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(54) **BATTERY ASSEMBLY**

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(73) Assignee: **Badger Meter, Inc.**, Milwaukee, WI (US)

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Related U.S. Patent Documents

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Appl. No.: **09/257,679**
Filed: **Feb. 25, 1999**

U.S. Applications:

(62) Division of application No. 08/909,907, filed on Aug. 12, 1997, now Pat. No. 5,877,703.

(51) **Int. Cl.**[7] **G08C 15/06**

(52) **U.S. Cl.** **340/870.02**; 324/157; 361/659; 429/100; 73/273

(58) **Field of Search** 340/870.02; 324/156, 324/157; 361/659

(56) **References Cited**

U.S. PATENT DOCUMENTS

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5,049,810	A	*	9/1991	Kirby et al.	324/156

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(57) **ABSTRACT**

An improved assembly **(10)** for housing electronics for remote reading to meter reading data in a subsurface enclosure **(11)** includes a first inner enclosure **(40)** of metal for housing the receiver/transmitter circuitry **(90)**, a second inner enclosure **(69, 86)** for housing a battery **(65)** and an outer enclosure **(24)** of plastic which encloses both of the inner enclosures.

13 Claims, 2 Drawing Sheets

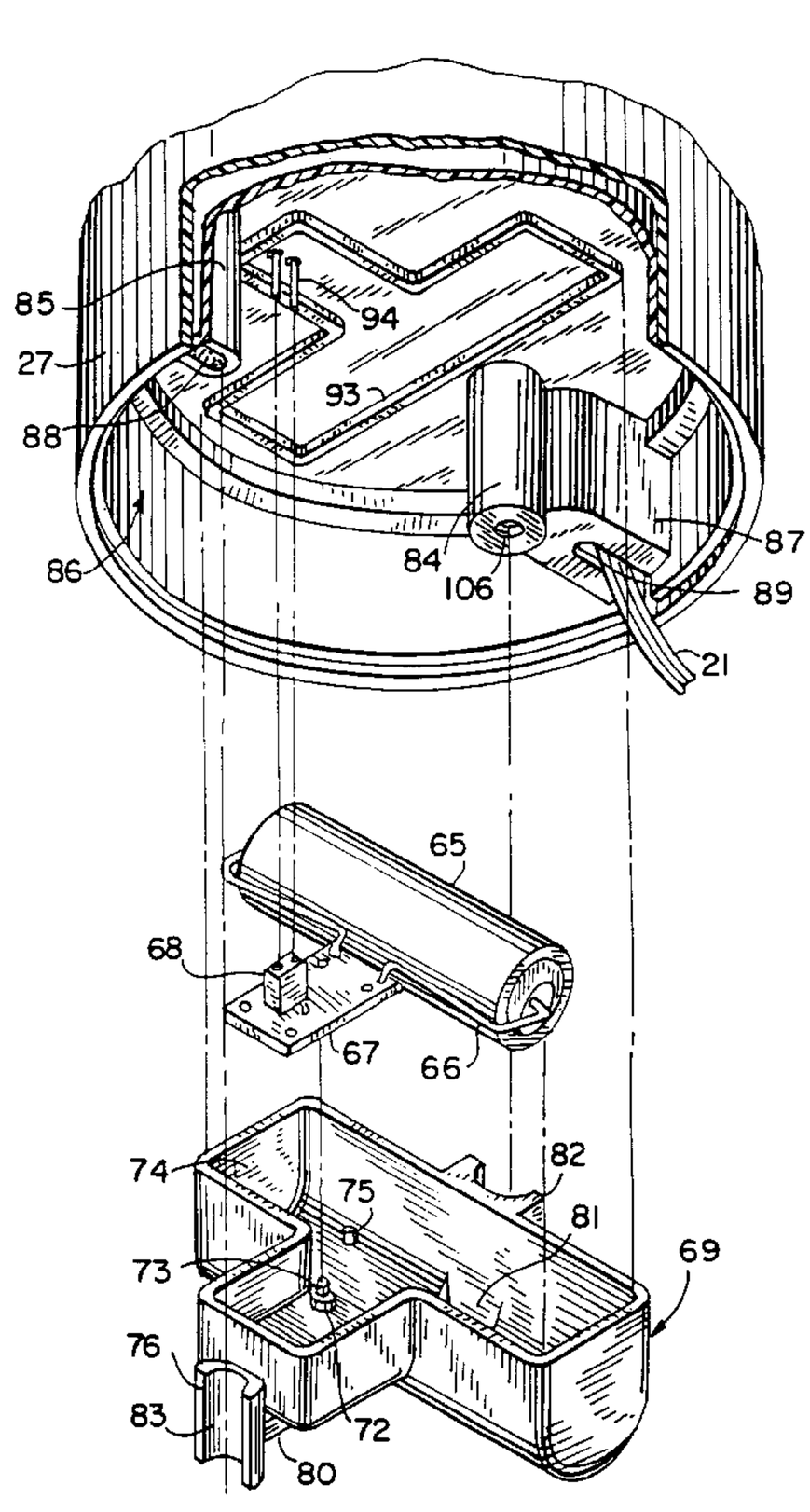

FIG. 1

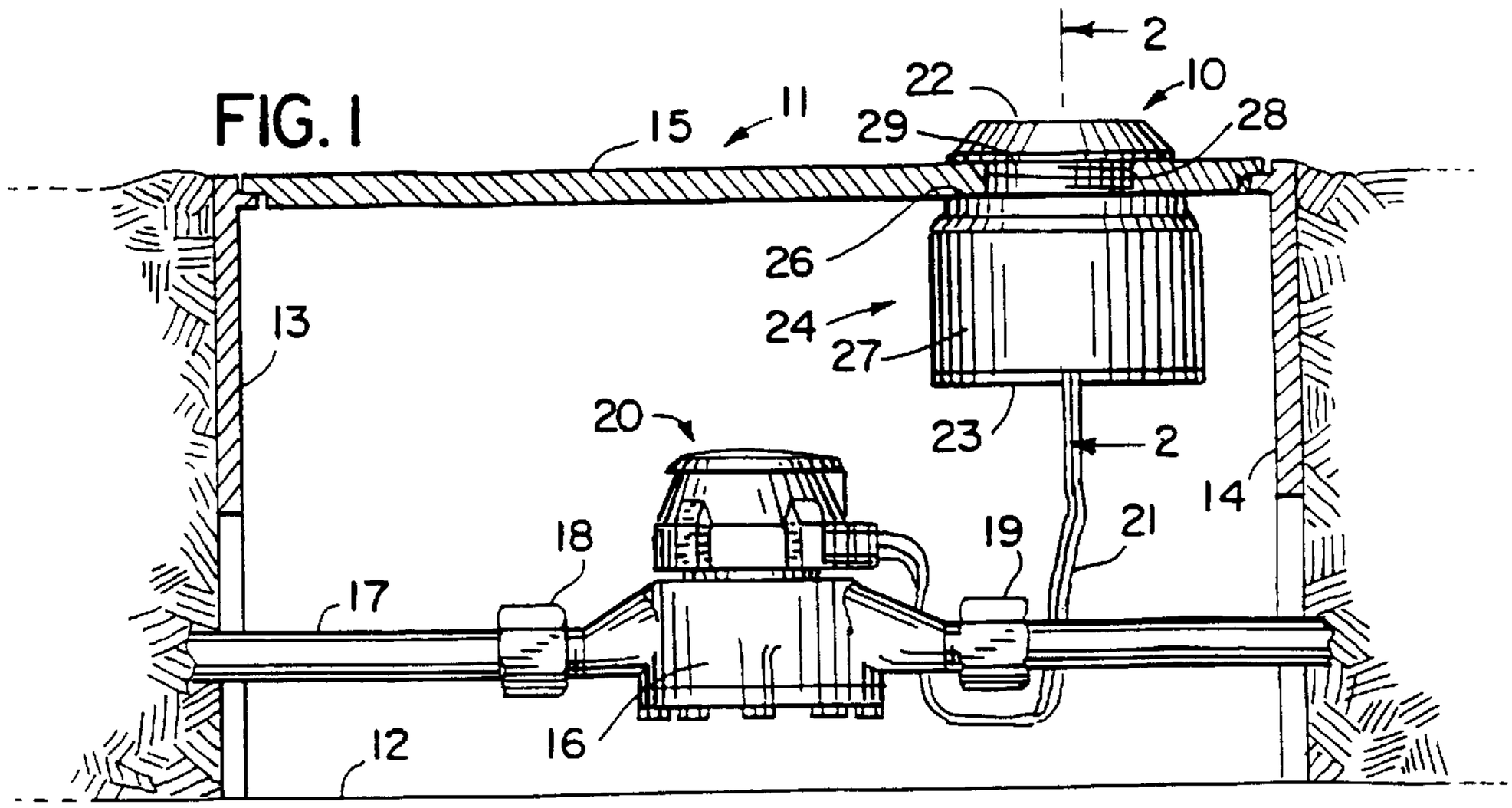
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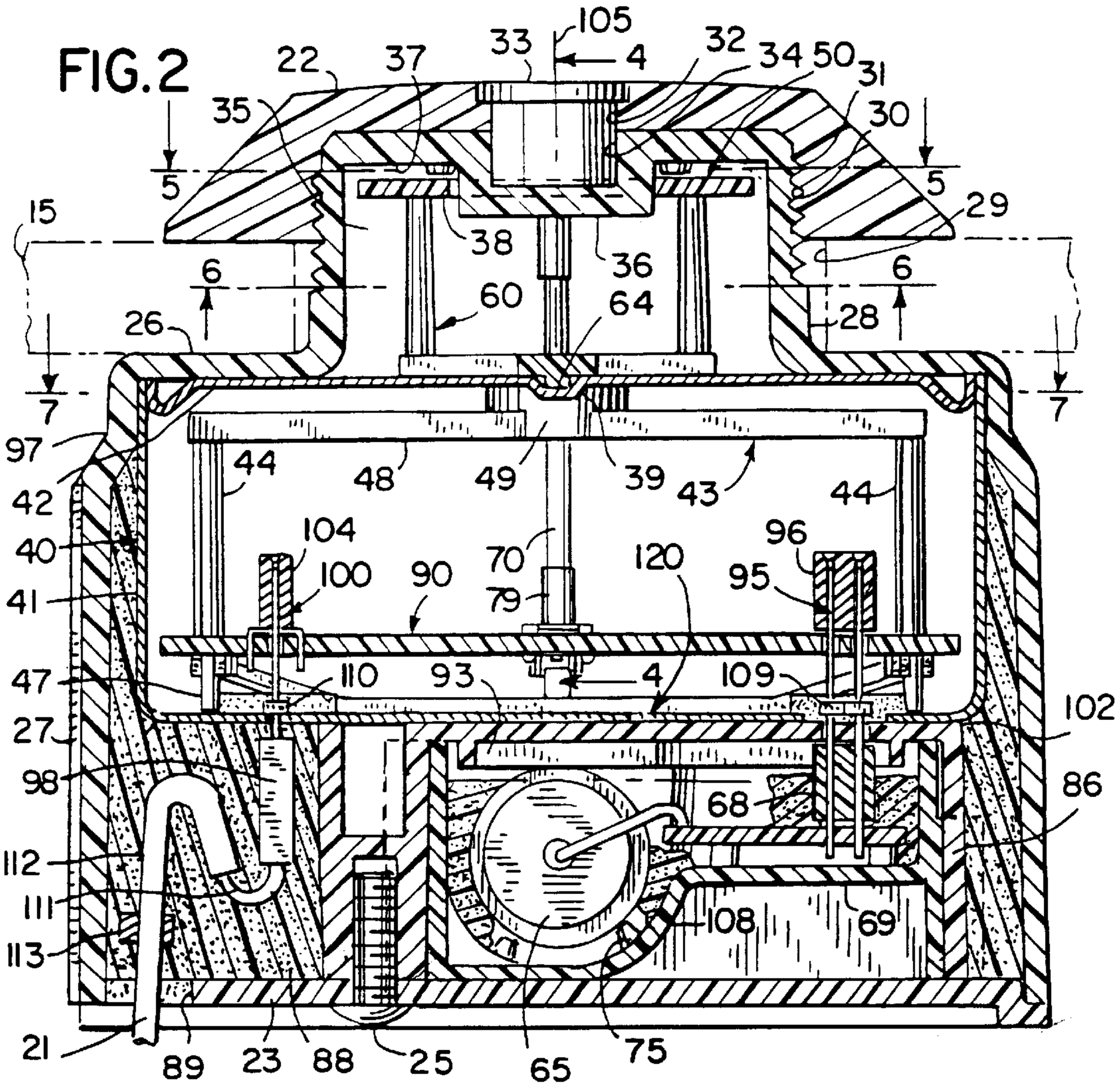
FIG. 2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110
93
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86
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111
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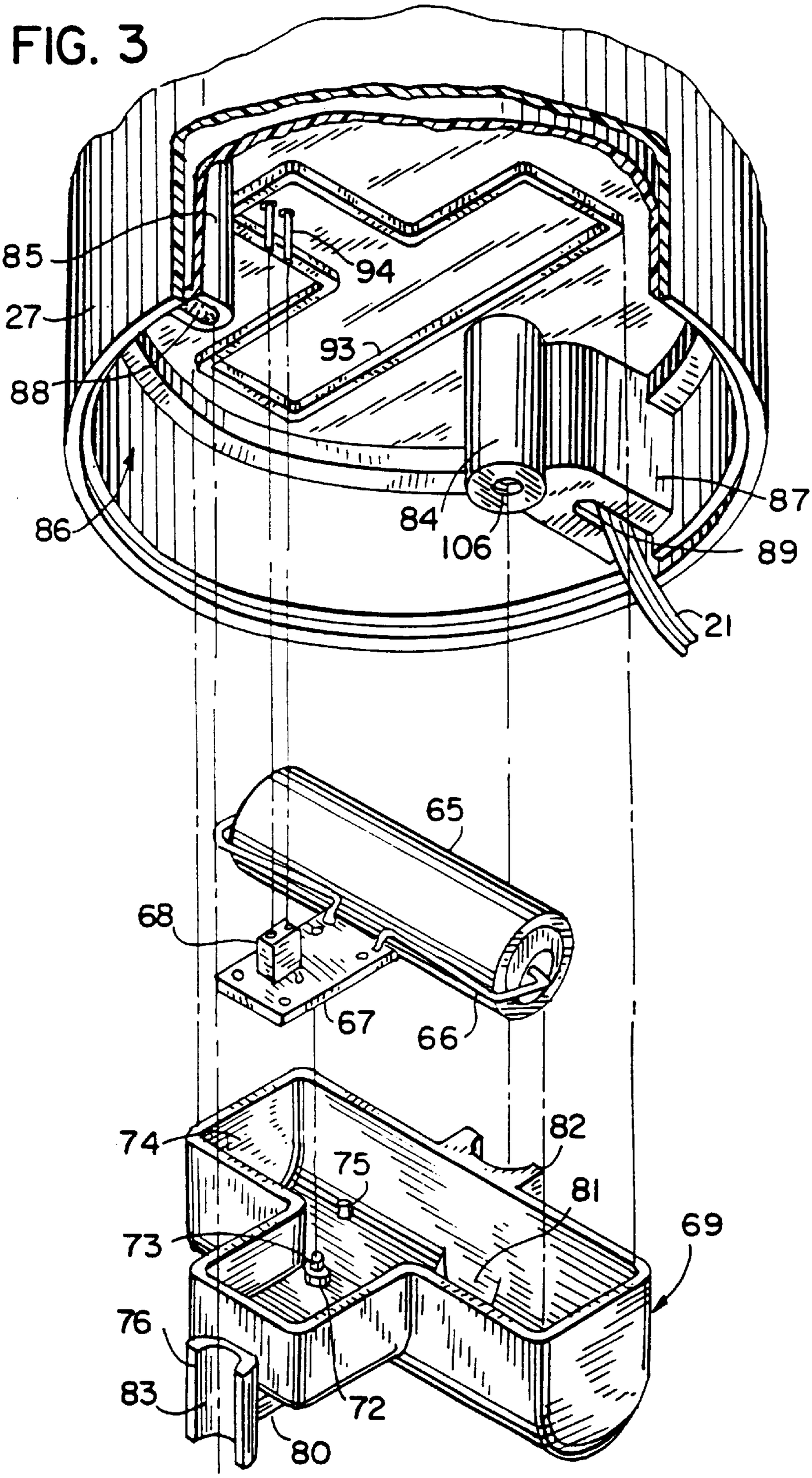
FIG. 3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BATTERY ASSEMBLY

