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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : G01P 13/00, G08B 26/00 | A1

(11) International Publication Number: **WO 00/62081**

(43) International Publication Date: 19 October 2000 (19.10.00)

(21) International Application Number: PCT/US00/09262

(22) International Filing Date: 7 April 2000 (07.04.00)

(30) Priority Data:
60/128,368 8 April 1999 (08.04.99) US

(63) Related by Continuation (CON) or Continuation-in-Part (CIP) to Earlier Application
US 60/128,368 (CON)
Filed on 8 April 1999 (08.04.99)

(71) Applicant *(for all designated States except US)*: INTERACTIVE TECHNOLOGIES, INC. [US/US]; 2266 North Second Street, North St. Paul, MN 55109 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: SEEMANN, Brian [US/US]; 16870 Judicial Road, Lakeville, MN 55044 (US). CHRISTIANSON, Joel, C. [US/US]; 11904 – 90th Avenue North, Maple Grove, MN 55369 (US). KREIER, James [US/US]; 1058 Wood Court, Amery, WI 54001 (US). BERGMAN, John, T. [US/US]; 306 Townsvalley Road, River Falls, WI 54022 (US).

(74) Agent: SHUMAKER, Steve, J.; Fish & Richardson, P.C., P.A., Suite 3300, 60 South Sixth Street, Minneapolis, MN 55402 (US).

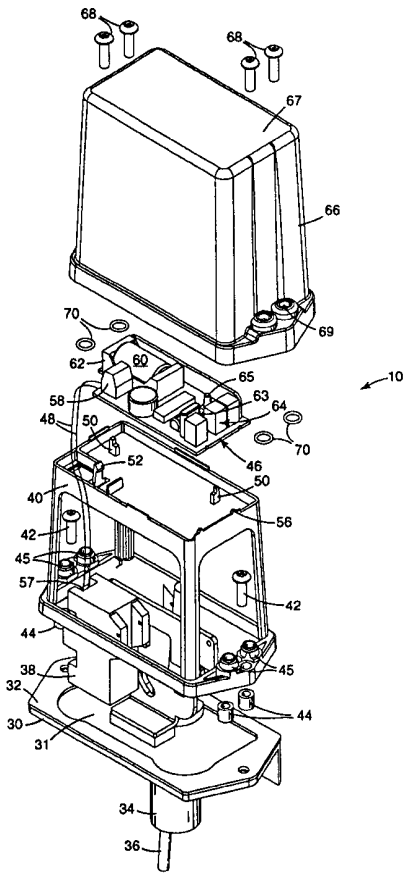
(81) Designated States: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: FLOW CONDITION DETECTOR FOR A FLUID FLOW SYSTEM

(57) Abstract

A detector for a flow condition within a pipe, and a transmitter that transmits a signal in response to the sensed flow condition. The detector may include a tamper sensor that senses a tamper condition, and an enrollment device that senses a user–initiated stimulus different from the sensed condition and the tamper condition. The transmitter transmits an enrollment signal when the user–initiated stimulus is sensed, the enrollment signal including an identification code associated with the detector for enrolling the detector. The use of a transmitter permits communication of a sensed flow condition to a remote control panel without the need for additional wiring and conduit hardware. The incorporation of a tamper sensor ensures the integrity of the detector against efforts to disable its sensing or communication capabilities.



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FLOW CONDITION DETECTOR FOR A FLUID FLOW SYSTEM

TECHNICAL FIELD

The present invention relates generally to fluid flow systems and, more particularly, to detection of flow conditions within a fluid flow system.

BACKGROUND

Detection of fluid flow conditions is necessary in a variety of systems. Fire protection systems, for example, typically include a network of piping that branches out from a central location through a building to supply water to numerous sprinkler heads. Each sprinkler head is placed in fluid communication with a pipe and has a device that normally blocks the flow of water out of the pipe. During a fire, heat from the fire causes a fusible link to melt, releasing the blocking device so that water can flow from the sprinkler head. Detectors located in the piping network of a fire protection system are commonly used to detect the presence or absence of water flowing in the pipes or to verify the operability of the system.

When a sprinkler head opens in response to heat from a fire, water begins to flow through the pipes to that sprinkler head. A flow detector mounted on a pipe that serves the opened sprinkler head can be used to sense the flow of the water, either by sensing fluid movement or pressure. Pressure detectors are often used to verify that fluid is not flowing within a pipe. By placing flow or pressure detectors in the piping network at appropriate locations, the owner of a building can quickly sense fluid flow conditions in the system and thereby trigger a fire alarm. An owner also may use a group of flow or pressure detectors to determine where in a particular building a fire is located.

Other types of flow detectors verify that valve hardware is set for proper system operability. If an inlet valve is closed, for example, the pipe feeding a

sprinkler head will not deliver water as required. Detectors can be mechanically coupled to valve hardware within the pipe to detect opening and closure of the valve. In the event the valve is actively controlled in response to a fire alarm, the detector can verify proper opening and closure. Alternatively, the detector can detect tampering or inadvertent closure of the valve. In this manner, the detector provides a mechanism to verify the integrity of the fire protection system.

Detection of fluid flow conditions is also important for industrial applications. In certain industrial processes, it may be important to verify that fluid is flowing in a particular pipe. Mere knowledge of whether a particular pump supplying that pipe is switched on may not be sufficient to verify that fluid is flowing, because the pump could be broken or a valve between the pump and the pipe under observation may be closed. A flow or pressure detector in a pipe at a particular location may provide a reliable indication that fluid is flowing or not flowing through the pipe at that location. A detector also can be used to verify proper valve orientation.

Multiple detectors are generally connected to a common monitoring network or control panel. Each flow detector may be connected to a control panel, which provides indications of the state of each detector. The control panel may include a programmed computer, and may be equipped with programs to respond in a certain manner to different events. For example, a control panel can be configured to dial a predetermined phone number or sound an alarm signal when flow is detected in a particular pipe. The detectors communicate with the control panel by way of wires that connect the detectors to devices that receive signals from the detectors. Each flow detector may also be provided with a switch to operate a local audible or visual annunciator.

Installation of a detector and, in particular, a detection system, can be difficult and time consuming. Each detector must be connected to the control panel with wires and conduits. Installation and materials costs can be very expensive. Where a detector is far away from the control panel, a great amount of wire may be needed. In an industrial setting, the wire may have to be snaked through hazardous areas. In addition, detectors that are added after a facility is initially constructed may be

particularly difficult to install. Where a facility is already built, and ceilings are up or shafts are closed in, running wire through the facility for a new detector can be particularly difficult. Also, in a very large system, there can be many wires meeting at the control panel. Technicians installing the system may confuse one set of wires with another, and create a false reading on the control panel.

SUMMARY

The present invention is directed to a detector that detects flow conditions associated with a pipe or other hardware in a fluid delivery system. The detector may be useful, for example, in detecting flow conditions associated with fire sprinkler systems. The detector, in various embodiments, takes advantage of a number of structural and functional design features that improve operation and facilitate installation and maintenance.

In one embodiment, the present invention provides a detector comprising a base, a cover for attachment to the base to define an enclosure, a flow condition sensor, mounted within the enclosure, that senses a flow condition associated with a pipe, and a wireless transmitter that transmits a signal indicative of the sensed flow condition, the transmitter being mounted to the base such that the cover is removable from the base independently of the transmitter.

In a further embodiment, the present invention provides a detector comprising a base, a cover for attachment to the base to define an enclosure, a flow condition sensor, mounted within the enclosure, that senses a flow condition within a pipe, and a transmitter that transmits one or more signals indicative of the sensed flow condition and an identity of the detector.

In another embodiment, the present invention provides a detector comprising a base, a cover for attachment to the base to define an enclosure, a sensor, mounted to the base, that senses a flow condition within a pipe, a tamper sensor, mounted in a substantially fixed position relative to the base, that senses tampering with the detector, and a transmitter, mounted within the enclosure, that transmits a signal in response to the sensed flow condition and a tamper signal when the tamper sensor senses tampering with the detector.

In an added embodiment, the present invention provides a detector comprising a base, a cover for attachment to the base to define an enclosure, a sensor that senses a flow condition within a pipe, an enrollment device that senses a user-initiated condition different from the sensed flow condition, and a transmitter that transmits a signal when the flow condition is sensed and an enrollment signal when the user-initiated condition is sensed, wherein the enrollment signal includes an identification code associated with the detector for enrolling the detector.

In a further embodiment, the present invention provides a detector comprising a housing, a sensor, mounted within the housing, that senses a condition within a monitored area, a tamper sensor that senses a tamper condition, an enrollment device that senses a user-initiated condition different from the sensed condition and the tamper condition, and a transmitter that transmits an enrollment signal when the user-initiated stimulus is sensed, the enrollment signal including an identification code associated with the detector for enrolling the detector.

In an added embodiment, the present invention provides a detector comprising a base, a cover for attachment to the base to define an enclosure, a sensor that senses a flow condition within a pipe, a testing device that senses a user-initiated condition different from the sensed flow condition, and a transmitter, a controller that controls the transmitter to transmit a flow condition signal when the flow condition is sensed and to transmit a test signal when the user-initiated condition is sensed, wherein the sensor and the testing device communicate with the controller along substantially the same electrical path.

In another embodiment, the present invention provides a method for enrolling a detector in a detection system, wherein the detector includes a sensor that senses a condition within a monitored area, and a tamper sensor that senses a tamper condition indicative of tampering with the detector, the method comprising applying to the detector a stimulus different from the sensed condition and the tamper condition, and transmitting an enrollment signal when the stimulus is sensed, the enrollment signal including an identification code associated with the detector for enrolling the detector.

In a further embodiment, the present invention provides a system for sensing flow conditions associated with one or more pipes, the system comprising a plurality of flow condition detectors having sensors that sense the flow conditions, a plurality of transmitters, each of the transmitters being associated with one of the flow condition sensors, wherein the transmitters transmit signals indicative of the flow conditions, and a control panel that receives the signals transmitted by the transmitters, wherein each of the signals includes an identity code designating one of the flow condition sensors.

The use of a transmitter with a unique identification code permits communication of a sensed flow condition to a remote control panel without the need for additional terminals at the control panel. Instead, several transmitters can be wired to a common terminal, and differentiated by respective identification codes. In particular, the identification code can be incorporated in each of the signals transmitted by a detector.

If the transmitter is wireless, there is no need for additional wiring or conduit hardware to connect the detector to the control panel. Also, in some embodiments, the transmitter can be powered with a battery provided in the detector housing, eliminating the need for wiring of line power to the detector. Wireless communication may be particularly desirable for installation in existing buildings, but can be advantageous in new construction.

"Flow condition" is used broadly herein to refer to a variety of conditions relating to flow of fluid within a pipe, such as fluid flow, absence of fluid flow, fluid pressure, or the disposition of valve hardware associated with the pipe. Accordingly, a variety of sensors are contemplated for incorporation in a detector in accordance with the present invention. In some embodiments, for example, the sensor may include a paddle that extends into a pipe to sense flow conditions. In other embodiments, the sensor may take the form of a switch that is responsive to actuation of a valve or other flow control hardware.

Mounting of the transmitter to allow removal of the cover from the base independently of the transmitter facilitates access to the detector for maintenance,

rework, or testing. Also, if the transmitter is mounted at a substantially fixed position relative to the base, according to some embodiments, different cover and flow sensor configurations can be readily accommodated without redesign. In general, the transmitter can be incorporated in the detector without disturbing existing hardware, thereby avoiding or at least streamlining qualification and testing of the detector by regulatory authorities.

