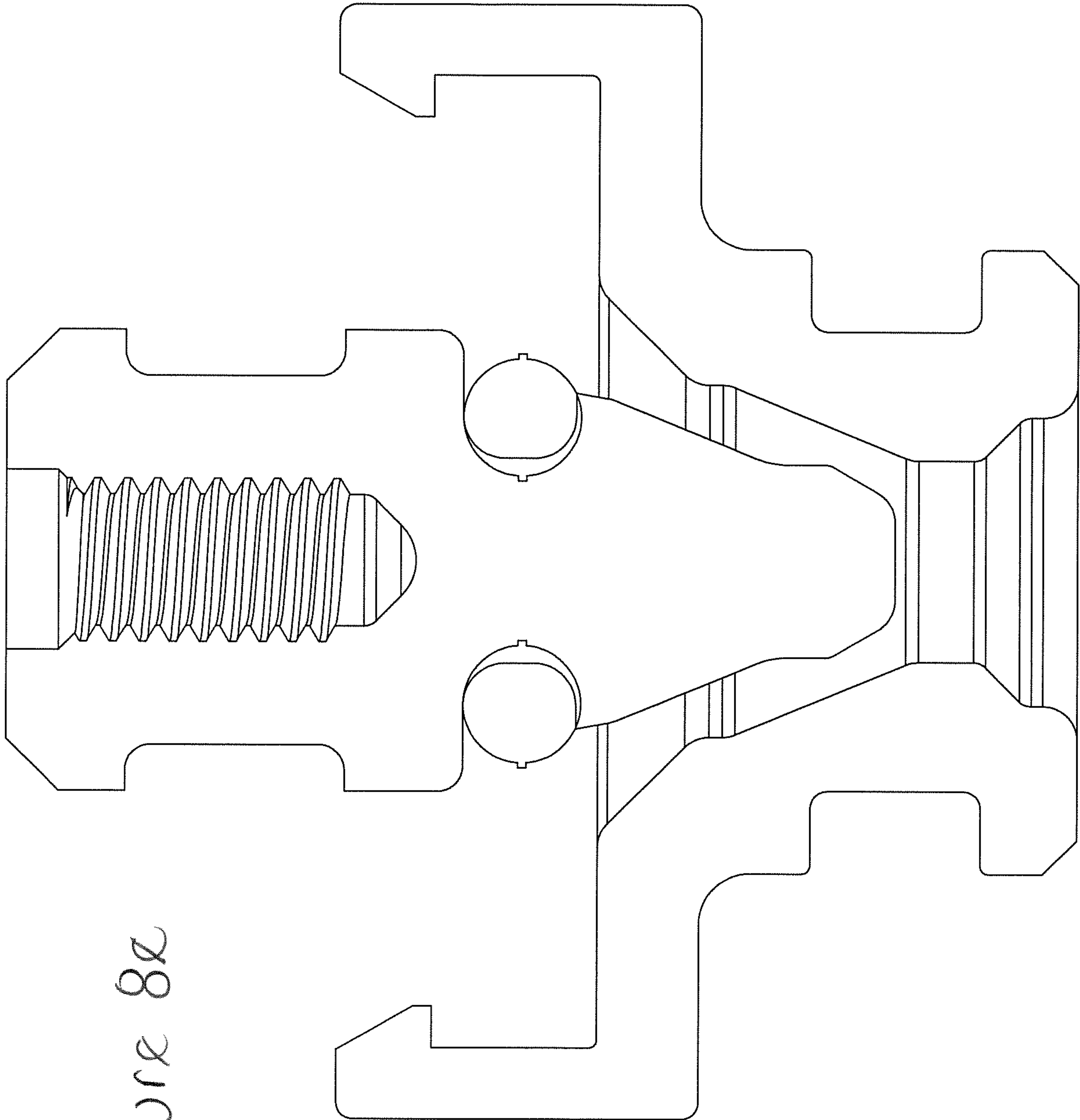


Figure 8a

78' Figure 9a

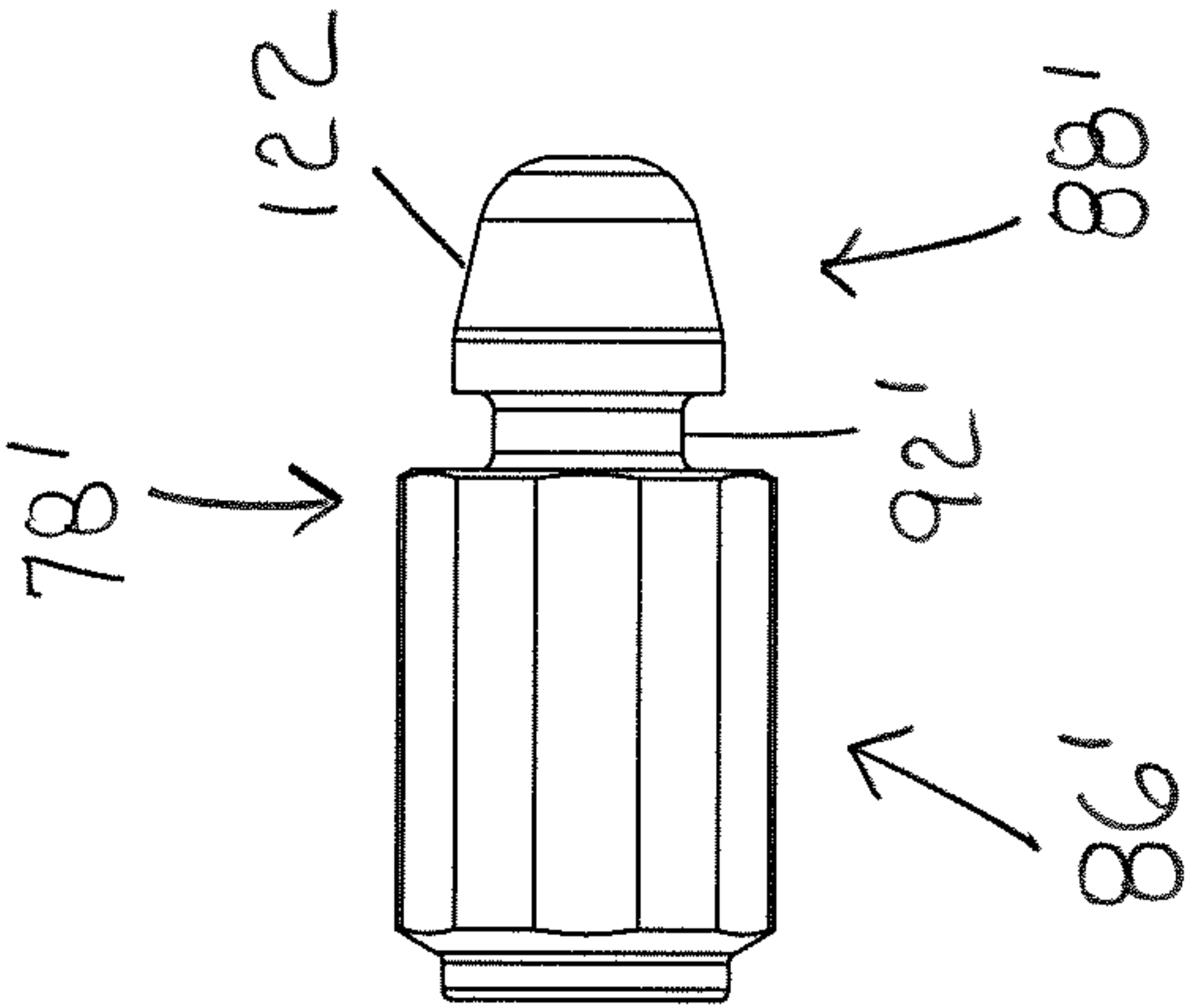
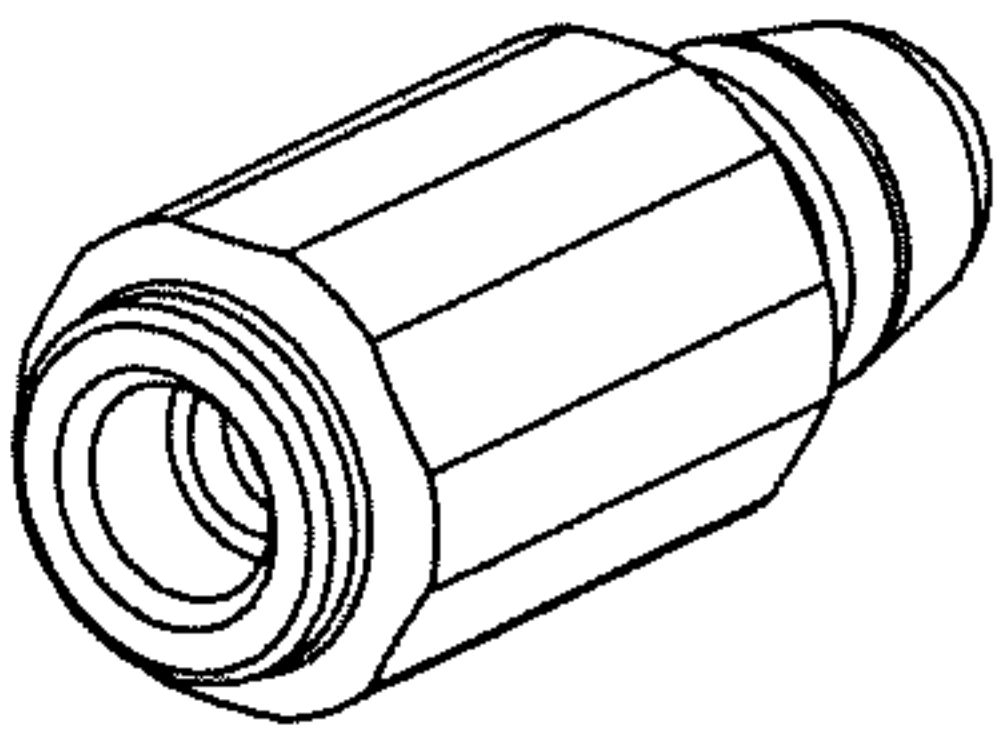