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.

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a divisional of U.S. application Ser. No. 08/909,907 filed Aug. 12, 1997, and now U.S. Pat. No. 5,877,703 issued Mar. 2, 1999.

TECHNICAL FIELD

The invention relates to electronic instrument enclosures that are located with utility meters outside of a building in underground enclosures.

DESCRIPTION OF THE BACKGROUND ART

In moderate climate zones, utility meters are located in subsurface enclosures in areas near residences or other dwellings. Such enclosures are referred to as "pits." An example of such enclosure is illustrated in Haase et al., U.S. Pat. No. 1,781,280.

In Edwards et al., EPO Publication No. 0 252 184, meter data is transmitted from a utility meter in an underground pit to an in-ground electronic coupling circuit and then to an electronic collection unit carried by a meter reading person. Scuilli, U.S. Pat. No. 4,758,836, shows an electronic metering unit which uses the inductive coupling method of the metering unit of Edwards et al.

Besides inductive coupling system, radio frequency transponder systems have also been known. Examples are illustrated and described in Cerny et al., U.S. Pat. No. 5,298,894, issued Mar. 29, 1994, and assigned to the assignee of the present invention. In these systems, a receiver/transmitter, and an associated antenna are enclosed in one or more sealed enclosures which are located in a larger pit for the water meter. When the transponder is interrogated by a signal, it returns a radio signal to a collection unit, either hand-held or carried by in a vehicle, where the radio signal can then be decoded to extract the meter data.

