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(54) **AUTOMATIC PROXIMITY FAUCET**

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Appl. No.: **11/067,549**
Filed: **Feb. 25, 2005**

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(60) Provisional application No. 60/441,091, filed on Jan. 16, 2003.

(51) **Int. Cl.**
E03C 1/05 (2006.01)

(52) **U.S. Cl.** **4/623**; 251/129.04
(58) **Field of Classification Search** 251/129.04, 251/129.03, 129.11, 30.02; 4/623; 137/801
See application file for complete search history.

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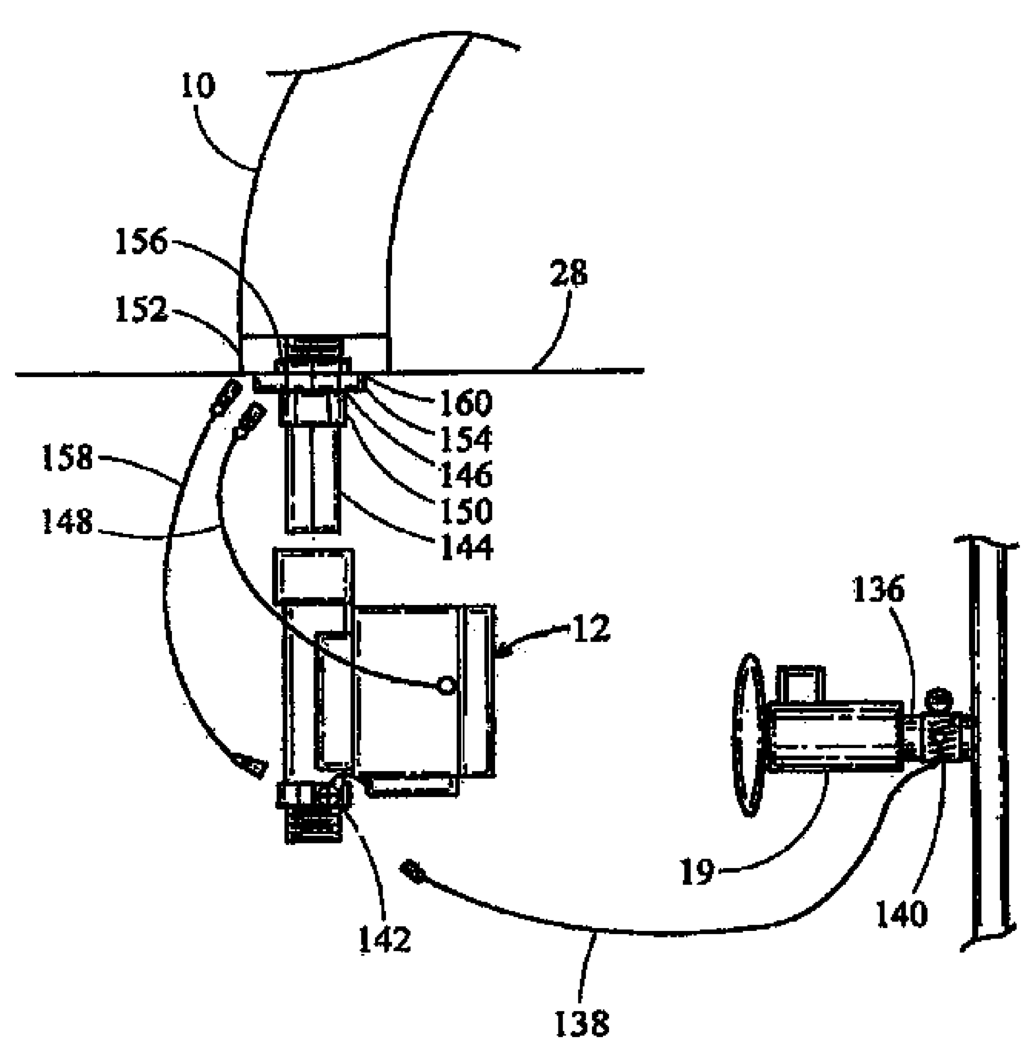
(57) **ABSTRACT**

A hands-free faucet includes a sensing plate, a capacitor-based sensor circuit, a non-conductive valve housing, a non-conductive seating ring, and a conductive connector. Preferably, the capacitor-based sensor circuit is electrically connected to said sensing plate. Furthermore, the non-conductive valve housing preferably further comprises a valve inlet and valve outlet. Preferably, said non-conductive seating ring is located between the valve inlet and valve outlet, and is traversed by the conductive connector. In a preferred embodiment, the conductive connector is a metal pin.

20 Claims, 9 Drawing Sheets



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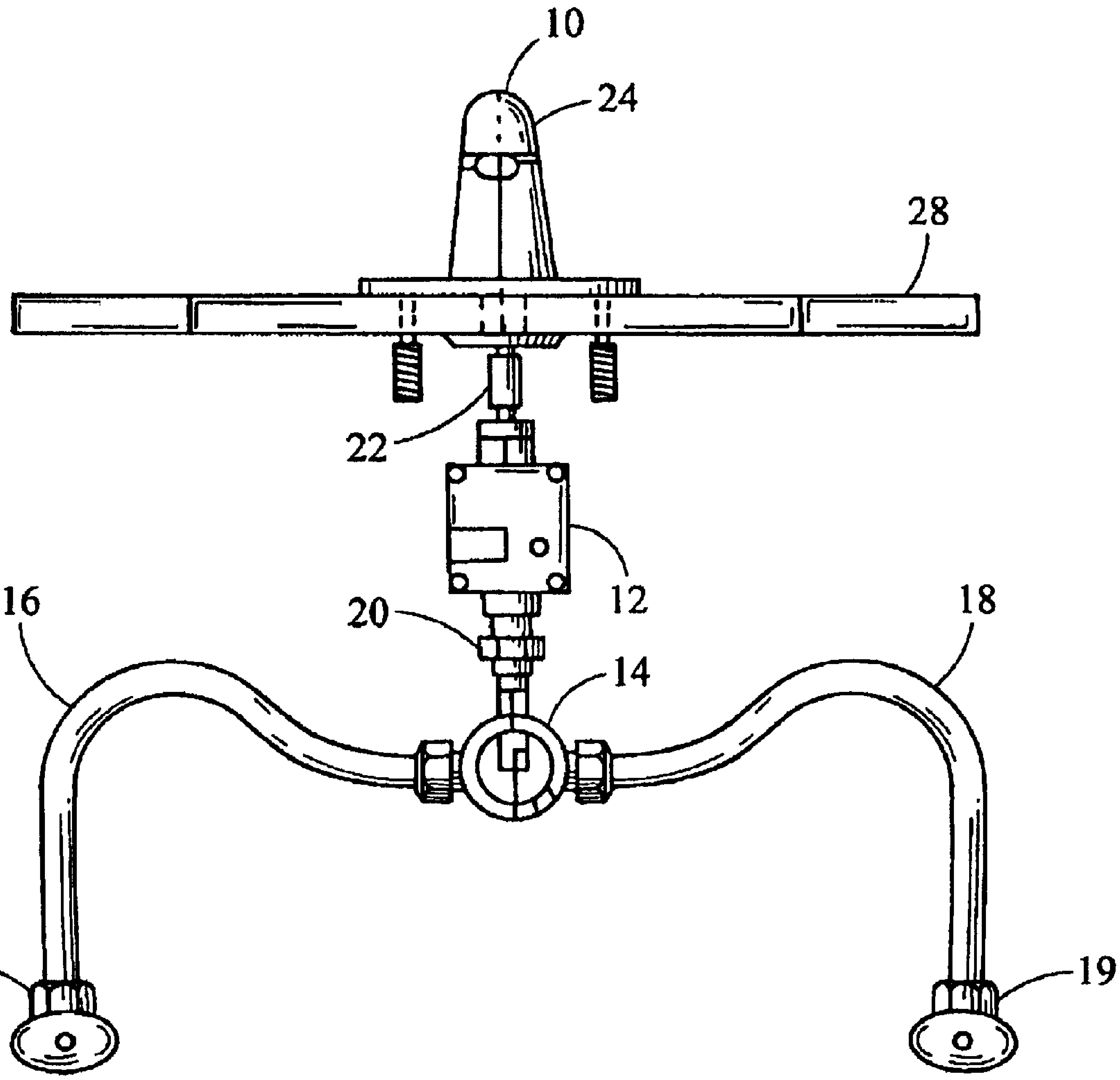