The incorporation of a tamper sensor ensures the integrity of the detector against efforts to disable its sensing or communication capabilities. Mounting of the tamper sensor at a substantially fixed position relative to the base enables the tamper sensor to occupy a consistent spatial relationship with the cover, which is removable from the base. This relationship is fixed without regard to changes in the configuration or dimensions of the sensor assembly. Thus, sensor assemblies having different dimensions, e.g., height, or other structural differences generally will not impact the ability of the tamper sensor to interact in a consistent manner with the cover. As with the transmitter, this aspect can be helpful in accommodating different cover and flow sensor configurations.

An enrollment device that is responsive to a user-initiated condition different from a flow condition and a tamper condition allows ready differentiation of enrollment and alarm modes. Enrollment refers to identification of a detector by a control panel. Upon enrollment, the control panel can determine the source of alarm signals and, in most cases, the location of the alarm condition. Differentiation of the enrollment and alarm modes can reduce the likelihood of unintentionally enrolling the wrong sensors in a control panel.

In addition, transmission of an enrollment signal independently of the tamper signal and flow condition signal facilitates use of the enrollment device as a testing device. The detector can be responsive to the user-initiated condition to transmit an enrollment signal that, in the event the detector has already been enrolled, will be processed by the control panel as a test signal. In this manner, the enrollment device can be used to verify the operability of the detector. Also, a dedicated testing device

could be provided independently of the enrollment device, and made responsive to a similar user-initiated condition.

Further, the enrollment device can be made responsive to a user-initiated condition occurring outside of the enclosure formed by the base and cover. As an example, the enrollment device may be responsive to the application of or a change in a magnetic field or some other external stimulus such as vibration or shock. In this manner, enrollment does not require removal of the cover, and thereby avoids exposure of the hardware within the detector. The ability to enroll the detector without removing the cover facilitates installation, and promotes continued environmental reliability by avoiding exposure of the internal hardware.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

FIG. 1A is a schematic representation of several flow detectors in wireless communication with a control panel;

FIG. 1B is a schematic representation of several flow detectors in solid media communication with a control panel;

FIG. 2 is an exploded isometric view of a flow detector;

FIG. 3 is an isometric view of an assembled flow detector;

FIG. 4 is a top view, showing the flow detector of FIG. 3;

FIG. 5 is a section view taken along section line 1-1' in FIG. 4;

FIG. 6 is a section view taken along line 4-4' in FIG. 5;

FIG. 7 is a section view taken along line 3-3' in FIG. 4;

FIG. 8 is a section view taken along line 2-2' in FIG. 4;

FIG. 9 is functional block diagram illustrating a system for detection of alarm, test, and enrollment mode stimuli;

FIG. 10 is a section view taken along line 4-4' in FIG. 5 showing an alternative tamper sensor arrangement;

FIG. 11 is a section view taken along line 4-4' in FIG. 5 showing an alternative cover arrangement; and

FIG. 12 is a section view taken along line 4-4' in FIG. 5 showing another alternative cover arrangement.

Like reference numbers and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION

FIGS. 1A and 1B illustrate a flow monitoring environment for use of a flow detector 10. FIG. 1A is a schematic representation of several flow detectors, designated by reference numerals 10a, 10b, 10c, 10d, in wireless communication with a control panel 2, e.g., by radio frequency or infrared communication. FIG. 1B is a schematic representation of several flow detectors, again designated by reference numerals 10a, 10b, 10c, 10d, in solid media communication with a control panel 2, e.g., by hard-wired electrical or fiber optic communication.

As shown in FIGS. 1A and 1B, control panel 2 may be configured as a single operating terminal, having buttons on its face for entering information. Control panel 2 may include a display 6, which may be a lighted alpha-numeric display. In a wireless embodiment, control panel 2 may also be provided with an antenna 8, which allows the control panel to communicate with various detectors. Control panel 2 may be mounted in a durable housing and located remotely from flow detectors 10a-10d.

Detector 10 may be connected to a pipe 12 and thereby sense fluid flow or pressure within the pipe. Alternatively, detector 10 may be coupled to valve hardware associated with a pipe to verify the status and position of such hardware. Thus, flow condition is used broadly herein to refer to a variety of conditions relating to flow of fluid within a pipe, such as fluid flow, absence of fluid flow, fluid pressure, or the disposition of valve hardware associated with the pipe. In the examples of FIGS. 1A and 1B, detectors 10a, 10b, 10c, 10d are coupled to detect flow within pipes designated by reference numerals 12a, 12b, 12c, 12d.

Again, detector 10 may communicate with control panel 2 through hard-wired communication or radio frequency wireless communication, as represented by arrow 14. Detector 10 may be placed a significant distance from control panel 2, to the extent that reliable wireless communication is possible. A repeater could also be provided to expand the range of communication. In a hard-wired embodiment, detector 10 can be electrically connected to control panel 2 either directly or via intermediate buffers or other circuitry. Hard-wired connection of detectors 10a, 10b, 10c, 10d to a common set of terminals 15, 17 associated with control panel 2 is illustrated by lines 19, 21.

FIG. 2 is an exploded isometric view of an exemplary detector 10 configured for detection of fluid flow or pressure. Other types of detectors are suitable for practice of the present invention. A detector sensitive to the flow of fluid, however, will be described herein for purposes of illustration. As shown in FIG. 2, detector 10 is provided with a base 30. Base 30 may be coupled directly to a pipe 12. A gasket 32 may be disposed on top of base 30. Gasket 32 may be constructed from a thin layer of foam or other suitable material, and extend about a periphery of base 30, leaving an area 31 for mounting of additional hardware. For a hard-wired embodiment, base 30 may be provided with knockouts to permit entry of wires for communication and power, as well as wires extending to a local annunciator. In most wireless applications, detector 10 more preferably will be battery-powered, eliminating the need for hard-wired connections. However, delivery of line power to a wireless transmitter is a possibility.

A tubular sleeve 34 may be provided on a bottom side of base 30, and may have a movable element 36 extending from its center. Movable element 36 may extend from the bottom of sleeve 34 so as to extend into the flow of fluid in a pipe when detector 10 is mounted to the pipe. Sleeve 34 may be threaded or may otherwise have provisions for attachment to a pipe. Movable element 36 can include a paddle-like extension that can take many shapes and sizes to match a particular application, and is one form of a sensor that may be used for detecting flow conditions. In the embodiment of FIG. 2, movable element 36 provides an indication of fluid flow, e.g., water in a fire sprinkler system or industrial fluids in an industrial

process. Detector 10 alternatively could be provided with a pressure sensor or other appropriate sensor to detect flow conditions, such as a temperature sensor, acoustic sensor, or ultrasonic sensor. Moreover, detector 10 could combine multiple sensor types to provide hybrid flow condition sensing.

A switch assembly 38 may be connected to movable element 36 to form part of the flow condition sensor. Switch assembly 38 may have one or more switches that are switched on or off by movement of movable element 36 in response to fluid flow against the movable element. Switch assembly 38 may include a single pole, double throw (SPDT), snap action switch. A single throw switch may be acceptable, however, in many applications. An additional switch may be provided to provide a second output from detector 10. When switch assembly 38 opens or closes, thereby changing state, it provides an indication of a flow condition within pipe 12. On this basis, detector 10 can be configured to transmit an alarm signal to advise remote control panel 2 of the flow condition.

Detector 10 may be provided with an adjustable, instantly recycling pneumatic retard to prevent false triggering. False triggering occurs when detector 10 senses fluid flow even though there is not true flow in the pipe. A false trigger could be generated, for example, by a surge of water in the pipe. A retard helps to ensure that water flows in one direction in the pipe for a sufficient amount of time before triggering the detector so that true flow can be assured. The pneumatic retard may comprise a plunger that forces air out of a chamber through a constricted passage. Movable element 36 may be connected to the chamber, and back-pressure from the air in the chamber may prevent quick movement by movable element 36. For example, the retard may act to prevent switch assembly 38 from changing state until a certain period of time has elapsed once flow begins in the pipe.

A mounting platform in the form of sub-chassis 40 may be provided to fit over and around switch assembly 38. Sub-chassis 40 may have a flat lower peripheral edge that rests flat against gasket 32. Sub-chassis 40 may be formed as a hollow box shape and may be provided with holes in its side to provide access to switch assembly 38. Sub-chassis 40 may be provided with extensions near its lower periphery that

allow it to be connected to base 30 by button-head screws 42. One or more button-head screws 42 may be provided at opposite ends of sub-chassis 40. In particular, button-head screws 42 may pass through holes provided in opposite ends of sub-chassis 40 and into corresponding holes on base 30, thereby holding sub-chassis 40 against base 30, with gasket 32 providing a tight seal between sub-chassis 40 and base 30. Button-head screws 42 may be provided with tamper-resistant heads, requiring a special key for removal.

A recessed area on a top surface of sub-chassis 40 receives a transmitter assembly 46. Raised mounts 50 hold transmitter assembly 46 off of the surface of sub-chassis 40, and mounting hook 52 holds transmitter assembly 46 in place. Tabs 56 formed around the upper periphery of sub-chassis 40 can be provided to prevent transmitter assembly 46 from moving laterally. Thus, in the example of FIG. 2, transmitter assembly 46 snaps into place on top of sub-chassis 40 and may later be removed. As one alternative to sub-chassis 40, transmitter assembly 46 could be corner-mounted on simple stand-offs that provide a mounting platform above base 30.

Switch assembly 38 communicates with transmitter assembly 46 through an electrical interface, shown as a wire interconnection 48. Wire interconnection 48 may connect terminals 57 on switch assembly 38 to transmitter terminal 58 so that the state of switch assembly 38 can be determined by various electronic components 64 mounted on transmitter assembly 46. A hole can be provided in the top surface of sub-chassis 40 to allow wire interconnection 48 to pass from terminals 57 on switch assembly 38 to transmitter terminal 58.

Electronic components 64 include those components necessary to process a signal from switch assembly 38 into a signal for transmission to control panel 2. For example, transmitter assembly 46 may include a controller and a transmitter. The controller can be realized by a microprocessor or logic circuitry configured to process signals from switch assembly 38 and drive the transmitter to transmit sensor signals via a hard-wired or wireless medium. In particular, the controller may take the form of an application specific integrated circuit (ASIC) having circuitry arranged to provide processing and control of flow condition signals. One example of a suitable

wireless transmitter assembly is disclosed in U.S. Patent No. 4,855,713 to Robert Brunius. Transmitter assembly 46 may be provided with a local power source, such as battery 60, mounted in battery holder 62, or may be powered by wire connection to an external power source. Transmitter assembly 46 thus may consist of a number of components gathered together as a module, and may further be connected to other portions of detector 10 to create a larger module.

The controller associated with transmitter assembly 46 preferably is configured to transmit an identification code with each sensor signal. The identification code identifies the particular flow detector 10. In this manner, multiple flow detectors can be hard-wired to common terminals associated with a control panel. Alternatively, a number of wireless flow detectors can be used in common monitoring area. The identification codes are unique to each transmitter, and serve to differentiate sensor signals received from different flow detectors.