Figure 9b

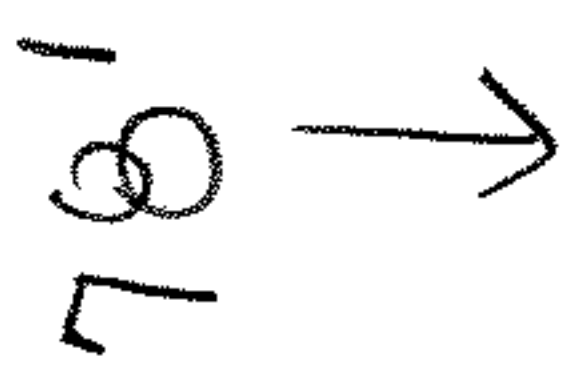


Figure 9c

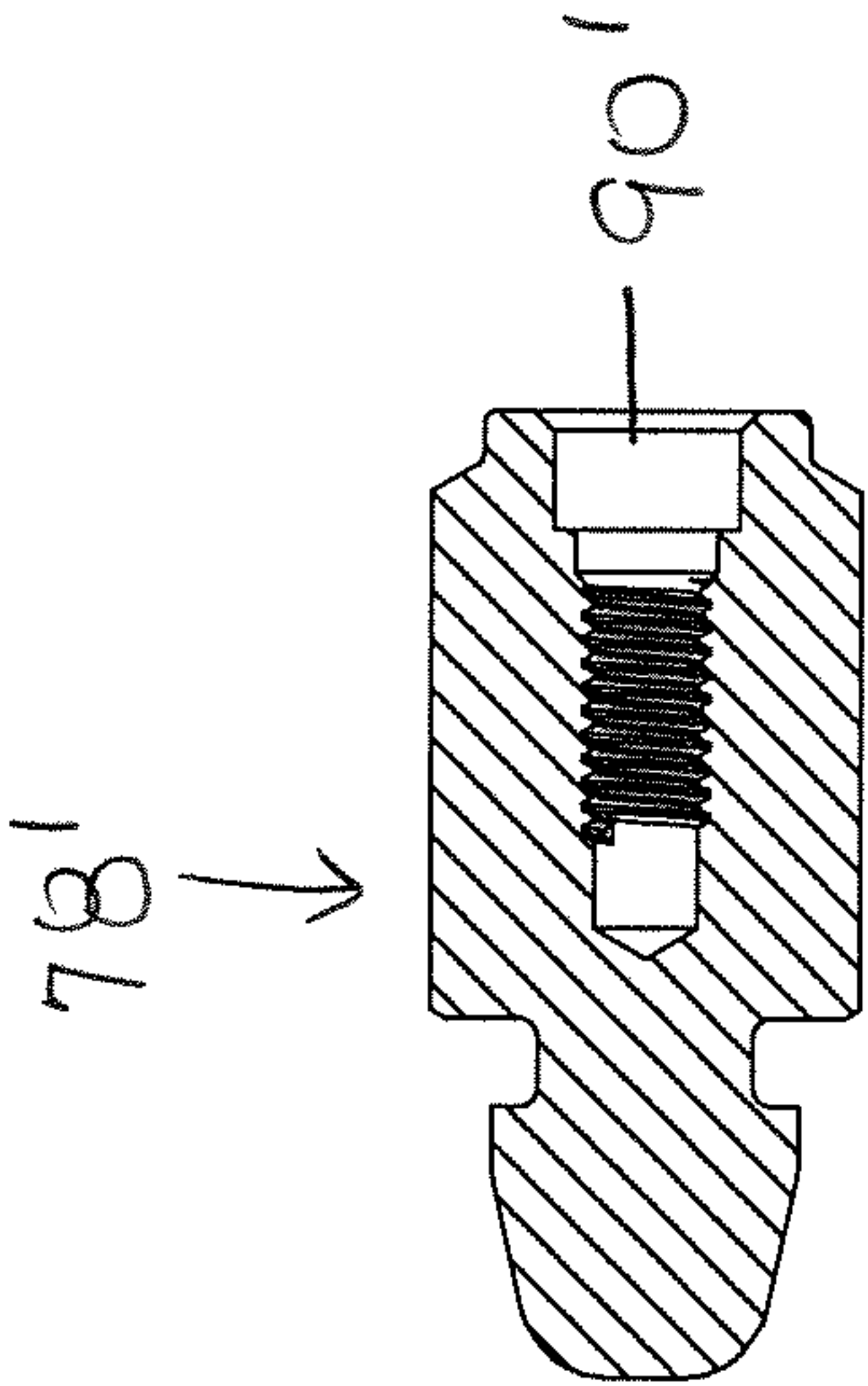


Figure 9d