Fig. 1

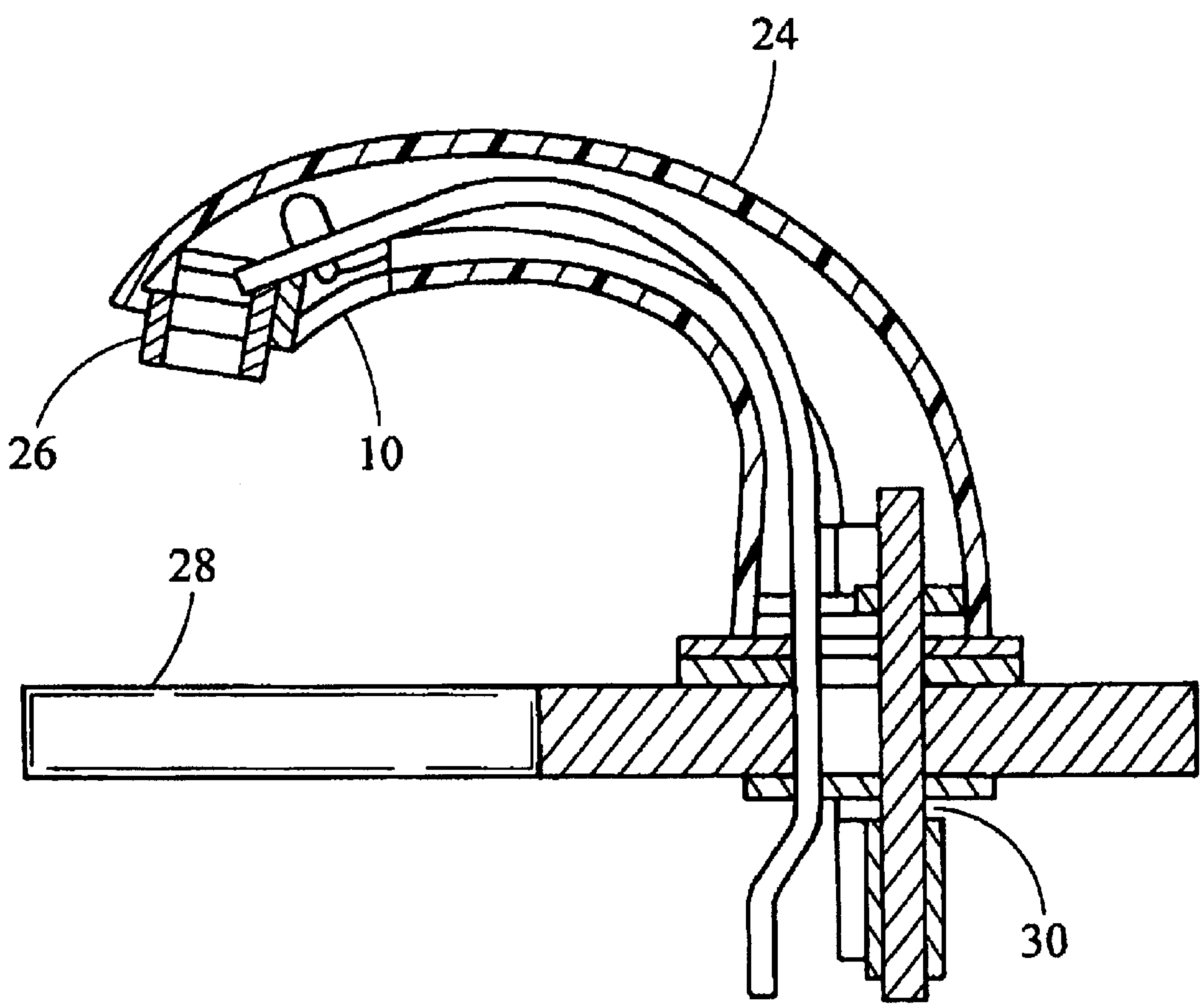

Fig. 2

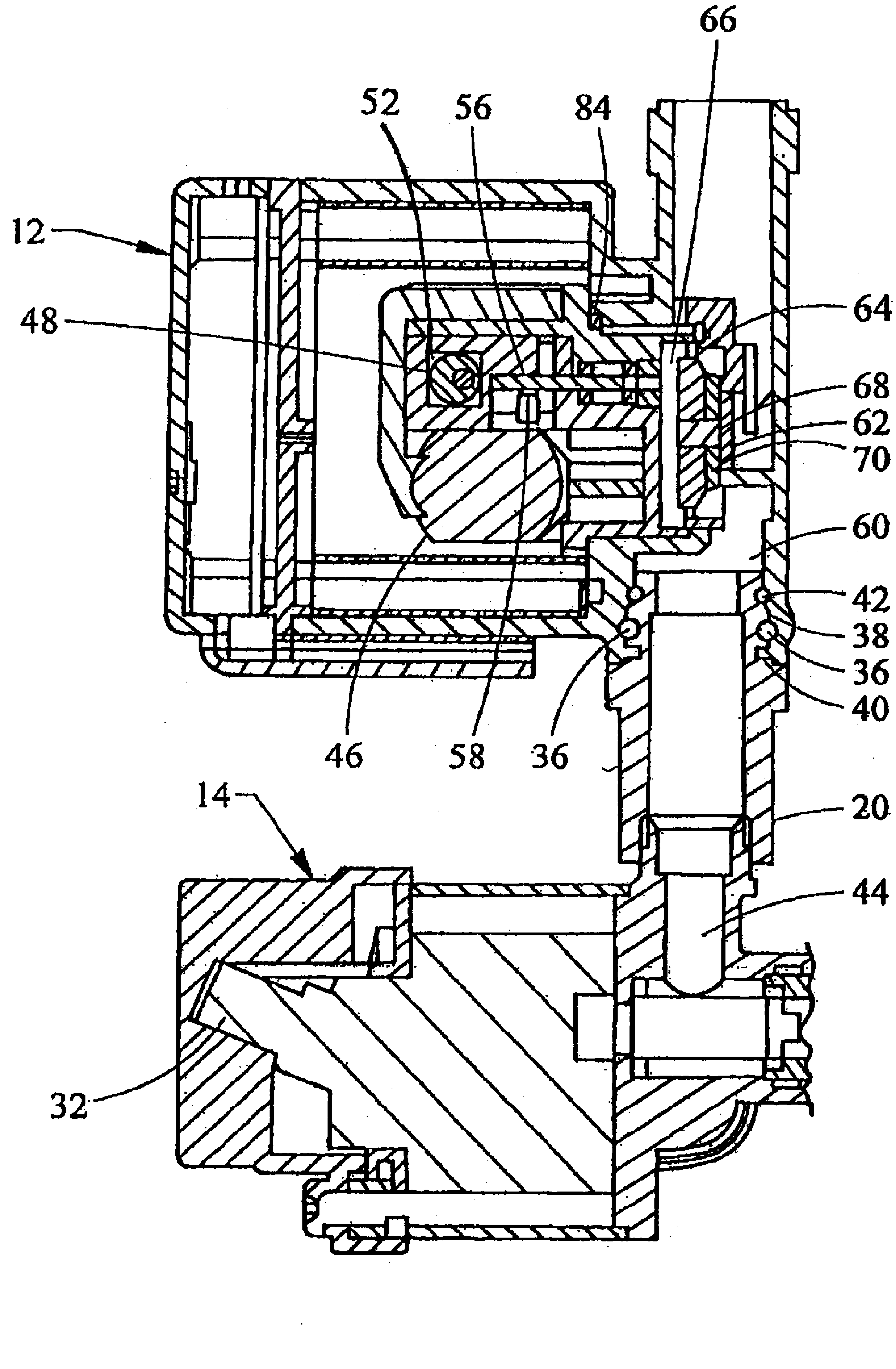

Fig. 3
(AMENDED)

