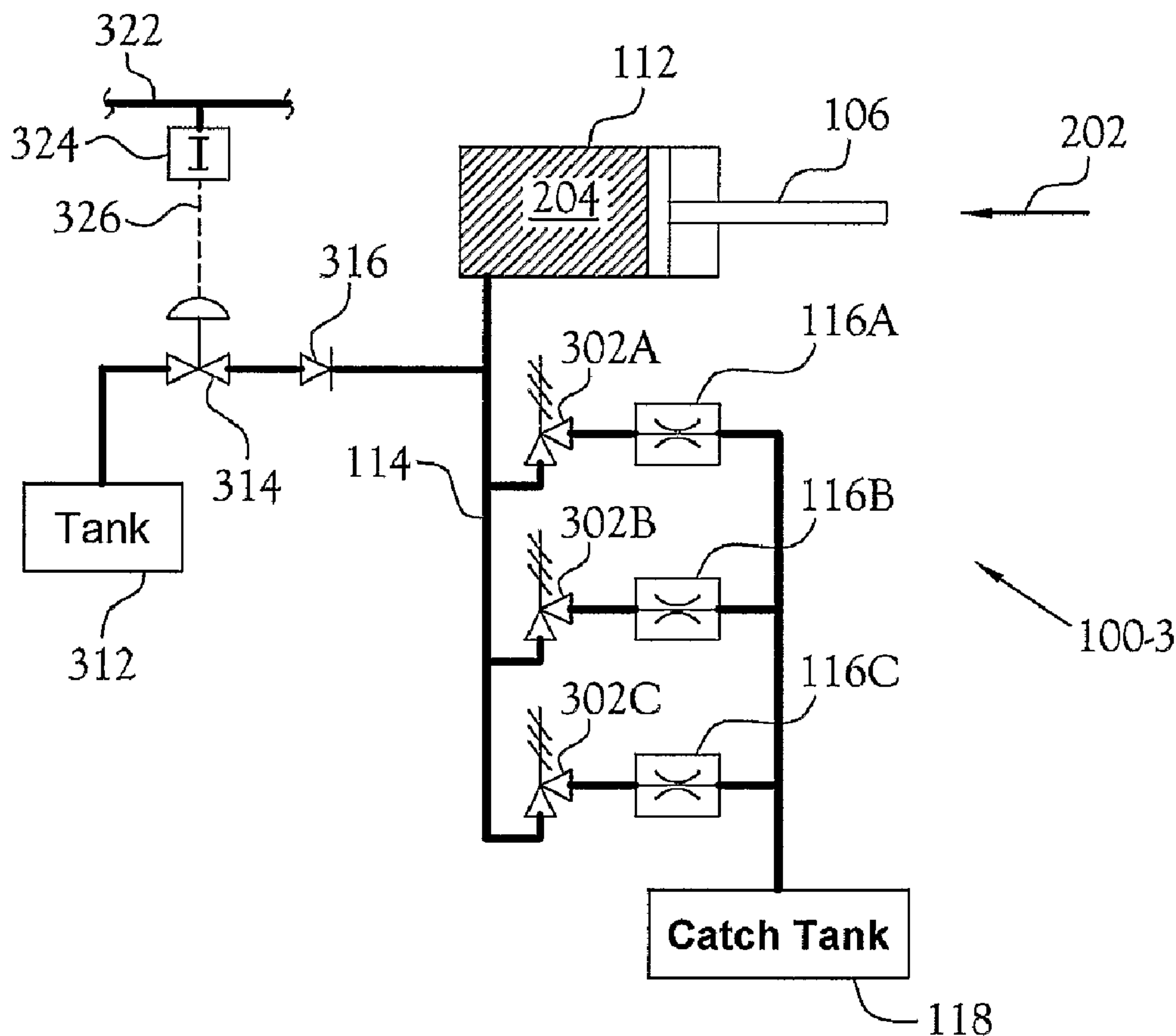




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(54) Titre : DISPOSITIF DE DISPERSION D'IMPACT
(54) Title: IMPACT DISPERSAL DEVICE



(57) Abrégé/Abstract:

An apparatus for impact dispersal of a force applied to a vehicle, which is a motor vehicle or other carrier. In various embodiments, the apparatus includes at least one hydraulic cylinder (112) in fluid communication with a relief valve (302) and a flow restrictor



(57) **Abrégé(suite)/Abstract(continued):**

(116) connected in series. The piston rod (106) of each cylinder (112) receives the force of an impact, which causes the fluid in the cylinder (112) to undergo an increase in pressure, which is relieved by multiple relief valves (302) and serially connected flow restrictors (116). In one embodiment, the relief valves (302) and the flow restrictors (116) are incorporated into a single valve (302'). The system responds to an amount of force caused by an impact and disperses the force accordingly at a controlled rate. Applications for such an embodiment include connection to vehicle bumpers (102), to a seat back (504) where the cylinder (112) is double-acting, and to landing feet (612) for air-drop carriers.

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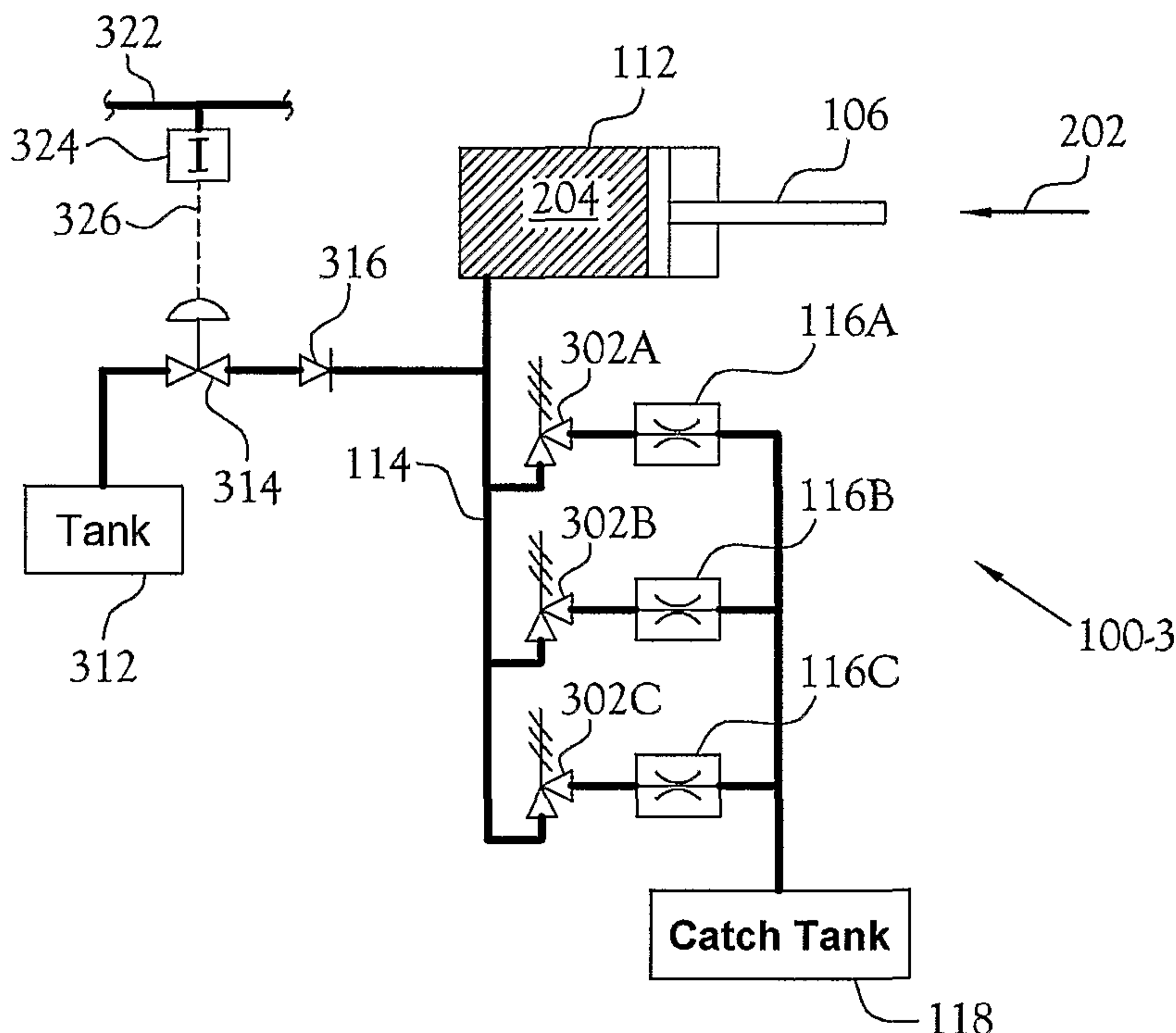
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(54) Title: IMPACT DISPERSAL DEVICE



(57) Abstract: An apparatus for impact dispersal of a force applied to a vehicle, which is a motor vehicle or other carrier. In various embodiments, the apparatus includes at least one hydraulic cylinder (112) in fluid communication with a relief valve (302) and a flow restrictor (116) connected in series. The piston rod (106) of each cylinder (112) receives the force of an impact, which causes the fluid in the cylinder (112) to undergo an increase in pressure, which is relieved by multiple relief valves (302) and serially connected flow restrictors (116). In one embodiment, the relief valves (302) and the flow restrictors (116) are incorporated into a single valve (302'). The system responds to an amount of force caused by an impact and disperses the force accordingly at a controlled rate. Applications for such an embodiment include connection to vehicle bumpers (102), to a seat back (504) where the cylinder (112) is double-acting, and to

landing feet (612) for air-drop carriers.

[0001] TITLE OF INVENTION

Impact Dispersal Device

[0002] BACKGROUND ART

1. Field of Invention

5 [0003] This invention pertains to an impact dispersal system. More particularly, this invention pertains to impact dispersal of an external force applied to a vehicle or other object.

2. Description of the Related Art

[0004] In today's fast paced society, there are sudden stops and unexpected impacts.
10 When these sudden stops and impacts involve vehicles or other massive objects, injury and/or equipment damage is likely. Various attempts have been made to minimize the damage due to such impacts.

[0005] For example, United States Patent Number 3,677,595, titled
"Automobile Bumper," issued on July 18, 1972, discloses a bumper that is
15 hydraulically extended by actuation of an electric switch connected to the brake pedal of a vehicle. The switch connects the power steering system to hydraulic cylinders that extend the bumper away from the vehicle. Upon an impact of the extended bumper, the pressure in the hydraulic cylinders is relieved by a pressure relief valve that allows the hydraulic fluid to return to the power steering system.

20 [0006] United States Patent Number 3,947,061, titled "Extensible vehicle bumper," issued on March 30, 1976, discloses a motor vehicle bumper that is operated by hydraulic slave cylinders connected to the master brake cylinder to extend the bumper upon the application of a predetermined amount of force to the brake to provide the bumper with a greater shock absorbing length of travel under collision
25 conditions. A spring forces the extended bumper to return to a non-extended position. Upon impact, the hydraulic pressure is relieved through a valve returning the hydraulic fluid to the brake system.

[0007] United States Patent Number 5,096,242, titled "Shock-absorbing bumper system," issued on March 17, 1992, discloses a brake-actuated shock-absorbing bumper system for an automotive vehicle. The shock-absorbing bumper system includes a supply subsystem **1** for supplying pressurized working fluid, a pressure-balancing subsystem **2**, a switching subsystem **3**, front and rear bumper subsystems **4** and **4'**, a feedback subsystem **5**, a safety-control subsystem **6**, and a conduit system having a plurality of oil paths for connecting subsystems **1**, **2**, **3**, **4**, **4'**, **5**, and **6**. In one embodiment, illustrated in FIGS. 6 and 6A, the bumper **41**, after being subject to an impact, has a working fluid within a second chamber **45** that absorbs a portion of the impact, a spring **47** that absorbs a portion of the impact, and a receiving space **481** that receives the cylinder **40** after a shear pin **43** breaks. United States Patent Number 6,312,027, titled "Shock absorbing system for an automotive vehicle," issued on November 6, 2001, is a later-issued patent by the same inventor that discloses a shock absorbing system for an automotive vehicle with additional features.