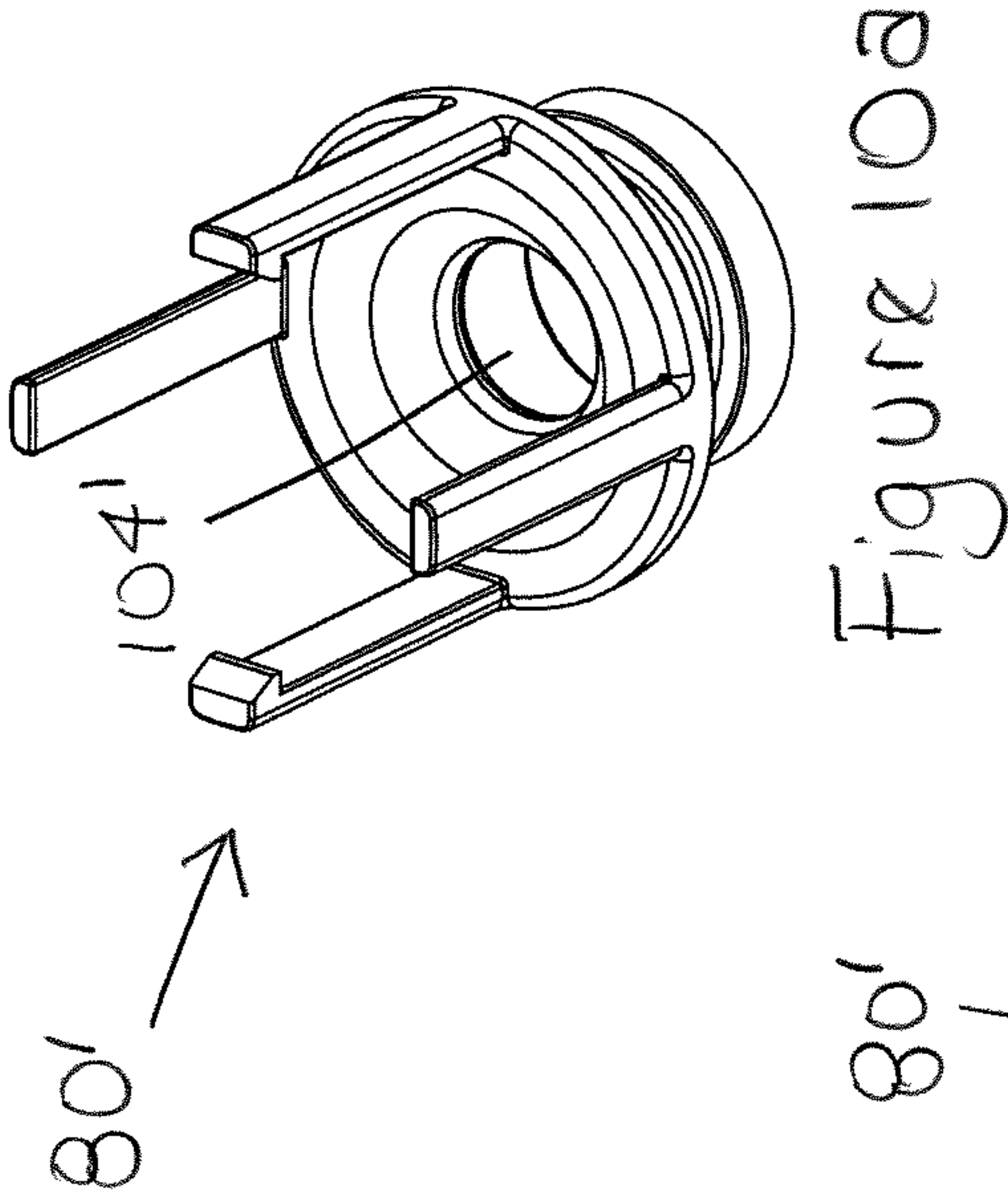


Figure 10a

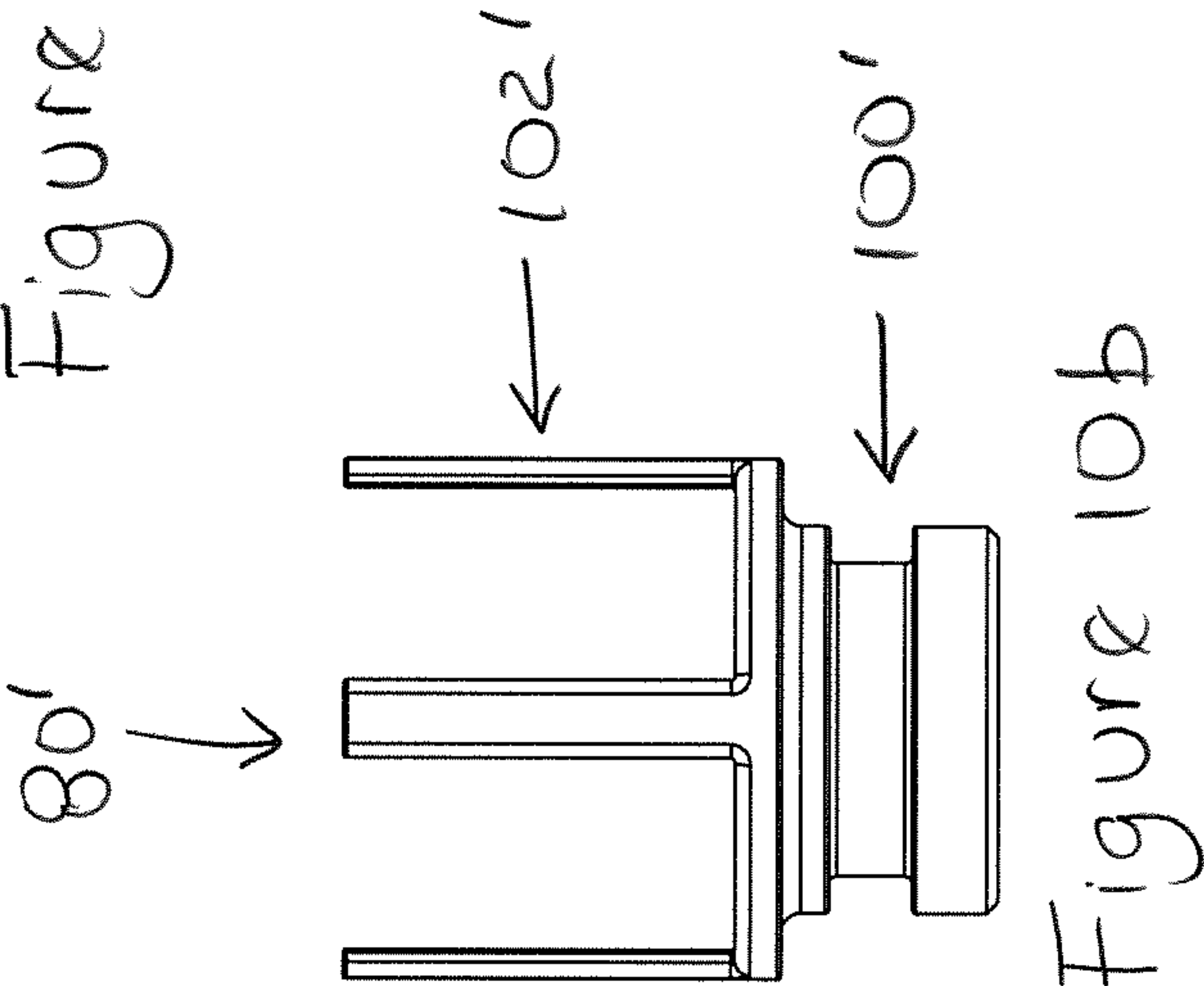


Figure 10b

