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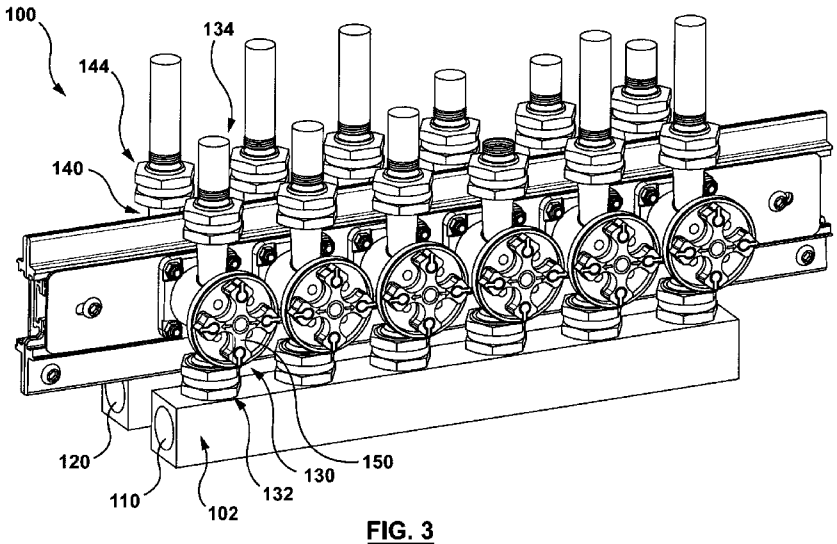


FIG. 3

(57) Abstract: An automated dual valve manifold system comprising a manifold having a first conduit and a second conduit. The system includes a first valve having a first inlet connected to the first conduit, a first outlet and a first passageway between the first inlet and the first outlet. The system includes a second valve having a second inlet connected to the second conduit, a second outlet and a second passageway between the second inlet and the second outlet. A cross gear is operably connected to both the first valve and the second valve such that rotation of the cross gear actuates both the first valve and the second valve. An actuator selectively rotates the cross gear. A controller is provided for controlling the actuator.

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AUTOMATED DUAL VALVE MANIFOLD

TECHNICAL FIELD

[0001] The present invention relates to manifolds and valves for controlling the flow of liquid, for example, controlling the flow of water in hot and cold water lines as well as in hydronic heating and cooling systems.

BACKGROUND

[0002] Various types of valves and manifolds are known for use in controlling the flow of liquids such as, for example, the flow of hot and cold water in water supply and return lines in houses, buildings, offices, etc.

[0003] It is also known to use valves and manifolds to control the flow of hydronic heating or cooling liquids. Hydronic heating or cooling systems deliver warm or cool liquid, e.g. water, through conduits to heat or cool surfaces such as floors (radiant floor heating/cooling) or walls (radiant wall heating/cooling). Some such systems deliver liquid through conduits to multiple zones. An example of a hydronic manifold is disclosed in United States Patent No. 8,555,926 (MacDuff) entitled “Supply Manifold for Hydronic System”.

[0004] Improvements to the existing technologies remain highly desirable.

SUMMARY

[0005] The following presents a simplified summary of some aspects or embodiments of the invention in order to provide a basic understanding of the invention. This summary is not an extensive overview of the invention. It is not intended to identify key or critical elements of the invention or to delineate the scope of the invention. Its sole purpose is to present some embodiments of the invention in a simplified form as a prelude to the more detailed description that is presented later.

[0006] The present specification discloses an automated dual valve manifold for controlling the flow of fluid for applications such as hot and cold water conduits and hydronic heating and cooling.

[0007] One inventive aspect of the disclosure is an automated dual valve manifold system comprising a manifold having a first conduit and a second conduit, a first valve having a first inlet connected to the first conduit, a first outlet and a first passageway between the first inlet and the first outlet and a second valve having a second inlet connected to the second conduit, a second outlet and a second passageway between the second inlet and the second outlet. A cross gear is operably connected to both the first valve and the second valve such that rotation of the cross gear actuates both the first valve and the second valve. An actuator selectively rotates the cross gear. A controller is provided for controlling the actuator.

[0008] Another inventive aspect of the disclosure is an automated dual valve manifold system comprising a manifold having a cold water conduit and a hot water conduit and a plurality of pairs of mechanically connected valves. A first valve of each pair is connected to the cold water conduit and a second valve of each pair is connected to the hot water conduit. The first and second valves are connected by a drive shaft that rotates the first and second valve simultaneously. A cross gear is operably connected to both the first valve and the second valve such that rotation of the cross gear actuates both the first valve and the second valve. An actuator selectively rotates the cross gear. A controller is provided for controlling the actuator.

[0009] Yet another inventive aspect of the disclosure is an automated dual valve manifold system comprising a hot water supply conduit connected to a hot water source, a hot water return conduit connected to the hot water source, a cold water supply conduit connected to a cold water source, and a cold water return conduit connected to the cold water source. The system has a manifold including a first group of paired valves and a second group of paired valves, wherein each pair of valves comprises a first valve and a second valve that are interconnected by a drive shaft that rotates the first and second valve simultaneously. Each first valve of the first group is connected to the hot water supply conduit. Each second valve of the first group is connected to the hot water return conduit. Each first valve of the second group is connected to the cold water supply conduit. Each second valve of the second group is connected to the cold water return conduit. A cross gear is connected to the first valve such that rotation of the cross gear actuates both the first valve and the second valve. An actuator selectively rotates the cross gear and is controlled by a controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] These and other features of the disclosure will become more apparent from the description in which reference is made to the following appended drawings.

[0011] Figure 1 is an exploded view of a manifold having single valves.

[0012] Figure 2 is a side cutaway view of the manifold of Figure 1 showing the actuator and controller.

[0013] Figure 3 is an isometric view of a dual valve manifold in accordance with an embodiment of the present invention.

[0014] Figure 4 is an isometric view of a dual valve manifold in accordance with another embodiment of the present invention.

[0015] Figure 5 is an exploded view of a dual valve assembly used in the dual valve manifolds of Figures 3 and 4.

