United States Patent [19]

Kurr

[11] **3,803,012**

[45] **Apr. 9, 1974**

[54] **CATHODIC PROTECTION ANODE CLAMP ASSEMBLY**

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[73] Assignee: **American Smelting and Refining Company,** New York, N.Y.

[22] Filed: **Mar. 9, 1972**

[21] Appl. No.: **233,193**

[52] **U.S. Cl.** ..... **204/197,** 204/286, 204/297 R, 24/243 CC, 24/243 B, 24/243 H, 24/243 E

[51] **Int. Cl.** **C23f 13/00**

[58] **Field of Search** ..... 204/147, 148, 196, 197, 204/286, 297 R, 297 M; 24/243 CC, 243 B, 243 H, 243 E

[56] **References Cited**

UNITED STATES PATENTS

3,553,094	4/1968	Scott et al.	204/197
3,623,968	11/1971	Bohne	204/148

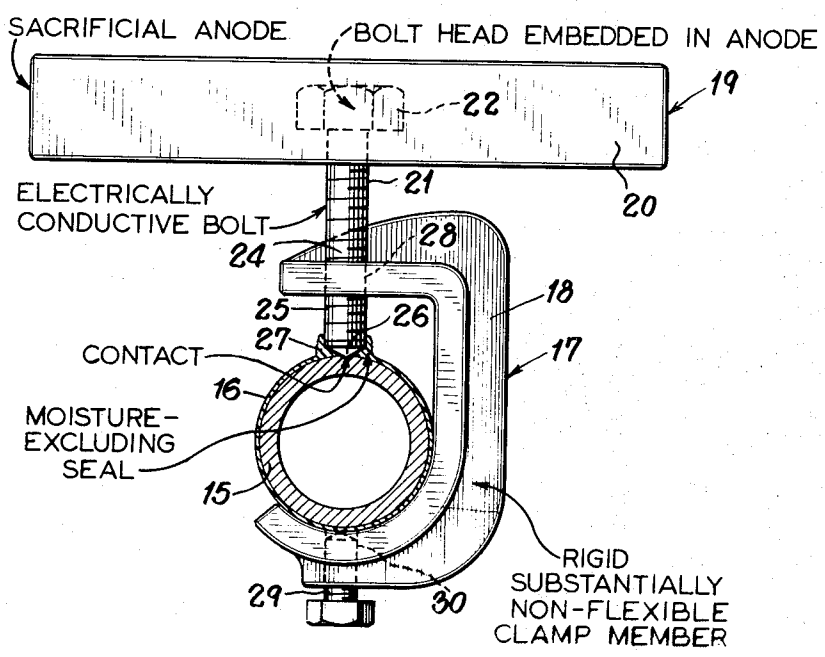
Primary Examiner—T. Tung

Attorney, Agent, or Firm—Roger J. Drew; Elwood J. Schaffer

[57] **ABSTRACT**

A sacrificial anode clamp assembly for cathodically protecting a corrosible metallic object disposed in an electrolyte, for instance a coated ferrous metal pipe buried in the ground. The anode clamp assembly includes one or more rigid, substantially non-flexible clamp members, for example a generally C-shaped clamp member, and means securing the clamp member or members about the metal pipe. A sacrificial anode including a body of sacrificial anode metal has an electrically conductive bolt embedded at one end thereof in the sacrificial anode body, and the opposite end of the bolt, which extends outwardly from the anode body, is threaded and has a penetratable terminal end. A correspondingly threaded aperture is provided in the clamp member, and the conductive bolt having the sacrificial anode body at the one end is rotated and threaded through the threaded aperture in the clamp member until its terminal end contacts and bites into the metal of the metal object to be cathodically protected, thereby providing an electrical contact between the conductive bolt and the metal of the object to be protected. A moisture-excluding seal of electrical insulating, organic, water-insoluble, plastic material is disposed about the locus or point of contact of the bolt terminal end with the metal object. The anode clamp assembly is eminently well suited for sacrificial cathodic protection of metallic service pipe lines and risers for natural gas and other gas and, in addition, can be utilized to cathodically protect other corrosible metal objects as is hereinafter disclosed.