The identification code permits the control panel to associate the sensor signal with a particular sensor, monitoring zone, or monitoring function, and thereby ascertain the nature of the flow condition. The identification code may take the form, for example, of an n-bit code that is generated according to a pseudo-random function either at the factory or in the field. Upon installation, a technician causes the control panel to learn or "enroll" the identification codes for flow detectors coupled to its terminals, as will be explained.

Cover 66 may be provided to protect the components of detector 10. Cover 66 may be sized to fit over sub-chassis 40 and transmitter assembly 46, and may have a generally concave shape to permit easy placement and removal. Cover 66 may have a peripheral bottom portion that fits over a peripheral bottom portion of sub-chassis 40. The bottom portion of cover 66 may be formed to seal tightly against the peripheral bottom portion of sub-chassis 40. Alternatively, cover 66 an be attached directly to base 30. In either case, cover 66 is attached directly or indirectly to base 30 to define an enclosure. Cover 66 can be made, for example, from metal, plastic, fiberglass, or other durable materials.

Cover 66 may be connected to sub-chassis 40 with two to four button-head screws 68. Button-head screws 68 are received into anchor bosses 45 formed in sub-chassis 40. Inserts 44 are provided within anchor bosses 45 and may be threaded to accept button-head screws 68. Inserts 44 may be molded and formed from 8-32 brass, or from other suitable material. Holes 69 in cover 66 receive button-head screws 68. When button-head screws 68 are tightened, their heads rest against the perimeter of holes 69, thus pulling cover 66 tightly against sub-chassis 40. Inserts 44 are also pulled upward inside anchor bosses 45, thus forming a tight fit between cover 66 and sub-chassis 40.

Because sub-chassis 40 may be tightly connected to base 30, cover 66 may also be pulled down tightly against base 30 when it is connected to sub-chassis 40. In the same manner, both cover 66 and sub-chassis 40 may be pulled tightly against gasket 32 and seal detector 10. O-ring seals 70 may be provided at the tops of anchor bosses 45 to produce a tight seal between cover 66 and sub-chassis 40 where button-head screws 68 pass through cover 66 and sub-chassis 40. Alternatively, a gasket may extend around the periphery of sub-chassis 40 and provide holes for passage of screws 68.

In addition to the various processing electronics, transmitter assembly 46 may include a tamper sensor in the form of a tamper switch 63. As shown in FIG. 2, tamper switch 63 may include a spring-biased plunger 65 that extends upward to engage the inside of cover 66. In particular, tamper switch 63 can be positioned via sub-chassis 40 such that plunger 65 contacts an interior surface of the upper side 67 of cover 66. When cover 66 is attached to base 30, it defines an enclosure for transmitter assembly 46, switch assembly 38, and the other components mounted to the base.

Upon attachment, the interior surface of upper side 67 engages plunger 65 and depresses it against the spring bias. In turn, plunger 65 engages or disengages conductive contacts within tamper switch 63 to indicate a normal condition. When cover 66 is removed, the spring bias forces plunger 65 outward to cause engagement or disengagement of the conductive contacts. In response to removal of cover 66, tamper switch 63 changes states to indicate a tamper condition. Tamper switch 63

communicates the tamper condition to electronic components 64 on transmitter assembly 46. In response, the transmitter electronics associated with transmitter assembly 46 transmit a tamper signal to control panel 2. The tamper signal, like the flow signals, includes the identification code assigned to the detector.

Sub-chassis 40 provides a number of advantages. In particular, sub-chassis 40 is arranged to substantially avoid contact with switch assembly 38 and movable element 36, which form the flow condition sensor. Thus, transmitter assembly 46 can be readily added to detector 10 without significantly changing the design of the flow condition sensor or impacting its performance. Sub-chassis 40 can reduce the design costs associated with detector 10, and facilitate qualification of the detector with appropriate regulatory authorities. Sub-chassis 40 also provides clearance for access to switch assembly 38 in the event maintenance, testing, or rework is necessary. Moreover, sub-chassis 40 can be mounted to base 30 simply by using screws 42.

As a further advantage, sub-chassis 40 permits transmitter assembly 46 to be mounted in a fixed relationship with base 30. When cover 66 is removed from base 30, transmitter assembly 46 remains on the base. In this manner, cover 66 can be removed from base 30 independently of transmitter assembly 46. Consequently, cover 66 is not constrained by wires extending between transmitter assembly 46 and switch assembly 38 nor any other structure joining the cover and base 30. Instead, cover 66 can be removed and completely separated from base 30 to facilitate maintenance, testing, or rework of detector 10. Sub-chassis 40 permits transmitter assembly 46 to accommodate different cover and flow sensor configurations without redesign.

Also, sub-chassis 40 permits electric terminals 58 on transmitter assembly 46 to be substantially fixed relative to electric terminals 57 on switch assembly 38. Thus, when cover 66 is removed from base 30, the terminals 58 of transmitter assembly 46 and terminals 57 of switch assembly 38 remain fixed relative to one another, avoiding stress and fatigue to wire interconnection 48. Consequently, this substantially fixed arrangement preserves the integrity and reliability of wire interconnection 48, promoting reliable operation and longevity of detector 10. Transmitter assembly 46

can be incorporated in detector 10 without disturbing existing hardware, such as switch assembly 38. In this manner, it may be possible to minimize requalification and testing of detector 10 by regulatory authorities.

At the same time, sub-chassis 40 serves to maintain tamper switch 63 at a substantially fixed position relative to base 30. Tamper sensor 63 and cover 66 have a substantially fixed relationship when the cover is attached to base 30. This relationship is fixed without regard to changes in the configuration of switch assembly 38. Thus, switch assemblies having different dimensions or other structural differences will not impact the ability of tamper switch 63 to interact in a consistent manner with cover 66. With this configuration, proper engagement of plunger 65 and interior surface 67 of cover 66 is assured, improving the integrity of the tamper sensor. For other switch configurations, e.g., in which the length of plunger 65 is greater or the plunger engages different surfaces within cover 66, sub-chassis 40 can provide similar advantages in terms of maintaining a consistent spatial relationship between tamper switch 63 and the cover.

Detector 10 can be enrolled in a detection system by identifying it to the system. Enrollment allows the system to recognize later flow and tamper signals transmitted by detector 10, even though other detectors may be coupled to the same terminals at the control panel. For this purpose, electronic components 64 may include an electronic memory device, such as EEPROM, that carries an identification code useful in identifying detector 10. Again, the identification code can be factory-programmed in the electronic memory device, or set in the field by a technician, e.g., using dip switches, handheld programmers, and the like. In this manner, the system can verify the identity and, in most cases, the location or monitoring function of the particular detector. An example of a system in which remote sensors are enrolled, or "learned," by a system control panel is disclosed in U.S. Patent No. 4,885,713, to Brunius. A process as described in the Brunius patent can be adapted for use in a system as described herein.

One way in which detector 10 may be enrolled is by sending an enrollment signal from transmitter assembly 46 to a control panel 2 in response to a user-initiated

stimulus applied to detector 10. The enrollment signal, as well as other signals transmitted by detector 10, preferably include the identification code associated with the detector. The enrollment mode can be initiated in a number of different ways. For example, inducing flow in a pipe so that detector 10 generates a trigger signal could be used to enroll detector 10. However, access to pipe 12 ordinarily will be restricted following installation of detector 10. Alternatively, a trigger signal could be generated by removing cover 66 to activate tamper switch 63. Removal of cover 66, particularly when installing many detectors at the same time, can be cumbersome.

To avoid the need to access pipe 12 or remove cover 66, detector 10 may include an enrollment device that makes use of either a dedicated switch or a switch that is integrated with an existing switch within detector 10 such as a switch associated with the flow condition sensor or tamper switch 63. In either case, the enrollment device can be made responsive to a dedicated enrollment event in the form of a user-initiated condition. An enrollment signal generated by transmitter assembly 46 could be the same as an ordinary trigger signal generated by transmitter assembly 46, or it could be different. The enrollment event could involve actuation of a switch associated with the enrollment device, either directly or indirectly.

As an example, a reed switch could be magnetically actuated from outside of detector 10 to initiate an enrollment mode. Alternatively, the enrollment device could take the form of a radio frequency receiver that is responsive to a user-initiated stimulus in the form of a radio frequency signal. As a further alternative, the enrollment device could take the form of a switch that extends through and is accessible from outside of cover 66, such that the stimulus includes manual actuation of the switch. The use of acoustic sensors for vibration or shock are also contemplated. In addition, detector 10 could be configured to transmit an enrollment signal upon power-up, e.g., upon installation of a battery or connection of another power source to the detector. In any event, it is desirable that removal of cover 66 not be necessary for enrollment. An exemplary enrollment device will be described in greater detail with reference to FIG. 9.

The various parts of detector 10 can be produced from any material that is suitable for the particular application. For example, cover 66 can be a die-cast metal, sheet metal, or cast aluminum. For wireless radio frequency communications, however, cover 66 preferably is made from a generally non-conductive material such as molded plastic. Likewise, cover 66 can be formed from a polycarbonate material to avoid attack or abuse from chemicals. Cover 66 can also be formed from textured polycarbonate to provide the detector with a cast aluminum look. In addition, cover 66 can be red in color to identify the detector as a fire protection sensor. The sub-chassis may be formed from ABS material or any other suitable material.

The embodiment shown in FIG. 2 permits easy assembly and servicing of the detector. For assembly, switch assembly 38 may first be attached to base 30, and wire interconnection 48 may be attached to the terminals on switch assembly 38. Sub-chassis 40 may then be attached to base 30. Transmitter assembly 46 may be connected to wire interconnection 48, and may be snapped into place on the top of sub-chassis 40. Transmitter assembly 46 could also be attached to base 30 in any other suitable location. Cover 66 may then be slid into place over sub-chassis 40, and is guided by the tapered edges of sub-chassis 40. Sub-chassis 40 therefore protects switch assembly 38 and transmitter assembly 46 when cover 66 is moved into place. For servicing, cover 66 may be removed, and sub-chassis 40 may provide easy access to the components of detector 10.

Referring to FIGS. 3 and 4, which show an assembled detector 10, movable element 36 may be positioned to extend downward from the center of sleeve 34, which is connected to base 30. Gasket 32 may be provided on top of base 30 and may form a seal between sub-chassis 40 and base 30. Button-head screws 68 hold cover 66 tight to sub-chassis 40 and thereby hold cover 66 tight against gasket 32 and base 30. Screws 68 can be keyed to require a special tool for removal, thereby making detector 10 more resistant to tampering.

FIG. 5 shows a section view taken along section line 1-1' in FIG. 4. Movable element 36 is shown extending from the center of sleeve 34, which is attached to base 30. Base 30 may be L-shaped in cross section to provide a mounting surface for

detector 10. Base 30 may also be provided with holes in its horizontal surface (not shown) for accepting the ends of a U-shaped mounting bracket that wraps around the pipe to which detector 10 is mounted. Holes for the mounting bracket may be provided on opposite sides of base 30, and the mounting bracket may have threaded portions which extend through those holes and are provided with mounting nuts that can tighten detector 10 to the pipe.

Cover 66 may be mounted on base 30 and gasket 32. Cover 66 may fit over sub-chassis 40, and thereby enclose the components of the detector. Mounting bracket 82 may be connected to base 30 and provide a structure to which switch assembly 38 may be mounted. A gap may be provided between the inside of cover 66 and the top of sub-chassis 40, to provide space for transmitter assembly 46. A space of 0.25 inch is adequate between transmitter assembly 46 and cover 66, but a smaller space may permit the detector 10 to have a lower height. Raised mount 50 holds transmitter assembly 46 away from the top of sub-chassis 40 and mounting hook 52 maintains transmitter assembly 46 in place.