A primary issue concerning all remote meter systems, whether used in pit installations or elsewhere, is their resistance to weather, and to submersion in the event that the pit fills with water. Therefore, a primary object of the invention is to provide a device that is resistant to environmental conditions in its operating environment.

Typically, the data storage device is powered by one or more batteries, which must also be contained in a sealed enclosure. For an example of a prior battery assembly, please refer to Karsten et al., U.S. Pat. No. 5,476,731, assigned to the assignee of the present invention.

Therefore, another object of the invention is to provide for battery replacement in the field without adversely affecting the environmental protection of the electronics in the assembly.

As with other electronic devices, there is also a desire to make the devices smaller in size, lower in the cost of manufacture, and easier to service in the field.

SUMMARY OF INVENTION

The invention is provided in an improved battery enclosure which can also be enclosed within an outer enclosure

but removed, in the event that the battery must be changed, without affecting the environmental protection of the other portions of the assembly.

The invention provides a fully remote meter reading system with weather-resistant features that permit installation of the transponder unit in outdoor underground enclosures.

The invention provides a unit of reduced size and weight, and yet provides the weather resistance and operating features of prior units.

The invention also provides a unit having advantages in its assembly and manufacturing.

Other objects and advantages, besides those discussed above, will be apparent to those of ordinary skill in the art from the description of the preferred embodiment which follows. In the description, reference is made to the accompanying drawings, which form a part hereof, and which illustrate examples of the invention. Such examples, however, are not exhaustive of the various embodiments of the invention, and, therefore, reference is made to the claims which follow the description for determining the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a general pictorial illustration showing the present invention in its operating environment;

FIG. **2** is a sectional view in elevation taken in the plane indicated by line **2**—**2** in FIG. **1**; and

FIG. **3** is a bottom perspective view of the outer enclosure seen in FIG. **2**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, the invention is incorporated in a remote transponder assembly **10** located in a subsurface pit enclosure **11**. The term "transponder" shall mean electronic circuitry for receiving an interrogation or "read" signal and electronic circuitry for sending meter data signals. The signals are received and transmitted through an associated antenna. These items will be described in more detail below with respect to the preferred embodiment.

The pit enclosure **11** (FIG. **1**) includes side walls **13**, **14** and a lid **15** which is removable to open the enclosure for access. A bottom wall **12** is optional. The pit enclosure **11** in this embodiment is made of metal, but in other embodiments could be made of concrete or plastic.

The pit enclosure **11** is located along the route of water supply pipe **17**. A water meter housing **16** is connected in the water supply line **17**, using hex-head nuts **18**, **19** which are sealed in a conventional manner against leaks at the connecting points. A water meter register **20** is mounted on top of the housing **16** and is magnetically coupled to the movements of the nutating disc in the water meter **16**.

The meter register **20** (FIG. **1**) is preferably the Recordall™ transmitter register offered by Badger Meter, Inc., the assignee of the present invention. This unit includes an electromechanical device for generating pulses representing units of consumption as described in Strobel et al., U.S. Pat. No. 4,868,566, entitled "Flexible Piezoelectric Switch Activated Metering Pulse Generators." The meter register **20** is electrically connected to the pit transponder assembly **10** via a cable **21**, which is preferably a "Belden 4541" shielded pair cable with drain wire. Metering pulses are transmitted from the meter register **20** to the pit transponder assembly **10**.

As disclosed in U.S. Pat. No. 5,298,894, cited in the Description of the Background Art, a transponder assembly **10** may communicate via electromagnetic, radio frequency waves to a handheld collection unit (not shown herein) carried by a meter reading person or a collection unit carried in a vehicle (not shown herein). The transponder assembly **10** may also be part of a networked system in which one or more transponder assemblies **10** communicate with local receiver stations which further communicates with a central data collection station.

In addition to different types of data collection systems, different types of meter registers can also be used, including the High Resolution Transmitter (HRT) Series, and the LMI Series from the assignee of the present invention, or other meter registers known in the art.

In the embodiment in FIG. **1**, the transponder assembly **10** is attached to pit lid **15** through a hole **29** in the pit lid **15**. The outer enclosure **24** for the assembly includes a body with a cylindrical wall **27** closed at the bottom by bottom closure **23**, and an upper flange portion **26** leading to the threaded stem **28** that extends through the hole **29**. A cap **22** is screwed onto the stem **28** to suspend the assembly **10** from the lid **15**. The outer enclosure **24** is preferably made of a durable plastic material to insulate the electronics inside and to provide resistance to corrosion and chemical degradation from substances such as salt water, which may be encountered in harsh environments.