[0008] United States Patent Number 5,286,138, titled "Vehicle positioning methods and apparatus with impact damper," issued on February 15, 1994, discloses a pair of hydraulic cylinders **68**, **69** having a check valve **108** in parallel with a needle valve **109** connected to the hydraulic cylinder **68**, **69**. The check valve **108** allows for filling the hydraulic cylinder **68**, **69** without subsequent escape of the fluid, and the needle valve **109** allows hydraulic fluid to bleed from the cylinder **68**, **69**, which results in a slow retraction of the pistons **72**, **73**.

[0009] United States Patent Number 5,370,429, titled "Bumper system having an extendable bumper for automotive vehicles," issued on December 6, 1994, discloses a hydraulic cylinder connected to a vehicle bumper, with the bumper being extended from the vehicle in response to conditions indicative of an imminent accident. In one embodiment, the cylinder includes a groove with a decreasing opening corresponding to the amount of retraction of the cylinder. The groove with the variable sized opening changes the impact resistance based on the amount of extension of the bumper.

[0010] United States Patent Number 6,435,578, titled "Energy dissipating device for an automobile bumper," issued on August 20, 2002, discloses a hollow rod piston **2**, **10** that selectively closes damping holes **6**, **14** as the hydraulic cylinder, or energy dissipater, **3**, **11** dissipates the energy from an impact.

BRIEF SUMMARY OF THE INVENTION

[0011] According to one embodiment of the present invention, an impact dispersal system is provided. In one embodiment, the impact dispersal system includes a hydraulic cylinder in fluid communication with at least one flow restrictor that limits the rate at which the fluid in the cylinder can escape the cylinder when the piston rod of the cylinder is subjected to an impact. Other embodiments include a relief valve between the hydraulic cylinder and the flow restrictor and a catch tank for receiving the fluid from the flow restrictor.

[0012] The hydraulic cylinder has a piston connected to a shaft. The shaft is adapted to receive shock or impact loads and to transfer those loads to the piston such that the hydraulic fluid in the cylinder is pressurized by the load and bleeds out at a controlled rate, with the device thereby dispersing the energy from the impact.

[0013] The impact dispersal system is adapted to be used in vehicles, such as a motor vehicle in which the impact dispersal system is connected to a bumper of the vehicle for dispersing front and/or rear vehicle impacts. In another embodiment, the impact dispersal system is connected to a seat back for dispersing the impact energy transferred to the seat back, which is allowed limited motion forward and backward due to the impact. In still another embodiment, the impact dispersal system is adapted to be used in a vehicle such as a carrier that is subject to being dropped, for example a carrier ejected from an airplane and attached to a parachute. In this embodiment the impact dispersal system is connected to feet or footers upon which the vehicle, or carrier, lands.

[0014] In one embodiment, a fluid chamber of the hydraulic cylinder is connected to a catch tank via a restriction orifice for controlling the bleed rate. The catch tank is connected to the cylinder through a pressure relief valve and an adjustable orifice. In another embodiment, the device includes a pressurized supply tank connected to the cylinder through a check valve. The pressurized tank is valved to the hydraulic cylinder to fill the fluid chamber of the cylinder. The connecting valve, in one embodiment, is actuated by operation of the vehicle braking system or other signal to cause the piston rod of the hydraulic cylinder to extend. In another embodiment, the connecting valve is actuated by a signal generated after an impact, thereby refilling the fluid chamber of the hydraulic cylinder. This embodiment is adapted for absorbing multiple impacts with the supply tank refilling the cylinder after each impact.

[0015] In another embodiment, the impact dispersal system includes a plurality of pressure relief valves, each having a different setpoint and an adjustable orifice. This embodiment is adapted for dispersing impacts at different force levels.

[0016] In still another embodiment, the impact dispersal system includes a double-acting hydraulic cylinder and a plurality of pressure relief valves and corresponding flow restrictors. The pressure relief valves are connected such that the fluid from one fluid chamber in the hydraulic cylinder is in fluid communication with the other fluid chamber through the plurality of valves and flow restrictors.

BRIEF DESCRIPTION OF DRAWINGS

[0017] The above-mentioned features of the invention will become more clearly understood from the following detailed description of the invention read together with the drawings in which:

FIG. 1 is a schematic diagram of one embodiment of an impact dispersal system attached to a vehicle bumper;

FIG. 2 is a schematic diagram of one embodiment of an impact dispersal system;

FIG. 3 is a schematic diagram of one embodiment of an impact dispersal system with three levels of dispersal and an automatic extension feature;

FIG. 4 is a schematic diagram of one embodiment of a two-way impact dispersal system with two levels of dispersal;

FIG. 5 is a pictorial view of one embodiment of an application of a two-way impact dispersal system;

FIG. 6 is a pictorial view of one embodiment of an application of an impact dispersal system;

FIG. 7 is a front view of a seat employing the two-way impact dispersal system shown in FIG. 5;

FIG. 8 is a side view of one embodiment of a seat belt harness retractor and lock assembly;

FIG. 9 is a front view of the seat belt harness retractor assembly shown in FIG. 7;

FIG. 10 is a schematic diagram of another embodiment of an impact dispersal system with a multi-level relief valve; and

FIG. 11 is a cross-sectional view of one embodiment of a relief valve with a variable rate of relief.

DETAILED DESCRIPTION OF THE INVENTION

[0018] An apparatus for dispersing impacts is disclosed. The impact dispersal system is generally shown as **100** in the figures. The impact dispersal system **100** disperses the energy from an impact after the pressure in the system **100** reaches a selected pressure setting. The rate of flow is controlled by, in various embodiments, adjustable or fixed orifices. The impact dispersal system **100** works with no recoil. As used herein, the term "vehicle" is used in its broad, common meaning of a means of carrying or transporting something. For example, an automobile is a motor vehicle, which is one type of a vehicle. A trailer and a wagon are other types of vehicles. Crates, carriages, containers and pallets are also vehicles.

[0019] FIG. 1 illustrates a schematic diagram of one embodiment of an impact dispersal system **100-1** attached to a vehicle bumper **102**. In the illustrated embodiment, the impact dispersal system **100** is disposed between a vehicle chassis, or frame, **104** and a vehicle bumper **102**. An impact to the bumper **102** parallel to the longitudinal axis of the piston rods **106** connecting the bumper **102** to the hydraulic cylinders **112** allows the system **100** to disperse the effects of the impact by slowly decelerating the vehicle. Those skilled in the art will recognize that the impact dispersal system **100-1** can be positioned at either the front or rear of the vehicle, or at both locations, without departing from the spirit and scope of the present invention.

[0020] The impact dispersal system **100-1** includes a pair of hydraulic cylinders **112A**, **112B** connected to a pair of three-way fill valves **126A**, **126B** by way of tubing **114A**, **114B**, a pair of flow restrictors, or orifices, **116A**, **116B**, and a catch tank, or reservoir, **118**. Connected to each three-way fill valves **126A**, **126B** is a connection **128A**, **128B** for filling the system. In one embodiment, the connection **128** allows for fluid **204** to be pulled from the catch tank **118** into the cylinders **112** to push the cylinders **112** so that the piston rod **106** is in the extended position. In one embodiment, the fluid **204** is an incompressible liquid, such as a hydraulic fluid. In another embodiment, the fluid is a compressed gas, such as air. In one embodiment of the impact dispersal system **100**, the system **100** discharges the fluid **204** to the atmosphere and not into the catch tank **118**. In such an embodiment, the fluid **204** is a bio-degradable or otherwise benign

hydraulic fluid." For a single-use system, the fluid **204** does not need to be retained and environmental friendly fluids will not contaminate the ground.

[0021] In one embodiment, the flow restrictors, or orifices, **116** are adjustable orifices that allow varying the flow rate from the cylinders **112**. In another embodiment, the flow restrictors, or orifices, **116** are orifices that are fixed, that is, the restrictors **116** are not adjustable. In this embodiment, the flow restrictors, or orifices, **116** are selected for the application.

[0022] For testing purposes, connected to each piece of tubing **114** is a check valve **122** and pressure gauge **124**. The pressure gauge **124** indicates the maximum pressure of the system. The catch tank **118** includes a pipe **132** connected to a valve **134** and a connector **136**. Opening the valve **134** after a supply of hydraulic fluid is connected to the connector **136** allows the catch tank **118** to be filled. Likewise, the catch tank **118** can be drained by opening the valve **134** with the connector **136** draining into an appropriate receptacle.

[0023] In operation, the cylinders **112** are filled with hydraulic fluid **204**, thereby extending the piston rod **106** and the bumper **102**. Upon impact, the bumper **102** forces the piston rod **106** into the cylinder **112**, thereby pressurizing the hydraulic fluid **204** and forcing the fluid **204** out of the cylinder **112** through the flow restrictor **116**.

[0024] FIG. 2 illustrates a simplified schematic diagram of one embodiment of an impact dispersal system **100-2**. In the illustrated embodiment, the impact dispersal system **100-2** includes a hydraulic cylinder **112** with a piston rod **106**. The hydraulic cylinder is connected, by way of tubing **114**, to a restrictor, or orifice, **116** that drains into a catch tank, or catch tank, **118**. A force **202** applied to the piston rod **106** causes the hydraulic fluid **204** to be forced out of the cylinder **112**. The restrictor **116** limits the flow rate of the hydraulic fluid **204** out of the cylinder **112**, thereby controlling the dispersal rate. A larger sized orifice in the restrictor **116** allows the fluid **204** to exit from the cylinder **112** at a faster rate, whereas a smaller size orifice in the restrictor **116** allows the fluid **204** to exit from the cylinder **112** at a slower rate.

[0025] The catch tank **118** illustrated in FIGS. 2 and 3 is at atmospheric pressure. The tank **118** is vented such that the flow of fluid **204** into the catch tank **118** is not restricted by any pressure buildup in the tank **118**.

[0026] FIG. 3 illustrates a schematic diagram of one embodiment of an impact dispersal system **100-3** with three levels of dispersal and with an automatic

extension feature. In the illustrated embodiment, the impact dispersal system **100-2** includes a hydraulic cylinder **112** with a piston rod **106**. The hydraulic cylinder is connected, by way of tubing **114**, to a bank of relief valves **302A, 302B, 302C** that are each connected to a restrictor **116A, 116B, 116C**, respectively. Each of the relief valves **302** has an increasingly higher setpoint. The restrictors **116** drain into the catch tank **118**. The illustrated impact dispersal system **100-3** allows for dispersing impacts of varying force. A greater impact results in a higher pressure in the cylinder **112**, which causes flow through more of the relief valves **302**.

[0027] When a force **202** is applied to the piston rod **106**, the pressure of the hydraulic fluid **204** in the cylinder **112** increases until the fluid pressure reaches the setpoint of the first relief valve **302A**, which opens, allowing the fluid **204** to pass through the restrictor **116A** into the catch tank **118**. If the force **202** applied to the piston rod **106** is greater than can be dispersed through the first relief valve **302A**, then the fluid pressure will increase further. If the fluid pressure reaches the setpoint of the second relief valve **302B**, the second relief valve **302B** will open, allowing the fluid **204** to pass through the restrictor **116B** into the catch tank **118**. If the force **202** applied to the piston rod **106** is greater than can be dispersed through the first and second relief valves **302A, 302B**, then the fluid pressure will increase further. If the fluid pressure reaches the setpoint of the third relief valve **302C**, the third relief valve **302B** will open, allowing the fluid **204** to pass through the restrictor **116C** into the catch tank **118**. After the fluid pressure decreases below the setpoint of each relief valve **302**, the relief valve **302** closes. In this manner, the dispersal rate varies depending upon the amount of force **202** applied to the piston rod **106**.

[0028] Also illustrated in FIG. 3 is an automatic extension feature that extends the piston rod **106** when the vehicle operator applies the vehicle brake with excessive force, as would be the case when the vehicle operator recognized that a collision is imminent. When the vehicle operator applies the vehicle brakes, the pressure in the brake line **322** increases. The pressure in the brake line **322** increases as the operator applies greater braking force. Connected to the brake line **322** is an isolator **324** that has an impulse line **326** to a pilot operated valve **314** that opens when the impulse pressure increases above a setpoint. A pressurized tank **312** feeds the pilot operated valve **314**, which has its outlet passing through a check valve **316** that feeds into the tubing **114** connected to the hydraulic cylinder **112**. The pressurized tank **312** is a vessel that partially contains hydraulic fluid **204** with the volume of the tank not containing the fluid **204** filled with a

pressurized gas. The gas pressurizes the contents of the tank **312**, including the fluid **204**, and when the valve **314** is opened, the fluid **204** is forced out of the tank **312** by the expanding gas.