Transmitter assembly 46 may receive power from outside of detector 10 through wires (not shown), or receive power internally from a power supply, such as battery 60 mounted in battery holder 62. Transmitter terminal 58 receives signals from switch assembly 38 through an electrical interface, such as wire interconnection 48. Wire interconnection 48 is connected at one end to terminals 80 associated with the switches in switch assembly 38 and at the other end to transmitter terminal 58. The embodiment illustrated by FIGS. 2-8 includes a switch assembly 38 having two switches combined with a movable element to sense flow, but any adequate flow sensor or combination of flow sensors is contemplated by the present invention. In the illustrated embodiment, a first switch may be provided to send a signal to transmitter assembly 46. A second switch may be provided to send a fluid flow signal elsewhere. For example, a second switch could be wired to a local annunciator, e.g., light, siren, buzzer, to provide an alarm near the detector. Alternatively, the second switch could be provided for redundancy in the event one of the switches fails. In many applications, use of a single switch may be acceptable.

As a further alternative, the second switch could be used to integrate an enrollment or test device with switch assembly 38. For example, magnetic actuation of both of the switches in switch assembly 38 could be used to differentiate an enrollment or test mode from the sensing of a flow condition. Specifically, switch assembly 38 could be arranged such that actuation of the movable element engages or disengages the contacts of a first switch but not the second switch to indicate a flow condition. Switch assembly 38 could be further arranged such that application of a magnet from the exterior of cover 66 engages or disengages the contacts associated with both switches to indicate an enrollment or test mode and differentiate it from a flow condition sensing mode. Application of the magnet provides a user-initiated condition, separate from tamper and flow condition events, for activation of the enrollment or test mode. Enrollment and testing will be discussed in greater detail with reference to FIG. 9.

FIG. 6 is a section view taken along line 4-4' in FIG. 5. Movable element 36 is shown extending from sleeve 34, which is attached to base 30. Holes 88 in base 30 may serve as anchor points for connecting mounting hardware for detector 10. Sub-chassis 40 may be connected, whether directly or indirectly, to base 30, and cover 66 may be connected to sub-chassis 40. Gasket 32 may be interposed between the top of base 30 and the bottom edges of sub-chassis 40 and cover 66, to provide a tight seal. In some embodiments, two gaskets may be provided, one between base 30 and sub-chassis 40 and the other between sub-chassis 40 and cover 66.

As further shown in FIG. 6, a tamper switch provides a plunger 65 that extends upward from transmitter assembly 46. A spring may be mounted on the plunger for engagement with an interior surface of cover 66. Plunger 65 is biased outward, but is pushed inward against the bias when cover 66 is attached to base 30, i.e., when cover 66 bears inward against the spring mounted on plunger 65. When cover 66 is removed, the spring is partially released and plunger 65 extends outward, changing the state of the tamper switch to indicate a tamper condition.

Switch assembly 38 may be connected to mounting bracket 84, and may be electrically connected to transmitter terminal 58 by wire interconnection 48.

Transmitter assembly 46 may be mounted in the space between cover 66 and the top of sub-chassis 40. Transmitter assembly 46 is separated from the top of sub-chassis 40 by raised mount 50, and is held in place by mounting hook 52. Transmitter assembly 46 may be powered by battery 60 mounted in battery holder 62.

FIG. 7 shows, in detail, the connection between cover 66, sub-chassis 40, and base 30 for the embodiment shown in FIGS. 2-6. Gasket 32 may be disposed on top of base 30 and may form a mounting pad for cover 66 and sub-chassis 40. Button-head screw 68 extends through a hole in cover 66 and secures to insert 44, thereby pulling cover 66 and sub-chassis 40 into tight contact. O-ring seal 70 may be provided around the top periphery of anchor boss 45 on sub-chassis 40, to seal cover 66 tightly to sub-chassis 40.

A crush rib may be provided on cover 66 under the head of button-head screw 68 to seal the head of button-head screw 68 tightly to cover 66. Cover 66 may also be provided with a rib 90 along its lower periphery to form a tight seal with gasket 32. Inserts 44 may be sized so as to allow full pressure to be exerted on gasket 32. The combination of gasket 32, which may form a full bottom seal, slide O-rings 92, and crush ribs may function together to produce a full sealing housing. The seals may be designed to provide for sealing to a six foot submersion level.

FIG. 8 shows, in detail, the connection between sub-chassis 40 and base 30, for the embodiment shown in FIGS. 2-6. Again, gasket 32 may be disposed between base 30 and cover 66 to provide a tight seal. Button-head screw 42 extends through a hole in sub-chassis 40 and engages the threads in a hole in base 30. Button-head screw 42 therefore tightens chassis 40 to base 30. Button-head screw 68 in turn tightens cover 66 to sub-chassis 40. In this manner, cover 66 may be connected to base 30.

FIG. 9 is functional block diagram illustrating a system 94 for detection of alarm, tamper, enrollment, and test mode stimuli for use with a detector 10 in accordance with the present invention. System 94 may incorporate the control and processing circuitry described above with reference to FIG. 2. As shown in FIG. 9, for example, system 94 may include control circuitry 96, a transmitter 98, and control

panel 100. Such components may be housed within cover 66 and form part of transmitter assembly 46, with the exception of control panel 100 which is located remotely from transmitter 98. Control circuitry 96 may take the form of a microprocessor or logic circuitry configured to process sensor signals and control transmitter 98 to transmit appropriate signals to control panel 100. In particular, control circuitry 96 can be configured to process flow condition signals, battery status signals, and tamper signals.

In the example of FIG. 9, an enrollment and test device is integrated with a flow condition sensor 102. The enrollment device could be integrated, however, with tamper switch 63. With reference to FIG. 9, flow condition sensor 102 includes a first switch 104 and a second switch 106 coupled to inputs 108 and 110, respectively, of control circuitry 96. In this example, switches 104, 106 may form part of a common switch assembly such as switch assembly 38 shown in FIG. 2. Switch 104 may comprise a set of switch contacts that are engaged or disengaged relative to one another upon movement of movable element 36. In this manner, movable element 36 opens or closes switch 104, coupling input 108 of control circuitry 96 to ground and thereby indicating a flow condition, e.g., fluid movement, pressure, or valve position.

Switch 106 is not actuated by movable element 36. Instead, switch 106 comprises a set of switch contacts that are engaged or disengaged relative to one another in response to application of a magnetic field or change in an applied magnetic field from outside of cover 66. In this manner, switch 106 can be used as an enrollment device. Although the enrollment mode could be initiated via a dedicated switch that is separate from flow condition sensor 102, integration of enrollment switch 106 with flow condition switch 104 is advantageous. Specifically, enrollment switch 106 can perform the dual function of initiating detector enrollment and providing a testing capability. Once detector 10 has been enrolled, switch 106 can be used thereafter to test detector 10.

Integration of switch 106 with sensor 102 enables the test signal to be transmitted along essentially the same electrical signal path used for transmission of a flow condition signal. The electrical signal path from switch 104 can be made

responsive to enrollment or testing, for example, by placing a magnetic reed switch 107 in parallel with it. When switch 104 is actuated by movable element 36, a water flow condition is indicated. When the magnetic reed switch 107 is placed in parallel with switch 104, magnetic actuation of that switch provides a testing event. Thus, like enrollment, the testing mode can be initiated by application of a magnetic field or change in a magnetic field applied from outside of cover 66. As a result, removal of cover 66 is not necessary. Control circuitry 96 is capable of differentiating between test/enrollment modes and a flow condition mode by reference to the signals at inputs 108, 110. If only input 108 changes state, control circuitry 96 determines that a switch 104 has been closed and that a flow condition exists, and controls transmitter 98 to transmit a flow condition signal to control panel 100. In this case, switch 104 has been actuated by movable element 36. If both inputs 108, 110 change state, e.g., by application of a magnetic field that actuates both sets of contacts at switch 106 and switch 107, control circuitry recognizes either the enrollment or test mode, by reference to the signal present at both inputs, instead of just input 108.

If input 110 is connected to ground by closure of switch 106, in addition to connection of input 108 to ground by closure of switch 104, control circuitry 96 determines that despite the receipt of a flow condition signal at input 108, the proper mode is testing or enrollment. Inputs 108, 110 may be normally high. If only input 108 is connected to ground, then control circuitry 96 determines that a flow condition has occurred. In this manner, control circuitry 96 is capable of controlling transmitter 98 to send an appropriate signal. When both inputs 108, 110 are connected to ground by closure of switches 106, 107, control circuitry 96 identifies an enrollment or test mode and uses the same electrical signal path used for a flow condition to drive transmitter 98. The enrollment, test, and alarm (flow condition or tamper) signals can be transmitted by transmitter 98 as a series of bits in a packet. Control circuitry 96 may set or reset one bit in the transmission, however, to indicate that the transmission is not a flow condition transmission, but rather a test or enrollment mode transmission. Control panel differentiates between a test or enrollment mode by determining whether detector 10 has already been enrolled, e.g., by reference to the identification code associated with the detector and transmitted with the signal. Thus,

the test and enrollment mode signals can be identical in form, differing only in context.

In a test mode, control panel 100 verifies proper operation upon receipt of the test signal from transmitter 98. In an enrollment mode, control panel 100, upon receiving an identity code for the first time, writes the code into a storage location in a memory associated with the control panel. Thereafter, the identity code is accessed prior to responding to any later received transmissions, to thereby correlate the transmissions with the appropriate detector 10. Enrollment normally occurs during installation of detector 10, but may occur later in the event control panel 100 is not immediately installed.

As further shown in FIG. 9, control circuitry 96 may be responsive to both a level of battery 112, which powers transmitter assembly 46 and electronic components 64, and tamper sensor 116. Input 114 of control circuitry 96 monitors the level of battery 112 either directly or via intermediate comparator circuitry. When the level of battery 112 is low, control circuitry 96 controls transmitter 98 to transmit a low battery signal to control panel 100. On this basis, control panel 100 provides notification that battery 112 requires replacement. When tamper switch 63 is actuated, e.g., by removal of cover 66, input 118 is connected to ground. In response, control circuitry 96 controls transmitter 98 to transmit a tamper signal to control panel 100.

FIG. 10 is a section view taken along line 4-4' in FIG. 5 showing an alternative tamper sensor arrangement. As in the embodiment illustrated in FIGS. 1-8, the tamper sensor is mounted at a substantially fixed position relative to base 30. In the example of FIG. 10, detector 10 incorporates a tamper sensor having a first component in the form of a magnetically actuated switch 122 mounted on sub-chassis 40 and a second component in the form of a magnet 124 mounted on an interior surface of cover 66. Alternatively, the first component mounted on sub-chassis 40 may take the form of a magnet, with the second component on cover 66 being a magnetically actuated switch. In this latter case, the switch would be wired to transmitter assembly 46. Switch 122 and magnet 124 are arranged adjacent one

another when cover 66 is attached to base 30, such that the magnet magnetically interacts with contacts within the switch. Switch 122 may comprise, for example, a conventional reed switch. Upon removal of cover 66, magnet 124 is displaced from switch 122. As a result, the contacts within switch 122 change state, indicating a tamper condition. The tamper condition is transmitted to a processor associated with transmitter assembly 46, which controls the transmitter assembly to transmit a tamper signal to control panel.