The cap **22**, which is also made of plastic, is formed with a recess having inner diameter threads **30** (FIG. **2**) for mating connection with outer diameter threads **31** (FIG. **2**) on stem **28**. The cap **22** also has a flat bottom side which engages a top side of the pit lid **15** and the circular flange portion **26** engages an underside of the pit lid **15** to trap a portion of the pit lid **15** between the flange portion **26** and the underside of the cap **22**. The cap **22** also has a hexagonal opening **32** through the center to receive a hex-sided anti-tamper plug **33** (FIG. **2**). Stem **28** includes hex socket **34** to receive plug **33**.

Referring to FIGS. **1** and **2**, the assembly **10** has three main compartments or sections inside the outer enclosure **24**. A middle compartment is formed by an inner enclosure **40**, which is typically made in two pieces, a seamless cylindrical body **41** and a disc-shaped lid **42**. The lid **42** (FIG. **3**) is inserted in the open end of the body **41** and welded around an upper rim of the body **41** to seal the inner enclosure **40**. The inner enclosure **40** is preferably made of a metal such as copper, tin, or an alloy of either of these materials. The material is preferably one which is easy to form in a thin-walled enclosure, which is easy to weld and which provides a final barrier against moisture penetration, while also providing some measure of corrosion resistance.

Inside the inner enclosure **40** in FIG. **2** is a transponder printed circuit board (PCB) **90** in which receiving and transmitting circuitry and any necessary data storage circuits are mounted on a circuit board substrate. If the system is of the remote, mobile data collector type, the PCB **90** can be purchased from American Meter Company. If the system is of the network type, the PCB **90** can be purchased from CellNet Data Systems of San Carlos, Calif., USA. In alternative embodiments contemplated by the invention, a timed or periodic call-in period could be used such that receiver circuitry would not be necessary and only transmitter circuitry would be included on PCB **90**.

This PCB **90** (FIG. **2**) is held down against upward movement by a support **43** having three upstanding legs **44**. The legs **44** have feet **47** tapering from wider at the top to narrower at the bottom which extend through the substrate of PCB **90**. In addition, the legs **44** extend upward to a Y-shaped horizontal member **48** with three angularly spaced parts. Two of the branches of the Y-shaped member are longer than the third branch, so that an annular flange **49** at an intersection of the three parts is eccentrically located with respect the central longitudinal axis **105** of enclosure **24**. Annular flange **49** (FIG. **2**) projects upward and bears against the ceiling of enclosure **40** to space the horizontal member **48** a distance of such ceiling. The depression **39** in the lid **42** of the inner enclosure **40** is positioned in front of the annular flange **49** as seen in FIG. **2**.

PCB **90** is supported from below by a Y-shaped support **120** (FIG. **2**) having a Y-shaped base, three extensions angling upward from the base **121** to the underside of the PCB **90**, and three arcuate collar parts for fitting around the feet **47** of the upper Y-shaped support member **43**.

The outer enclosure **14**, which is preferably made of plastic, to resist chemical attack, completely surrounds and encloses the metal inner enclosure **40**. The plastic is typically a modified polyphenylene oxide (PPO) material which is resilient to provide protection against unintentional impacts. The outer enclosure provides additional space **35** (FIG. **2**) in the hollow stem **28** to form an upper compartment for housing an antenna **50** and an antenna support **60**. This hollow portion **35** includes a boss **36** resulting from formation of a socket **34** for receiving the anti-tamper plug **33**. Race **37** is formed between the boss **36** and the side wall of stem **28**, and this race **37** receives the antenna **50**, which is provided as a printed circuit board (PCB). Within the race **37**, stand-offs **38** project down from the ceiling to provide spacing of the printed circuit board **50** from the inside surface of the stem **28**.

The antenna PCB **50** is supported by a support frame **60**, having a Y-shaped base, three legs rising from the ends of base, and pins on the ends of the legs which are received in holes on the PCB **50**. The antenna support **60** also has a projection **64** (FIG. **2**) extending downward from its center portion to locate the support frame **60** in a depression **39** (FIG. **2**) in the lid **42** of the inner metal enclosure **40**.

In the present embodiment, the antenna PCB **50** is positioned slightly above the metal pit lid **15** when the transponder assembly **10** is attached to the pit lid **15**. However, in embodiments for use in pit enclosures of concrete or plastic, the transponder assembly **10** can be mounted by a mounting flange having a threaded opening similar to cap **22**, but fastened with screws underneath the pit lid **15**. In these alternative embodiments, the antenna can be positioned underneath the pit lid. The present invention could also be used in other remote transmitter and transponder assemblies, provided that power requirements for the transponder are reduced in accordance with FCC regulations.