[0029] The check valve **316** prevents any fluid **204** from the cylinder **112** from flowing back to the tank **312** as a result of an impact dispersed by the system **100-3**. When the vehicle operator uses excessive braking force, the pressure in the brake line **322** is transmitted to the impulse line **326** through the isolator **324**. The pressure in the impulse line **326**, if it is greater than the setpoint of the pilot operated valve **314** causes the pilot operate valve **314** to open, thereby allowing the pressurized hydraulic fluid in the tank **312** to flow into the cylinder **112** and forcing the piston rod **106** into the extended position. In another embodiment, the valve **314** is a pressure operated valve that is actuated when the pressure in the brake line **322** exceeds a setpoint value.

[0030] In this embodiment, the bumper **102**, or other impact receiving member, is carried in a retracted position during normal operation. However, when an impact is imminent, as indicated by extreme pressure on the vehicle brakes, the bumper **102**, or other impact receiving member, is extended so as to protrude from the vehicle. This allows the full length of travel of the piston rod **106** to be available for impact dispersal. In another embodiment, the valve **314** is opened by some other means, such as a mechanical trip or an electric solenoid, thereby extending the piston rod **106** and readying the impact dispersal system **100-3** for use. Such an embodiment is useful for the application illustrated in FIG. 6.

[0031] In various embodiments, the bumper **102** is carried in the fully extended position, partially extended position, or the fully retracted position. With the bumper **102** in the fully extended position, such as the embodiment illustrated in FIG. 1, the impact dispersal system **100-1** is always available for use. With the bumper **102** carried in the partially extended or fully retracted positions, some action is necessary to fully extend the bumper **102** before the bumper **102** is required to disperse an impact. As illustrated in FIG. 3, on such embodiment for extending the bumper **102** immediately before it is required to be available is by using the braking of the vehicle to extend the bumper **102**.

[0032] In another embodiment, the valve **314** connecting the pressurized tank **312** to the hydraulic cylinder **112** is actuated by another sensor or switch. For example, in one embodiment, the valve **314** is actuated immediately after an impact is dispersed by the system **100-3**, thereby setting up the system **100-3** to be

ready for another impact. In one such embodiment, the connection valve **314** is actuated by a limit switch controlled by the position of the piston rod **106**.

[0033] The impact dispersal system **100-1** illustrated in FIG. 1, in other embodiments, incorporates one or more of the features illustrated in FIG. 3. For example, the discharge line **114** of each hydraulic cylinder **112A**, **112B** of the system **100-1** includes a relief valve **302** in series with a flow orifice **116**. In another embodiment, the system **100-1** illustrated in FIG. 1 includes a pressurized tank **312** and connecting valve **314**.

[0034] FIG. 4 illustrates a schematic diagram of one embodiment of a two-way impact dispersal system **100-4** with two levels of dispersal. A double-acting hydraulic cylinder **412** has a front piston rod **106** and a rear piston rod **106'** with a pair of hydraulic lines **414A**, **414B**, each connected to one of the back chamber **404** and the front chamber **406**. Connecting the two lines **414A**, **414B** is a normally closed cross-connect valve **414**. The lines **414A**, **414B** terminate in normally closed valves **404A**, **404B** that each communicate with a connector **408A**, **408B**. The arrangement of these three valves **404A**, **404B**, **414** and connectors **408** allow the hydraulic cylinder **412** to be positioned and/or charged. The double acting hydraulic cylinder **412** with the two piston rods **106**, **106'** has a constant fluid volume for the two chambers **404**, **406**. That is, the volume of the back chamber **404** and the volume of the forward chamber **406**, when added together, is constant regardless of the position of the piston rods **106**, **106'**. With the constant volume of the two chambers **404**, **406**, the two-way impact dispersal system **100-4** is a closed system. Those skilled in the art will recognize that the number of relief valves **302** and flow restrictors **116** can vary without departing from the spirit and scope of the present invention.

[0035] The double acting hydraulic cylinder **412** operates in two modes: retracting and extending. A force **402** acting on the piston rod **106** moves the rod **106** in one of two directions. With the direction of the force **402** toward the cylinder **412**, the rod **106** retracts, thereby increasing the pressure of the fluid **204**, which flows from the contracting back chamber **404**, through the tubing **414A** to the relief valves **302C**, **302D**, which are configured similarly to those illustrated in FIG. 3. The relief valves **302C**, **302D** have different setpoints whereby the second valve **302D**, **302C** opens only when the force **402** is so great that the pressure cannot be relieved by the first valve **302C**, **302D**. The discharge from each relief valve **302C**, **302D** flows through a restrictor **116C**, **116D**, respectively, and into the expanding, front chamber **406**.

[0036] With the direction of the force **402** in the opposite direction, away from the cylinder **412**, the rod **106** extends, thereby increasing the pressure of the fluid **204** in the forward chamber **406**. The fluid **204** flows from the contracting forward chamber **406**, through the tubing **414B** to the relief valves **302A**, **302B**, which are configured similarly to those illustrated in FIG. 3. The relief valves **302A**, **302B** have different setpoints whereby the second valve **302B**, **302A** opens only when the force **402** is so great that the pressure cannot be relieved by the first valve **302A**, **302B**. The discharge from each relief valve **302A**, **302B** flows through a restrictor **116C**, **116D**, respectively, and into the expanding, back chamber **404**.

[0037] With the illustrated arrangement of the two-way impact dispersal system **100-4**, the system **100-4** provides impact dispersal for impacts that occur in opposite directions. For example, FIG. 5 illustrates a pictorial view of one embodiment of an application of a two-way impact dispersal system **100-4**. A vehicle seat **502** has a seat back **504** that, in normal operation, is in a position adjusted for the comfort of the seat occupant. The seat back **504** will tend to move to a forward position **504A** or a backward position **504B** as result of any impact the vehicle in which the seat **502** is installed undergoes, whether the impact be to the rear or the front of the vehicle. The seat back **504** pivots about a pivoting axis **512** when the seat back **504** is adjusted normally or the seat back **504** moves as a result of an impact. In the illustrated embodiment, a double acting hydraulic cylinder **412** is fixed to the seat bottom or other member that is normally held in a fixed position relative to the seat back **504** during an impact. The piston rod **106** of the cylinder **412** is attached to a point **514** on the seat back **504** that moves as the seat back **504** moves between its forward and backward positions **504A**, **504B**.

[0038] The seat back **504** is normally constrained to move between a forward and backward position **504A**, **504B**. During an impact sustained by the vehicle, the two-way impact dispersal system **100-4** is able to disperse impact forces applied in part by the momentum of the occupant of the seat **502**. With a seat restraining system secured to the seat back **504** such that the occupant is restrained relative to the seat **502**, the momentum of the occupant and the seat back **504** is dispersed by the two-way impact dispersal system **100-4**, which is connected to the seat back **504**. In one embodiment, a portion of the shoulder harness of the seat restraining system is secured to the seat back **504**. The two-way impact dispersal system **100-4** disperses a portion of an impact to the vehicle from either the front or the rear. Such an impact causes the seat back **504**, and the occupant, to move rearward or forward, respectively, with the system **100-4** keeping the head and upper body

adjacent the headrest and seat back **204**, thereby lessening the risk of head and neck injuries resulting from body recoil.

[0039] In one embodiment, stops are provided to limit the movement of the seat back **504** between the forward position **504A** and the backward position **504B**. The stops are integral with the rod **106** such that the rod **106** is constrained to move only between the stops, thereby limiting the range of motion of the seat back **504**. In another embodiment, the stops are integrated with the seat **502** and seat back **504** assembly such that the seat back **504** is constrained to move only between the stops.

[0040] FIG. 6 illustrates a pictorial view of one embodiment of an application of an impact dispersal system **100**. In the illustrated embodiment, a vehicle, such as a carrier or crate, **602** is attached to a parachute **604**. The carrier **602** includes a hydraulic cylinder **112** near each corner. The piston rod **106** of each cylinder **112** has a foot **612** attached. When the object **602** lands, the feet **612** contact the ground and cause the attached piston rods **106** to retract into the cylinders **112**. Each cylinder **112** and foot **612** is independent, thereby facilitating landing the object **602** on uneven surfaces or rough terrain.

[0041] In various embodiments, the object **602** is a vehicle, such as a motor vehicle or a crate, dropped from an airplane. In the embodiment in which the carrier **602** is a motor vehicle, the hydraulic cylinders **112** are attached to the motor vehicle frame or structure. In the embodiment in which the carrier **602** is a crate, the cylinders **112** are attached to the sides of the crate **602**, as illustrated. In another embodiment, the cylinders **112** are attached to a skid or pallet with the feet **612** extending below the skid or pallet bottom.

[0042] In one embodiment, the piston rods **106** and feet **612** are extended just after the object **602** is dropped from the aircraft. One embodiment includes a rope or other actuator for opening the valve **314**, which allows the fluid **204** stored in a pressurized tank to position the piston rods **106** in the cylinders **112** such that the system **100-3** is ready for deployment. After the vehicle **602** is on the ground, the piston rods **106** are retracted, thereby lifting the feet **612** off the ground and allowing the vehicle **602** to be moved. In one embodiment of the impact dispersal system **100**, the system **100** discharges the fluid **204** to the atmosphere and not into a catch tank **118**. In this embodiment, the fluid **204** is a bio-degradable or otherwise benign hydraulic fluid. Because the illustrated embodiment depicts a single-use system, the fluid **204** does not need to be retained and environmental friendly fluids will not contaminate the ground.

[0043] In another embodiment, the impact dispersal system **100** illustrated in FIG. 6 includes a fixed orifice or restrictor **116** and a fixed setpoint pressure relief valve **302**. The size of the restrictor **116** and the setpoint of the valve **302** are determined based on the characteristics of the object **602**, such as weight, rate of descent, and weather conditions.

[0044] FIG. 7 illustrates a front view of a vehicle seat **502** and seat back **504** of the embodiment of the application employing the two-way impact dispersal system **100-4** shown in FIG. 5. As described above, the seat back **504** moves between a forward position **504A** and a backward position **504B**. It is known to have the shoulder harness portion of a seat belt of a vehicle attached to the vehicle, such as on the support column adjacent the door. With the seat harness attached to a fixed point and the seat back **504** moving between two positions **504A**, **504B**, the passenger occupying the seat **502** will experience a too tight seat harness and a too loose seat harness, respectively. The embodiment illustrated in FIG. 7 overcomes the relative movement between the seat back **504** and the seat harness **702A**.

[0045] Adjacent one side of the seat **502** is a seat belt mount **714** with bracket **704** to which one end of the seat belt **702** is attached. The portion of the seat belt **702B** crosses over the seat **502** and is adapted to lie adjacent the lap of the passenger occupying the seat **502**. The seat belt **702** passes through a seat belt latch tongue **706**, which clips into the seat belt latching mechanism **716**. The seat belt latching mechanism **716** includes a seat belt release button **726**, which in the illustrated embodiment is shown on the side of the latching mechanism **716**. Those skilled in the art will recognize that the release button **726** can be located at other positions on the latching mechanism **716** without departing from the spirit and scope of the present invention. The upper end of the shoulder portion **702A** of the seat belt **702** connects to the seat belt retractor **708**. The seat belt retractor assembly **708** coils the excess length of the seat belt **702** to allow the seat belt **702** to fit snugly against the passenger occupying the seat **502**. The seat belt retractor assembly **708** also includes a locking mechanism that prevents the seat belt **702** from being released from the retractor assembly **708** when the seat belt **702** is needed to restrain the passenger occupying the seat **502** during a collision or impact to the vehicle.

[0046] In the illustrated embodiment, the seat belt retractor **708** is attached to the seat back **504** with structural support to withstand the forces encountered by the seat harness system during an accident. Because the seat belt retractor **708**

is in a fixed position relative to the seat back **504**, the shoulder portion **702A** of the seat belt **702** maintains its pre-determined position with respect to the passenger occupying the seat **502** during an accident or when the seat harness system is otherwise required.