DETAILED DESCRIPTION OF EMBODIMENTS

[0016] The following detailed description contains, for the purposes of explanation, specific embodiments, implementations, examples and details in order to provide a thorough understanding of the invention. It is apparent, however, that the embodiments may be practiced without these specific details or with an equivalent arrangement. In other instances, some well-known structures and devices are shown in block diagram form in order to avoid unnecessarily obscuring the embodiments of the invention. The description should in no way be limited to the illustrative implementations, drawings, and techniques illustrated below, including the exemplary designs and implementations illustrated and described herein, but may be modified within the scope of the appended claims along with their full scope of equivalents.

[0017] Exemplary embodiments of the automated dual valve manifold are depicted in the figures. It should be understood that these exemplary embodiments represent only some ways of implementing this invention. In other words, many variations, modifications and refinements may be made to the mechanisms presented herein without departing from the fundamental inventive concept(s).

[0018] To understand the construction and operation of the automated dual valve manifold, it is helpful to first refer to a simpler single-valve manifold such as the one illustrated in Figure 1 and disclosed by Applicant in PCT Publication WO 2018/141042. The single-valve manifold of Figure 1 generally designated by reference numeral 10 has a frame 12 (e.g. a channel-shaped member as shown by way of example in Figure 1 or any equivalent bracket, base or support) and a generally U-shaped manifold housing 14 (or cover or case). A pair of side panels 16 enclose the manifold on each side (although only one such panel 16 is shown in Figure 1). The side panel 16 has a mount 18 for supporting a drive screw 20 and a splined rotatable shaft 22. The drive screw and splined rotatable shaft are parallel to each other. The drive screw displaces a slider 30 whereas the splined rotatable shaft acts as a linear guide for the slider. As will be described below in greater detail, the splined rotatable shaft 22 also functions to rotate an actuator within the slider to actuate a desired valve, i.e. to open or close a desired valve.

[0019] As shown in Figure 1, the slider 30 (which carries the actuator) is displaced along the screw drive 20. The screw drive 20 comprises an elongated screw-type drive shaft in the form of a threaded rod or threaded shaft. The actuator, which is carried by the slider 30, is shaped to engage a cross gear 40 connected to a respective valve 50. Rotation of the cross gear causes rotation of the valve to which it is connected. As the slider 30 is advanced by the screw drive 20, the actuator selectively protrudes to engage and rotate the cross gear by an angle of ninety degrees (i.e. one quarter turn). This quarter-turn rotation causes the quarter-turn valve 50 to open (if it was closed) or to close (if it was open). Once the cross gear has been rotated one quarter turn the actuator is disengaged from the cross gear. The screw drive 20 can be then actuated to move the slider (and its actuator) to another valve for opening or closing as desired. The slider 30 can thus be displaced to any desired one of the inline valves 50 by the screw drive 20. Once the screw drive 20 has positioned the slider 30 in the desired position, the actuator in the slider 30 actuates/engages the gear cross connected to the valve to open or close the valve.

[0020] In the embodiment shown in Figure 1, the manifold 10 includes a plurality of valves 50 and a plurality of respective cross gears 40. The valves 50 are quarter-turn plug valves or alternatively quarter-turn ball valves. These valves can be opened or closed by a ninety-degree rotation of the plug or ball inside the valve. In the illustrated embodiment, the valves 50 are arranged in an inline arrangement, i.e. side by side and equally spaced apart. Although there are

four outlets (and four valves) in the manifold depicted by way of example in Figure 1, the number of valves 50 in the manifold 10 and/or their relative spacing may be varied in other embodiments.

[0021] As shown in Figure 1, a water supply tube 60 is in orthogonal fluid communication with the valves 50. Water from the water supply tube 60 enters an inlet 52 of the valve 50 and, if the valve is open, flows out of the valve through an outlet 54. Each of the valves 50 can be opened or closed independently. The manifold 10, when used in a hydronic heating or cooling system, can thus control the flow of water to any one or more of the zones of the dwelling or building in which the hydronic system is installed. In other words, the water supply tube 60 receives a heating liquid for a hydronic heating system (or a cooling liquid for a hydronic cooling system) from an upstream source that is not shown in the figures. The tube 60 may be copper tubing with a flat upper surface or any equivalent tube, pipe or conduit.

[0022] In the embodiment depicted in Figure 1, the manifold housing 14 has a channel-like portion adapted to receive and retain a circuit board, e.g. a printed circuit board (PCB) on which various electronic sensors may be disposed. The PCB may include slider positioning sensors to sense a position of the slider. The PCB may include cross gear positioning sensors that sense the position (or angular orientation) of the cross gears (indicative of whether the valves are open or closed).

[0023] The manifold may be assembled with the outlets 54 facing upwardly, as depicted in Figure 2, or with the outlets 54 facing downwardly. Figure 2 also depicts an example of an external controller 19 (which may be a microcontroller, microprocessor, printed circuit board, etc). The controller 19 can interact wirelessly (or via wired connection) with the manifold to open and close the valves. The controller may be programmed to operate the actuator in response to one or more signals from one or more thermostats disposed in various rooms or zones of a building or dwelling.

[0024] As shown by way of example in Figure 2, the cross gear 40 attached to each respective valve has four semicircular receptacles or semicircular recesses 42 (or arc-shaped zones) for receiving the round tip of the actuator carried by the slider. On each side of the receptacles 42 are concave surfaces 46 that terminate in one of four pointed tips 44. This construction ensures that the actuator cannot get stuck on the cross gear. In other words, regardless where the actuator engages along the surface of the cross gear, the actuator will be forced into proper engagement

with one of the four receptacles 42. Because the valves in the manifold are in a linear arrangement, the actuator can be moved to access any desired valve by simply translating the slider back and forth using the screw drive. Since the valves are quarter-turn valves, it does not matter whether the actuator engages from the left or from the right to either open or close any given valve. In the embodiment depicted by way of example in Figure 2, a first electric motor 15 drives the screw drive 20. A second electric motor 17 drives the splined rotatable shaft 22 to rotate the actuator.

[0025] Figure 2 also shows a sensor 70 which is communicatively connected (e.g. wirelessly or by wire) to the controller 19. The sensor (or alternatively a group of sensors) can provide a signal (or signals) to the controller to enable the controller to open and close the valves selectively in order to intelligently manage the flow of liquid in the manifold.