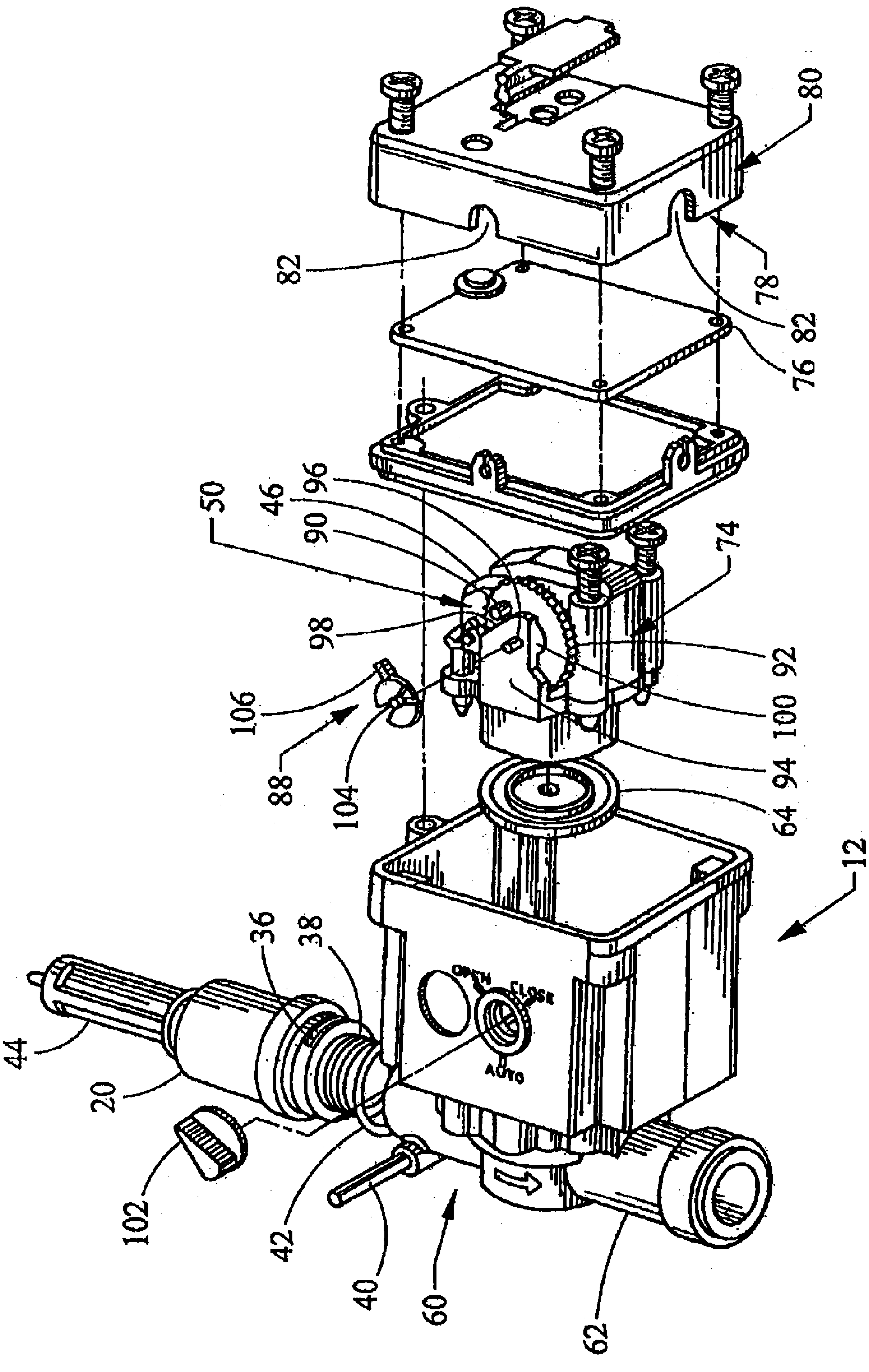

Fig. 4
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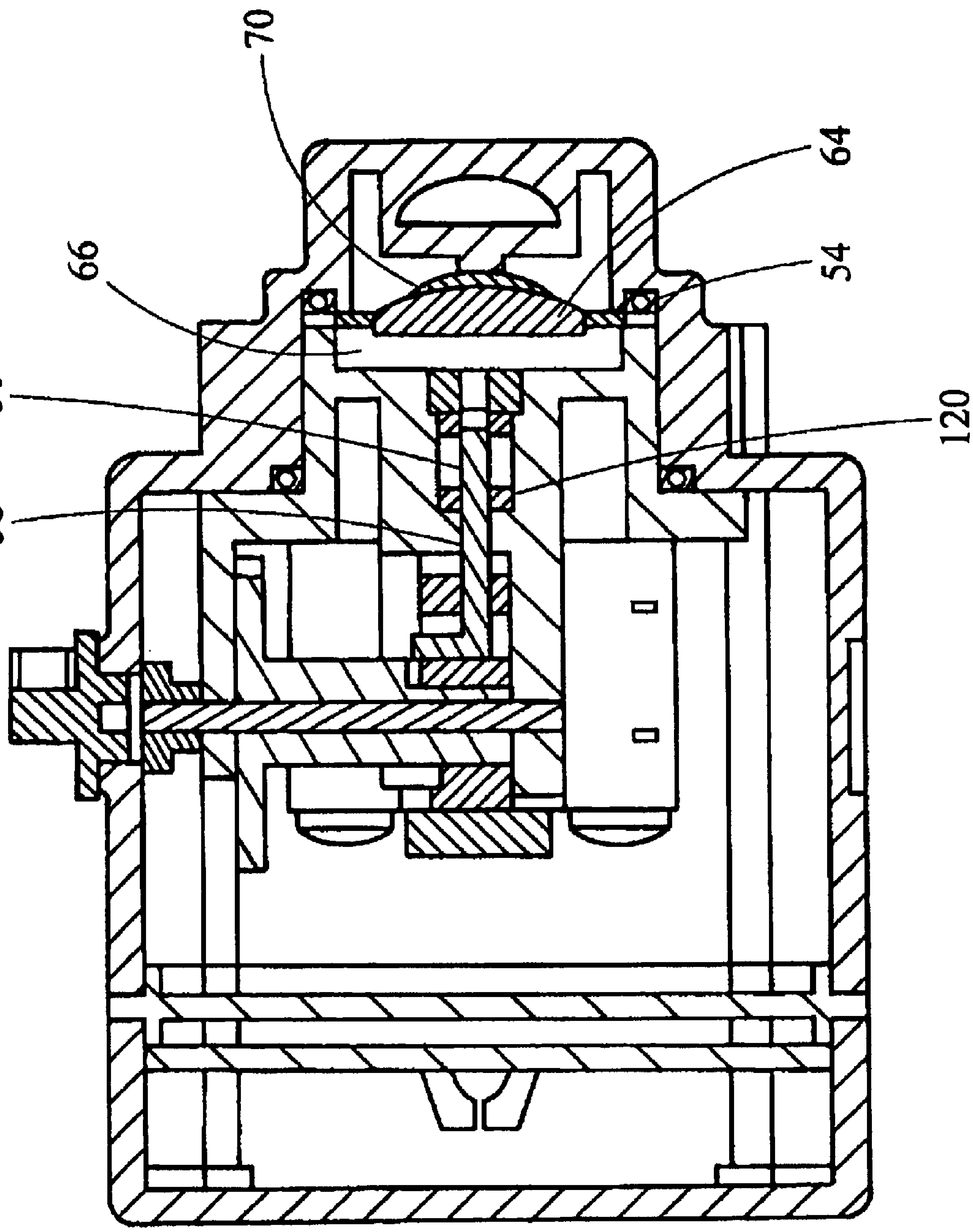