Referring again to FIGS. **2** and **3**, a lower compartment in the assembly houses a battery **65**. The lower compartment is formed by a base member **86** (FIG. **3**) and a battery casing member **69** (FIG. **3**). The base member **86** supports the inner enclosure **40**. Referring to FIG. **3**, the base member **86** is cylindrical in shape with a closed top end and an open bottom end. The base member **86** forms a potting well **87** and wire entry port **89** where the cable **21** enters the assembly, is connected to the transponder PCB **90**, and where the connection is sealed with potting material **88** seen in FIG. **2**. As further seen in FIG. **3**, a first cylindrical post **84** having a threaded hole **106** for receiving a fastener is integrally formed with the potting well **87**. Opposite the first post **84** is a second, hollow, semi-cylindrical post **85**, which

forms a second injection port for potting material **88**. The two spaced apart posts **84**, **85** are also utilized to locate the battery casing **69** when it is assembled to the base member **86**.

The battery casing **69** is formed to hold a single battery **65** in this embodiment. The battery **65** is connected by leads **66** to connector **68** via a battery circuit board **67**. This assembly of parts **65–68** is positioned in battery casing **69**, with the circuit board supported by posts **72** having pins **73** to retain and locate the circuit board **67**. The battery **65** is received in semi-cylindrical battery trough **74** in which stand-offs **75** are formed to support the battery **65** above the casing wall. A first guide channel member **76** is formed on a wall of the battery casing which extends around the circuit board **67**. A web **80**, partially visible in FIG. **3**, runs perpendicular to the trough **74** along the bottom of the casing to a well **81**. The web **80** provides a place to grip the battery casing **69** with a thumb and forefinger when installing or removing the battery assembly **65–69** in the larger assembly **10**. The well **81** is necessary for forming another guide channel member **82**. The members **76**, **82**, provide semi-circular channels **83** for sliding onto the posts **84**, **85** formed in the base member **86** to thereby locate the battery casing **69**. A grease is applied to the socket **68** to prevent potting material **108** from flowing into the openings for receiving the pins **94**.

When assembling the battery subassembly, the battery **65** is placed in casing **69** and a sealing material **108** is filled in, around and over the battery **65** as seen in FIG. **2**. This seating material **108** is softer, more ductile and has a longer cure time than sealing material **88**. The base member **86** has a gasket **93** formed by a guard rail that traces an outline of the open side of the battery casing **69**, but is sized to fit inside the outside walls of the battery casing **69**, when it is pressed against the base member **86**. The gasket **93** is then spaced a short distance inside the walls of casing **69**. The sealing material **108** is filled in, around and over the battery **65** in the subassembly of components **69**, **86** and is allowed to cure and solidify. It remains, however, deformable, and when the battery casing **69** and battery are installed over guard rail **93**, the guard rail **93** is pressed into the soft body of sealing material **108** and becomes embedded there.

As seen in FIG. **3**, the gasket **93** also orients the battery casing **63** so that the 2-pin socket **68** on the battery circuit board **67** will be aligned with two pins **94** on an electrical connector **95** for making connection with the transponder PCB **90**. The pins **94** on the electrical connector **95** extend through a plastic body **109** for supporting and mounting the connector **95**. The pins **94** are received in a socket **96** mounted on PCB **90**.

The cable **21** with plug socket **98** is inserted and connected as shown in FIG. **2**. The cable **21** has three insulated wires **111**, one of which is shown in FIG. **2**. The three insulated wires are sheathed in a cable insulation jacket **112**. A strain relief collar **113** of metal is crimped on a cable insulation jacket **112**, and prevents a length of cable **21** from being pulled through wire entry port **89**.

A room temperature vulcanizing adhesive/sealant **88** is admitted through the port **85** until it fills the annular space (FIG. **2**) between side wall **27** of enclosure **24** and the side wall of inner enclosure **40**. The outer enclosure **24** has an inwardly tapering shoulder **97** at the upper end of side wall **27** to block sealant from entering antenna chamber **35**.

Cable socket **98** is plugged into pins of connector **100** (FIG. **2**) to electrically connect the cable **21** to connector **100**. Electrical connectors **95**, **100** are preassembled with inner enclosure **40** using molded disks of epoxy adhesive. The epoxy is used to cover slots **102** in the metal enclosure body **41** to secure the plastic bodies **109**, **110** of connectors **95**, **100** in place and to insulate the pins from the metal enclosure body **41**. The three pins of connector **100** are aligned along an axis that is rotated 90° from an axis of alignment for the two pins of connector **95**. Similarly, socket **96** on PCB **90** is rotated 90° from an axis of alignment for socket **104** on PCB **90**.