[0026] In one embodiment, the sensor may be a motion sensor for detecting a user. The motion sensor is configured to transmit a signal to the controller to control the first and second valves in response to the signal. The motion sensor may be a passive infrared sensor, an ultrasonic sensor, a microwave sensor or any other type of motion detector. For example, the motion sensor can detect the presence of a user in a room or zone, e.g. in a hotel room, condo, office, house, building, etc. and then turn on the water supply to that room or zone when occupied. When the user vacates the premises (room or zone) the motion sensor can send a signal to the controller to shut off the supply of water to the room or zone. The valves can be configured to be normally closed or normally open, depending the design requirements.

[0027] In another embodiment, the sensor may be a moisture sensor for detecting moisture, wherein the moisture sensor is configured to transmit a signal to the controller to control the first and second valves in response to the signal. For example, the moisture sensor can detect a leak to enable the controller to shut off a water supply, which is particularly useful in vacant houses or buildings where a leak could otherwise go undetected for a long time and lead to water damage.

[0028] In yet another embodiment, the controller can be configured to receive an activation signal from an appliance to open the first and second valves to supply water to the appliance. Similarly, the controller can receive a shutoff signal from an appliance when it is finished. The controller may receive a signal from any water-using appliance such as a dishwasher, washing machine, refrigerator with an ice maker, coffeemaker with a water supply line, etc.

[0029] Figure 3 illustrates an automated dual valve manifold system 100 in accordance with an embodiment of the present invention. The system 100 comprises a manifold 102 having a first conduit 110 and a second conduit 120, a first valve 130 having a first inlet 132 connected to the first conduit, a first outlet 134 and a first passageway between the first inlet and the first outlet. The system further comprises a second valve 140 having a second inlet (not visible in this figure) connected to the second conduit, a second outlet 144 and a second passageway between the second inlet and the second outlet. A cross gear 150 is operably connected to both the first valve and the second valve such that rotation of the cross gear actuates both the first valve and the second valve. An actuator (such as the one shown in Figures 1 and 2) can be used to selectively rotate the cross gear. A controller (such as the one shown in Figure 2) is provided for controlling the actuator. The controller may be a microcontroller (e.g. an integrated circuit on a chip), a microprocessor, a computer, a field-programmable gate array (FPGA), etc. The controller may receive a signal from a sensor such as a motion sensor, a moisture sensor or other type of sensor such as a temperature sensor, force/load/pressure transducer, etc.

[0030] In the embodiment depicted by way of example in Figure 3, the automated dual valve manifold system 100 may comprise a cold water conduit (e.g. as the first conduit) and a hot water conduit (e.g. as the second conduit), or vice versa. In the system depicted in Figure 3, the valves are aligned as pairs of mechanically connected valves. In one embodiment, a first valve of each pair is connected to the cold water conduit and a second valve of each pair is connected to the hot water conduit (or vice versa). The first and second valves are connected by a drive shaft that rotates the first and second valve simultaneously (thus providing the mechanical interconnection between the valves of a given valve pair). As noted above, the cross gear operably connects both the first valve and the second valve such that rotation of the cross gear actuates both the first valve and the second valve. In one embodiment, the valves are quarter-turn valves although it will be appreciated that other suitable types of valves may be used. As noted above, the controller controls movement of the actuator which selectively engages and rotates the cross gear. In the example depicted in Figure 3, there are six pairs of valves arranged in two rows although it will be appreciated that the number of pairs of valves may be varied. For example, and solely as an illustration of how useful this manifold is, the first pair of valves may deliver hot and cold water to a first bathroom, the second pair of valves may deliver hot and cold water to a second bathroom, and the third pair of valves may deliver hot and cold water to a kitchen. In some cases, one of the

valves may be capped if only hot or cold water is needed. In this particular example, the first valve of the fourth pair of valves is capped whereas the second valve is connected to a tube or pipe to deliver hot water to a dishwater. In the example of Figure 3, the fifth pair of valves delivers hot and cold water to a clothes washer (washing machine). In the example of Figure 3, the sixth pair of valves delivers hot and cold water to faucets of a laundry sink. The specific examples are merely meant to illustrate how the manifold system can be used. It will be appreciated that the manifold can have a different number of valves and can be connected to any suitable plumbing (tubes or pipes) for delivering water in a house, apartment, condo, office, school, or any other building. By opening and closing each pair of valves, the controller can control the flow of hot and cold water to each of the various zones or plumbing fixtures. The manifold may be used to supply water to a radiator, fan coil unit, or hydronic heating system.

[0031] Figure 4 illustrates an automated dual valve manifold system 200 in accordance with another embodiment of the present invention. The automated dual valve manifold system 200 includes, or cooperates with, a hot water source 210 (e.g. boiler or heat pump) and a cold water source 220 (e.g. a chiller or heat pump). The dual valve manifold system 200 comprises a hot water supply conduit 212 connected to the hot water source 210 and a hot water return conduit 214 connected to the hot water source 210. The dual valve manifold system 200 includes a cold water supply conduit 222 connected to the cold water source 220 and a cold water return conduit 224 connected to the cold water source 220. The system 200 has a manifold divided into a first group 230 of paired valves and a second group 240 of paired valves. In this example, the first group has three pairs of valves and the second group also has three pairs of valves, although in other variants there may be a different number of pairs of valves. Each pair of valves comprises a first valve 250 and a second valve 260 that are interconnected by a drive shaft that rotates the first and second valve simultaneously. In the embodiment illustrated in Figure 4, each first valve 250 of the first group 230 is connected to the hot water supply conduit 212. Each second valve 260 of the first group 230 is connected to the hot water return conduit 214. Each first valve 250 of the second group 240 is connected to the cold water supply conduit 222. Each second valve 240 of the second group 260 is connected to the cold water return conduit 224. A cross gear 270 is connected to the first valve 250 such that rotation of the cross gear 270 concurrently actuates both the first valve 250 and the second valve 260. An actuator (not shown in this figure) selectively rotates the cross gear of the valve pair that is selected by the controller.