FIG. 11 is a section view taken along line 4-4' in FIG. 5 showing an alternative cover arrangement. As shown in FIG. 11, detector 10' incorporates a tamper sensor arrangement corresponding to that of FIG. 10. The cover 66' is arranged differently, however, in the embodiment of FIG. 11. Specifically, the cover includes a wall 126 that extends about a periphery of base 30, defining a continuous side wall. Wall 126 can be integrated with or attached to sub-chassis 40. Wall 126 defines an opening 127 toward the top of detector 10'. The cover 66' further includes a cover plate 128 that mounts to wall 126 to cover opening 127. Cover plate 128 can be mounted to wall 126, for example, via screws 130, 132 that engage a lip 134 defined by wall 126. In this embodiment, cover plate 128 may carry a portion of the tamper sensor, e.g., magnet 124, at a position opposite magnetically actuated switch 122. Thus, when cover plate 128 is removed from wall 126, switch 122 indicates a tamper condition.

FIG. 12 is a section view taken along line 4-4' in a view as shown in FIG. 5 showing a detector 10'' with another alternative cover arrangement. In the example of FIG. 12, detector 10'' conforms substantially to detector 10 of FIGS. 1-9, but incorporates an alternative interface between cover 66, a sub-chassis 40', and a base 30'. In particular, sub-chassis 40' incorporates a central mounting pedestal 136 that extends upward within the interior defined by cover 66 to support transmitter assembly 46. Pedestal 136 may be two- or four-sided. Sub-chassis 40' defines a hollowed lower recess for receipt of base 30'. A gasket 140 separates the lower portion of sub-chassis 40' from the lower portion of cover 66, which may be coupled to one another with screws 68 at opposite sides. A gasket 142 may separate base 30' from the interior surface of sub-chassis 40'. Screw holes 144 can be provided for coupling sub-chassis 40' and base 30'. Thus, detector 10'' has a three-part

construction in which the lower portion of sub-chassis 40' separates cover 66 from base 30', along with gaskets 140 and 143.

It is to be understood that while the invention has been described in conjunction with the detailed description thereof, the foregoing description is intended to illustrate and not limit the scope of the invention, which is defined by the scope of the appended claims. Other aspects, advantages, and modifications are within the scope of the following claims.

CLAIMS:

1. A detector comprising:

a base;

a cover for attachment to the base to define an enclosure;

a flow condition sensor, mounted within the enclosure, that senses a flow condition within a pipe; and

a wireless transmitter that transmits a signal indicative of the sensed flow condition, the transmitter being mounted to the base such that the cover is removable from the base independently of the transmitter.

2. The detector of claim 1, further comprising a mounting platform extending from the base, the transmitter being mounted on the mounting platform at a substantially fixed position relative to the base.

3. The detector of claim 2, wherein the mounting platform is arranged to substantially avoid contact with the flow condition sensor.

4. The detector of claim 1, further comprising a tamper sensor that senses tampering with the detector, the transmitter transmitting a tamper signal when the tamper sensor senses tampering with the detector, wherein the tamper sensor is mounted at a substantially fixed distance relative to the base.

5. The detector of claim 4, wherein the tamper sensor is mounted on the mounting platform with the transmitter, the mounting platform maintaining the tamper sensor at a substantially fixed position relative to the cover when the cover is attached to the base.

6. The detector of claim 4, wherein the flow condition sensor includes a sensor assembly disposed within the enclosure defined by the cover and the base, and the tamper sensor is mounted independently from the sensor assembly such that the relationship of the tamper sensor to the base is substantially unaffected by the dimensions of the sensor assembly.

7. The detector of claim 1, further comprising an enrollment device that stores an identification code associated with the detector, and causes the transmitter to transmit the code in response to an enrollment event.

8. The detector of claim 7, wherein the enrollment device is responsive to an enrollment event in the form of a user-initiated condition different from the flow condition.

9. The detector of claim 8, further comprising a tamper sensor that senses a tamper condition upon removal of the cover from the base, the transmitter transmitting a tamper signal when the tamper sensor senses removal of the cover, wherein the enrollment device is responsive to an enrollment event in the form of a user-initiated condition different from the flow condition and the tamper condition.

10. The detector of claim 9, wherein the user-initiated condition includes application of a magnetic field from outside of the cover, the enrollment device including a magnetically actuated switch that changes state upon application of the magnetic field, wherein the transmitter transmits the code when the state of the magnetically actuated switch changes.

11. The detector of claim 1, wherein the flow condition comprises at least one of fluid flow, fluid pressure, and flow hardware status.

12. A detector comprising:

a base;

a cover for attachment to the base to define an enclosure;

a flow condition sensor, mounted within the enclosure, that senses a flow condition within a pipe; and

a transmitter that transmits one or more signals indicative of the sensed flow condition and an identity of the detector.

13. The detector of claim 12, wherein the signals transmitted by the transmitter are hard-wired signals, the detector including signal transmission terminals for hard-wired connection to a control panel.

14. The detector of claim 12, further comprising a mounting platform extending from the base, the transmitter being mounted on the mounting platform at a substantially fixed position relative to the base such that the cover is removable from the base independently of the transmitter, wherein the mounting platform is arranged to substantially avoid contact with the flow condition sensor.

15. The detector of claim 12, further comprising a tamper sensor that senses tampering with the detector, the transmitter transmitting a tamper signal when the tamper sensor senses tampering with the detector.

16. The detector of claim 15, wherein the tamper sensor is mounted at a substantially fixed distance relative to the base.

17. The detector of claim 12, further comprising an enrollment device that stores an identification code associated with the detector, and causes the transmitter to transmit the code in response to an enrollment event.

18. The detector of claim 47, wherein the enrollment device is responsive to an enrollment event in the form of a user-initiated condition different from the flow condition.

19. The detector of claim 18, further comprising a tamper sensor that senses a tamper condition upon removal of the cover from the base, the transmitter transmitting a tamper signal when the tamper sensor senses removal of the cover, wherein the enrollment device is responsive to an enrollment event in the form of a user-initiated condition different from the flow condition and the tamper condition.

20. The detector of claim 19, wherein the user-initiated condition includes application of a magnetic field from outside of the cover, the enrollment device including a magnetically actuated switch that changes state upon application of the magnetic field, wherein the transmitter transmits the code when the state of the magnetically actuated switch changes.

21. The detector of claim 12, wherein the flow condition comprises at least one of fluid flow, fluid pressure, and flow hardware status.

22. A detector comprising:

a base;

a cover for attachment to the base to define an enclosure;

a sensor, mounted to the base, that senses a flow condition within a pipe;

a tamper sensor, mounted in a substantially fixed position relative to the base, that senses tampering with the detector; and

a transmitter, mounted within the enclosure, that transmits a signal in response to the sensed flow condition and a tamper signal when the tamper sensor senses tampering with the detector.

23. The detector of claim 22, further comprising a mounting platform extending from the base, wherein the tamper sensor and the transmitter are mounted on the mounting platform.

24. The detector of claim 23, wherein the mounting platform is arranged to substantially avoid contact with the flow condition sensor.

25. A detector comprising:

a base;

a cover for attachment to the base to define an enclosure;

a sensor that senses a flow condition within a pipe;

an enrollment device that senses a user-initiated condition different from the sensed flow condition; and

a transmitter that transmits a flow condition signal when the flow condition is sensed and an enrollment signal when the user-initiated condition is sensed, wherein the enrollment signal includes an identification code associated with the detector for enrolling the detector.

26. A detector comprising:

a base;

a cover for attachment to the base to define an enclosure;

a sensor that senses a flow condition within a pipe;

a testing device that senses a user-initiated condition different from the sensed flow condition; and

a transmitter;

a controller that controls the transmitter to transmit a flow condition signal when the flow condition is sensed and to transmit a test signal when the user-initiated condition is sensed, wherein the sensor and the testing device communicate with the controller along substantially the same electrical path.

27. A method for enrolling a detector in a detection system, wherein the detector includes a sensor that senses a condition within a monitored area, and a tamper sensor that senses a tamper condition indicative of tampering with the detector, the method comprising:

applying to the detector a stimulus different from the sensed condition and the tamper condition; and

transmitting an enrollment signal when the stimulus is sensed, the enrollment signal including an identification code associated with the detector for enrolling the detector.

28. A system for sensing flow conditions associated with one or more pipes, the system comprising:

a plurality of flow condition detectors having sensors that sense the flow conditions;

a plurality of transmitters, each of the transmitters being associated with one of the flow condition sensors, wherein the transmitters transmit signals indicative of the flow conditions; and

a control panel that receives the signals transmitted by the transmitters, wherein each of the signals includes an identity code designating one of the flow condition sensors.

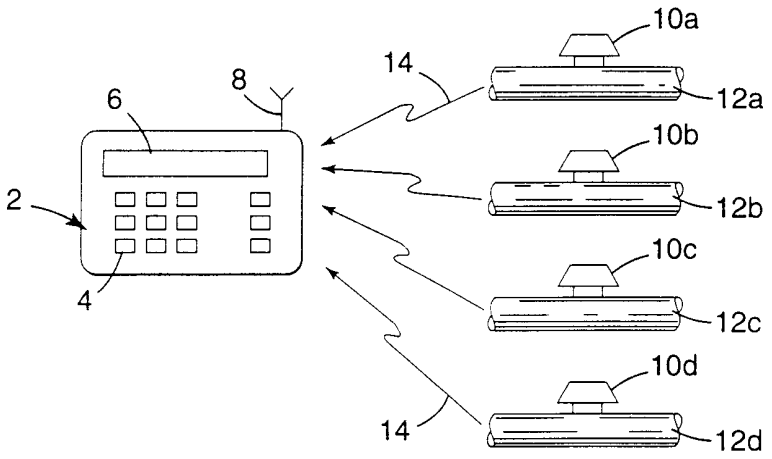
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Fig. 1A

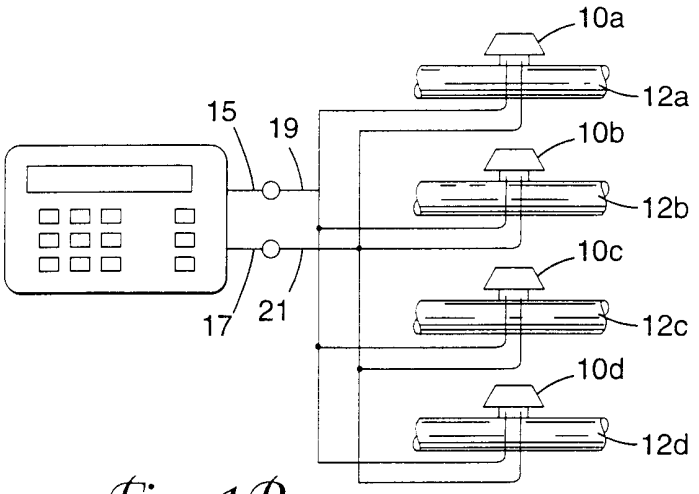
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Fig. 1B