[0047] FIG. 8 illustrates a side view of one embodiment of a seat belt harness retractor assembly **708**. FIG. 9 illustrates a front view of the seat belt harness retractor assembly **708** shown in FIG. 7. The retractor assembly **708** includes a rotating shaft **812** about which the excess length of the seat belt **702** winds for storage. The shaft **812**, in the illustrated embodiment, has a slot **912** that receives the end of the belt **702**. The shaft **812** is connected to a coil spring **902** that provides the winding force.

[0048] As an alternative to the automatic locking mechanisms used in the seat belt retractors **708**, the illustrated embodiment includes a pawl **804** that selectively engages a toothed wheel **802** to lock the wheel **802** and the shaft **812** in a fixed position. The pawl **804** pivots about a pin **816** in a support member **806** attached to the retractor housing **810**. One end of the pawl **804** is attached to an actuator shaft **808** that is selectively extended and retracted from an actuator **908**, thereby causing the opposite end of the pawl **804** to engage and disengage from the toothed wheel **802**. The disengaged position of the pawl **804A** is illustrated in FIG. 8 with broken lines. Near the end of the pawl **804** adjacent the toothed wheel **804** is a spring **814** held in tension. The spring **814** pulls the pawl **804** toward the wheel **802** and forces the pawl **804** to engage the wheel **802**. Those skilled in the art will recognize that the spring **814** can be of other types, such as a torsion spring, without departing from the spirit and scope of the present invention.

[0049] In one embodiment, the pawl **804** moves between the engaged and disengaged positions solely through the movement of the actuator shaft **808**. In another embodiment, a spring **814** attached to the housing **810** acts on the pawl **804** to force the pawl **804** into the engaged position. Such a spring **814**, in one embodiment, is a torsion spring that forces the pawl **804** into the engaged position. In the illustrated embodiment, a coil spring **814** is attached to the pawl **804** near the toothed wheel **802**, thereby forcing the pawl **804** into the engaged position. With the pawl **804** forced into the engaged position, actuation of the actuator shaft **808** pulls the opposite end of the pawl **804** down, thereby unlocking the toothed wheel **802** and allowing adjustment of the seat belt **702**.

[0050] In one embodiment, a locking button **728** is mounted on the seat belt retractor assembly **708**. The locking button **728** operates the actuator **908** to move

the pawl **804** to the disengaged position **804A**. In one embodiment, the locking button **728** is an electrical switch that is connected to the actuator **908**, which is a solenoid. In another embodiment, the locking button **728** is connected to a cable that causes the actuator shaft **808** to move. In either embodiment, the button **728** allows the passenger in the seat **502** to have freedom of movement unrestrained by the belt **702** with the push of a pushbutton **728**.

[0051] FIG. 10 illustrates a schematic diagram of another embodiment of an impact dispersal system **100-4** with a multi-level relief valve **302'**. The illustrated embodiment of the system **100-4** is similar to the embodiment illustrated in FIG. 3 except the three relief valves **302A**, **302B**, **302C**, each with a single setpoint, and the three associated flow restrictors **116A**, **116B**, **116C** are replaced with a single relief valve **302'** that has a first setpoint where the valve **302'** first opens and then has a variable flow rate until the valve is submitted to a pressure where the valve is fully open. In the illustrated embodiment, as the piston rod **106** moves due to an impact **202**, the pressure of the fluid **204** increases. As the pressure increases to the first setpoint, the relief valve **302'** opens allowing fluid **204** to be released to the catch tank **118** at a pre-determined flow rate. If the pressure in the cylinder **112** continues to increase to the second setpoint of the valve **302'**, the relief valve **302'** allows a greater flow rate of fluid **204** to be released from the cylinder **112** to the catch tank **118**.

[0052] FIG. 11 illustrates a cross-sectional view of one embodiment of a relief valve **302'** with a variable setpoint. The illustrated relief valve **302'** is a direct acting piston valve. The piston **1104** moves within a bore **1108** of the valve body **1102** with the position of the piston **1104** related to the pressure of a fluid at the inlet port **1112**. A lower o-ring **1106B** is positioned between the piston **1104** and the surface of the bore **1108** in the valve body **1102**, and an upper o-ring **1106A** is positioned on the piston **1104** proximate the spring **1116**. A spring **1116** between the piston **1104** and a plug **1108** in the valve body **1102** counteracts the force of the fluid applied to the lower face of the piston **1104**. The plug **1108**, in one embodiment, has a threaded engagement with the valve body **1102** in which the plug **1108** position relative to the bottom of the bore **1108** in the valve body **1102** is adjustable, thereby changing the force applied to the piston **1104** by the spring **1116**. In another embodiment, the plug **1108** is fixed in position in the valve body **1102** such that the spring **1116** applies a preselected force to the piston **1104**.

[0053] The outlet port **1114** of the valve **302'** has a central bore **1124** with a slot **1126** positioned towards the inlet port **1112**. As the pressure of the fluid

increases, causing the piston **1104** to move up, when the pressure reaches the first setpoint the slot **1126** is exposed to the fluid from the inlet port **1112**, thereby allowing the fluid to pass through the valve **302'** at a rate based on the cross-sectional area of the slot **1126** exposed by the piston **104**. If the pressure continues to increase, the piston **1104** continues to move up, thereby exposing more of the area of the slot **1126** until the piston exposes the main outlet bore **1124** when the second setpoint is reached. In the illustrated embodiment, the slot **1126** is slanted such that, as the piston **1104** moves upward, a greater volume of fluid flows into the slot **1126**. Those skilled in the art will recognize that the angle and shape of the slot **1126** can vary without departing from the scope and spirit of the present invention. As the main outlet bore **1124** is exposed by the piston **1104** moving up, the rate of flow from the inlet port **1112** to the outlet port **1114** increases. In one embodiment, the slot **1126** is a channel in the valve body **1102**.

[0054] In the illustrated embodiment, the valve **302'** has a first setpoint associated with initially exposing the slot **1126**, a second setpoint associated with exposing the main outlet bore **1124**, and a high setpoint associated with having the maximum area of the main outlet bore **1124** exposed. The outlet port **1114** is a staged outlet port because of the slot **1126** and the main outlet bore **1124** allow the flow rate through the outlet port **1114** to vary by stages. That is, the first stage of the illustrated embodiment begins when the piston **1104** exposes the slot **1126**, thereby allowing fluid to flow through the valve in relation to the amount of the slot **1126** exposed by the piston **1104** movement. The second stage begins when the piston **1104** exposes the main bore **1124**, thereby allowing a greater flow rate through the valve **302'**.

[0055] In various embodiments, the shape, size, and location of the slot **1126** is configured to obtain the number of setpoints desired and the flow rate at and between each of those setpoints. The slot **1126** and main outlet bore **1124** act as a variable flow restrictor, with the amount of flow restriction being a function of the exposed area and the position of the piston **1104** based on the fluid pressure. In another embodiment, the two sets of relief valves **302** and flow restrictors **116** illustrated in FIG. 4 are replaced with a pair of multiple setpoint relief valves **302'**, with each valve **302'** discharging to one of the chambers **404**, **404**.

[0056] The impact dispersal system **100** includes various functions. The function of receiving an impact is implemented, in one embodiment, by the bumper **102** connected to the hydraulic cylinder **112** as illustrated in FIG. 1. In another embodiment, the function of receiving an impact is implemented by the seat back

504 that is connected to the hydraulic cylinder **412** as illustrated in FIG. 5. In still another embodiment, the function of receiving an impact is implemented by the feet **502** upon which the vehicle, or object, **602** lands after being dropped, as illustrated in FIG. 6.

[0057] The function of retracting a seat belt **702** for securing a passenger to the seat back **504** is implemented, in one embodiment, by the seat belt harness retractor assembly **708** as illustrated in FIGS. 7, 8, and 9. In one embodiment, the seat belt harness retractor assembly **708** includes a conventional seat belt retractor with an automatic locking device. In another embodiment, the seat belt harness retractor assembly **708** includes a manual locking device including a pawl **804** engaging a toothed wheel **802** with the pawl **804** responding to an actuator **908**.

[0058] From the foregoing description, it will be recognized by those skilled in the art that an impact dispersal system **100** has been provided. This system **100**, in its various embodiments, includes a cylinder **112** with a piston rod **106** adapted to receive the forces from an impact. The cylinder **112** has a fluid **204** that is forced out of the cylinder **112** by the impact. In the various embodiments, the fluid **204** passes through at least one flow restrictor **116** and at least one pressure relief valve **302**.

[0059] While the present invention has been illustrated by description of several embodiments and while the illustrative embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. The invention in its broader aspects is therefore not limited to the specific details, representative apparatus and methods, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of applicant's general inventive concept.

CLAIMS

What is claimed is:

1. An apparatus for impact dispersal of a force applied to a vehicle, said apparatus comprising:

5 a hydraulic cylinder having a piston rod and a first fluid chamber filled with a fluid, said hydraulic cylinder connected to a first structural member of a vehicle and said piston rod connected to a second structural member of said vehicle;

a first relief valve in fluid communication with said first fluid chamber, said first relief valve having a first setpoint;

10 a first flow restrictor in fluid communication with said first relief valve, said first relief valve and said first flow restrictor being in series connection;

a second relief valve in fluid communication with said first fluid chamber, said second relief valve having a second setpoint, said first setpoint being different than said second setpoint; and

15 a second flow restrictor in fluid communication with said second relief valve, said second relief valve and said second flow restrictor being in series connection, said first relief valve and said first flow restrictor being parallel to said second relief valve and said second flow restrictor;

20 whereby an impact force applied along a longitudinal axis of said piston rod pressurizes said fluid which escapes said first fluid chamber through said first and second relief valves and at a rate controlled by said first and second flow restrictors.

2. The apparatus of claim 1 wherein said first relief valve and said first flow restrictor direct said fluid from said first fluid chamber when said first relief valve actuates and said second relief valve and said second flow restrictor directs said fluid
25 from said first fluid chamber when said second relief valve actuates.

3. The apparatus of claim 1 wherein said first relief valve, said first flow restrictor, said second relief valve, and said second flow restrictor are incorporated into a single valve assembly.

4. The apparatus of claim 3 wherein said single valve assembly includes a piston, a spring, and a staged outlet port, said staged outlet port allowing a rate of fluid flow to vary in relation to a pressure of said fluid.
5. The apparatus of claim 3 wherein said single valve assembly includes a piston,
5 a spring, and an outlet port, said outlet port having a main outlet channel and a slot, said slot being exposed to said fluid from an inlet port before said main outlet channel is exposed to said fluid as a pressure of said fluid increases.
6. The apparatus of claim 1 wherein a bumper of said vehicle is attached to one of said first structural member and said second structural member.
- 10 7. The apparatus of claim 1 wherein a seat back of said vehicle is attached to one of said first structural member and said second structural member, said seat back pivotally constrained to move between a forward position and a backward position by said piston rod during said impact.
8. The apparatus of claim 1 wherein said hydraulic cylinder further includes a
15 second fluid chamber filled with said fluid, said hydraulic cylinder being a double-acting cylinder whereby movement of said piston rod acts on said first and second fluid chambers, said first relief valve and said first flow restrictor directing said fluid to said second fluid chamber when said first relief valve actuates, and said second relief valve and said second flow restrictor directing said fluid from said second fluid
20 chamber when said second relief valve actuates.
9. The apparatus of claim 1 wherein said vehicle is a carrier subject to a dropping force, one of said first and second structural members being a footer upon which said carrier rests after being subject to said dropping force.
10. The apparatus of claim 1 further including means for receiving said impact.
- 25 11. The apparatus of claim 1 further including a pressurized tank containing said fluid, said pressurized tank in fluid communication with a connection valve that is in fluid communication with said first fluid chamber.

12. The apparatus of claim 1 further including a pressurized tank containing said fluid, said pressurized tank in fluid communication with a connection valve that is in fluid communication with said first fluid chamber, said connection valve actuated by a signal from a vehicle braking system.