[0032] Figure 5 is an exploded view of a dual valve assembly 300 used in the dual valve manifold systems 100, 200 of Figures 3 and 4. In the embodiment depicted in Figure 5, the valve assembly 300 includes a first valve 350 and a second valve 360 which are mechanically coupled together by a common drive shaft 370. The first and second valves 350, 360 each have respective valve bodies 352, 362. The first valve 350 has a first inlet 354 and a first outlet 356 defining a first fluid passageway through the first valve body 352. The second valve 360 has a second inlet 364 and a second outlet 366 defining a second fluid passageway through the second valve body 362.

[0033] The cross gear 340, which was introduced earlier, is mounted to a respective disk 342. The disk 342 sits between a neck 344 of the valve body 352 and the cross gear 340. In one embodiment, each disk 342 has a pair of magnets to enable a magnetic sensor to sense an orientation of each of the cross gears. The magnets may be attached to two diametrically opposed tips of the cross gear. The magnets are detectable by a magnetic sensor connected to a microcontroller. The microcontroller (or microprocessor) can then determine a position of the cross gear 48 of the valve 50 based on the magnets. Any suitable control system and control algorithm can be adapted to operate this mechanism. The control system may be implemented in hardware, software, firmware or any suitable combination thereof.

[0034] In the embodiment depicted in Figure 5, the first valve 350 comprises a first frusta-conical plug 358 fitted into a plug-receiving space or valve cavity inside the first valve body 352. Likewise, the second valve 360 comprises a second frusta-conical plug 368 fitted into a plug-receiving space or valve cavity inside the second valve body 362.

[0035] As illustrated by way of example in Figure 5, a spring 375 surrounding the drive shaft 370 and compressed between the first and second frusta-conical plugs 358, 368 mechanically biases the frusta-conical plugs outwardly into their respective conically shaped valve cavities. The spring force exerted by the compressed spring 375 secures the cone-shaped plugs inside the valves. When secured in its proper position in the plug-receiving space, the plug provides a fluid-tight seal to minimize leakage. Each plug has a circular bore 359 passing through its frusta-conical body defining a fluid passage.

[0036] In the embodiment depicted by way of example in Figure 5, the first and second valves 350, 360 each further comprises a flange 380, 382 for mounting to a valve-supporting frame 390 and further comprising an O-ring 392, 394 disposed between the flange and the frame.

[0037] In the embodiment shown in Figure 5, the first and second cone-shaped plugs taper in opposite directions, with the first plug tapering outwardly in a direction away from the cross gear. The taper may be a nonlinear taper as shown. In this embodiment using tapered plugs, the angle of the taper is 10-25 degrees, preferably 17-18 degrees and more preferably 17.5 degrees. The plug may be made of Teflon®, i.e. polytetrafluoroethylene (PTFE), or any other equivalent or suitable material. The valve body may be made of high-temperature nylon or any other equivalent or suitable material, optionally with a solid film lubricant such as, for example, a Teflon film or any other suitable dry film lubricant.

[0038] With this novel dual valve manifold for heating and cooling with a hot water source and a cold water source, the manifold can totally isolate the supply/return side of both valves allowing heating and cooling simultaneously controlled from the same manifold. Shutting off both the supply and return ensures that hot and cold water do not mix. For example, zone 1 could be cold water to a fan coil unit whereas zones 2 and 3 could be hot water to a fan coil unit or any other combination.

[0039] It should be understood that the manifold depicted in the figures is presented by way of example only. This particular design of the manifold is believed to be the best mode of implementing the present invention but it should be appreciated that many variations in the mechanism(s) may be made without departing from the inventive concept(s) presented herein.

[0040] It is to be understood that the singular forms “a”, “an” and “the” include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to “a device” includes reference to one or more of such devices, i.e. that there is at least one device. The terms “comprising”, “having”, “including” and “containing” are to be construed as open-ended terms (i.e., meaning “including, but not limited to,”) unless otherwise noted. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of examples or exemplary language (e.g. “such as”) is intended merely to better illustrate or describe embodiments of the invention and is not intended

to limit the scope of the invention unless otherwise claimed.

[0041] While several embodiments have been provided in the present disclosure, it should be understood that the disclosed systems and methods might be embodied in many other specific forms without departing from the scope of the present disclosure. The present examples are to be considered as illustrative and not restrictive, and the intention is not to be limited to the details given herein. For example, the various elements or components may be combined or integrated in another system or certain features may be omitted, or not implemented.

[0042] In addition, techniques, systems, subsystems, and methods described and illustrated in the various embodiments as discrete or separate may be combined or integrated with other systems, modules, techniques, or methods without departing from the scope of the present disclosure. Other items shown or discussed as coupled or directly coupled or communicating with each other may be indirectly coupled or communicating through some interface, device, or intermediate component whether electrically, mechanically, or otherwise. Other examples of changes, substitutions, and alterations are ascertainable by one skilled in the art and could be made without departing from the inventive concept(s) disclosed herein.

CLAIMS

1. An automated dual valve manifold system comprising:

a manifold having a first conduit and a second conduit;

a first valve having a first inlet connected to the first conduit, a first outlet and a first passageway between the first inlet and the first outlet;

a second valve having a second inlet connected to the second conduit, a second outlet and a second passageway between the second inlet and the second outlet;

a cross gear operably connected to both the first valve and the second valve such that rotation of the cross gear actuates both the first valve and the second valve;

an actuator for selectively rotating the cross gear; and

a controller for controlling the actuator.

2. The system of claim 1 further comprising a motion sensor for detecting a user, wherein the motion sensor transmits a signal to the controller to control the first and second valves in response to the signal.

3. The system of claim 1 further comprising a moisture sensor for detecting moisture, wherein the moisture sensor transmits a signal to the controller to control the first and second valves in response to the signal.

4. The system of claim 1 wherein the controller receives an activation signal from an appliance to open the first and second valves to supply water to the appliance.

5. The system of any one of claims 1 to 4 wherein the first conduit carries cold water whereas the second conduit carries hot water.

6. The system of claim 5 wherein the manifold comprises multiple pairs of valves, each pair of valves controlling a flow of hot and cold water to different zones.

7. The system of claim 1 wherein the first and second valves are connected to a hydronic radiant heating loop.

8. The system of claim 1 wherein the first and second valves are connected to a radiator.

9. The system of claim 1 wherein the first and second valves are connected to a fan coil unit.

10. The system of claim 1 wherein the controller is connected to a plurality of thermostats.

11. The system of claim 1 wherein the controller has a wireless transceiver for receiving a wireless signal from a wireless communications device.