Fig. 5

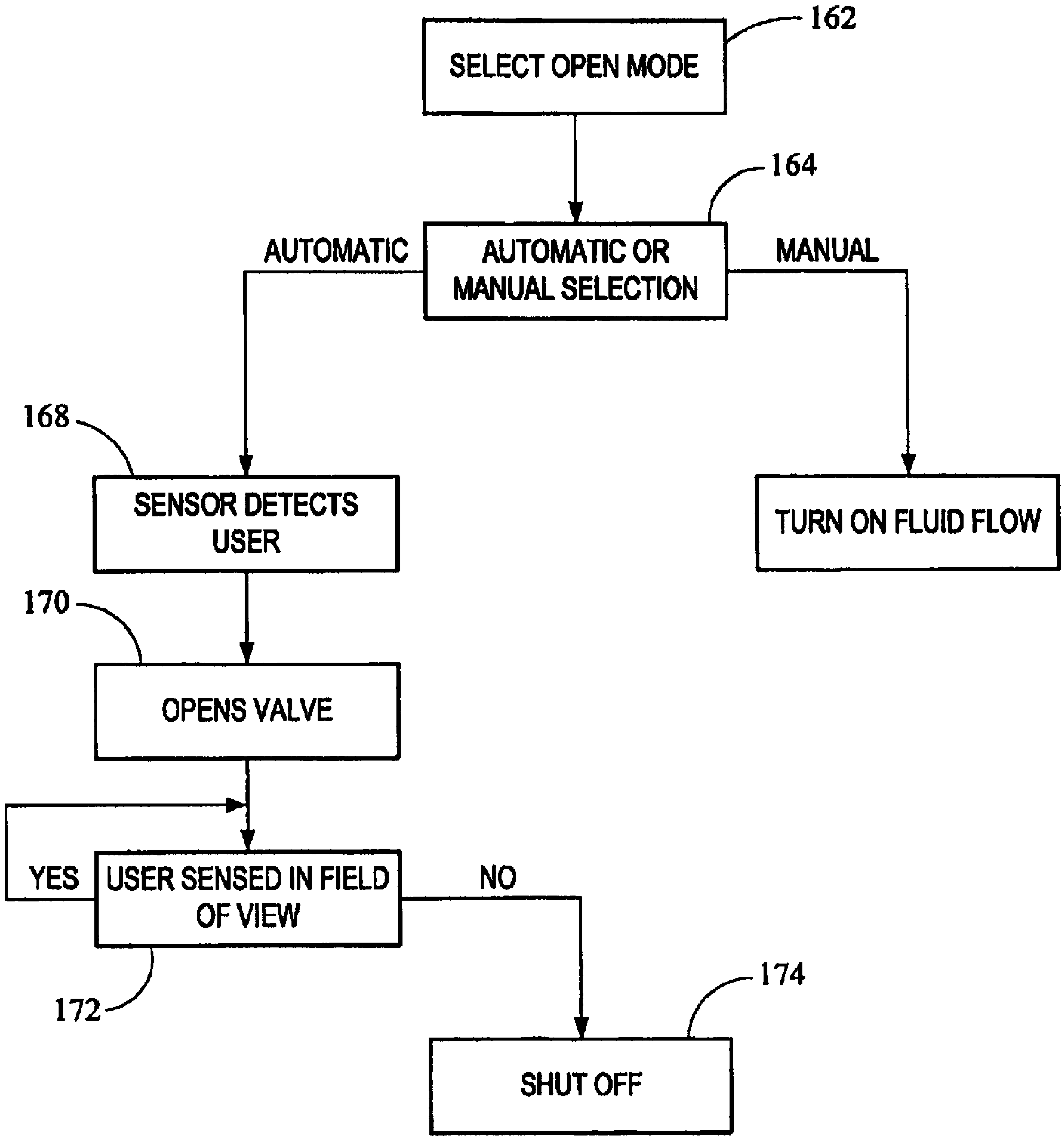
162
SELECT OPEN MODE
164
AUTOMATIC
AUTOMATIC OR MANUAL SELECTION
MANUAL
168
SENSOR DETECTS USER
TURN ON FLUID FLOW
170
OPENS VALVE
YES
USER SENSED IN FIELD OF VIEW
NO
172
174
SHUT OFF

Fig. 6

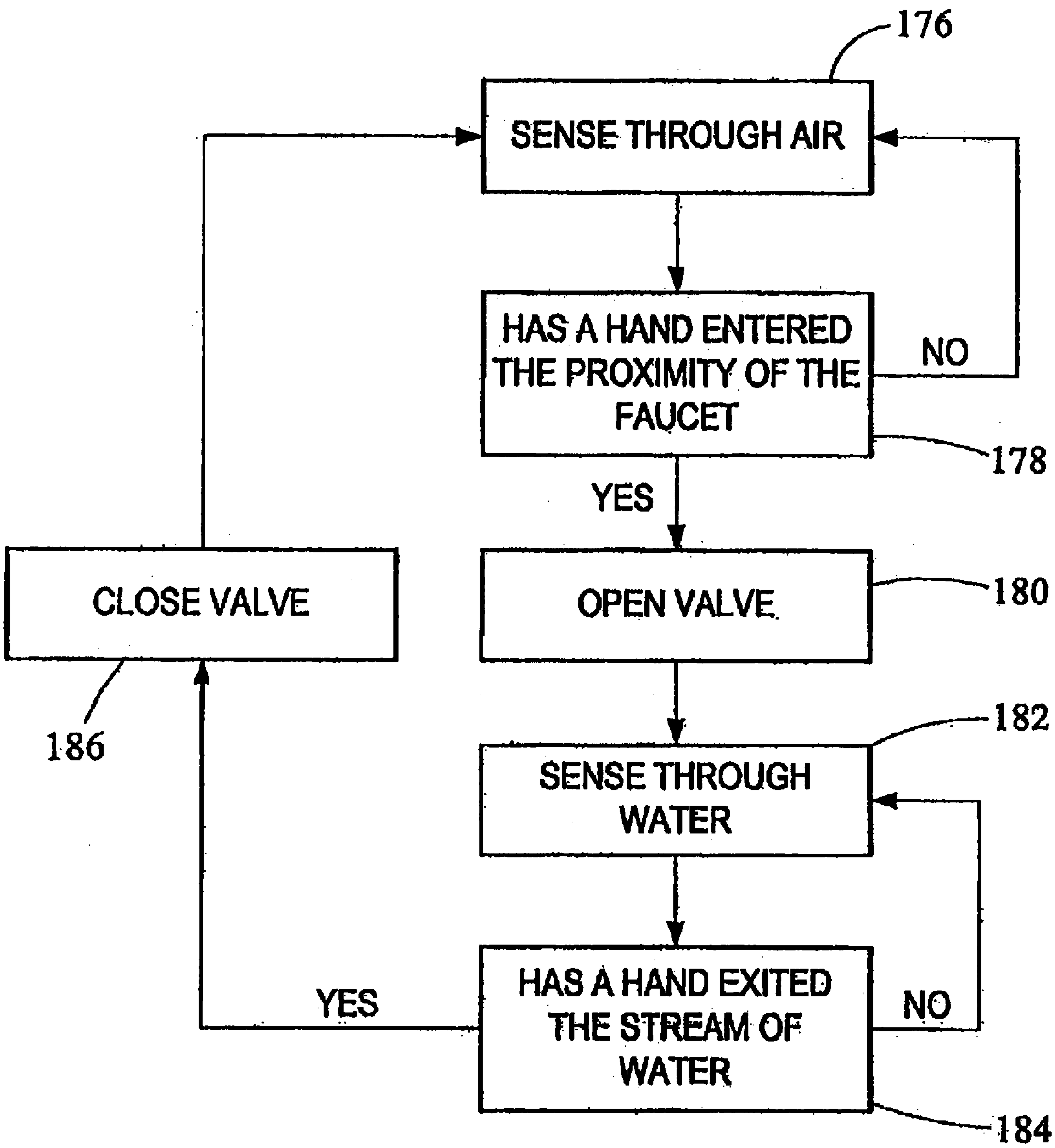

Fig. 7
(AMENDED)