5 13. An apparatus for impact dispersal of a force applied along one axis, said apparatus comprising:

a hydraulic cylinder having a piston rod, said hydraulic cylinder being a double-acting hydraulic cylinder having a first fluid chamber and a second fluid chamber filled with a fluid, said hydraulic cylinder connected to a first structural member of a vehicle and said piston rod connected to a second structural member of said vehicle;

a first relief valve in fluid communication with said first fluid chamber, said first relief valve having a first setpoint;

a first flow restrictor in fluid communication with said first relief valve, said first relief valve and said first flow restrictor being in series connection, said first relief valve and said first flow restrictor directing said fluid to said second fluid chamber when said first relief valve actuates;

a second relief valve in fluid communication with said first fluid chamber, said second relief valve having a second setpoint;

20 a second flow restrictor in fluid communication with said second relief valve, said second relief valve and said second flow restrictor being in series connection, said second relief valve and said second flow restrictor directing said fluid to said second fluid chamber when said second relief valve actuates;

a third relief valve in fluid communication with said second fluid chamber, said third relief valve having a third setpoint; and

a third flow restrictor in fluid communication with said third relief valve, said third relief valve and said second flow restrictor being in series connection, said third relief valve and said third flow restrictor directing said fluid to said first fluid chamber when said third relief valve actuates;

whereby an impact of sufficient force to actuate one of said first, second, and third relief valves applied in either direction along a longitudinal axis of said piston rod forces said fluid to flow between said first and second fluid chambers.

14. The apparatus of claim 13 wherein said first relief valve, said first flow restrictor, said second relief valve, and said second flow restrictor are incorporated into a single valve assembly.

15. The apparatus of claim 14 wherein said single valve assembly includes a piston, a spring, and a staged outlet port, said staged outlet port allowing a rate of fluid flow to vary in relation to a pressure of said fluid.

16. The apparatus of claim 14 wherein said single valve assembly includes a piston, a spring, and an outlet port, said outlet port having a main outlet channel and a slot, said slot being exposed to said fluid from an inlet port before said main outlet channel is exposed to said fluid as a pressure of said fluid increases.

17. The apparatus of claim 13 wherein said first relief valve, said first flow restrictor, said second relief valve, and said second flow restrictor are incorporated into a first single valve assembly; and said third relief valve and said third flow restrictor are incorporated into a second single valve assembly.

18. The apparatus of claim 17 wherein each of said first and second single valve assembly includes a piston, a spring, and an outlet port, each one of said outlet ports having a main outlet channel and a slot, said slot being exposed to said fluid from an inlet port before said main outlet channel is exposed to said fluid as a pressure of said fluid increases.

19. The apparatus of claim 13 wherein a seat back of said vehicle is attached to one of said first structural member and said second structural member, said seat back pivotally constrained to move between a forward position and a backward position during said impact by said piston rod.

20. The apparatus of claim 19 further including a seat belt retractor attached to said seat back;

said seat belt retractor maintaining a preselected tension on a seat belt

regardless of said seat back being in either of said forward position and said backward position, said seat belt retractor having a locking mechanism operable from a remote location.

21. The apparatus of claim 19 further including a seat belt retractor attached to
5 said seat back, said seat belt retractor having a remotely controlled locking mechanism preventing a seat belt from unwinding from said seat belt retractor.

22. The apparatus of claim 19 further including a means for retracting a seat belt for securing a passenger to said seat back.

23. The apparatus of claim 13 wherein a seat back of said vehicle is attached to
10 one of said first structural member and said second structural member, said seat back movable between a forward position and a backward position during said impact, said forward position and said backward position defined by a first stop and a second stop, said first and second stops limiting said seat back from moving beyond said forward position and said backward position.

15 24. An apparatus for impact dispersal of a force applied to a vehicle, said apparatus comprising:

a hydraulic cylinder having a piston rod and a first fluid chamber filled with a fluid, said hydraulic cylinder connected to a first structural member of a vehicle and said piston rod connected to a second structural member of said vehicle;

20 a first relief valve in fluid communication with said first fluid chamber, said first relief valve having a first setpoint;

a first flow restrictor in fluid communication with said first relief valve, said first relief valve and said first flow restrictor being in series connection, said first relief valve and said first flow restrictor directing said fluid from said first fluid
25 chamber when said first relief valve actuates;

a second relief valve in fluid communication with said first fluid chamber, said second relief valve having a second setpoint, said first setpoint being different than said second setpoint; and

a second flow restrictor in fluid communication with said second relief valve, said second relief valve and said second flow restrictor being in series connection, said first relief valve and said first flow restrictor being parallel to said second relief valve and said second flow restrictor, said second relief valve and said second flow
 5 restrictor directing said fluid from said first fluid chamber when said second relief valve actuates;

a pressurized tank containing said fluid, said pressurized tank in fluid communication with a connection valve that is in fluid communication with said first fluid chamber;

10 whereby an impact force applied along a longitudinal axis of said piston rod pressurizes said fluid which escapes said first fluid chamber through said first and second relief valves and at a rate controlled by said first and second flow restrictors.

25. The apparatus of claim 24 wherein said first relief valve, said first flow restrictor, said second relief valve, and said second flow restrictor are incorporated
 15 into a single valve assembly.

26. The apparatus of claim 25 wherein said single valve assembly includes a piston, a spring, and a staged outlet port, said staged outlet port allowing a rate of fluid flow to vary in relation to a pressure of said fluid.

27. The apparatus of claim 25 wherein said single valve assembly includes a
 20 piston, a spring, and an outlet port, said outlet port having a main outlet channel and a slot, said slot being exposed to said fluid from an inlet port before said main outlet channel is exposed to said fluid as a pressure of said fluid increases.

28. The apparatus of claim 24 wherein a bumper of said vehicle is attached to one of said first structural member and said second structural member.

25 29. The apparatus of claim 24 wherein a seat back of said vehicle is attached to one of said first structural member and said second structural member, said seat back pivotally constrained to move between a forward position and a backward position during said impact by said piston rod.

30. The apparatus of claim 24 wherein said hydraulic cylinder further includes a second fluid chamber filled with said fluid, said hydraulic cylinder being a double-acting cylinder whereby movement of said piston rod acts on said first and second fluid chambers;

5 said apparatus further including a third relief valve and a third flow restrictor in series communication, said third relief valve having a third setpoint, said third relief valve and said third flow restrictor directing said fluid to said first fluid chamber from said second fluid chamber when said third relief valve actuates;

10 said first relief valve and said first flow restrictor directing said fluid to said second fluid chamber; and said second relief valve and said second flow restrictor directing said fluid to said second fluid chamber.

31. The apparatus of claim 24 wherein said vehicle is a carrier subject to a dropping force, one of said first and second structural members being a footer upon which said carrier rests after being subject to said dropping force.

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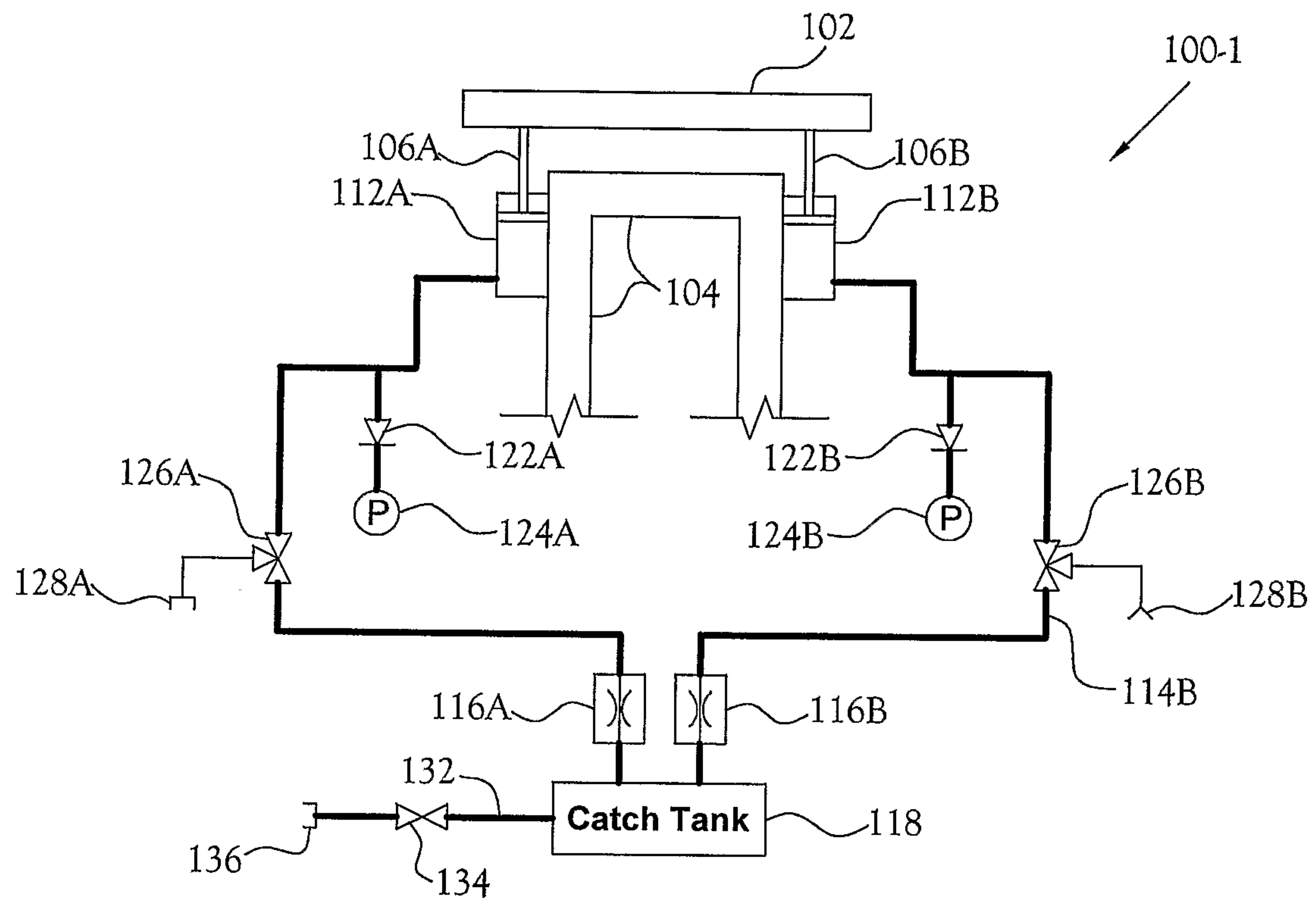