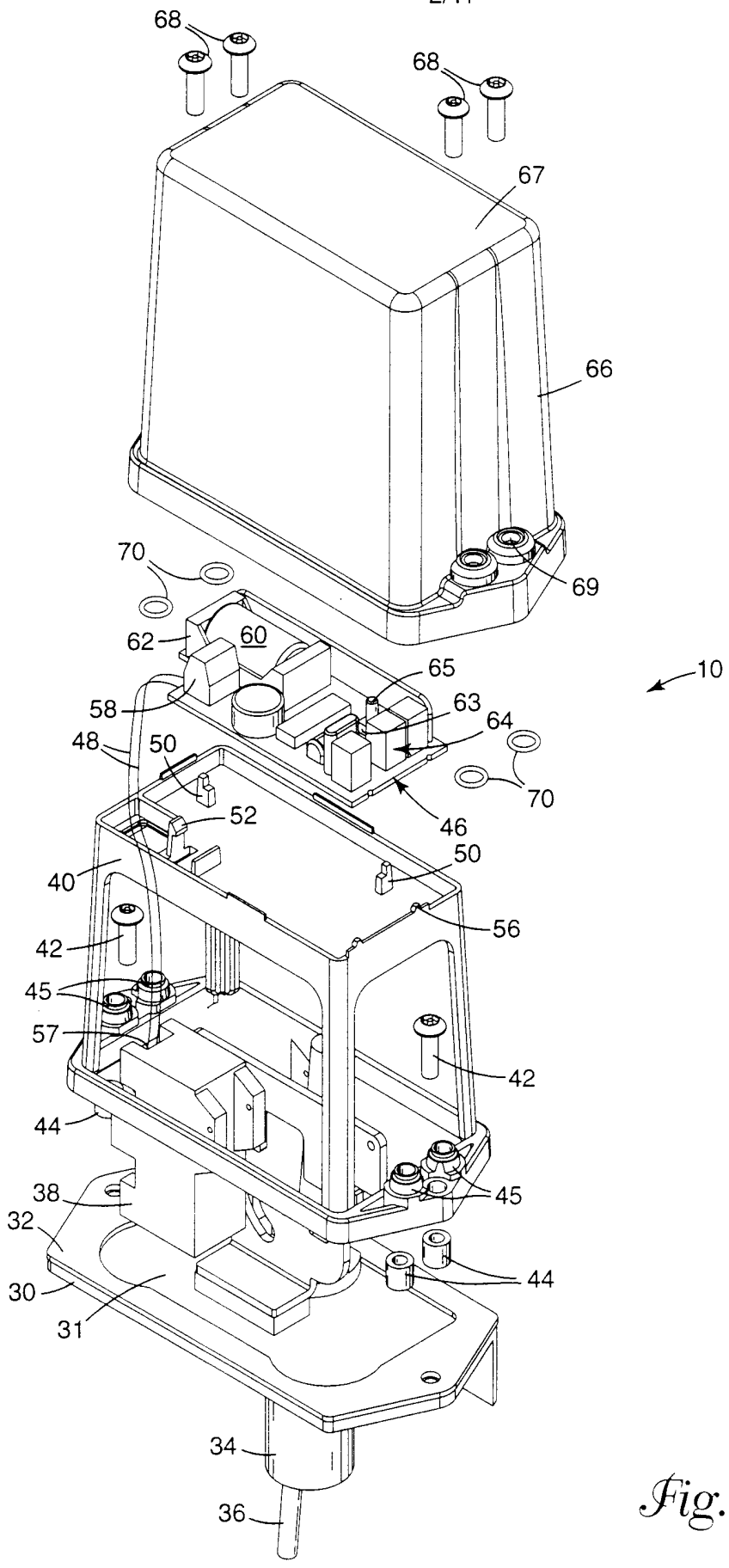
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Fig. 2