12. The system of any one of claims 1 to 11 wherein the first valve comprises a first frusta-conical plug and wherein the second valve comprises a second frusta-conical plug.

13. The system of claim 12 wherein the first and second frusta-conical plugs are connected by a drive shaft so as to be simultaneously rotatable.

14. The system of claim 13 further comprising a spring surrounding the drive shaft and compressed between the frusta-conical plugs to mechanically bias the frusta-conical plugs outwardly into their respective conically shaped valve cavities.

15. The system of claim 14 wherein the each of the first and second valves further comprises a flange for mounting to a valve-supporting frame and further comprising an O-ring disposed between the flange and the frame.

16. An automated dual valve manifold system comprising:

a manifold having a cold water conduit and a hot water conduit;

a plurality of pairs of mechanically connected valves, wherein a first valve of each pair is connected to the cold water conduit and a second valve of each pair is connected to the hot water conduit, wherein the first and second valves are connected by a drive shaft that rotates the first and second valve simultaneously;

a cross gear operably connected to both the first valve and the second valve such that rotation of the cross gear actuates both the first valve and the second valve;

an actuator for selectively rotating the cross gear; and

a controller for controlling the actuator.

17. The system of claim 16 further comprising a motion sensor, wherein the motion sensor transmits a signal to the controller to control the first and second valves in response to the signal.

18. The system of claim 16 further comprising a moisture sensor, wherein the moisture sensor transmits a signal to the controller to control the first and second valves in response to the signal.

19. An automated dual valve manifold system comprising:

a hot water supply conduit connected to a hot water source;

a hot water return conduit connected to the hot water source;

a cold water supply conduit connected to a cold water source;

a cold water return conduit connected to the cold water source;

a manifold including a first group of paired valves and a second group of paired valves, wherein each pair of valves comprises a first valve and a second valve that are interconnected by a drive shaft that rotates the first and second valve simultaneously;

wherein each first valve of the first group is connected to the hot water supply conduit;

wherein each second valve of the first group is connected to the hot water return conduit;

wherein each first valve of the second group is connected to the cold water supply conduit; and

wherein each second valve of the second group is connected to the cold water return conduit.

a cross gear connected to the first valve such that rotation of the cross gear actuates both the first valve and the second valve;

an actuator for selectively rotating the cross gear; and

a controller for controlling the actuator.

20. The system of claim 19 wherein the first valve of the first group is fluidly coupled to the second valve of the second group and wherein the first valve of the second group is fluidly coupled to the second valve of the first group.