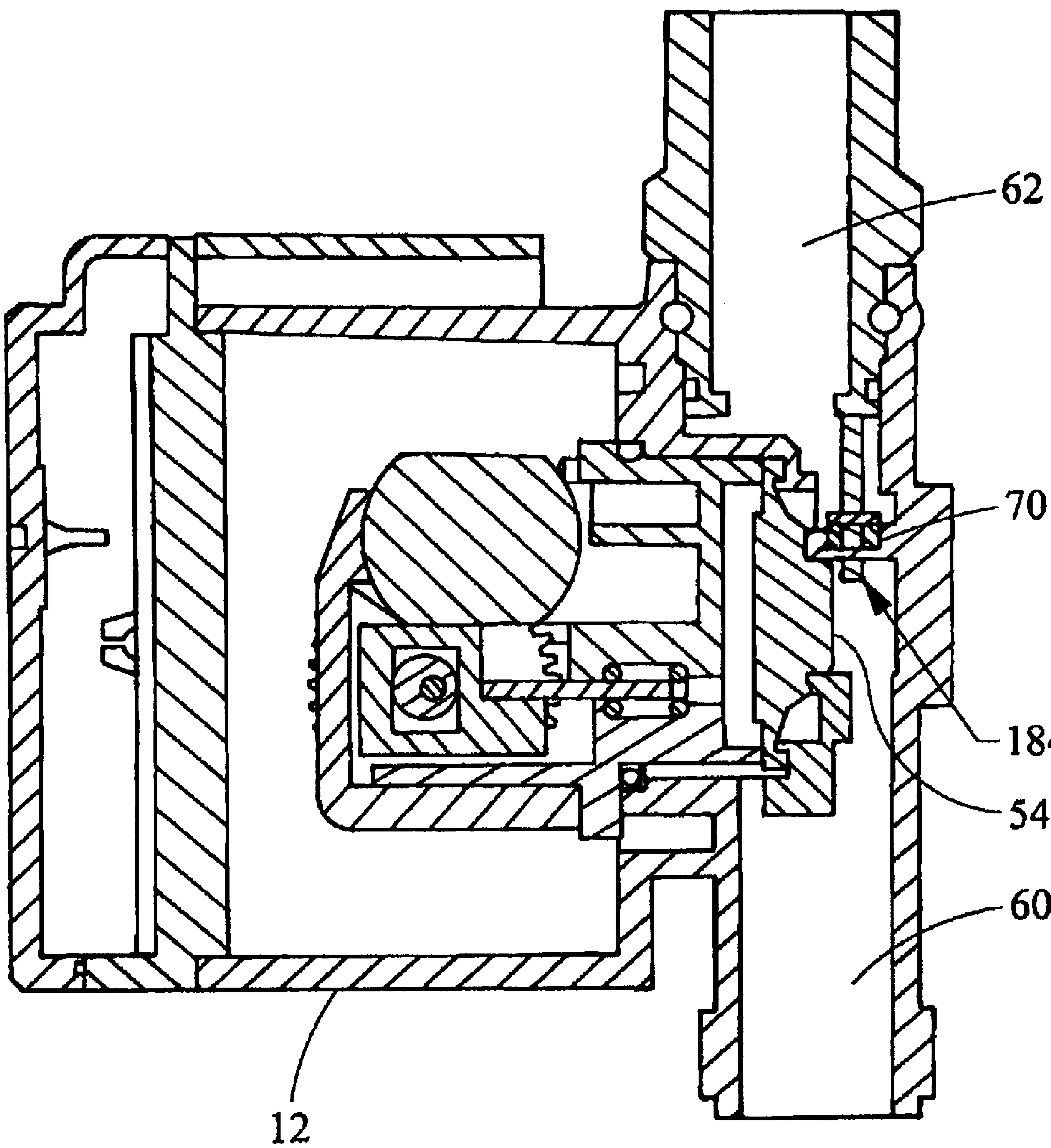

Fig. 8

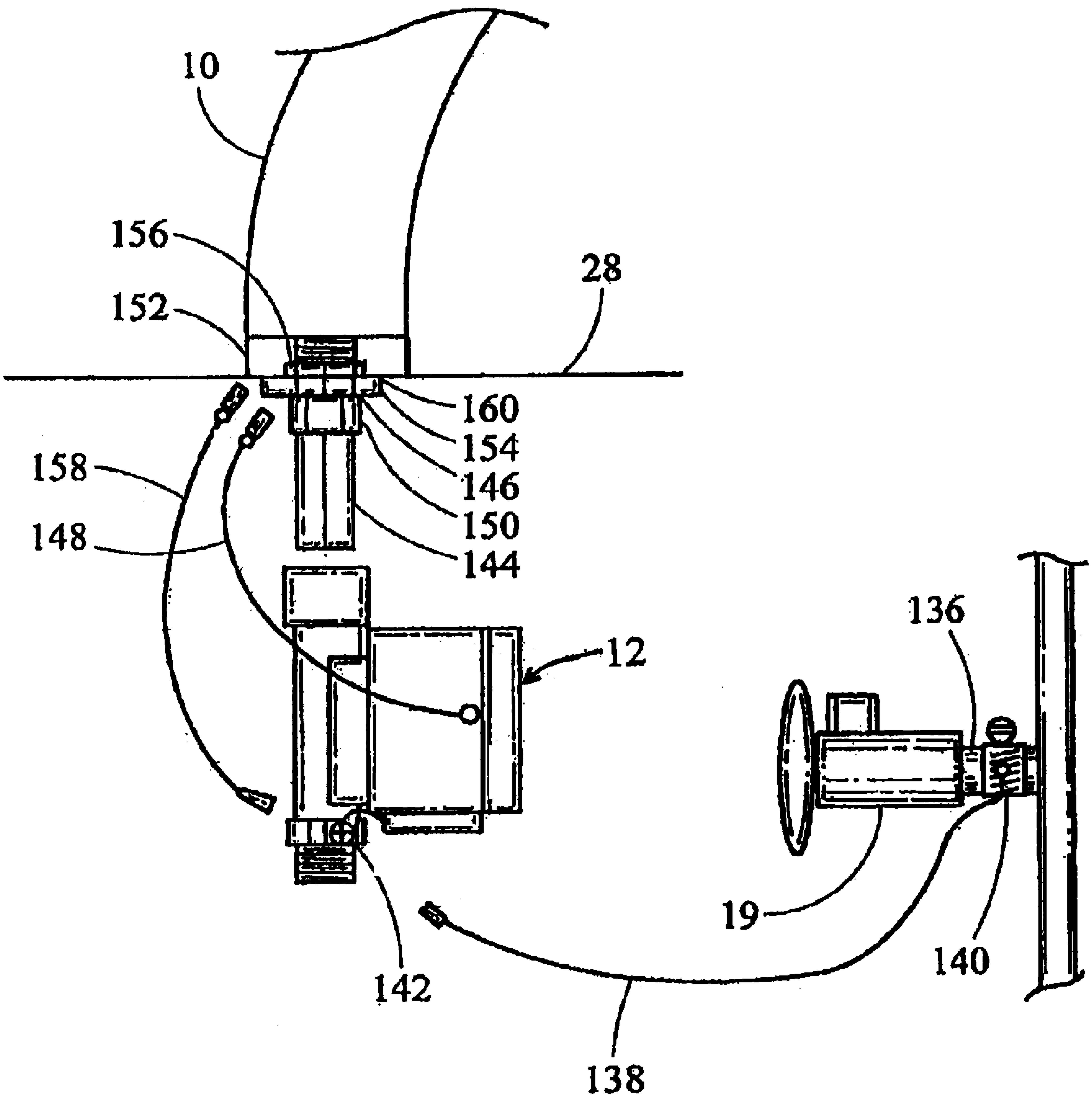

Fig. 9
(AMENDED)

AUTOMATIC PROXIMITY FAUCET

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

RELATED APPLICATIONS

The present patent document is a continuation-in-part of U.S. patent application Ser. No. 10/757,839, filed Jan. 14, 2004, now U.S. Pat. No. 7,083,156 which claims the benefit of the filing date under 35 U.S.C. § 119(e) of Provisional U.S. Patent Application Ser. No. 60/441,091, filed Jan. 16, 2003. All of the foregoing applications are hereby incorporated by reference.

FIELD OF THE INVENTION

The invention relates a hands-free faucet and, more particularly, a hands-free faucet that operates consistently and that reduces intermittent and undesired activation and deactivation of fluid flow.

BACKGROUND

A serious drawback in traditional faucets is that they are easily contaminated with germs. The germs can then be transferred from one person using the faucet to the next person using the faucet when each person has touched the handle of the faucet. Many users fear contacting the germs by touching the faucet handle. This fear prevents many users from using faucets in public. A hands-free faucet, on the other hand, eliminates the problem of users contacting germs and the fear of using faucets in public.

In many hands-free faucets, a sensor detects the presence of the user. Many of the sensors use infrared light. In order to sense the user with these units, the user must be located directly in the path of the light beam. Accordingly, if the user does not stand directly in that light path, or moves out of the light path, then the sensor does not detect the user, and the water will not turn on or will turn off before it should. One way to overcome this shortcoming in a hands-free faucet is to utilize a capacitive field sensor. This type of sensor, which works by detecting an electric charge at or near the sensor, can detect the presence of a user whenever he or she is near the faucet. A faucet using a capacitive field sensor is designed to remain activated as long as the user is near the faucet.

Automatic faucets using capacitive field sensors, however, have been found to have several significant problems. First, faucets have turned on for no apparent reason. This appears to have occurred when there is some movement near the faucet, even if not by an approaching user. Such movement can be a nearby faucet turning on, a nearby toilet flushing, or someone walking by the unit. Second, these faucets have not always worked consistently and, at times, would not stay on as long as they should. This appears to have occurred when the sensor switches its operational mode from sensing a user through the air surrounding the sensor, to sensing the continued presence of the user through the flow of water.

The present invention solves these problems in hands-free faucets that use capacitive field sensors. It is desirable, in particular, to have a hands-free faucet that uses a capacitive field sensor and that will turn on only when approached by the person desiring to use the faucet. It is also desirable to have a hands-free faucet that uses a capacitive field sensor in which the faucet will continuously be on, without shutting

off prematurely, the whole time that the user is near the faucet and desiring to wash his or her hands.

BRIEF SUMMARY

These and other objectives and advantages are provided in an automatic proximity faucet.

In one embodiment, a hands-free faucet includes a sensing plate, a capacitor-based sensing logic, a non-conductive valve housing, a non-conductive seating ring, and a conductive connector. Preferably, the capacitor-based sensing logic is electrically connected to said sensing plate. Furthermore, the non-conductive valve housing preferably comprises a valve inlet and valve outlet. The non-conductive seating ring is located between the valve inlet and valve outlet, and is traversed by the conductive connector. A wire further connects the capacitor-based sensing logic to an earth ground.