Fig.1

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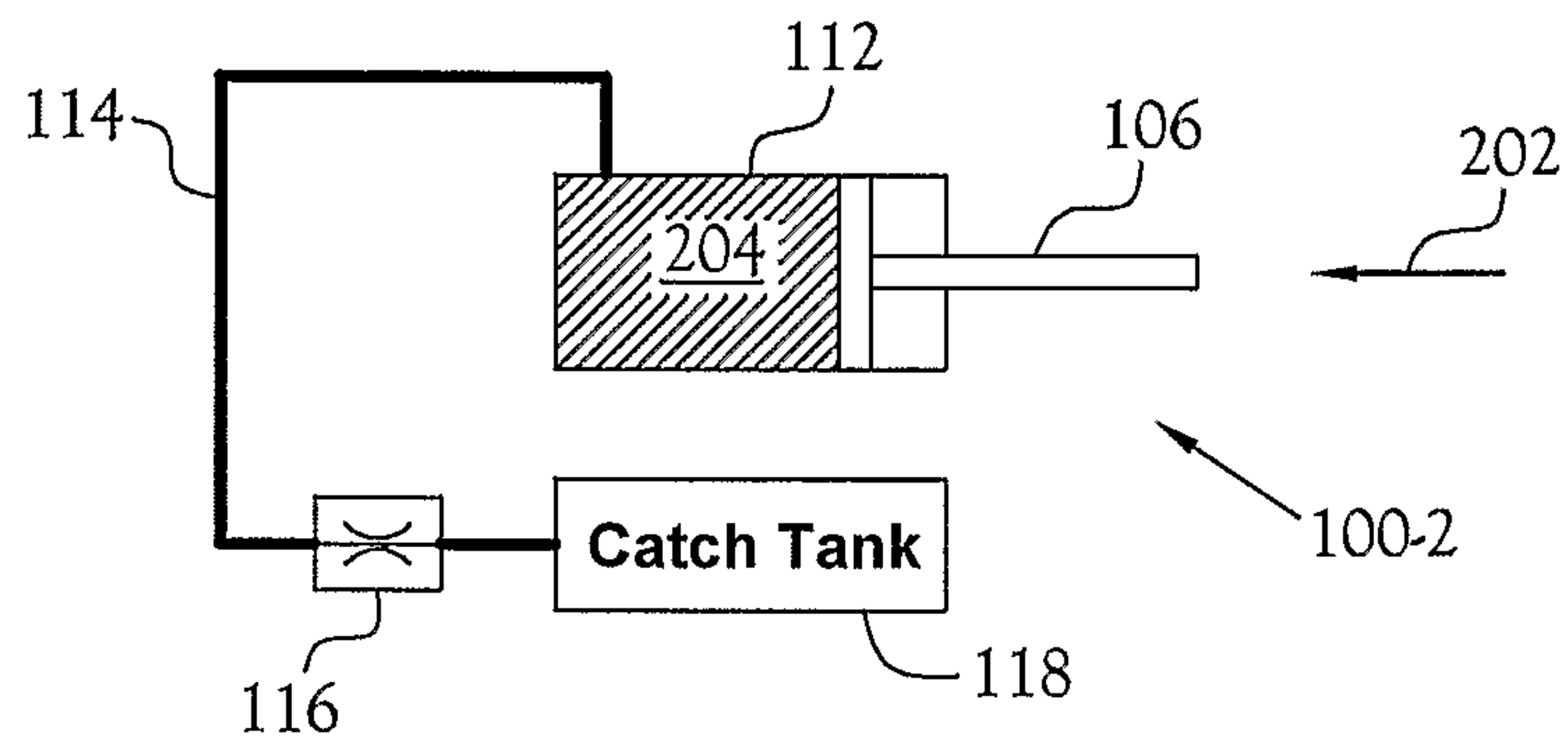


Fig. 2

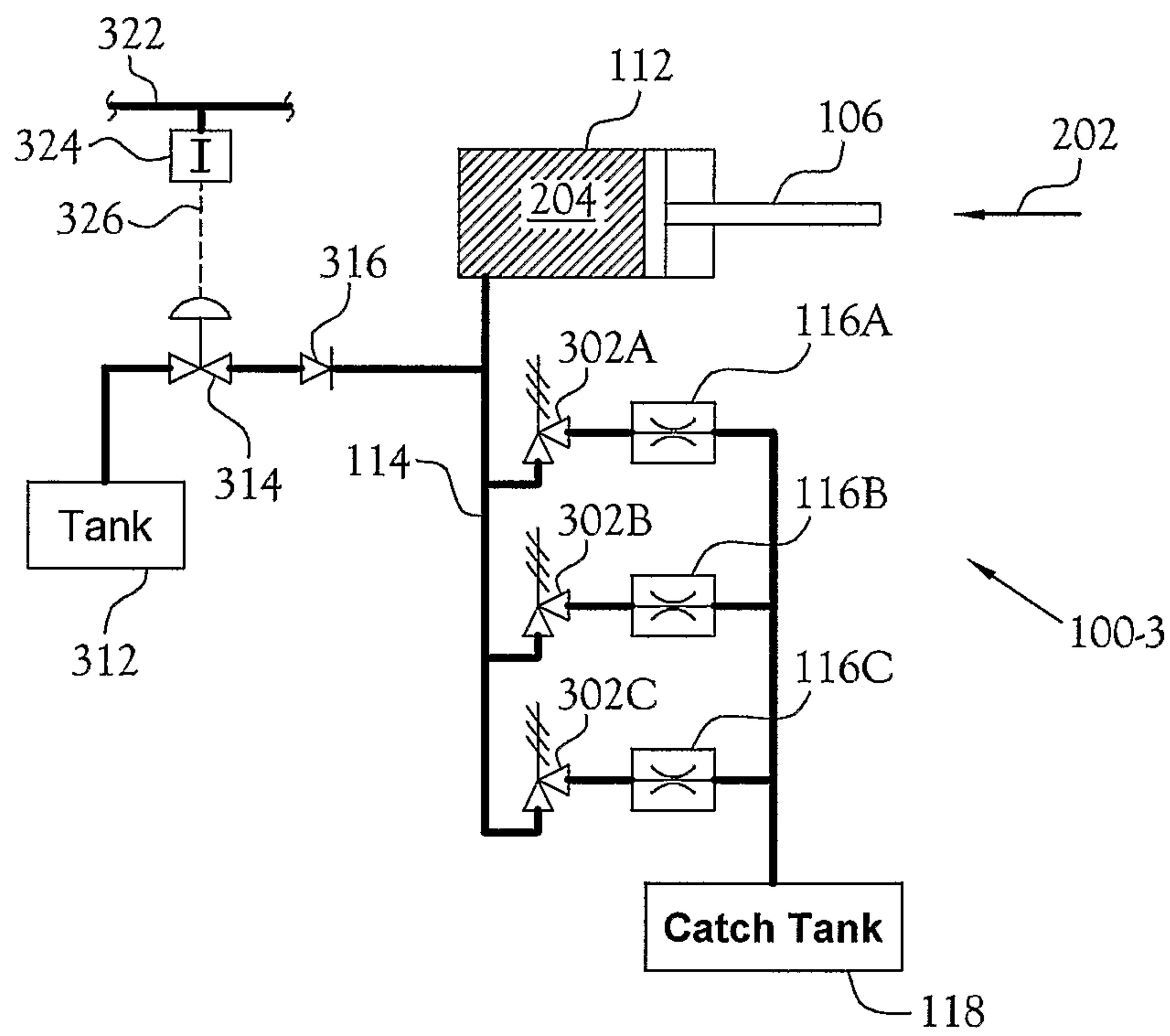


Fig. 3

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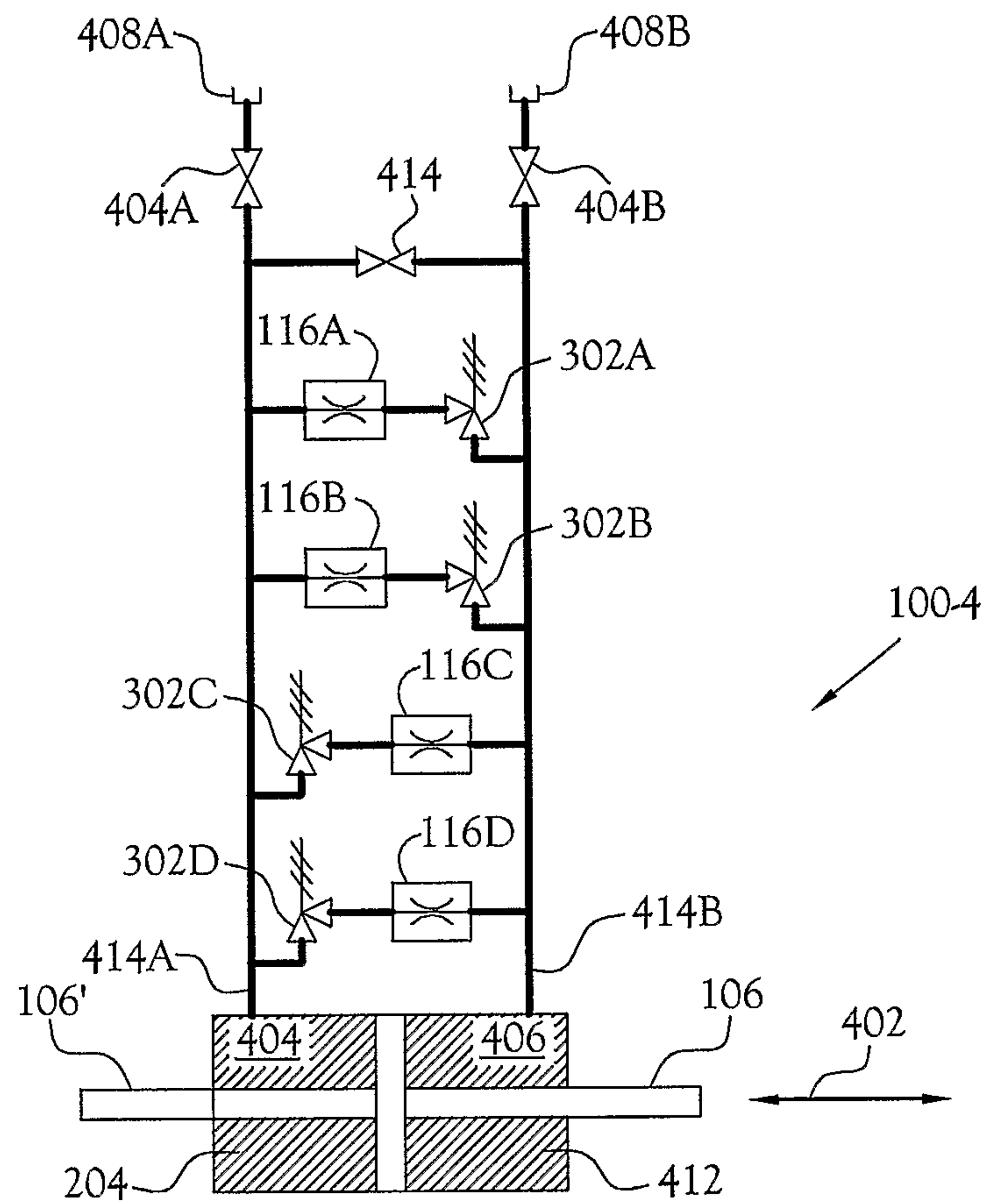
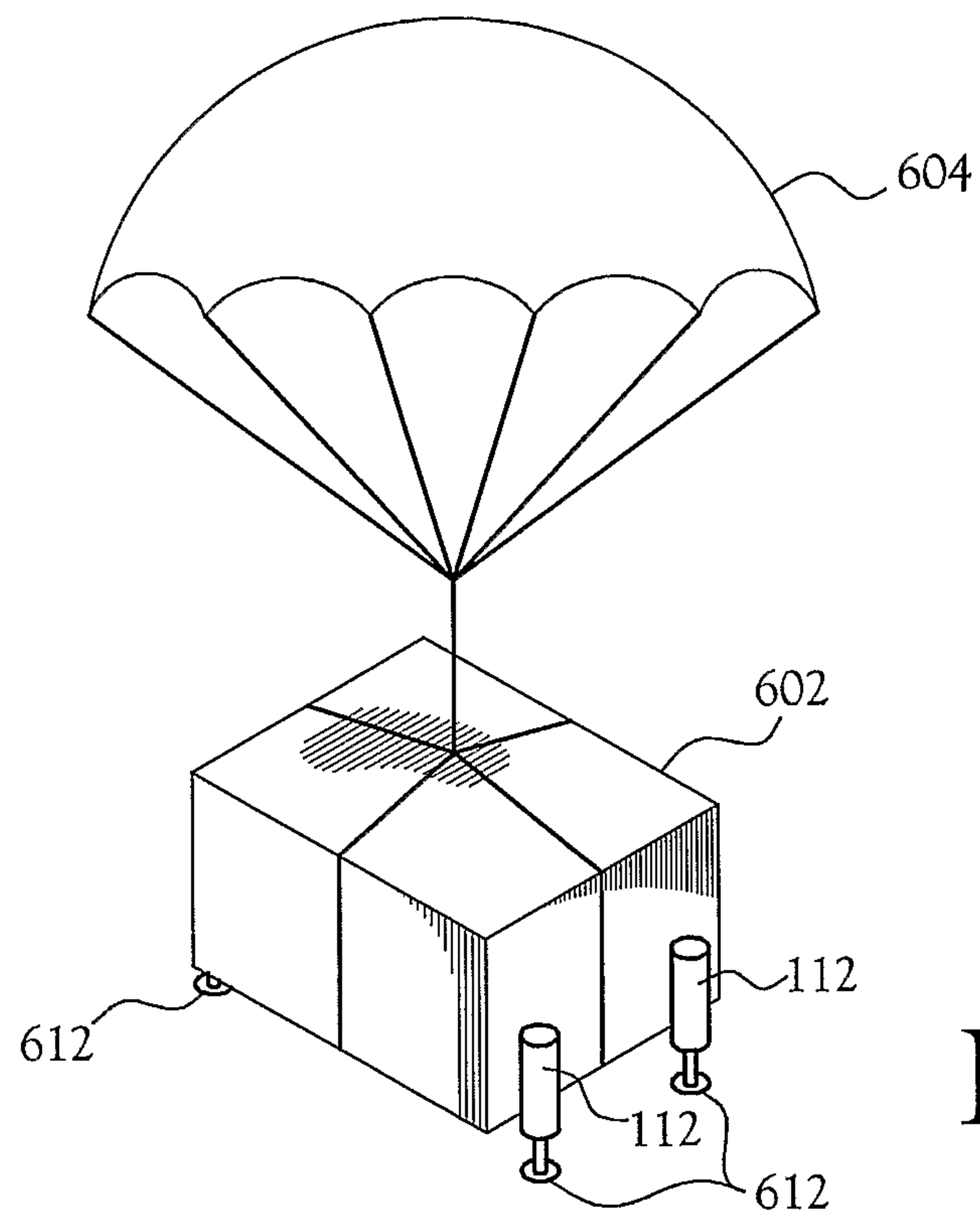
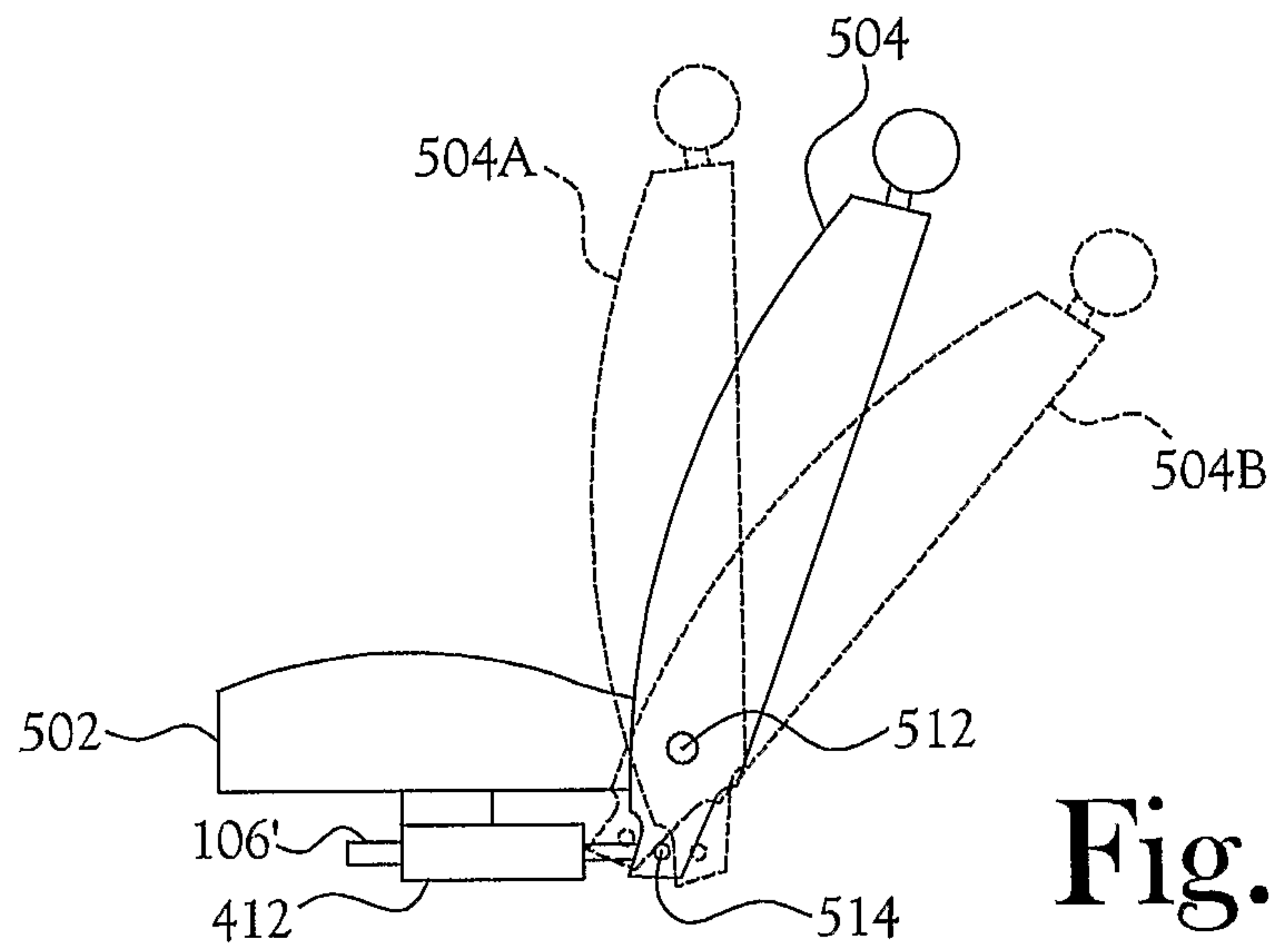