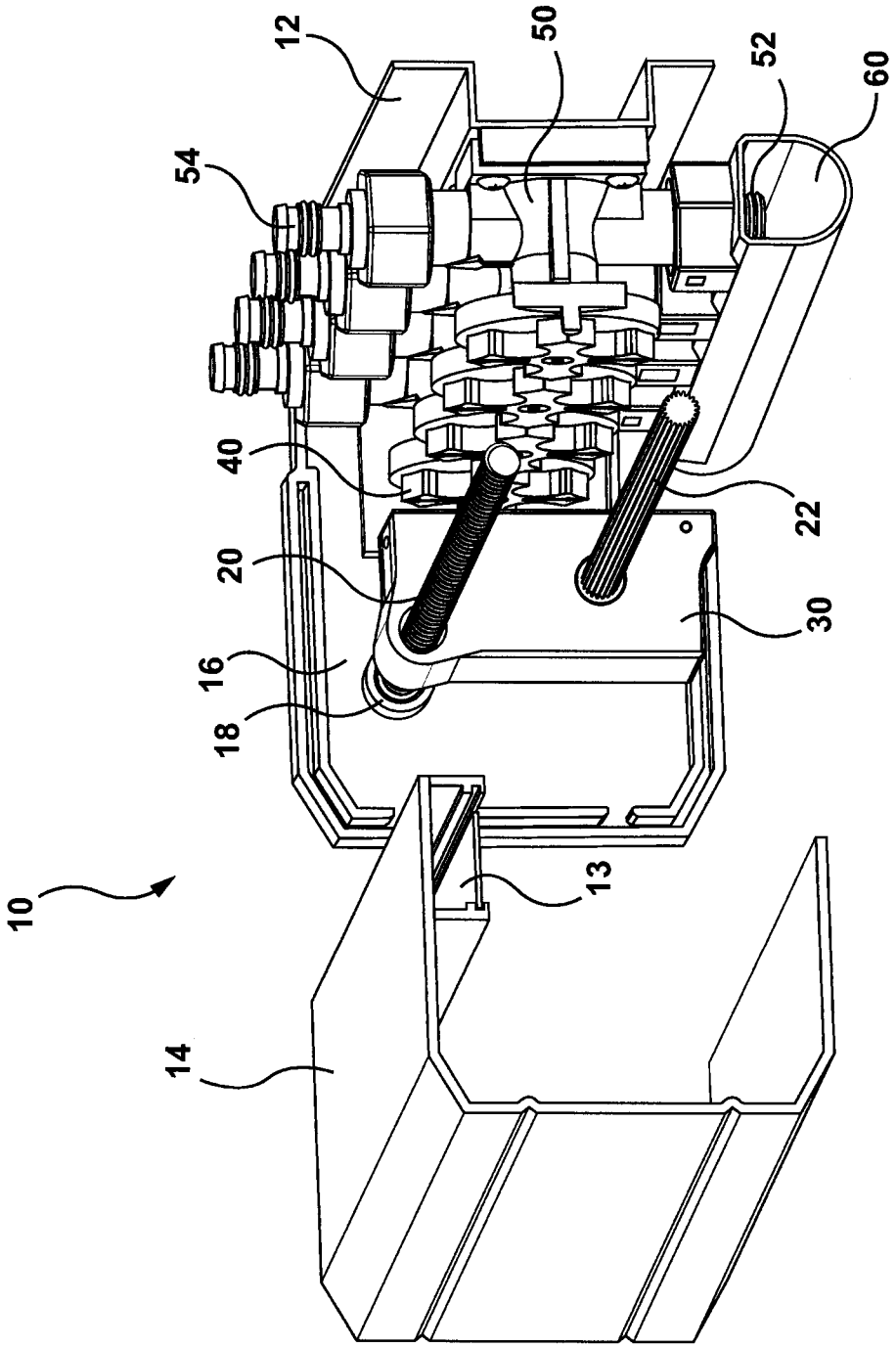


FIG. 1

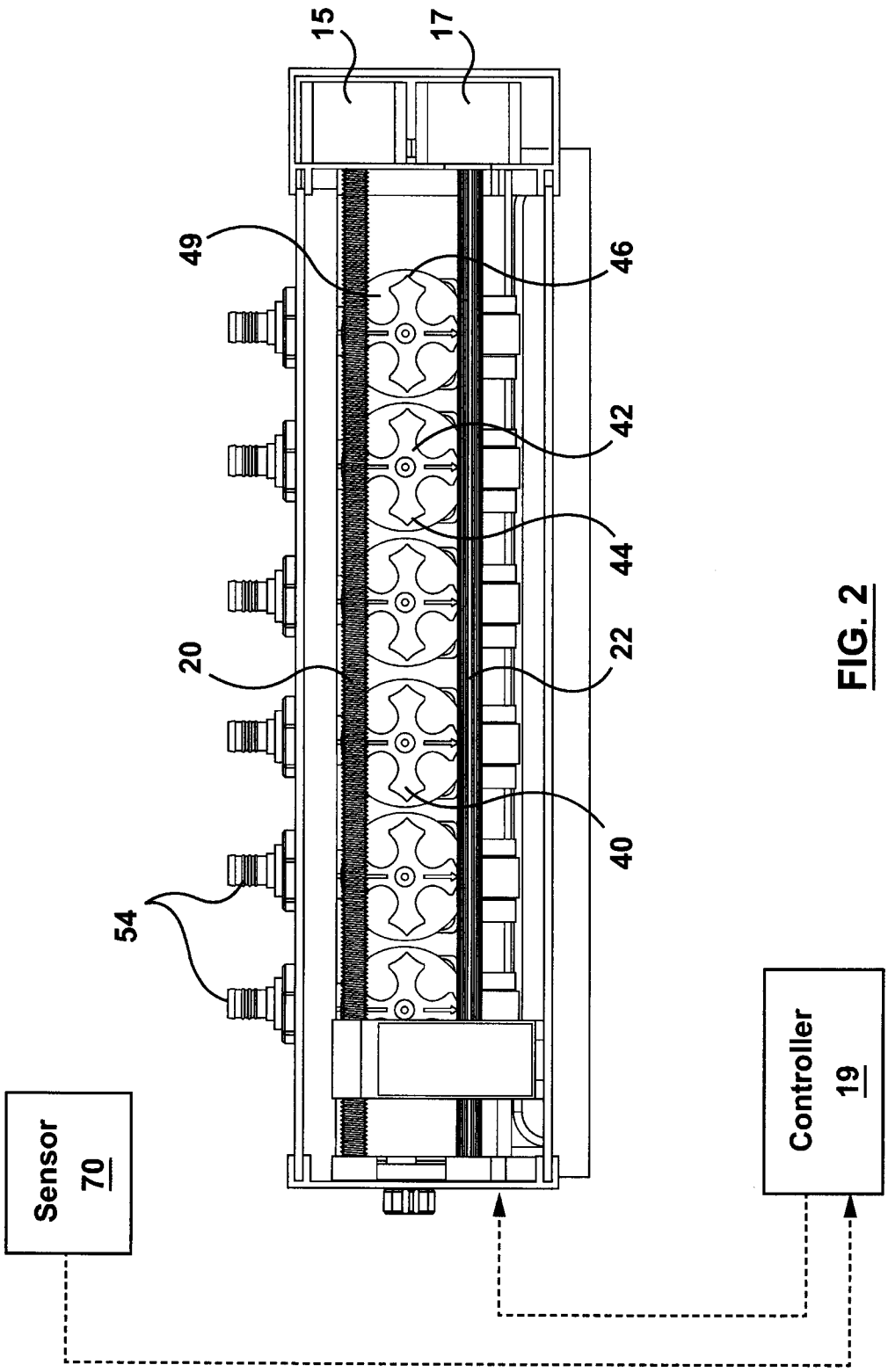


FIG. 2

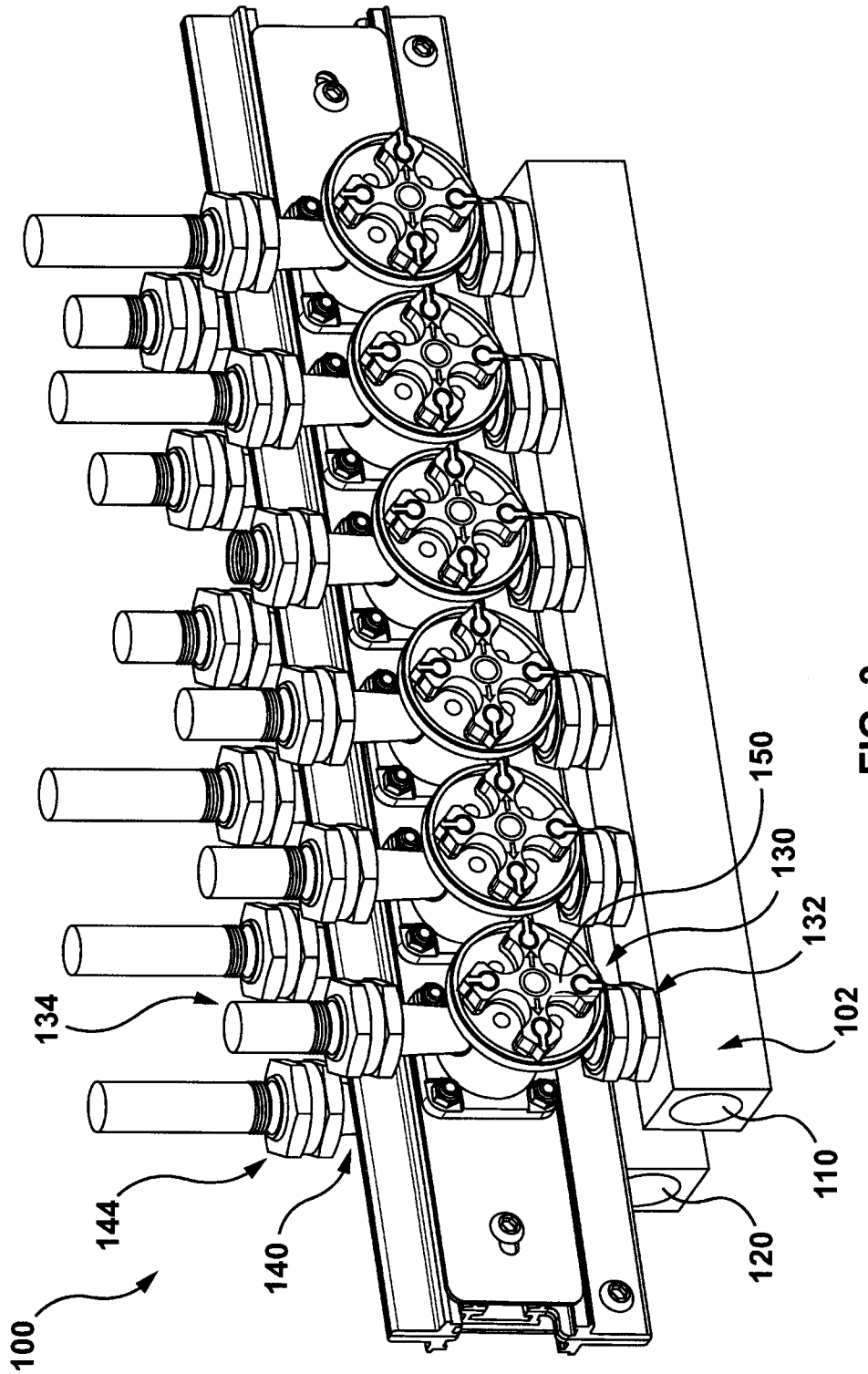


FIG. 3

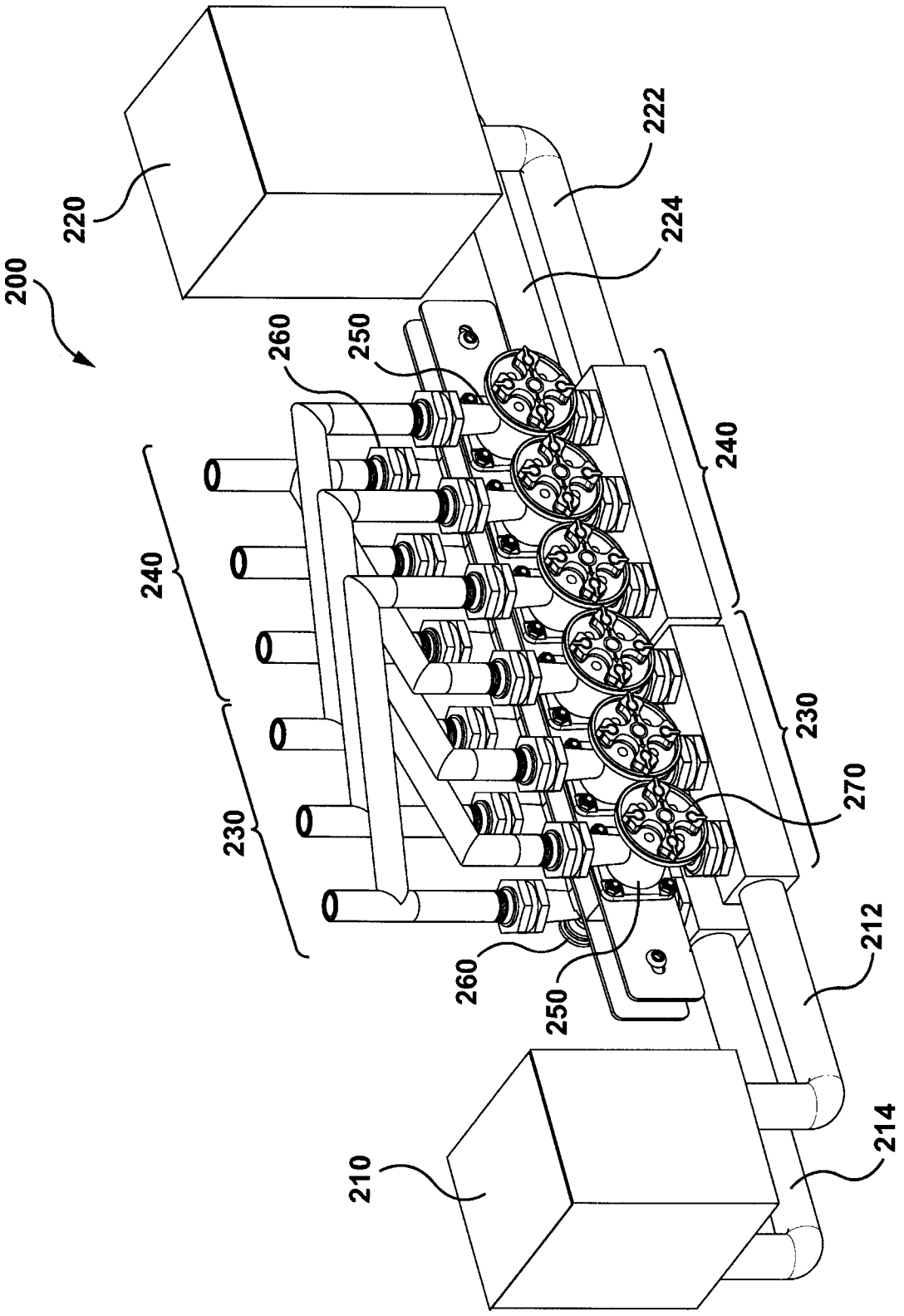


FIG. 4

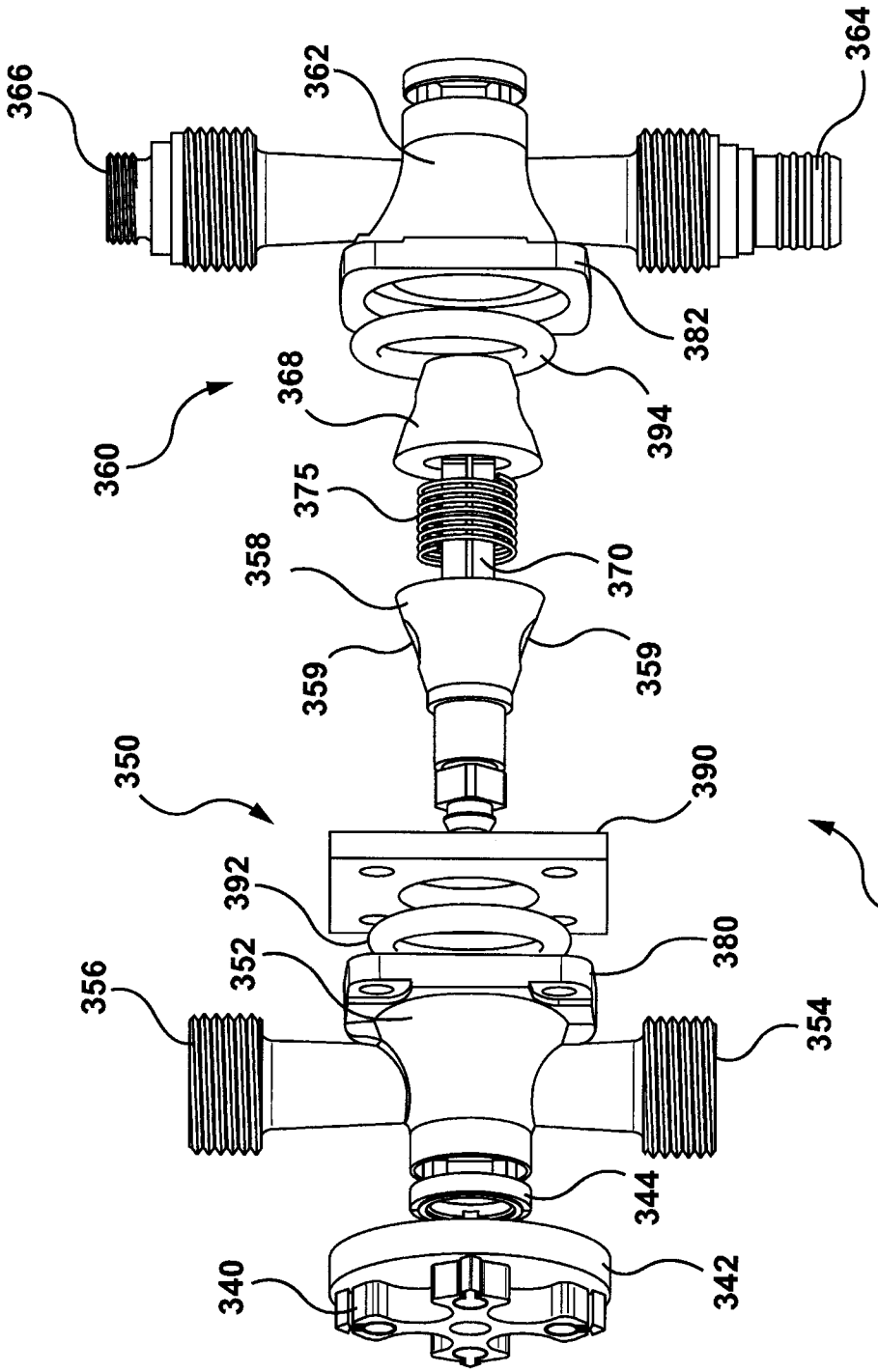

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FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2018/051184

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***F16K 11/083*** (2006.01) , ***E03B 7/07*** (2006.01) , ***E03C 1/044*** (2006.01) , ***F16K 11/22*** (2006.01) , ***F16K 31/02*** (2006.01) , ***F24D 19/10*** (2006.01) , ***F24F 11/89*** (2018.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: ***F16K 11/083*** (2006.01) , ***E03B 7/07*** (2006.01) , ***E03C 1/044*** (2006.01) , ***F16K 11/22*** (2006.01) , ***F16K 31/02*** (2006.01) , ***F24D 19/10*** (2006.01) , ***F24F 11/89*** (2018.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Questel-Orbit (FAMPAT)
Search terms used: manifold, valve, cross gear, actuator, control+, IPCs, inventor's name