In another embodiment, a hands-free faucet for installation on an electrically conductive surface includes a conductive spout, a non-conductive top and bottom spacer, a capacitor-based sensing logic, a non-conductive valve housing having a valve inlet and valve outlet, an conductive pin within the valve housing which provides a continuous electrical connection between the valve inlet and valve outlet, and an electrically conductive conduit. In this embodiment, the spacer electrically insulates the spout from the conductive surface. Preferably, the capacitor-based sensing logic is electrically connected to the spout. Also, the electrically conductive conduit electrically connects the capacitor-based sensing logic to the electrical ground.

The present invention is defined by the following claims. The description summarizes some aspects of the presently preferred embodiments and should not be used to limit the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view of an embodiment of a hands-free faucet;

FIG. **2** is a partial cutaway view of a spout mounted to a surface in FIG. **1**;

FIG. **3** is a front cutaway view of the mixing and valve housing;

FIG. **4** is a side exploded view of a valve assembly;

FIG. **5** is a partial top cutaway view of FIG. **3**;

FIG. **6** is a flow diagram of a manual override method;

FIG. **7** is a flow diagram of a control logic of a sensor utilizing two modes;

FIG. **8** is a side cutaway view of a valve housing; and

FIG. **9** is a side perspective of the hands-free faucet mounted on a sink.

DETAILED DESCRIPTION OF THE DRAWINGS AND THE PRESENTLY PREFERRED EMBODIMENTS

The presently preferred embodiment provides a system for ensuring consistent control of an automatic faucet. In one embodiment, the system contains a faucet that utilizes a sensor to detect the presence of a user within a predetermined proximity of the faucet. The sensor is grounded and isolated to prevent the faucet from shutting off prematurely, and the field of the sensor from extending beyond a predetermined size. As a result, the system provides consistent operation and ensures that the faucet functions as intended.

FIG. **1** shows a front view of an embodiment of an automatic faucet. The embodiment comprises a spout **10**, a valve housing **12**, and a mixing housing **14**. Preferably, hot and cold water enter the system through a hot water inlet line **16** and a cold water inlet line **18**. The hot and cold water inlet lines **16**, **18** have shut-off valves **17**, **19** to allow for simplified maintenance of the system. The hot and cold water inlet lines **16**, **18** are operatively connected to the mixing housing **14**. In the present embodiment, the hot water inlet line and cold water inlet line **16**, **18** are connected to the mixing housing **14** at the nine and three o'clock positions respectively. The hot water inlet line **16** and cold water inlet line **18** are connected to the mixing **[**valve**]** *housing* **14** by compression fittings, solder, or other means known in the art.

Preferably, the mixing housing **14** mixes the hot and cold water from the hot water inlet line **16** and cold water inlet line **18** respectively to a desired temperature, as described below. The mixed water then travels through a valve adapter **20** to the valve housing **12**. The valve housing **12** contains an electrically-operable valve, hereinafter discussed in detail, which controls the flow of the water. When the valve is open, the stream of mixed water travels through an outlet **22** to the spout **10**. Preferably, the spout **10** directs the stream of mixed water through an opening in the spout **10** to the atmosphere.

In an alternate embodiment, a mixing housing **14** is not utilized. In this embodiment, either the hot water inlet line **16**, the cold water inlet line **18**, or an alternate line is directly connected to the valve housing **12**.

In the present embodiment, the spout **10** also serves as a sensing plate **24**. In the present embodiment, the sensing plate **24** is electrically connected to a capacitor-based sensor circuit, embodiments of which are described in U.S. Pat. Nos. 5,730,165 and 6,466,036, which are incorporated by reference. The sensing plate **24** and capacitor-based sensor circuit, which will be described hereinafter, serves as a sensor to detect the user. When the sensor detects the approach of a user, it sends the activation signal to a valve actuation mechanism. The valve actuation mechanism then opens the valve. The sensor also monitors the presence of the user, and when the sensor no longer detects a user, the sensor terminates the activation signal, and the valve closes. Although the illustrated sensing plate **24** is a spout **10**, the sensing plate **24** can be a separate element positioned adjacent to or away from the spout **10**.

As shown in FIG. **2**, an aerator **26** is threaded to the spout **10** at the terminal end of the spout **10**. The aerator **26** maintains fluid pressure by mixing air into the fluid. At another end, a threaded fitting **30** couples the spout **10** to a surface **28**. In this embodiment, the spout **10** can have many shapes. Besides the rectangular and circular cross-sections that are shown, the spout **10** encompasses many other designs that vary by shape, height, accessories (e.g. use of a built-in or attachable filters, for example), color, etc.

Referring to FIGS. **1** and **3**, the presently preferred mixing housing **14** encloses a mixing valve **32**. As noted above, hot and cold water are blended to a pre-set temperature. The mixing valve **32** blends the hot and cold waters by combining the two waters utilizing means known in the art. In the present embodiment, the mixing housing **14** and valve housing **12** are connected by a valve adapter **20**.

As shown in FIG. **3**, in the present embodiment, the mixing housing **14** is coupled to the valve housing **12** by a valve adapter **20**. Presently, the valve adapter **20** is a cylinder having a keyway **36** and threads **38** at one end as shown in FIG. **4**. When secured to the valve housing **12**, a valve pin **40** sits within the keyway **36**, ensuring a secure connection between the valve housing **12** and the valve adapter **20**. An O-ring **42** preferably provides a positive fluid tight seal between the valve housing **12** and the valve adapter **20**. An axial filter **44** can be disposed within the valve adapter **20** to separate fluids from particulate matter flowing from the mixing housing **14** to the valve housing **12**. The filter **44** can comprise a mesh or a semi-permeable membrane. In another embodiment, other materials that selectively pass fluids without passing some or all contaminants can be used as a filter. In an alternate embodiment, the valve housing **12** and mixing housing **14** are combined into a unitary housing. In this alternate embodiment, a valve adapter **20** is not required.

As shown in FIGS. **3** and **4**, the valve housing **12** encloses a motor **46**. Preferably, the motor **46** is mechanically coupled to a cam **48**. In the embodiment, the cam **48** is a wheel with a varying radius. The cam **48** is mounted to the motor **46** through a shaft and gear train **50**. Preferably, the cam **48** and a cam follower **52** translate the rotational motion of the shaft into a substantially linear movement that opens and closes a diaphragm **[54]** *64*. In this embodiment, the cam **48** has an offset pivot that produces a variable or reciprocating motion within a cutout portion of the cam follower **52**. The cam follower **52** is moved by the cam **48** within an orifice, which engages a rod-like element. Preferably, the rod-like element comprises a pilot **56** that slides through an orifice **58**. Movement of the pilot **56** can break the closure between the inlet port **60** and the outlet port **62** by moving the diaphragm **64**.

The diaphragm **64** is connected to the pilot **56** by a bias plate **66**. Preferably, the diaphragm **64** is coupled between legs of the bias plate **66** by a connector **68**. In this embodiment, the connector **68** comprises a threaded member. However, the connector **68** can be an adhesive, a fastener or other attaching methods know in the art.

As shown in FIGS. **3**–**5**, when the valve mechanism is closed, the diaphragm **64** sits against a seating ring or seating surface **70**. In this position, the fluid and the pilot **56** exert a positive pressure against the diaphragm **64** which assures a fluid-tight seal between the inlet port **60** from an outlet port **62**. When the pilot pressure is released the fluid pressure acting on the underside of the diaphragm **64** exceeds the seating pressure of the fluid pressing against the inlet surface of the diaphragm **64**. When the pressure is greater on the underside than that on the inlet side, the diaphragm **64** is forced up which opens the valve and allows for a continuous angled fluid flow. When a pilot pressure is re-exerted, a fluid backpressure builds up on the inlet surface of the diaphragm **64**. Preferably, the pilot **56** and fluid backpressure force the diaphragm **64** to seat, which in turn, stops the flow. The build up of backpressure occurs after the sensor no longer senses an appendage such as a hand.

As shown in FIGS. **3**–**5**, the diaphragm **64**, which is the part of a valve mechanism that opens or closes fluid communication between the inlet port **60** and the outlet port **62**, is wedge-shaped. Some diaphragms **64**, however, can have a uniform thickness throughout or have many other shapes depending on the contour of the seating surface.

FIG. **4** shows an exploded view of the valve assembly **[72]**. A housing **12** encloses a pilot valve assembly **74** and a board containing the sensor circuit **76**. In this embodiment, the capacitor-based sensor circuit **76** interfaces the sensing plate **24** to the motor **46**. A compression of a molding **78** that outlines the lower edges of the housing cover **80** causes a fluid tight seal to form around the edges of the housing **12**. Preferably, power to the sensor circuit **76** and motor **46** are passed through the sides of the housing cover **80** through orifices **82**. In the present embodiment, battery packs provide the primary power. Preferably, low-voltage direct current power supplies or battery packs drive a Direct Current motor and the logic. In an alternate embodiment, the power is provided by hardwired alternating current with or without a battery backup.