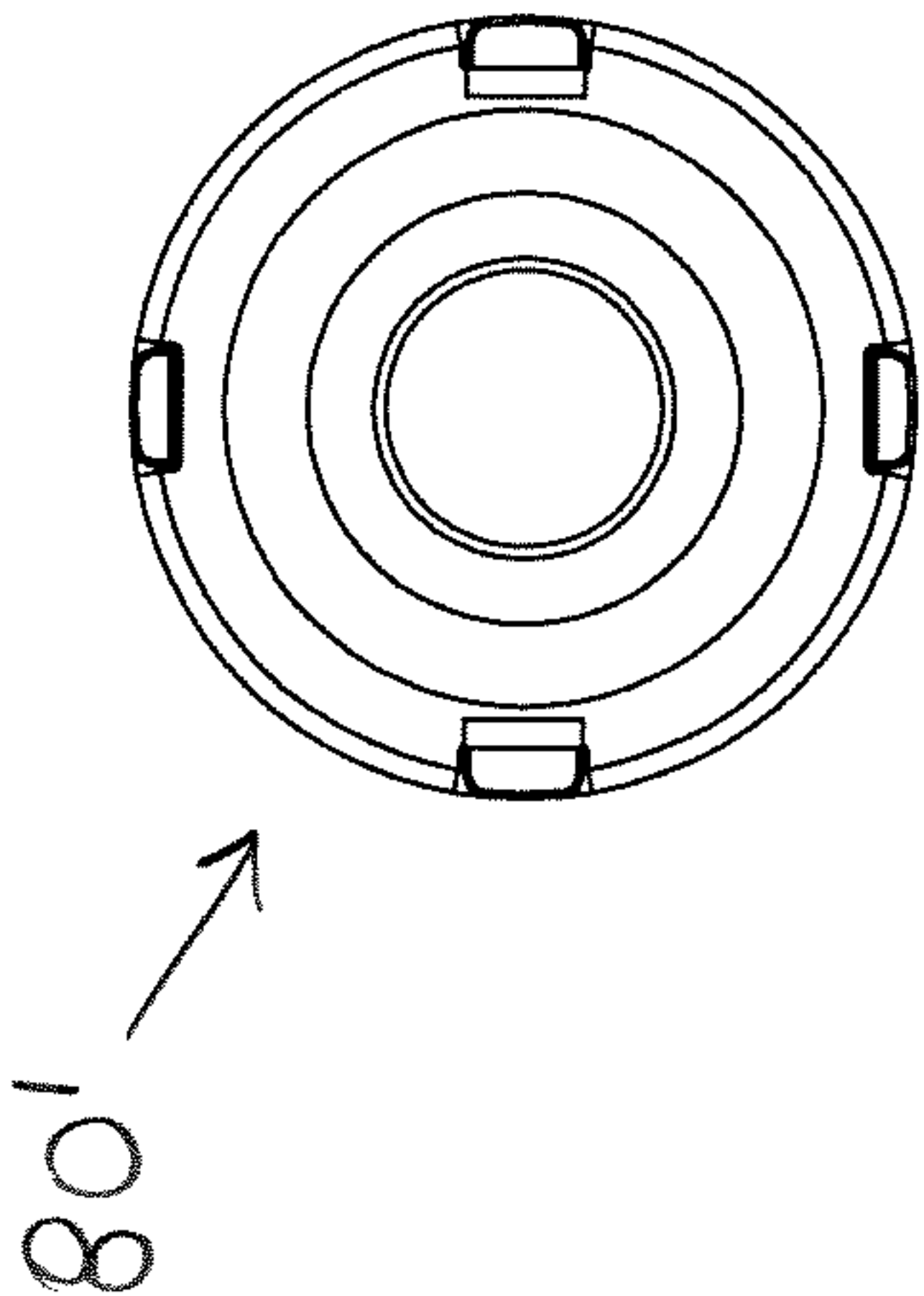


Figure 10c

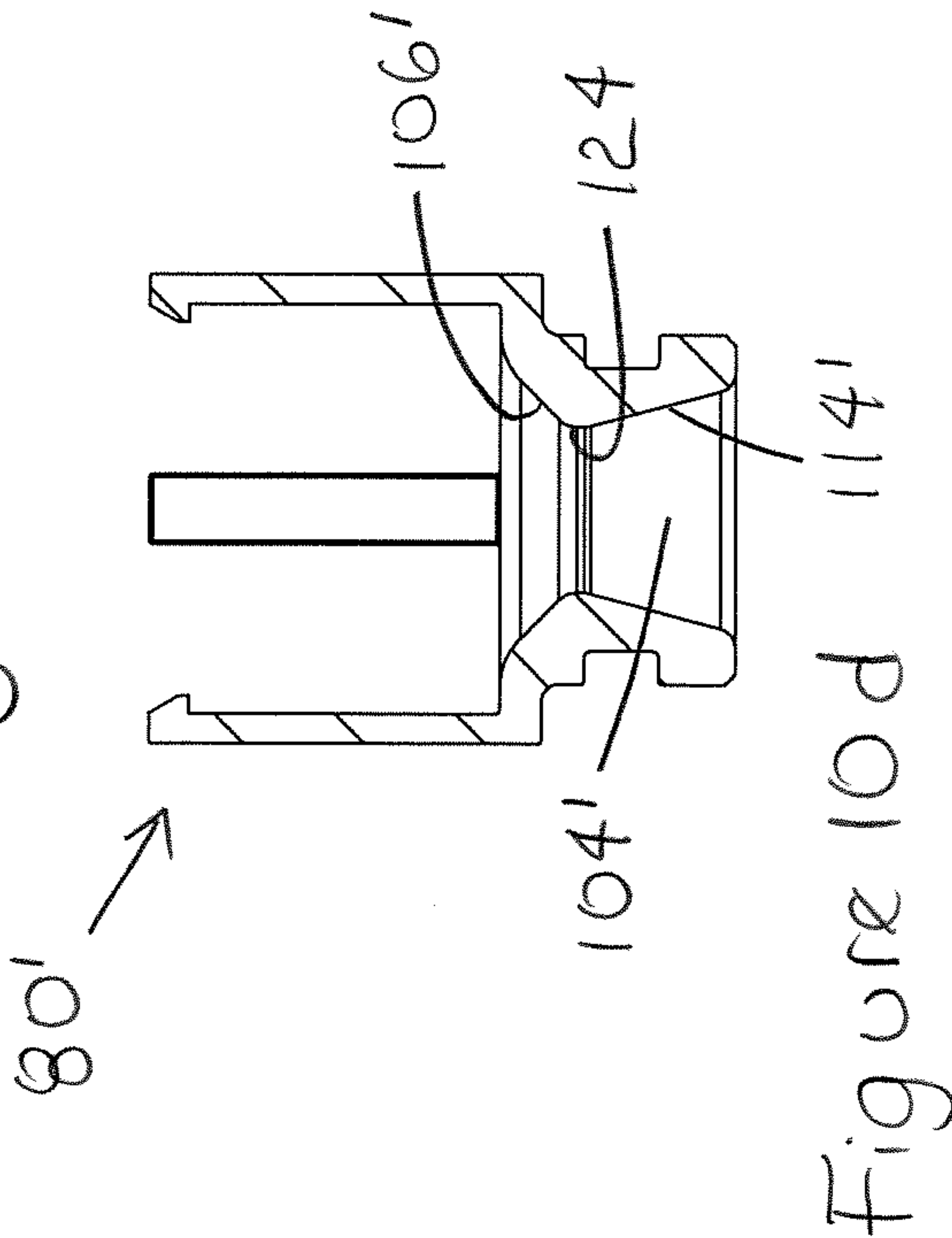
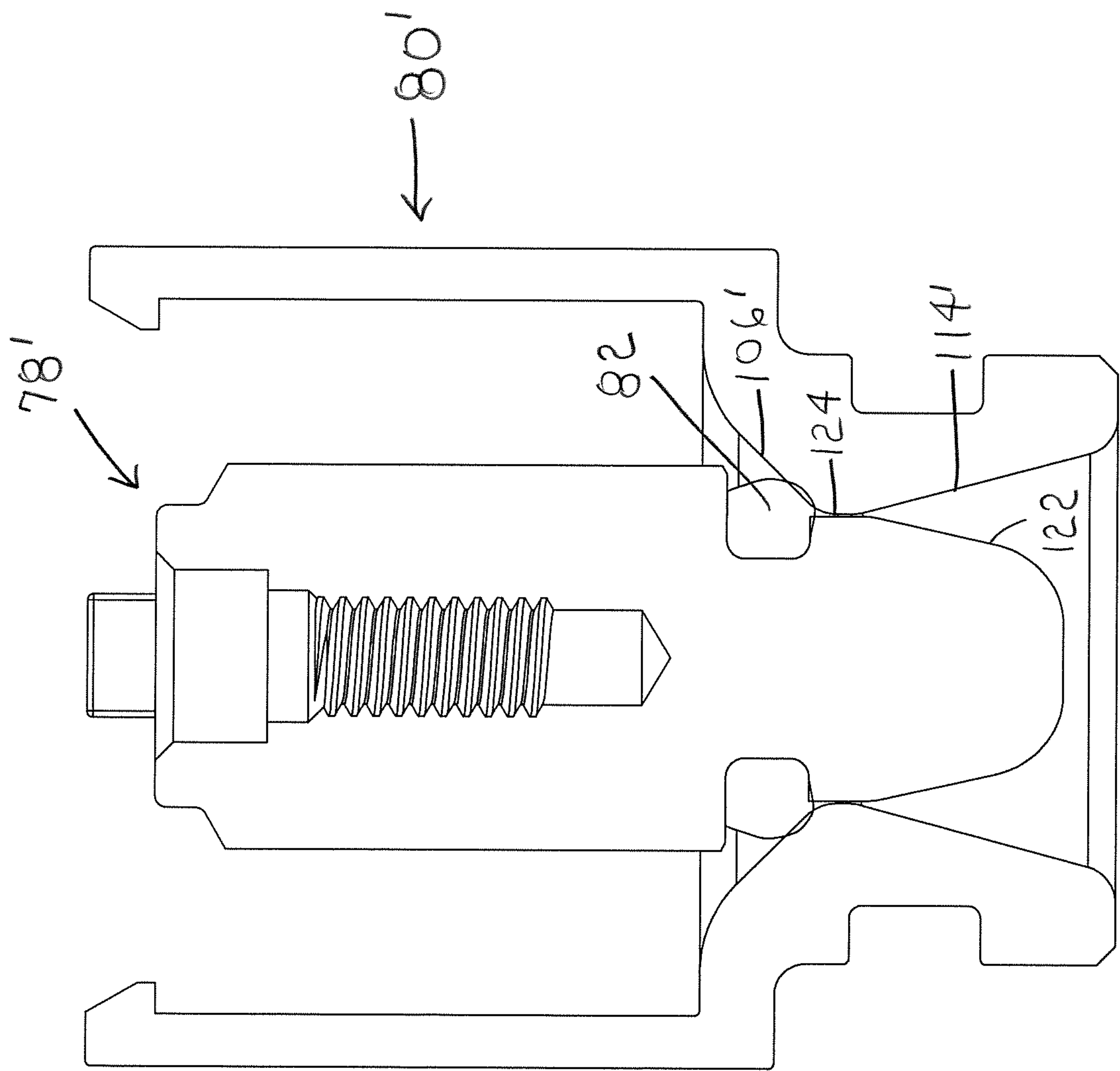