This asymmetrical arrangement of the pins assures proper orientation and electrical connection of the battery casing assembly to the PCB **90** in inner enclosure **40**. In lieu of using sockets **96**. **104**, the pins could also be directly soldered to the PCB **90**.

After the battery casing **69** with battery **65** is assembled within casing **86**, cable **21** has been connected, and sealing operations have been completed, the bottom cover **23** (FIG. **2**) is attached and fastened with a screw **25** (FIG. **2**) which is received in a threaded hole **106** in post **84** (FIG. **3**). The screw **25** has a head requiring a specific driver for inserting and removing the screw **25**, which provides tamper resistance.

Although the preferred embodiment utilizes a battery casing with one battery, a battery casing for two batteries and for a larger single batteries is also contemplated as being within the scope of the invention. In such an assembly, the casing may be oriented perpendicular to the position of battery **65** with respect to posts **84**, **85**, and the battery casing may more completely fill the cavity in base member **86**.

This has been a description of examples of how the invention can be carried out. Those of ordinary skill in the art will recognize that various details may be modified in arriving at other detailed embodiments, and these embodiments will come within the scope of the invention.

Therefore, to apprise the public of the scope of the invention and the embodiments covered by the invention, the following claims are made.

We claim:

1. A battery assembly for use in a utility meter data collection unit, the battery assembly comprising:

a casing for receiving a battery and sealing material to be disposed in the casing and around at least a portion of the battery;

an electrical socket which is electrically connectable to said battery and which is connectable to supply battery power to the utility meter data collection unit;

means formed on said casing for locating said casing in position within said utility meter data collection unit; and

said casing being insertable and removable from a position in which said socket can be connected to supply battery power to the utility meter data collection unit.

2. The battery assembly of claim **1** in which said casing is T-shaped with a stem portion and a cross bar portion, and wherein said socket is disposed in said stem portion and said battery is disposed in said cross bar portion, and said means for locating is formed along an axis perpendicular to said cross bar portion and to a longitudinal axis of said battery.

3. The battery assembly of claim **1**, further comprising sealing material disposed in the casing to cover the battery.

4. The assembly of claim **3**, in which the assembly includes a base member, wherein the sealing material is deformable and wherein a gasket is formed on a bottom interior surface of the base member, said gasket being received in the seating material when the battery casing is assembled to the base member to provide a sealed bottom enclosure for the battery.

5. A battery assembly for use in a utility meter data collection unit, the battery assembly comprising:

a casing for receiving a battery and sealing material to be disposed in the casing and around at least a portion of the battery;

at least two electrical leads which are electrically connectable to said battery and which are connectable to supply battery power to the utility meter data collection unit;

a pair of oppositely disposed projections formed on said casing for locating said casing in a position within said utility meter data collection unit which is defined by a pair of oppositely disposed members, wherein each of said members cooperates with a respective one of said projections; and

said casing being insertable and removable from the position within said utility meter data collection unit in which said leads can be connected to supply battery power to the utility meter data collection unit.

6. The battery assembly of claim 5, wherein the sealing material is disposed in the casing to fully cover all portions of the battery that would otherwise be exposed.

7. The battery assembly of claim 5, wherein said projections for orienting and holding said battery casing are formed along an axis perpendicular to a longitudinal axis of said battery.

8. The battery assembly of claim 5, wherein said projections on said battery casing include channels and wherein said members are in the form of posts which are received in said channels when said battery casing is inserted into said utility meter data collection unit.

9. A battery assembly for use in a utility meter data collection unit, the battery assembly comprising:

a casing for receiving a battery and sealing material to be disposed in the casing and around at least a portion of the battery;

at least two electrical leads which are electrically connectable to said battery and which are connectable to supply battery power to the utility meter data collection unit;

a pair of oppositely disposed guides for orienting and holding said casing in position within said utility meter data collection unit; and

said casing being insertable and removable from a position between said guides in which said leads can be connected to supply battery power to the utility meter data collection unit.

10. The battery assembly of claim 9, wherein the sealing material is disposed in the casing to fully cover all portions of the battery that would otherwise be exposed.

11. The battery assembly of claim 9, wherein said guides for orienting and holding said battery casing are formed along an axis perpendicular to a longitudinal axis of said battery.

12. The battery assembly of claim 9, wherein said guides are formed as oppositely disposed members on said utility meter data collection unit and wherein said battery casing is inserted into position between said oppositely disposed members to locate said battery casing in said utility meter data collection unit.

13. The battery assembly of claim 12, wherein said battery casing forms at least a pair of projections which cooperate with said members to locate said battery casing when said battery casing is inserted into said utility meter data collection unit.

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