Fig.4

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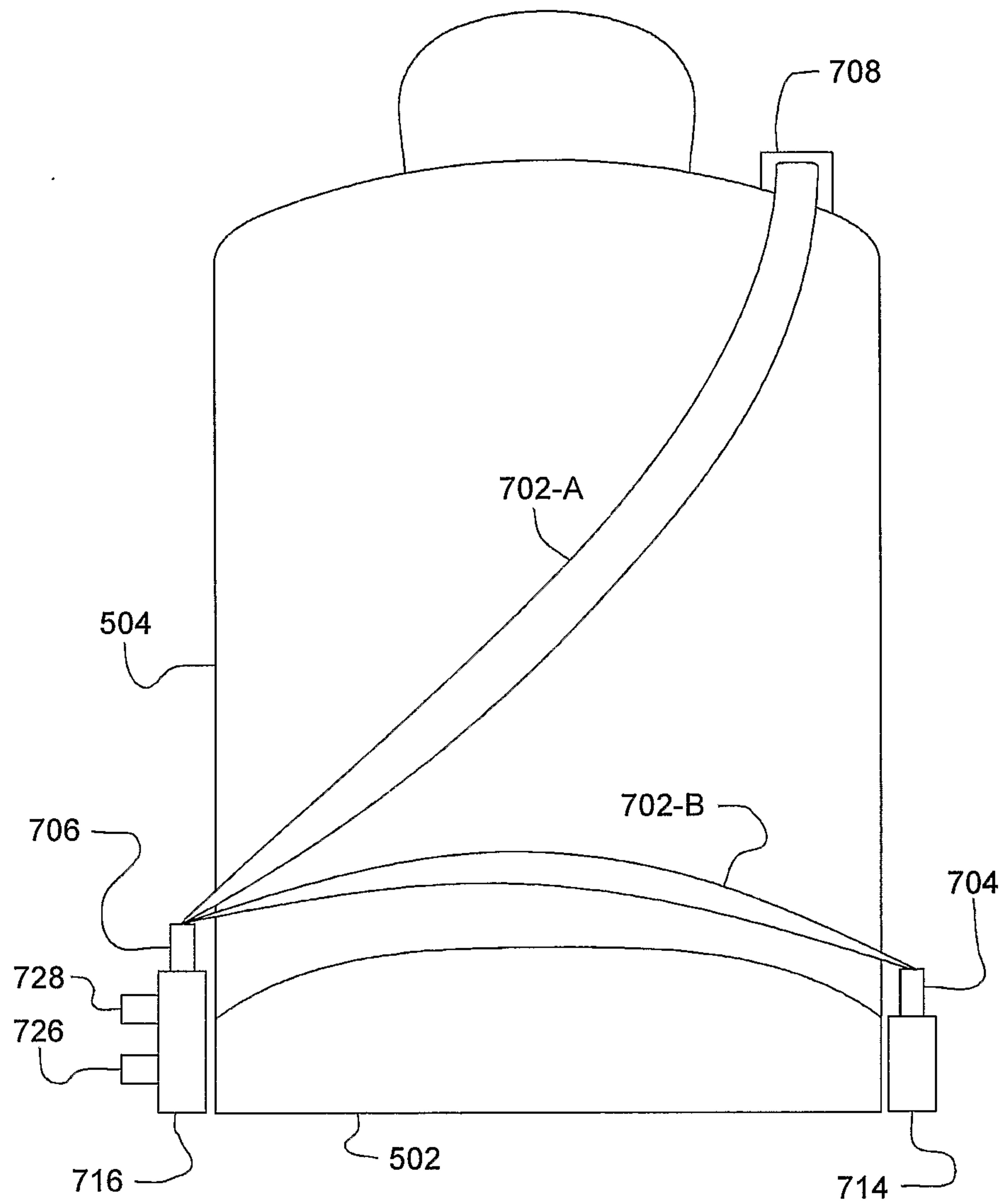


Fig. 7

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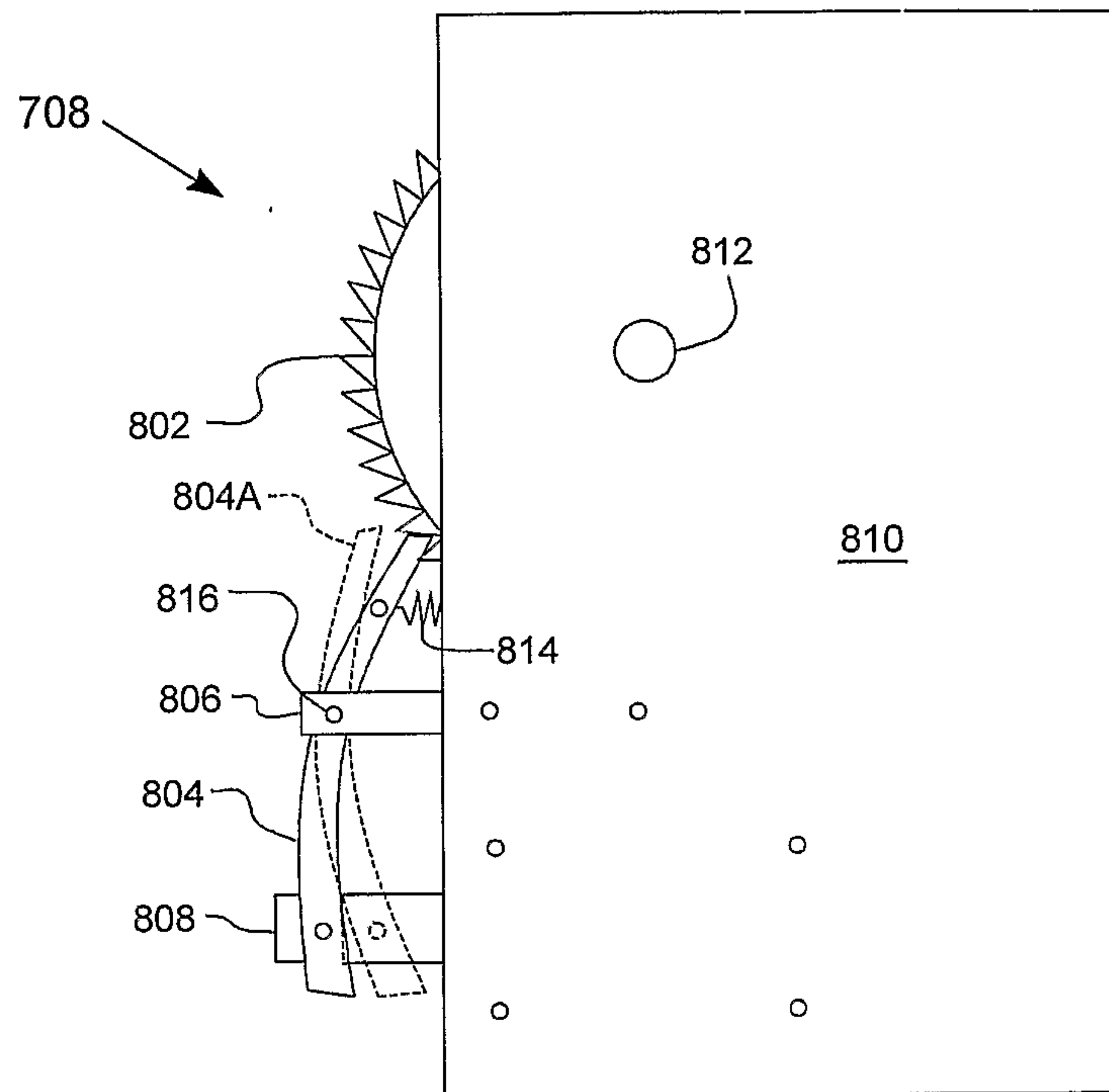