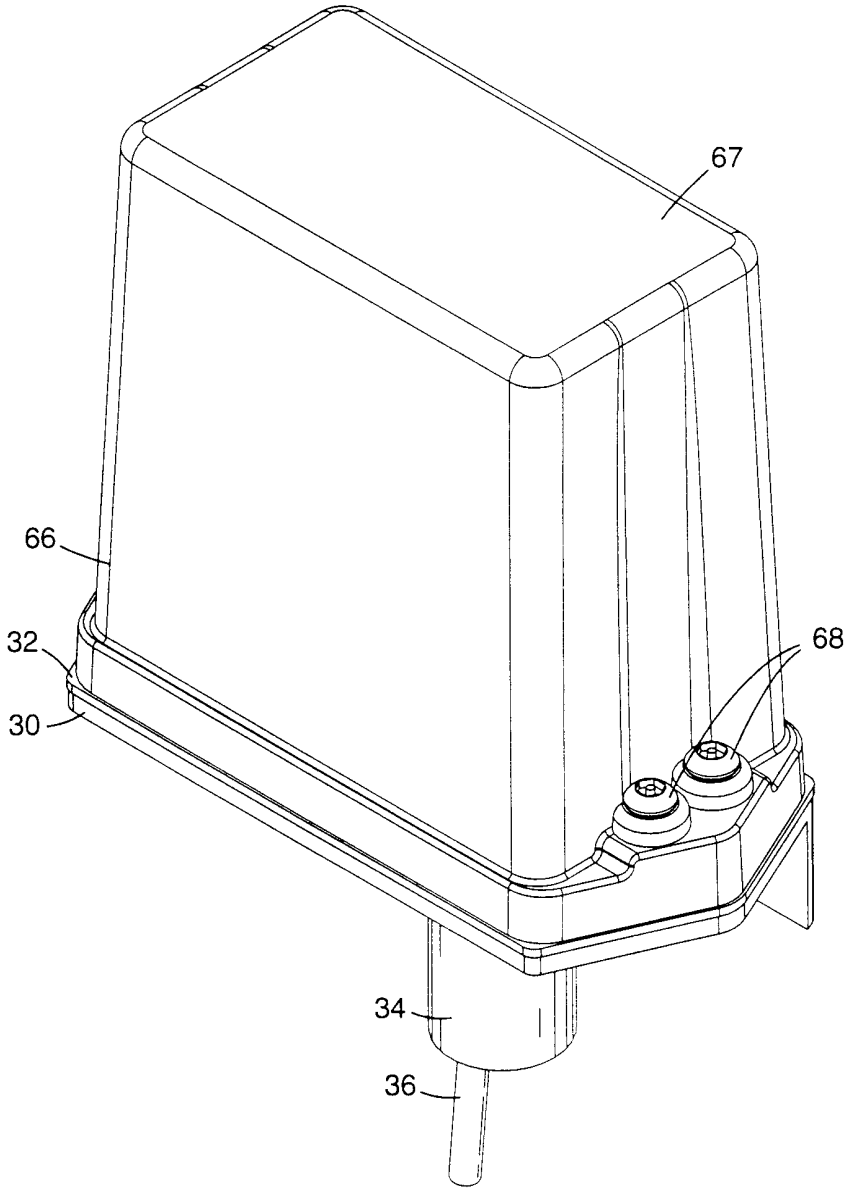


Fig. 3

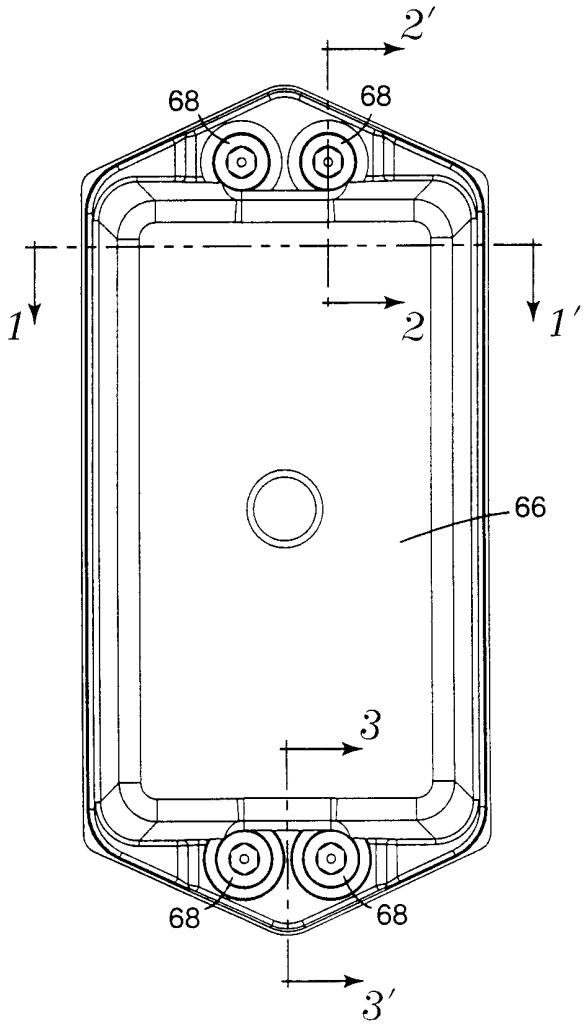


Fig. 4

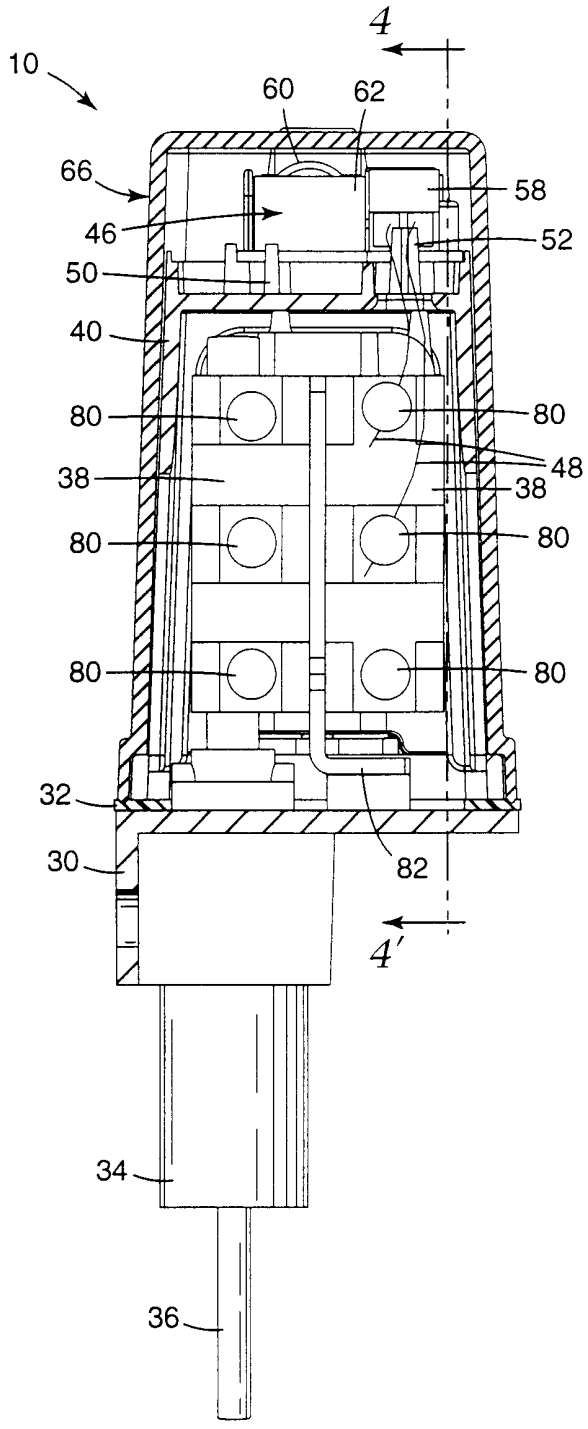


Fig. 5

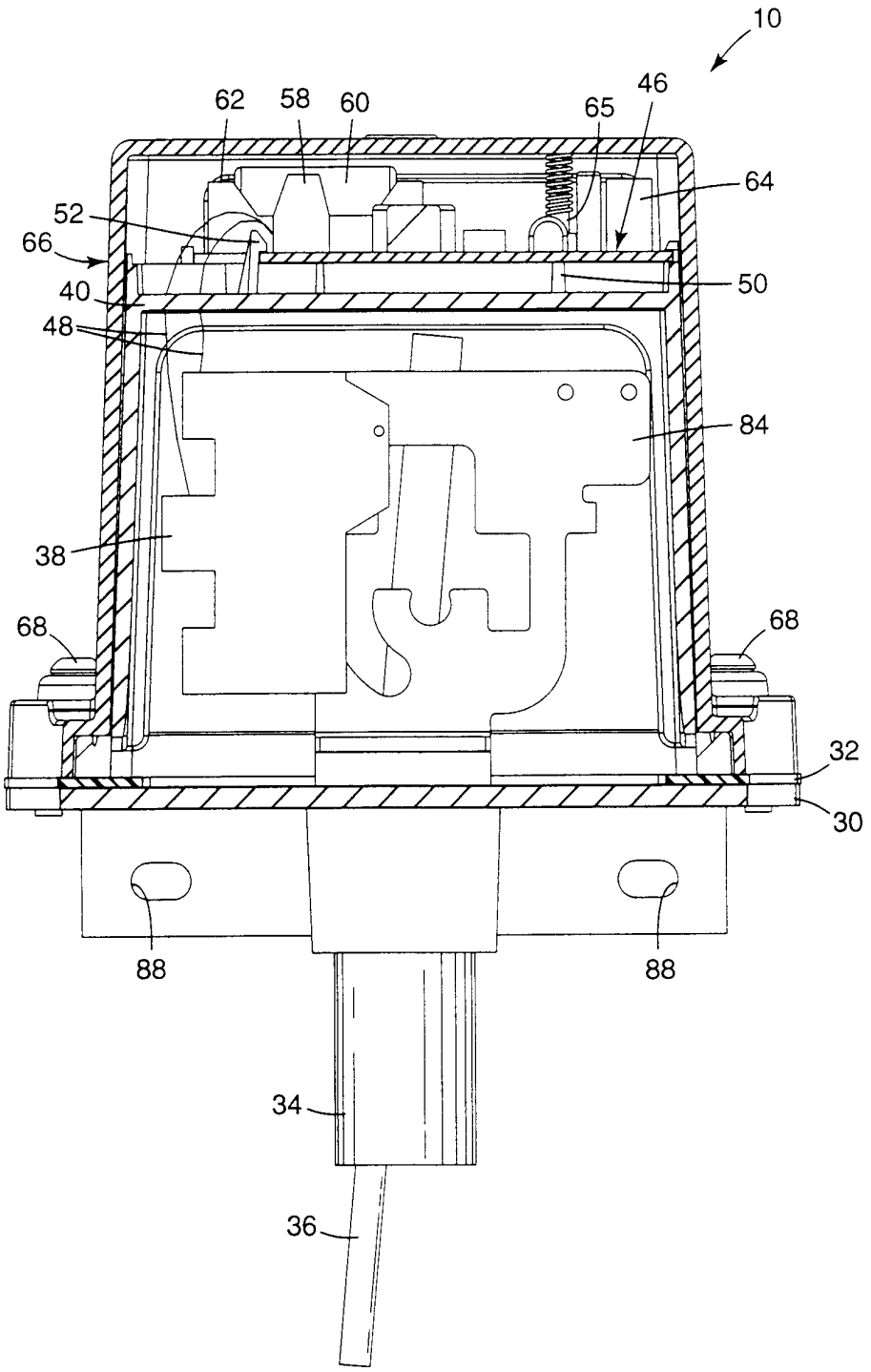


Fig. 6

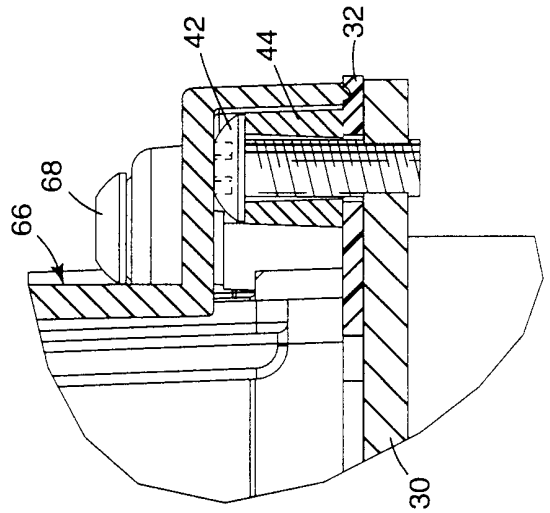


Fig. 8

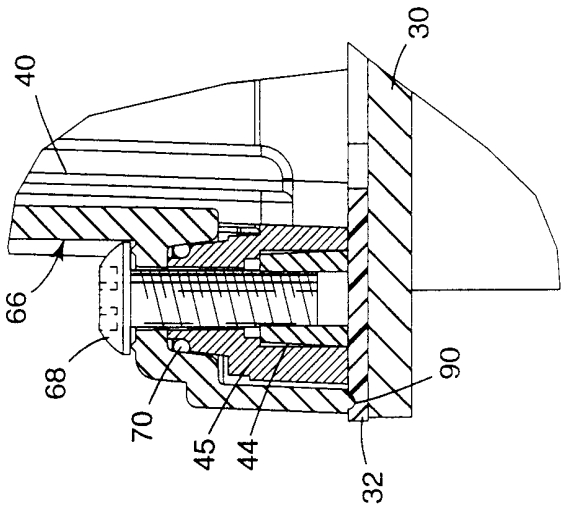
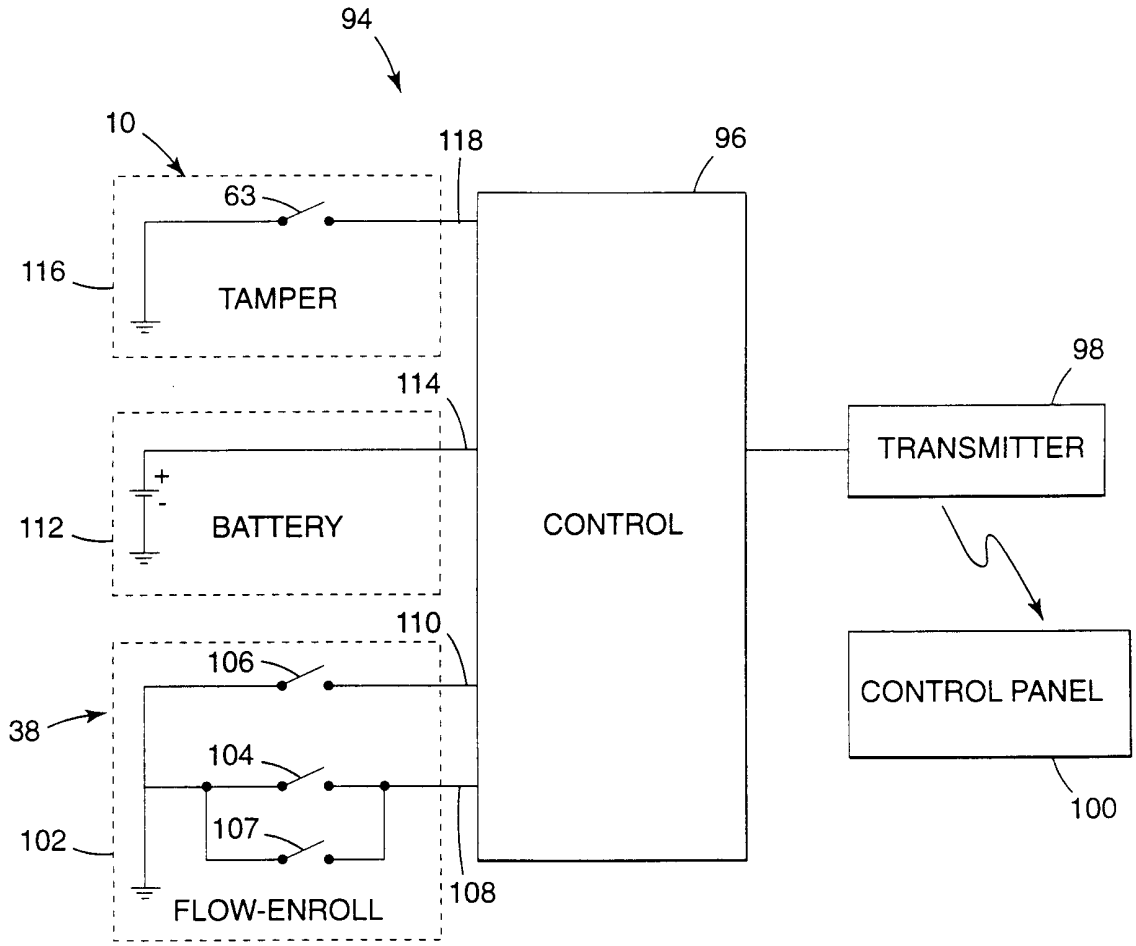


Fig. 7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TRANSMITTER
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CONTROL PANEL
38
104
107
102
100
FLOW-ENROLL
108