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 9 803 876 B2; (MacDUFF et al.); 31 October 2017 (31-10-2017) Column 3, line 8 to column 6, line 19; Figures 1 and 9 to 11	1 - 20
A	US 2018/0239371 A1; (DREES et al.); 23 August 2018 (23-08-2018) Paragraphs [0054] to [0061]; Figure 6	1 - 20
A	WO 2018/141042 A1; (MacDUFF et al.); 09 August 2018 (09-08-2018) Paragraphs [0031] to [0047]; Figure 1	1 - 20
A	US 8,555,926 B2; (MacDUFF et al.); 15 October 2013 (15-10-2013) Figures 1 to 4	1 - 20

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

*	Special categories of cited documents:
"A"	document defining the general state of the art which is not considered to be of particular relevance
"E"	earlier application or patent but published on or after the international filing date
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O"	document referring to an oral disclosure, use, exhibition or other means
"P"	document published prior to the international filing date but later than the priority date claimed
"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&"	document member of the same patent family

Date of the actual completion of the international search
01 May 2019 (01-05-2019)

Date of mailing of the international search report
11 June 2019 (11-06-2019)

Name and mailing address of the ISA/CA
Canadian Intellectual Property Office
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50 Victoria Street
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 9,423,036 B1; (GARM et al.); 23 August 2016 (23-08-2016) Entire document	1 - 20
A	US 2,530,581 A; (MARKIS et al.); 21 November 1950 (21-11-1950) Entire document	1 - 20
A	US 2,030,543 A; (ROSS); 11 February 1936 (11-02-1936) Entire document	1 - 20

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2018/051184

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		US2017321906A1	09 November 2017 (09-11-2017)
		WO2017059517A1	13 April 2017 (13-04-2017)
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		EP3387301A1	17 October 2018 (17-10-2018)
		EP3387301A4	06 March 2019 (06-03-2019)
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US9423036B1	23 August 2016 (23-08-2016)	None	
US2530581A	21 November 1950 (21-11-1950)	None	
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		US2030544A	11 February 1936 (11-02-1936)