Figure 10d



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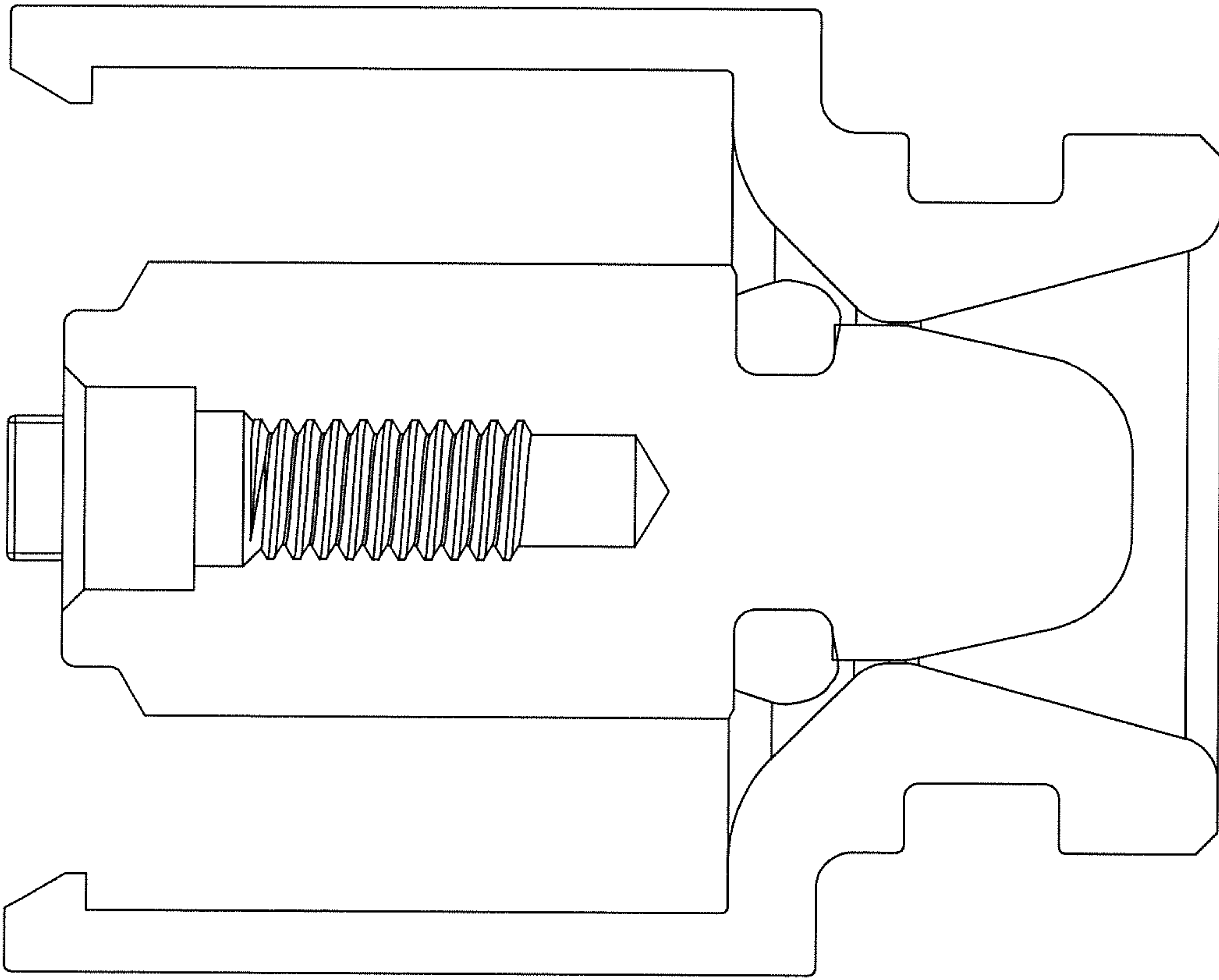


Figure 11b

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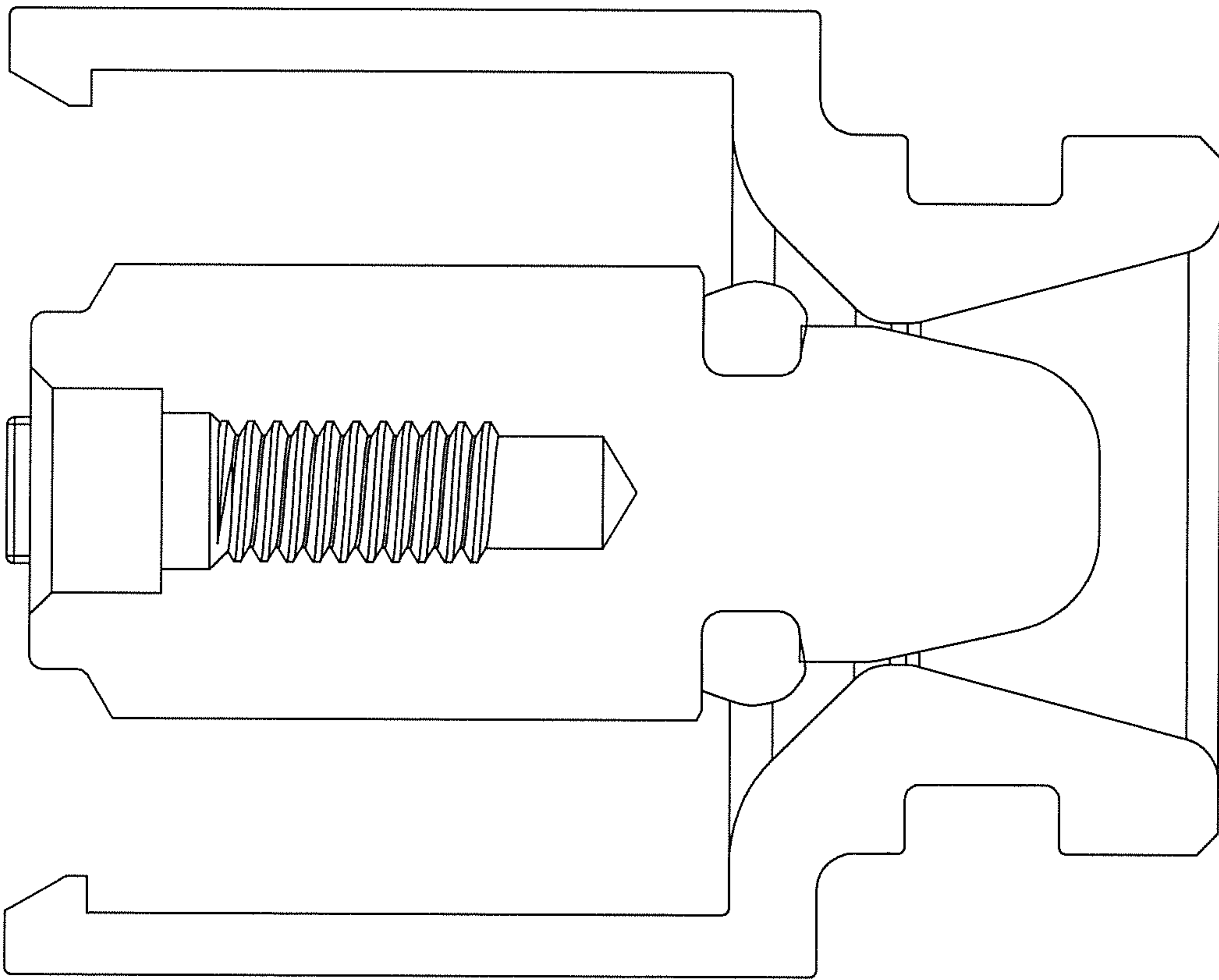