Fig. 9

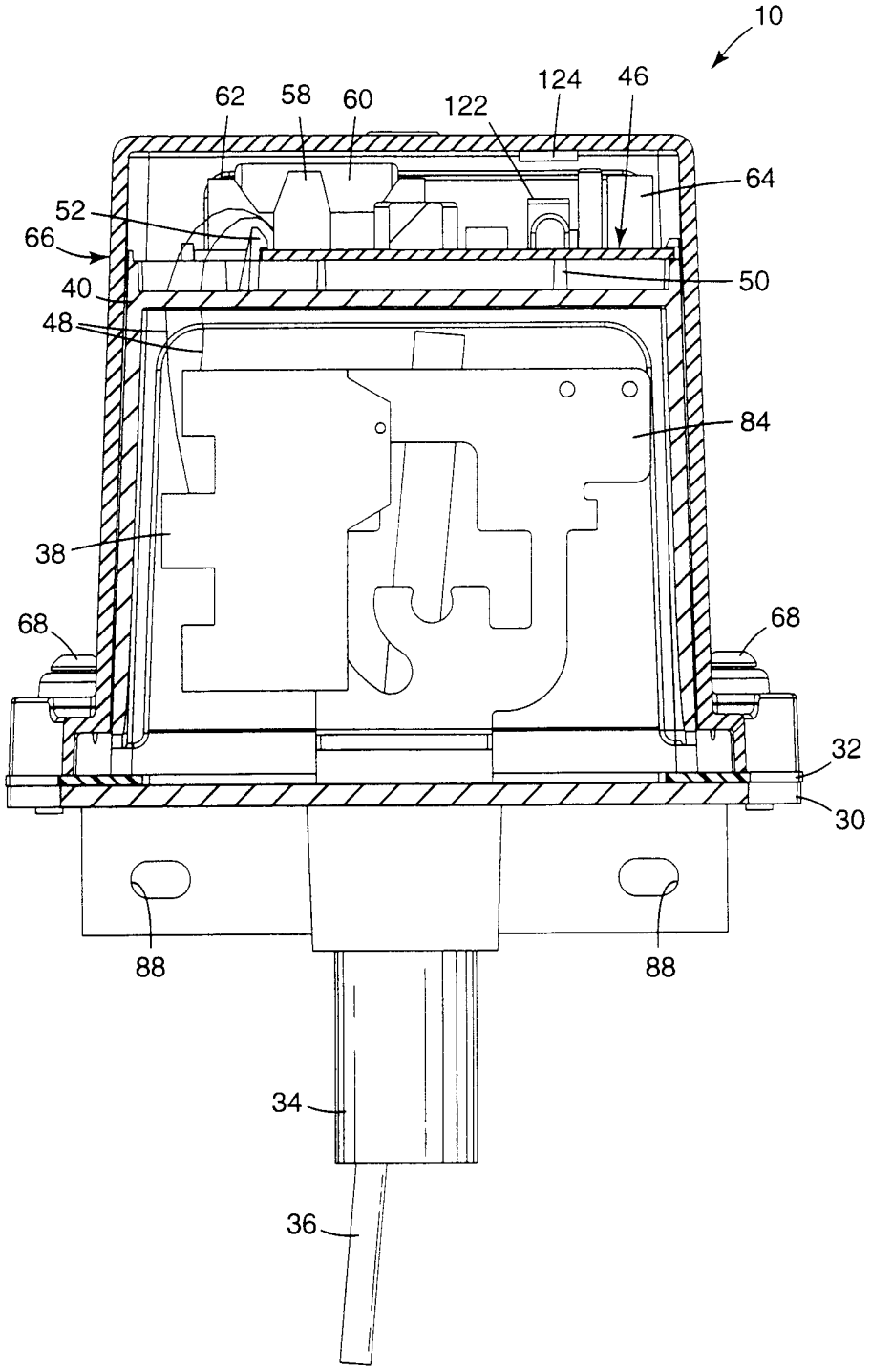
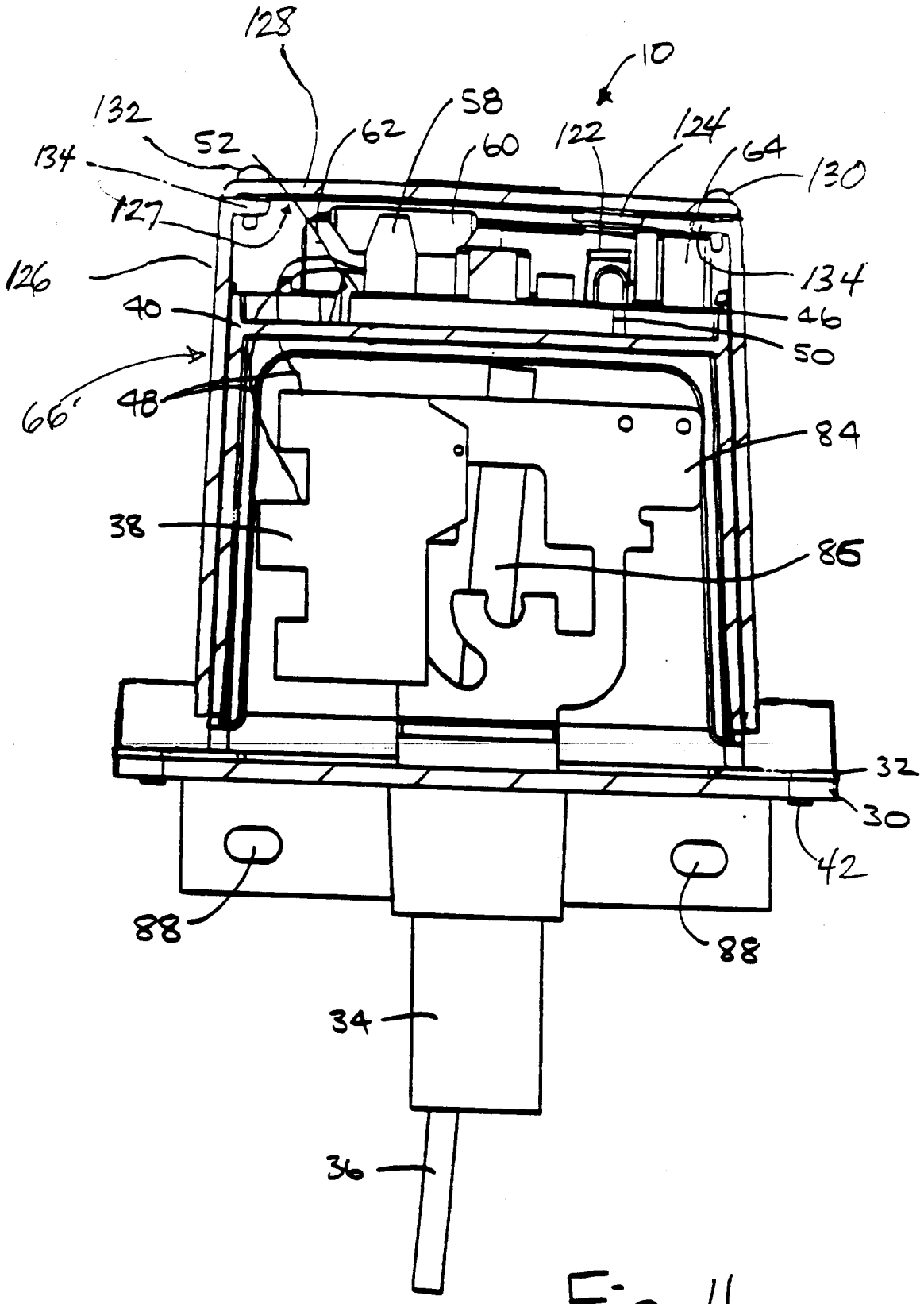


Fig. 10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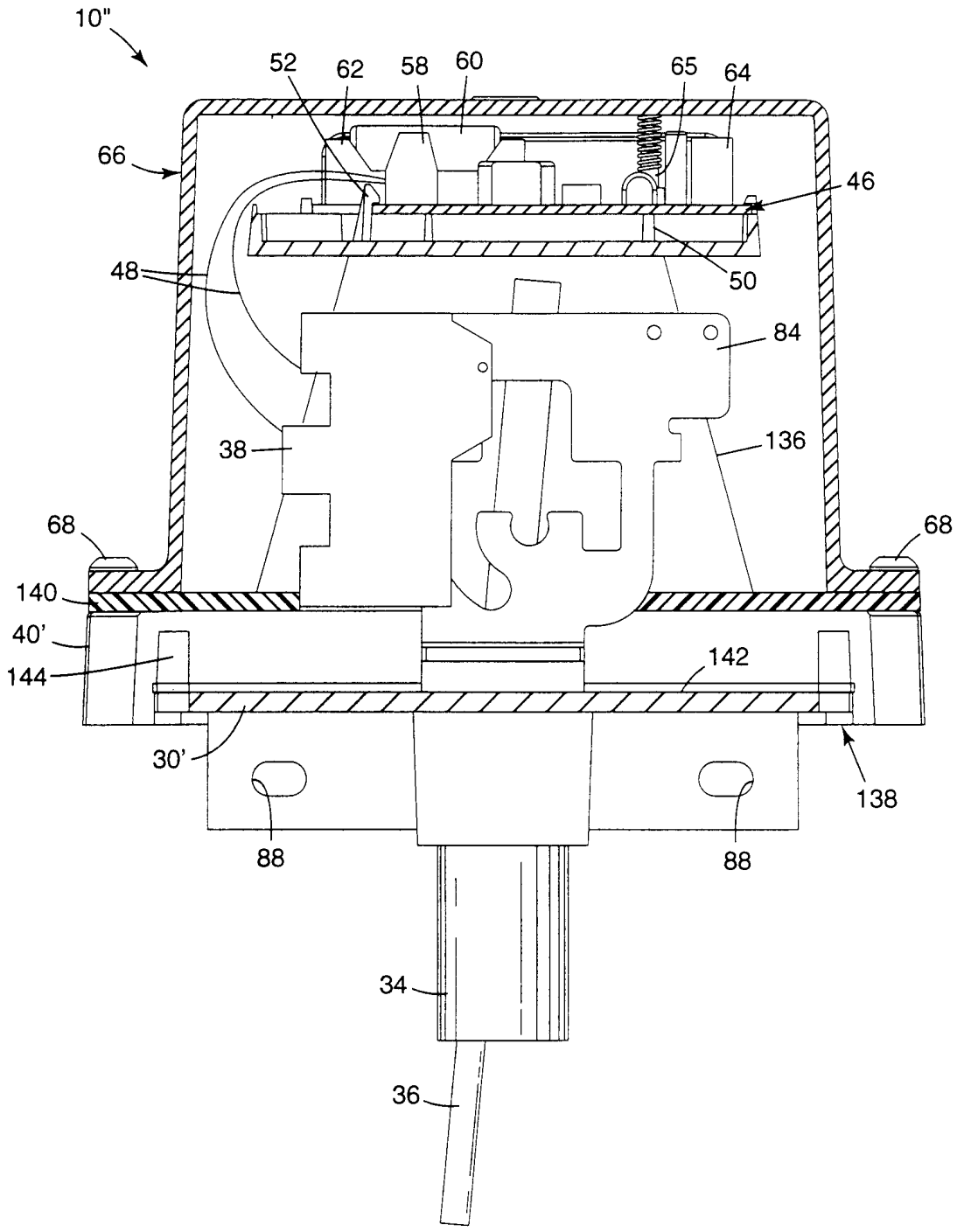
36

Fig 11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48
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84
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136
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68
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40'
144
142
30'
138
88
88
34
36

Fig. 12

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 00/09262

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01P13/00 G08B26/00

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 7 G01P G08B G01F

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 197 19 010 A (IFM ELECTRONIC GMBH) 27 November 1997 (1997-11-27)	12,15, 17,18, 21,22, 25,26,28
A	column 5, line 4 - line 10 column 10, line 36 - line 53; figures 6,10,16	1-11
Y	US 4 855 713 A (BRUNIUS ROBERT E) 8 August 1989 (1989-08-08) cited in the application	12,15, 17,18, 21,22, 25,26,28
A	column 3, line 31 - line 55	1-11
A	GB 2 151 383 A (HEGGIE J ROBERT;MICHLIG STEPHAN PAUL) 17 July 1985 (1985-07-17) page 1, line 106 -page 2, line 30; figure	1,12, 22-28

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"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	Date of mailing of the international search report
8 August 2000	21/08/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Pflugfelder, G

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INTERNATIONAL SEARCH REPORT

Inte ional Application No
PCT/US 00/09262

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	GB 868 278 A (AMERICAN DISTRICT TELEGRAPH SYSTEM) 17 May 1961 (1961-05-17) page 1, line 15 - line 20 page 2, line 15 - line 60; figure 1	1-3,11, 13,14, 21,23
A	US 4 072 934 A (HILLER TRUEMAN W ET AL) 7 February 1978 (1978-02-07) column 6, line 9 - line 51; figure 5	1,7,11, 12,28
A	EP 0 245 682 A (ALIOTH ALEXANDRA) 19 November 1987 (1987-11-19) the whole document	4-6,9, 15,19, 22,23

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte ional Application No
PCT/US 00/09262

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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