The pilot valve assembly **74** of the hands-free embodiment shown in FIG. **3**–**5** is preferably comprised of the motor **46**, its shaft, the cam **48**, the cam follower **52**, the gear train **50**, and the pilot **56**. Preferably, the O-ring **84** shown in FIG. **3** makes a fluid tight seal between the motor **46**, its shaft, the cam **48**, cam follower **52**, the gear train **50** and a portion of the pilot **56**. Preferably, the seal is located approximately three quarters down the length of the pilot valve assembly **74**.

In the present embodiment, the hands-free faucet also includes an override control that allows for continuous water flow without requiring a user to be present. The override control shown in FIG. **4** comprises an override arm **88**. The override arm **88** fits on a stem **90**. The stem **90** is a cylindrical projection extending from an outward face of one of the interconnected gears that form the gear train **50**. In this embodiment, the stem **90** is a part of a spur gear **92** having teeth radially arrayed on its rim parallel to its axis of rotation.

In the present embodiment, a strike plate **94** is connected to the spur gear **92** by a shaft **96**. The shaft **96** transmits power from the motor **46** through the gear train **50** to the pilot **56**. As shown, the strike plate **94** can interrupt the rotation of the shaft **96** and gear train **50** when the pilot **56** reaches a top or a bottom limit of travel, preferably established by the stem **90** contacting the convex surfaces of the strike plate **94**. At one end, the stem **90** strikes a positive moderate sloping side surface **98** of the strike plate **94**. At another end, the stem **90** strikes a substantially linear side surface **100**.

Preferably, an override knob **102** shown in FIG. **4** is coupled to an override shaft **104** projecting from the override arm **88**. In this embodiment, when the override knob **[86]** *102* is turned clockwise, the gear train **50** rotates until a projection **106** on the override arm **88** strikes the substantially linear side surface **100** of the strike plate **94**. In this position, the pressure on the underside of the diaphragm **[54]** *64* will be greater than that on the inlet side, and the valve will be open.

Preferably, an electronic detent locks the movement of the shaft **96** until the sensor detects a user or the override knob **102** is manually turned to another mode. When the sensor detects a user, the valve remains open. When the user is no longer detected, which can occur when the sensor no longer senses an appendage, the hands-free embodiment automatically returns to its automatic mode. As the hands-free embodiment transitions from the open to the automatic mode, the override knob **102** will automatically rotate from the open marking to the auto marking on the housing. In this embodiment, **[**fixtures are**]** *the hands-free faucet is* continuously flushed by an uninterrupted fluid flow that is shut off by a sensor detection after a manual selection.

While some embodiments encompass only an open and an automatic mode, another hands-free embodiment also encompasses a closed mode. In this mode, the valve is closed and the motor **46** will not respond to the sensor. While such a control has many configurations, in one embodiment this control can be an interruption of the ground or power source to the motor **46** by the opening of an electronic, mechanical, and/or an electromechanical switch. Only a turning of the override knob **102** to the automatic or open mode will allow fluid to flow from the inlet port **60** to the outlet port **62**.

As shown in FIG. **6**, the operation of the open mode begins when an open selection is made at act **162**. Once the open selection is made, fluid flows. Fluid flow is shut off by either an automatic or manual selection at act **164**. In a manual mode, the detection of a user biases the motor **46** to rotate the gear train **50** which is already in an open position. When a user is no longer detected, the motor **46** rotates the gear train **50** and the override knob **102** to the auto position shutting off fluid flow **[**at act **166]**. In an automatic selection, the sensor initiates a fluid flow when a user is detected in a field of view at act **168**. When an activation signal is received, an electronic switch electrically connected to the sensor actuates the motor **46** at act **170**. Once the user is no longer detected, the motor **[64]** *46* rotates the gear train **50**, cam **48**, and the cam follower **52** from an active state of continuous fluid flow to an inactive state of no fluid flow at acts **172** and **174**. When in an automatic state, fluid will again flow when a user is again detected in the field of view.

The above-described system provides an easy-to-install, reliable means of flushing a hands-free fixture without requiring continuous sensor detection. While the system and has been described in cam and gear embodiments, many other alternatives are possible. Such alternatives include automatic actuators, solenoid-driven systems, and any other system that uses valves for fluid distribution.

Furthermore, the detent is not limited to an electronic detent that can be unlocked by an activation signal sourced by a sensor. The electronic detent can comprise a programmable timing device that sustains an uninterrupted fluid flow for an extended period of time. Moreover, the hands-free system and method also embrace mechanical detents, for example, that lock movement of the motor **[64]** *46* or the gear train **50** and/or the shaft **96**. One such embodiment can comprise a catch lever that seats within a channel of the spur gear **92** of the gear train **50**. Preferably, the torque of the motor **[64]** *46* and/or a manual pressure can unlock some of these embodiments.

Many other alternative embodiments are also possible. For example, the mixing valve **14** shown in FIGS. **1** and **3** can comprise an above surface or an above-deck element that provides easily accessible hot and cold adjustments which allows users to adjust or preset the temperature of the water being dispensed from the spout **10**. In an alternative embodiment, the hand-free fixture can include a scalding prevention device, such as a thermostatic control that limits water temperature and/or a pressure balancing system that maintains constant water temperature no matter what other water loads are in use, as known in the art Preferably, the non-scalding device and pressure balancing systems are interfaced to and control the mixing valve **14** and are unaffected by water pressure variations.

In yet another alternative embodiment, the limits of travel of the pilot **56** can be defined by the contacts between the override arm **88** and the convex surfaces of the strike plate **94**. At one end of this embodiment, the override arm **88** strikes a positive moderate sloping side surface **98** of the strike plate **94** and at another end the override arm **88** strikes a substantially linear side surface **100**. In another alternative, pilot **56** movement causes the pilot supply air **120** shown in FIG. **5** to be vented to the atmosphere which unseats the diaphragm **64** allowing fluid to flow from the inlet *port 60* to the outlet port **[60** and**]62**. In this embodiment, the fluid which comprises a substance that moves freely but has a tendency to assume the shape of its container will flow continuously until the venting is closed. Once the vent is closed, a backpressure builds up on the diaphragm **[54]** *64* isolates the inlet port **60** from the outlet port **62**.

Installation of the hands-free embodiments can be done above or below a sink deck or surface. While the complexity of the installation can vary, the above-described embodiments can use few pre-assembled parts to connect the outlet port **62** to an output accessory. For example, a valve pin seated within a keyway can provide a seal between the valve housing and the output accessory. An O-ring can also be used to provide a positive fluid tight seal between the valve housing and accessory.

As illustrated in FIG. **7** above, the sensor circuit **76** controls the sensor. In a preferred embodiment, the software involves two modes of operation. The first mode **176** of operation is through the air. During this mode, the sensor provides a group of short pulses through the air. When a user approaches, the sensor detects the user at act **178**, and the sensor circuit **76** sends a signal to activate the motor **46**, which opens the valve at act **180**, and the sensor circuit **76** switches to the second mode of operation. The second mode **182** operates through the stream of water. In this mode, the sensor monitors the presence of the user in the water stream at act **184**. When the user is no longer in the water stream, the sensor detects the absence of the user, and deactivates the motor **[64** at act **186]** *46*, thereby closing the valve *at act 186*, and shutting off the water flow. The sensor circuit **76** then returns to the first mode of operation **176**.

To ensure consistent operation of the sensor, a consistent ground reference must be maintained during transition between the two modes of operation. More specifically, a consistent ground reference must be maintained during the transition from sensing through the air **176** to sensing through the water stream **182**. In the present embodiment, the non-conductive **[**input**]** *inlet* port **60** and **[**output**]** *outlet* port **62** are situated within a non-conductive valve housing **12**. Prior to the detection of a user, a diaphragm **54** separates the inlet port **60** from the outlet port **62**. In the preferred embodiment, the diaphragm **54** is made of rubber, and therefore, interrupts the ground potentially provided by the water in the inlet port **60** and outlet port **62**. In the present embodiment, a consistent ground reference is accomplished by electrically connecting the **[**input**]** *inlet* port **60** to **[**output**]** *outlet* port **62** regardless of the position of the diaphragm **54**.

As indicated in FIG. **8**, a pin **184** is present to electrically connect the **[**input**]** *inlet* port **60** to the **[**output**]** *outlet* port **62** through the seating surface **70**. By locating the pin **184** in the seating surface **70**, the pin **184** electrically connects the **[**input**]** *inlet* port **60** to the **[**output**]** *outlet* port **62** regardless of the position of the diaphragm **54**. The pin **184** prevents a large change in the ground reference when the diaphragm **54** opens; thereby providing a stable ground reference connection between the inlet port **60** and outlet port **62**. The establishment of a stable ground reference ensures that the change in resistance remains in the normal range of the signal, thereby preventing premature deactivations.