Figure 11c

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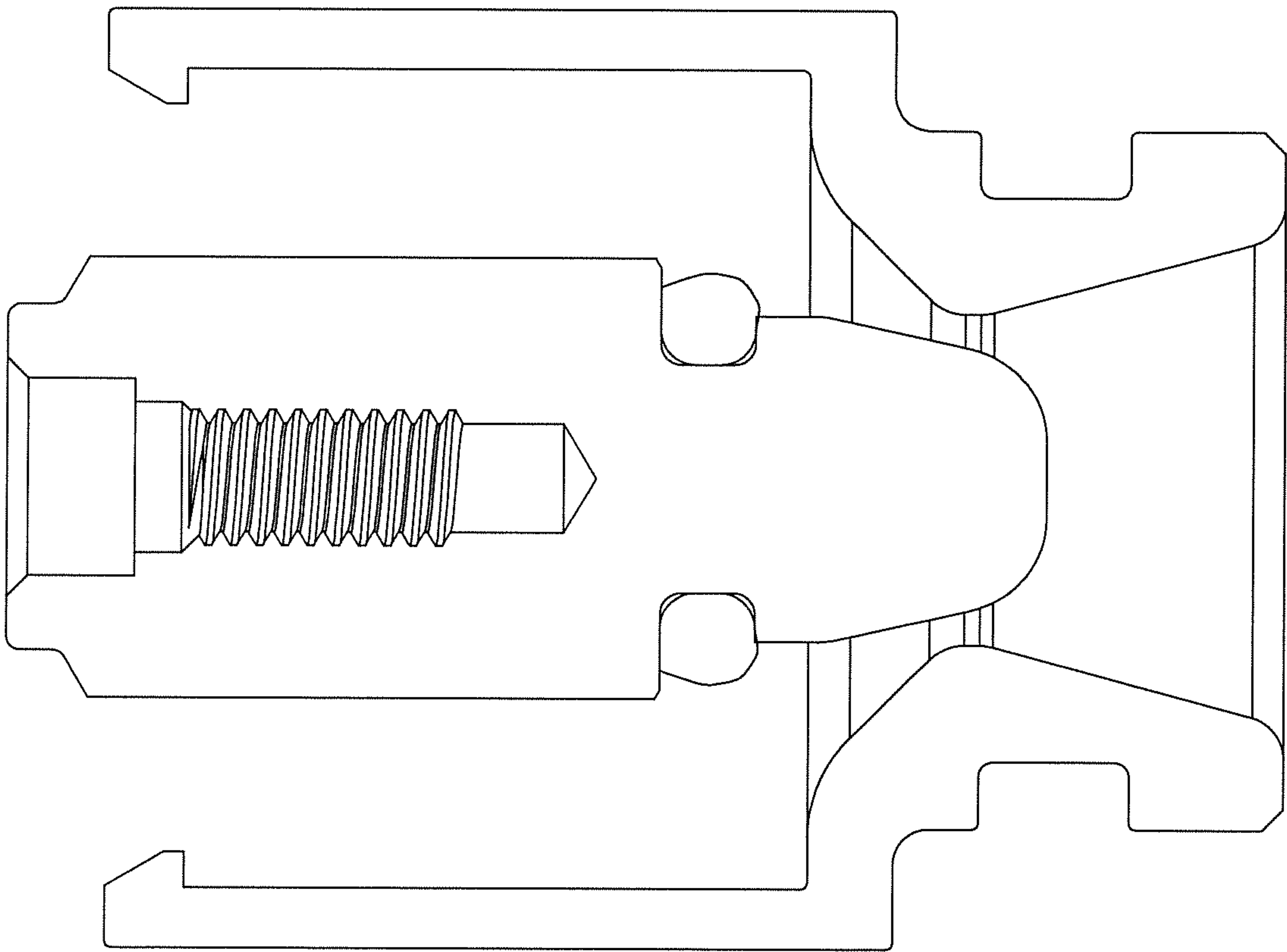


Figure 11d

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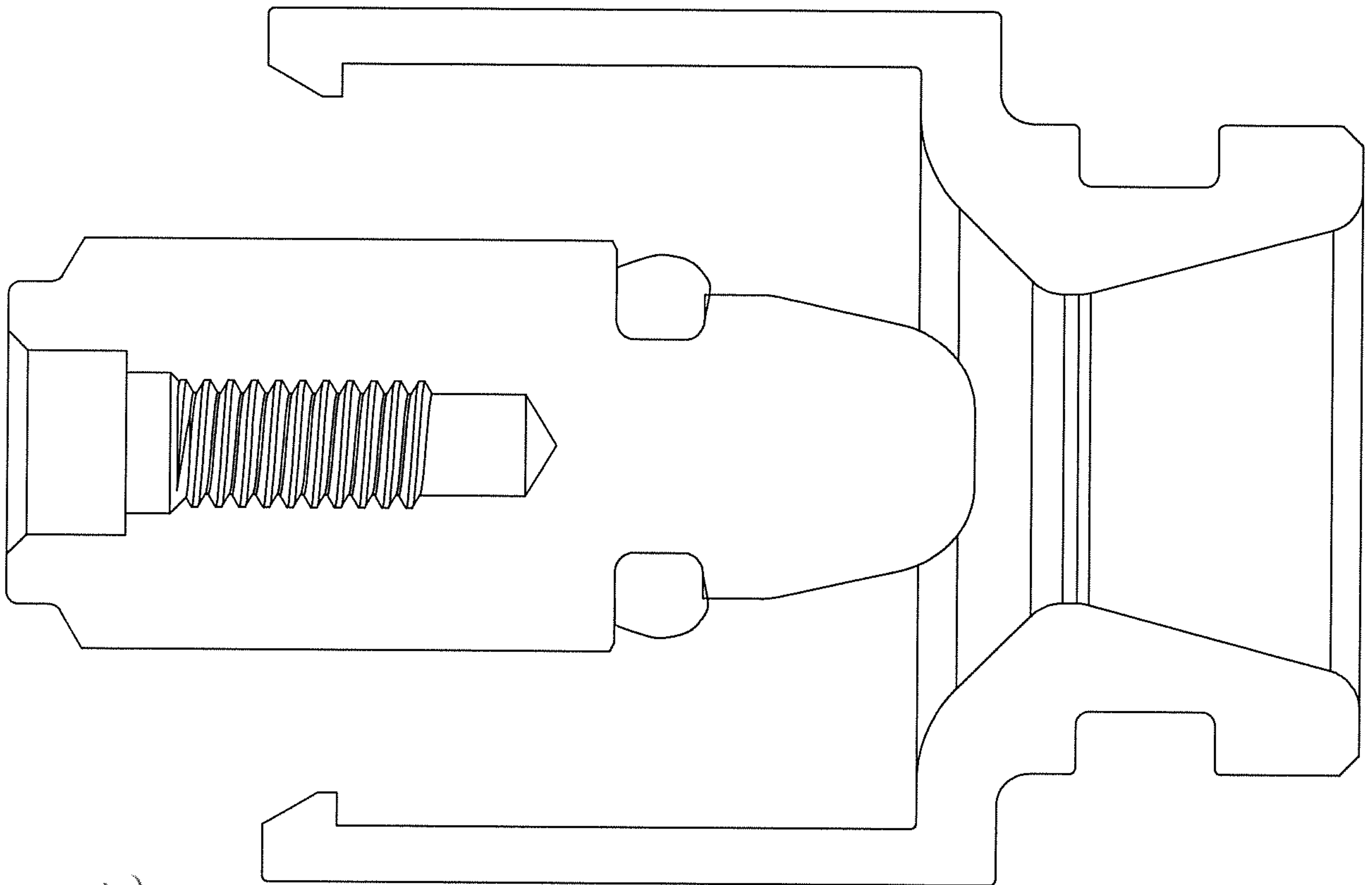