Fig. 8

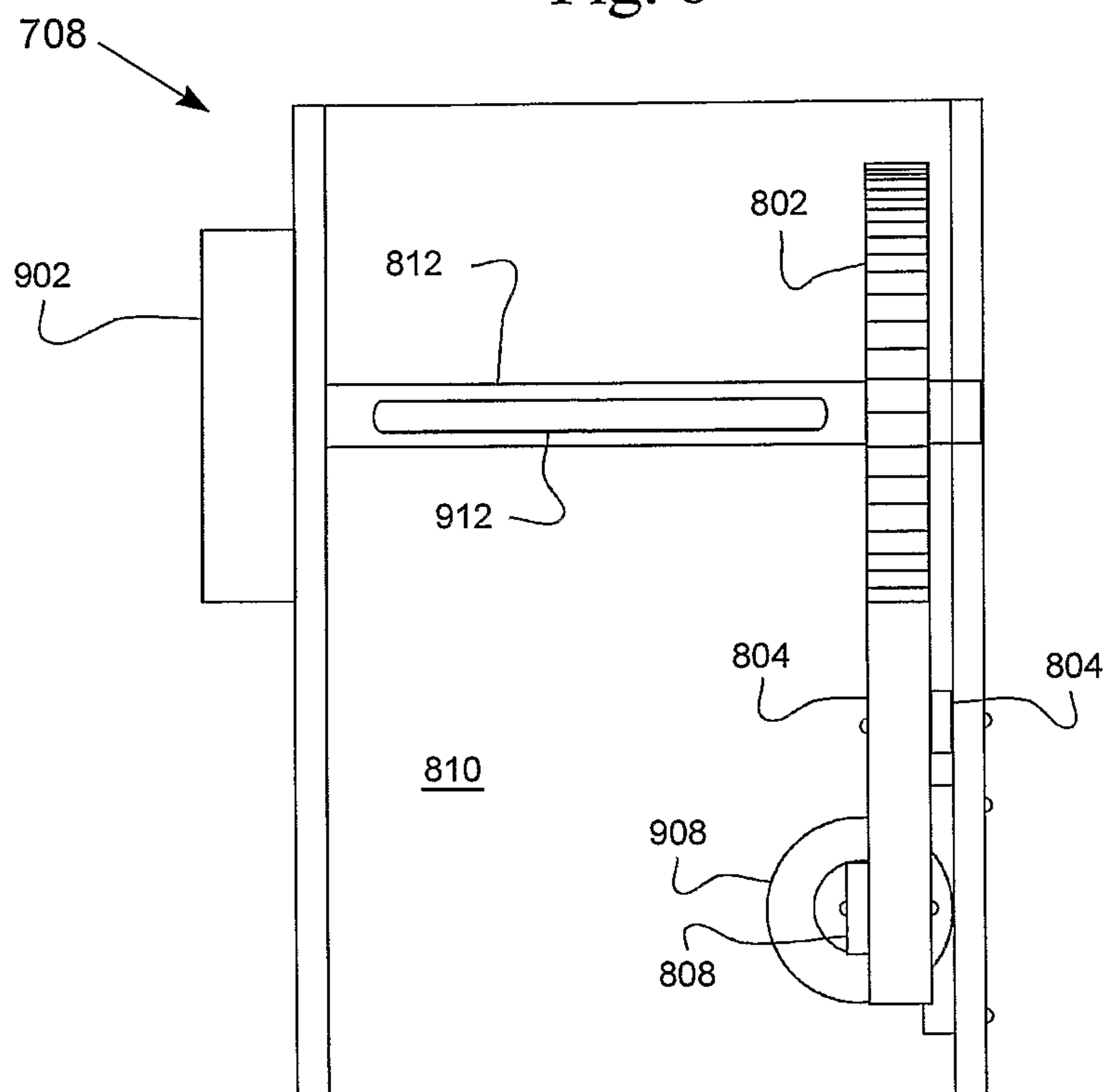


Fig. 9

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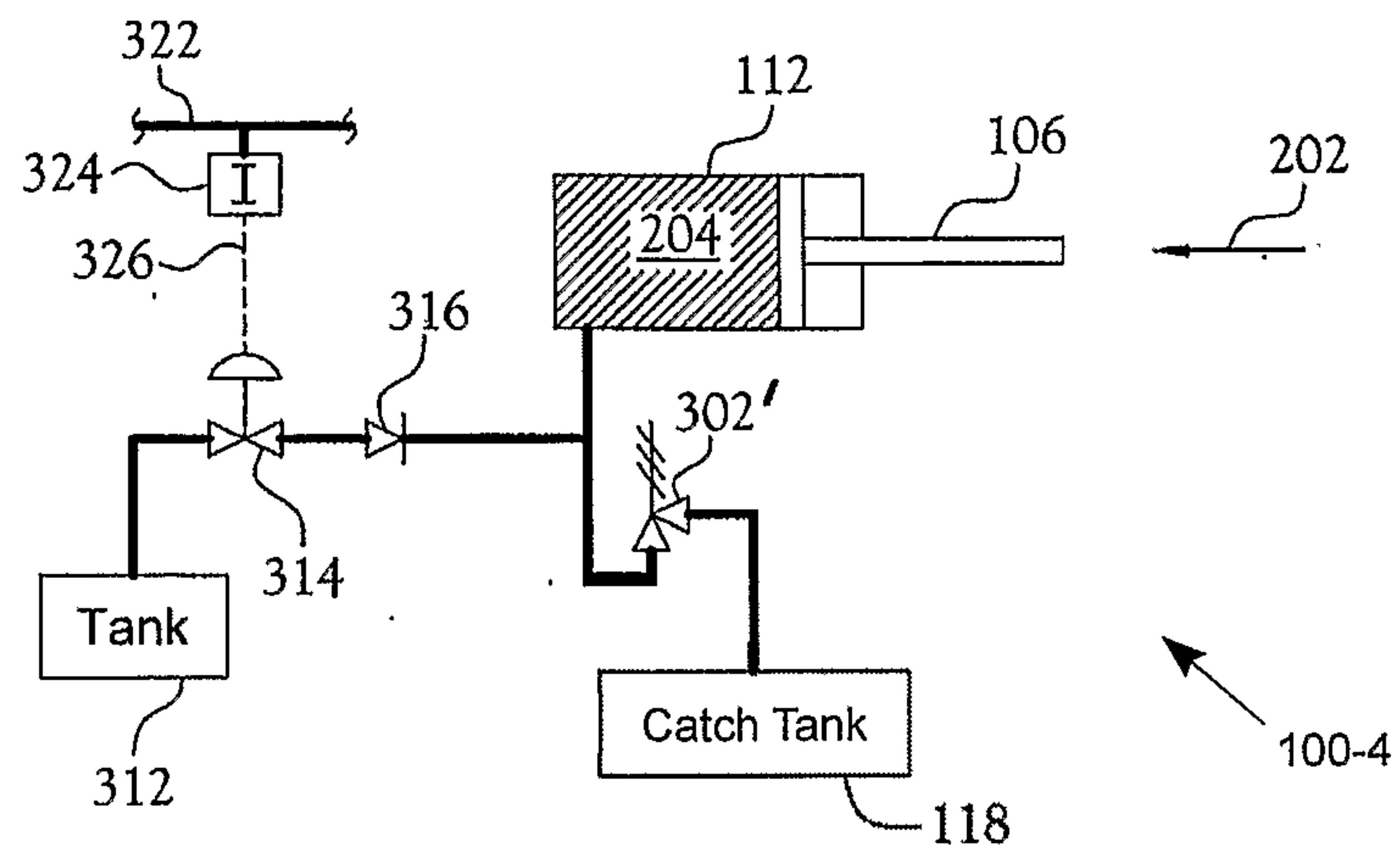


Fig. 10

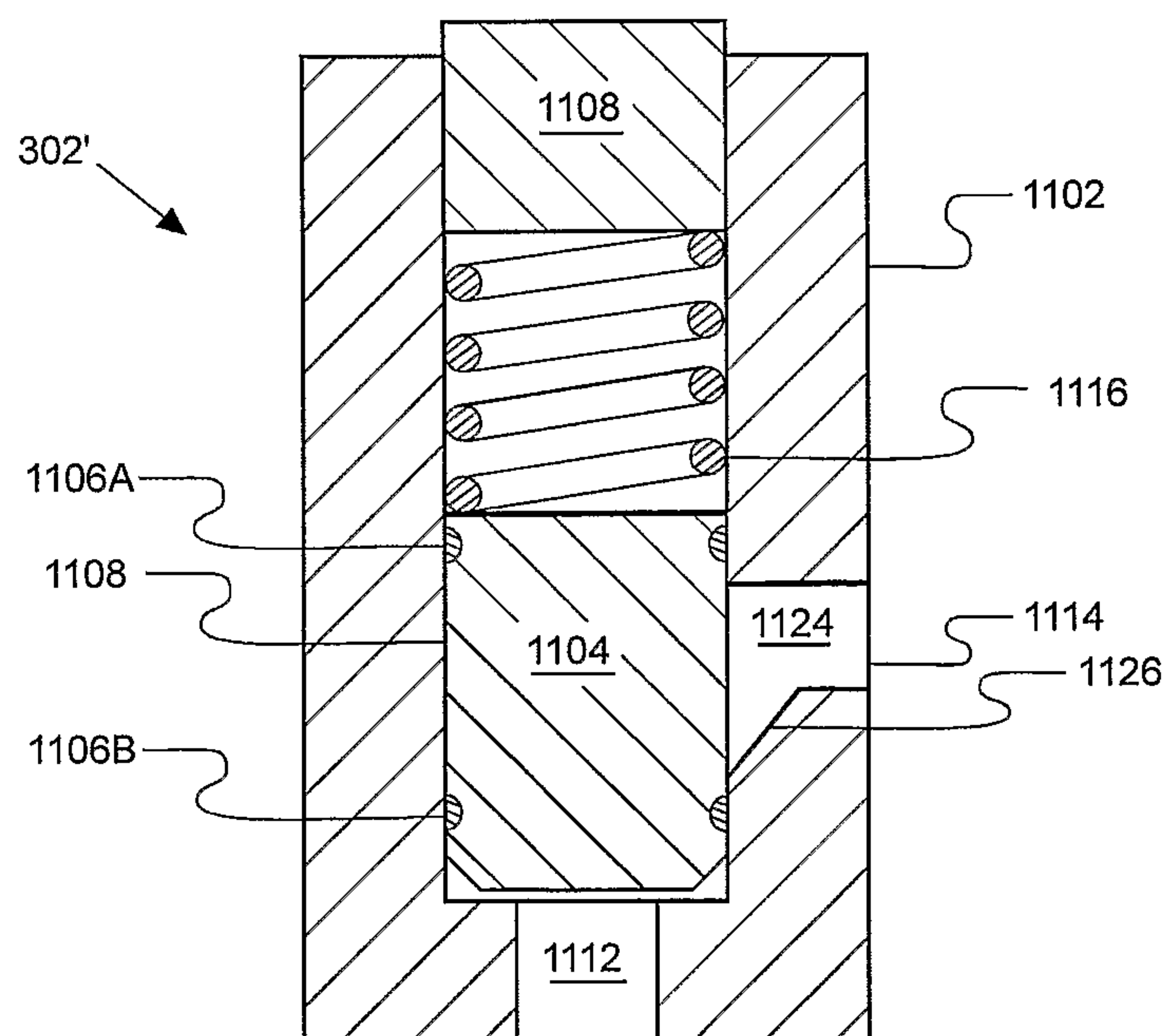


Fig. 11