As shown in FIG. **9**, the presence of a direct ground further ensures a robust ground reference. In the present embodiment, the direct connection to the earth ground **136** is obtained through a first ground wire **138** connecting the sensor circuit **76** to an earth ground **136**. Presently, the earth ground **136** is a metal pipe that leads to the cold water inlet valve **19**. The first ground wire **138** is electrically attached to the earth ground **136** by a metallic clamp **140**. In the preferred embodiment, a screw **142** serves as a junction between the first ground wire **[130]** *138* and a ground wire **141** originating from the sensor circuit **76**, which is located within the valve housing **12**. In alternate embodiments, the first ground wire **[130]** *138* can be attached directly to the earth ground **136**, or by any other means that allows electricity to be conducted from the first ground wire **[130]** *138* to the earth ground **136**. By bypassing any crimps in metal braided fittings or any pipe tape or dope, the direct ground avoids any possible compromises to the ground connection. The direct ground further provides a robust ground reference that decreases the possibility of the faucet prematurely activating.

Installation of the preferred embodiment onto or near a metallic surface **28**, including but not limited to stainless steel and cast iron sinks, requires additional grounding. More specifically, in the preferred embodiment, the spout **10** is electrically connected to the sensor circuit **76** by a sensing wire **148**. The sensing wire **148** extends from the sensor circuit **76** and is connected to an electrically conductive stem **144** of the spout **10** by a first metallic tab washer **146**. In the preferred embodiment, the stem **144** contains threading and is situated in a aperture within the metallic surface **28**. A nut **150** secures the first metallic tab washer **146** to the stem **144**. The nut **150** contains threading that corresponds to the threading on the stem **144**. Preferably, the nut **150** is electrically conductive, as to ensure an electrical connection between the first metallic tab washer **146** and the stem **144**.

To ensure that spout **10**, stem **144**, tab washer **146**, and nut **150** are not in electrical contact with the metallic surface **28**, the assembly contains a top spacer **152** and a bottom spacer **154**. In the present embodiment, the top spacer **152** is positioned between the spout **10** and the surface **28**. The top spacer **152** contains a similar cross-section to that of the spout **10**. However, the top spacer **152** in other embodiments may utilize other shapes that isolate the spout **10** from the surface **28**. The top spacer **152** contains an aperture through which the stem **144** can be positioned.

Preferably, the bottom spacer **154** is positioned below the metallic surface **28**, but above the first metallic tab washer **[160]** *146*. The bottom spacer **154** in the present embodiment has a washer shape; although other embodiments may contain bottom spacers of other shapes. The bottom spacer **154** contains an aperture through which the stem **144** can be positioned. In the present embodiment, the bottom spacer has a ridge **156**, which is located around the diameter of the aperture of the bottom spacer **154**. In the preferred operation, the ridge **156** extends through the metallic surface **28** and enters the aperture of top spacer **[154]** *152*, thereby completely isolating the stem **144**, spout **10**, and sensor wire **148** from the metallic surface **28**, while allowing the nut **150** to be tightened onto the stem **144** to ensure that the spout **10** is securely attached to the metallic surface **28**. The tightening of the nut **150** also ensures that the sensor wire **148** has an electrical connection to the stem **144** and spout **10**. To ensure proper isolation, the top spacer **152** and bottom spacer **154** should be made of an electrical insulator.

In the preferred embodiment, a second ground wire **158** grounds the metallic surface **28**. In the present embodiment, the second ground wire **158** is electrically connected to the metallic surface **28** by a second metallic tab washer **[154]** *160*. The second metallic tab washer **[154]** *160* is located between the metallic surface **28** and the bottom spacer **154**. The second metallic tab washer **[154]** *160* contains an aperture through which the ridge **156** of the bottom spacer **154** can be **[**position**]** *positioned*. The ridge **156** thereby isolates the second metallic tab washer **[154]** *160* from the stem **144** and spout **10**. In the presently preferred embodiment, the second ground wire **158** is electrically connected to the first ground wire **138** by the screw **142** that serves as a junction.

By isolating and grounding the metallic surface **28**, the sensing plate **24** is limited to the stem **144** and spout **10**, and therefore, the hands-free faucet will not activate when a user approaches the metallic surface **28**, but does not approach the spout **10**. In an alternate embodiment, the second ground wire **158** can be directly connected to the earth ground **136**.

It is therefore intended that the foregoing detailed description be regarded as illustrative rather than limiting, and that it be understood that it is the following claims, including all equivalents, that are intended to define the spirit and scope of this invention.

The invention claimed is:

1. A hands-free faucet in the proximity of an electrical ground to provide water from at least one reservoir comprising:

a conductive sensing plate;

a capacitor-based sensor circuit electrically connected to said sensing plate;

a non-conductive valve housing having a valve inlet and valve outlet, wherein said valve outlet is operatively connected to said conductive **[**spout**]** *sensing plate*;

a non-conductive seating ring situated between said valve inlet and said valve outlet;

a conductive connector traversing said seating ring; and

a grounding wire connecting said capacitor-based sensor circuit to said electrical ground.

2. The hands-free faucet of claim **1** further comprising a non-conductive diaphragm in the proximity of the **[**diaphragm seat**]** *seating ring*, wherein in a first state, said diaphragm does not contact said **[**diaphragm seat**]** *seating ring*, and in a second state, said diaphragm operatively seals said valve inlet from valve outlet.

3. The hands-free faucet of claim **2** wherein said conductive connector is a metal pin.

4. The hands-free faucet of claim **3** further comprising a motor *including a shaft*, wherein said motor is operatively connected to said diaphragm, and switches said diaphragm from said first state to said second state when activated.

5. The hands-free faucet of claim **4** wherein said capacitor-based sensor circuit is electrically connected to said motor.

6. The hands-free faucet of claim **5** wherein said sensing plate is a spout.

7. The hands-free faucet of claim **6** wherein said sensing plate and said capacitor-based sensor circuit comprise a proximity sensor.

8. The hands-free faucet of claim **7** wherein said proximity sensor operates in a first mode that senses the presence of a user by sending a plurality of short pulses.

9. The hands-free faucet of claim **8** wherein said proximity sensor operates in a second mode that senses the presence of a user by sending a plurality of wide pulses.

10. The hands-free faucet of claim **9** wherein said proximity sensor switches from said first mode to said second mode when said proximity sensor detects a user.

11. The hands-free faucet of claim **10** wherein said proximity sensor switches from said second mode to said first mode when said proximity sensor no longer detects a user.

12. The hands-free faucet of claim **7** wherein said motor receives an activation signal from said proximity sensor**[**;**]**, *and further comprising:*

an override control coupled to the motor, said override control being configured to allow a continuous flow of fluids through said faucet when said motor is not receiving said activation signal from said proximity sensor; and

an electronic detent coupled to the override control, the electronic detent being configured to unlock and allow movement **[**said**]** *of the shaft of the motor when* the activation signal is received from said override control.

13. The hands-free faucet of claim **6** further comprising **[**a**]** nonconductive top and bottom **[**spacer**]** *spacers* located between said spout and a surface upon which the spout is mounted.

14. The hands-free faucet of claim **13** further comprising a second grounding wire electrically connecting said surface to said electrical ground.

15. The hands-free faucet of claim **1** wherein said conductive sensing plate is electrically connected to said capacitor-based sensor circuit by a sensing wire.

16. A hands-free faucet for installation on an electrically conductive surface in the proximity of an electrical ground comprising:

a conductive spout;

[a**]** non-conductive top and bottom **[**spacer**]** *spacers* located between said spout and said conductive surface;

a capacitor-based sensor circuit electrically connected to said spout;

a non-conductive valve housing having a valve inlet and valve outlet, wherein said valve outlet is operatively connected to said conductive spout;

a conductive pin within said valve housing which provides a continuous electrical connection between said valve inlet and valve outlet; and

a first electrically conductive conduit electrically connecting said capacitor-based sensor circuit to said electrical ground.

17. The hands-free faucet of claim **16** wherein said electrically conductive surface is electrically connected to said electrical ground.

18. The hands-free faucet of claim **17** further comprising a second electrically conductive conduit electrically connecting said electrically conductive surface to said electrical ground.

19. The hands-free faucet of claim **18** wherein said second electrically conductive conduit is electrically connected to said first electrically conductive conduit.

20. The hands-free faucet of claim 16, wherein the spout includes a stem, and the non-conductive top and bottom spacers electrically isolate the spout from the conductive surface.

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