Figure 11e

	O-Ring Details								
	Nominal Dimensions SAE Standard AS568								
	P1	P2	P3	P4	R1	R2			R3
Piston O-ring	Outer Diameter of O-ring (OD) (in inches)	Inner Diameter of O-ring (ID) (in inches)	Cross-Section of O-ring (1/2 (OD-ID)) (in inches)	Seal Area of O-ring (pi * ((1/2 OD of O-ring) squared)) (in inches squared)	Ratio of Piston O-ring Seal Area to Motor Shaft O-ring Seal Area	Ratio of Piston O-ring OD to Motor Shaft O-ring ID	Ratio of Piston O-ring OD to Motor Shaft O-ring OD	Force to Close Valve at Specified Line Pressure (150 psi or 60 psi) (Line Pressure * (Seal Area of Piston O-ring - Seal Area of Motor Shaft O-ring)) (in pounds)	
								150	60
O-Ring #	0.09375	0.03125	0.03125	0.007	0.53	0.73	0.35	-0.92	-0.37
#2	0.140625	0.046875	0.046875	0.016	1.19	1.09	0.52	0.37	0.15
#3	0.1875	0.0625	0.0625	0.028	2.11	1.45	0.70	2.18	0.87
#4	0.203125	0.078125	0.0625	0.032	2.48	1.57	0.76	2.90	1.16
#5	0.21875	0.09375	0.0625	0.038	2.88	1.70	0.81	3.68	1.47
#6	0.25	0.125	0.0625	0.049	3.76	1.94	0.93	5.40	2.16
#7	0.28125	0.15625	0.0625	0.062	4.75	2.18	1.05	7.36	2.94
#8	0.3125	0.1875	0.0625	0.077	5.87	2.42	1.16	9.54	3.82
#9	0.34375	0.21875	0.0625	0.093	7.10	2.66	1.28	11.96	4.78
#10	0.375	0.25	0.0625	0.110	8.45	2.91	1.39	14.60	5.84
#11	0.4375	0.3125	0.0625	0.150	11.50	3.39	1.63	20.59	8.23
#12	0.5	0.375	0.0625	0.196	15.02	3.88	1.86	27.49	10.99
#13	0.5625	0.4375	0.0625	0.248	19.01	4.36	2.09	35.31	14.12
	S1	S2	S3	S4					
Motor Shaft O-ring	Outer Diameter of O-ring (OD) (in inches)	Inner Diameter of O-ring (ID) (in inches)	Cross-Section of O-ring (1/2 (OD-ID)) (in inches)	Seal Area of O-ring (pi * (1/2 ID of O-ring) squared)) (in inches squared)					
	0.269	0.129	0.07	0.013					

Figure 12

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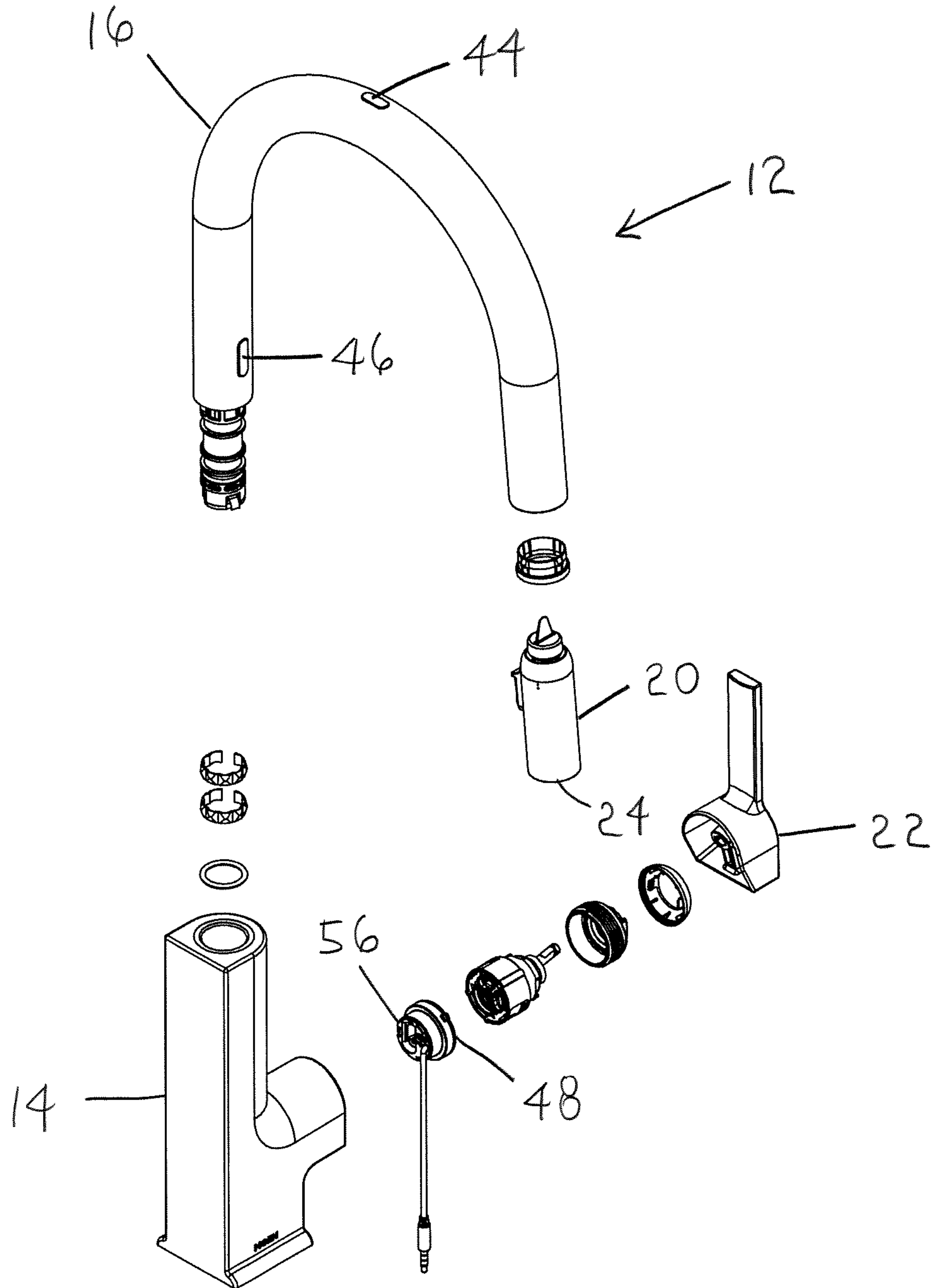


Figure 13a

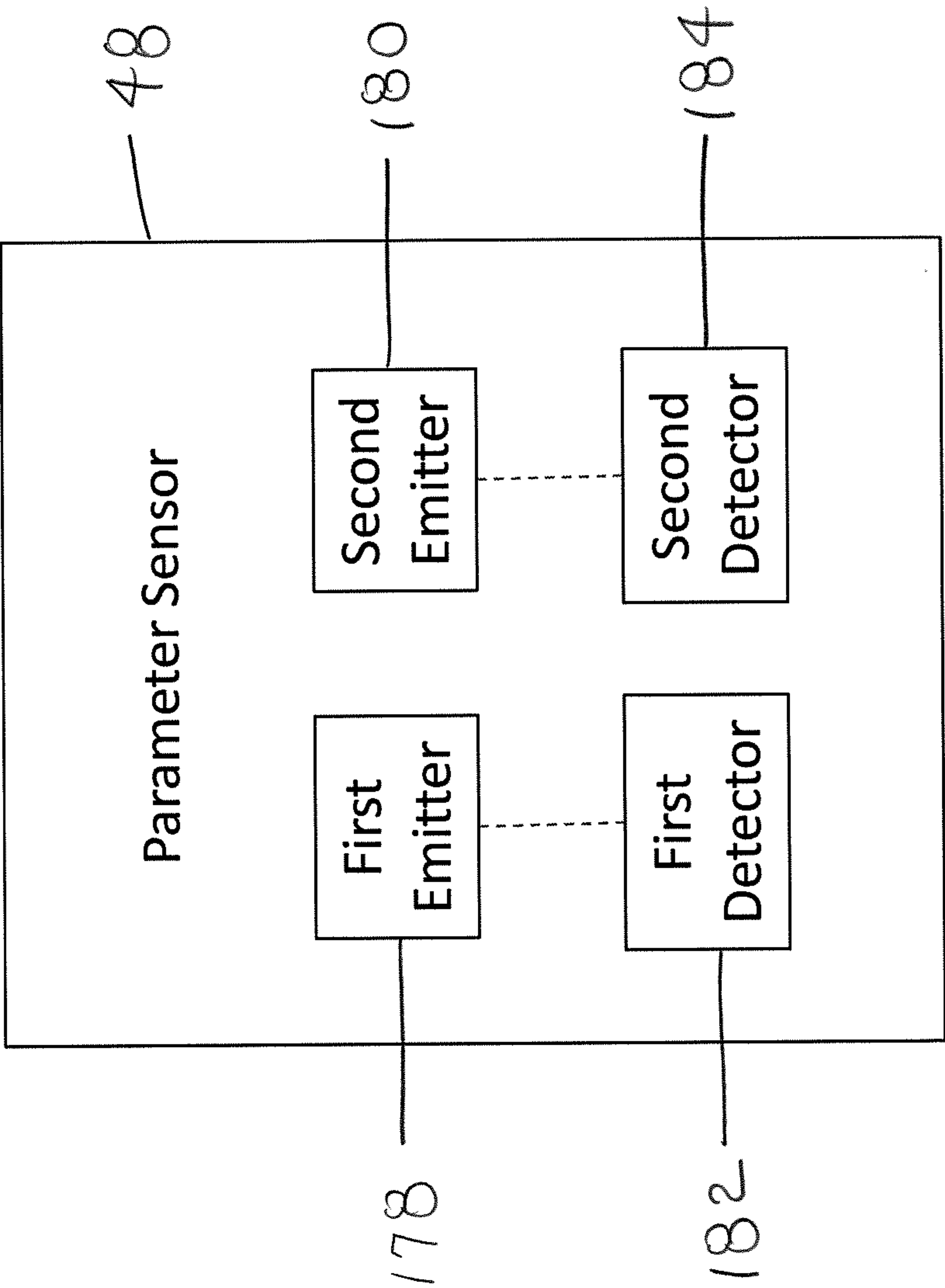


Figure 13b

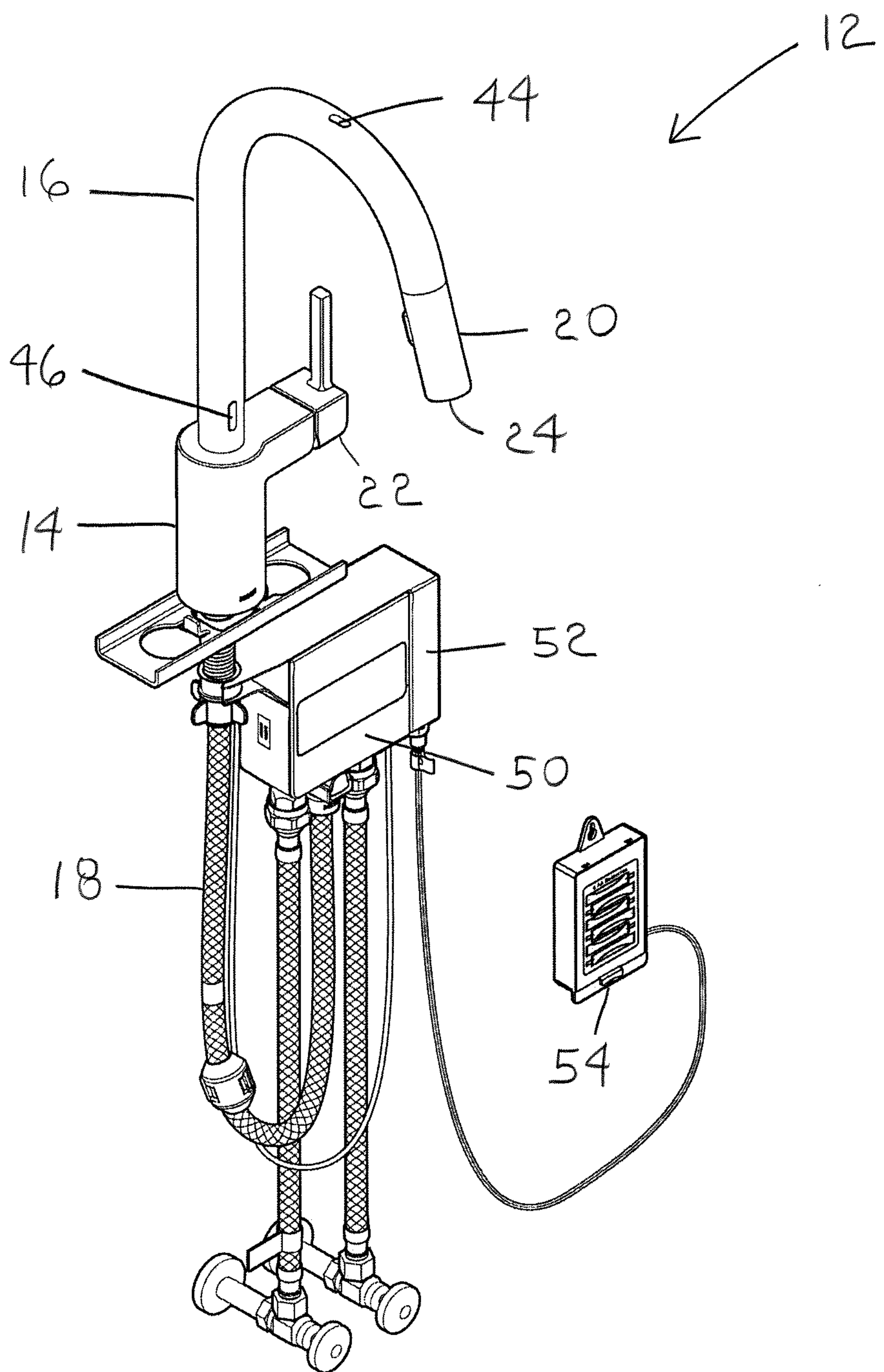


Figure 2