11 Claims, 11 Drawing Figures



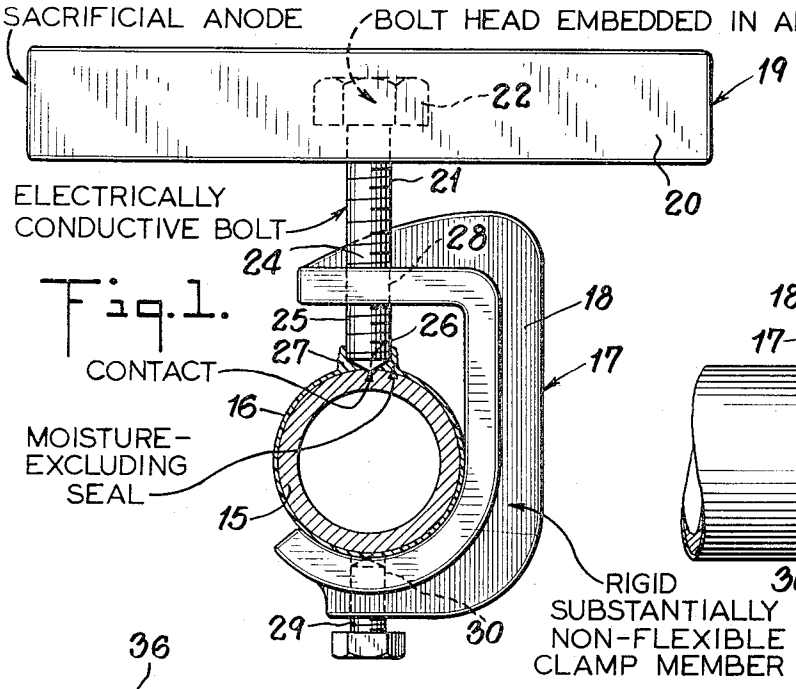


Fig. 1.

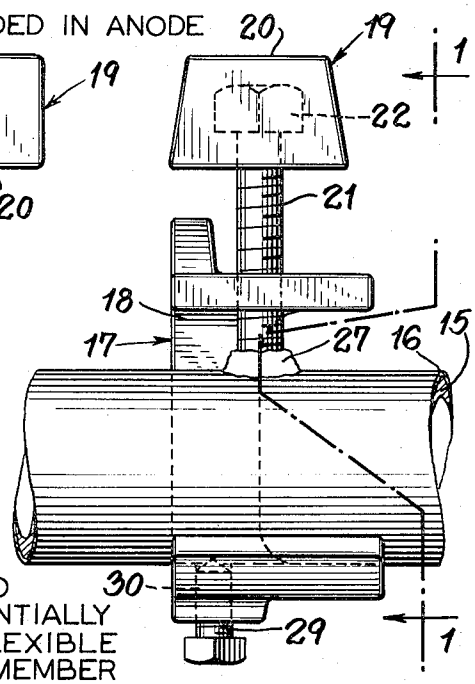


Fig. 2.

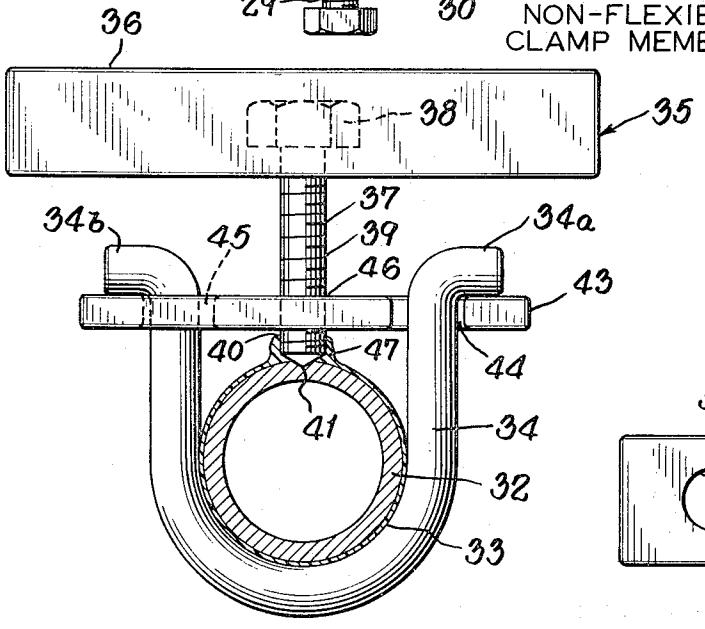


Fig. 3.

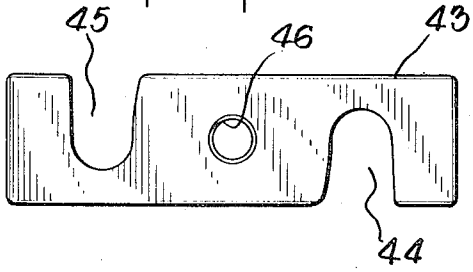


Fig. 4.

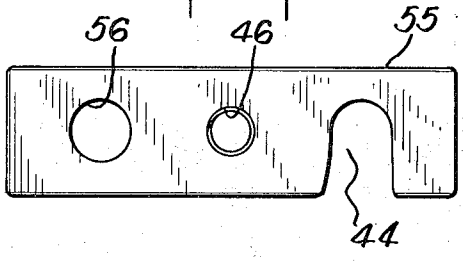


Fig. 5.

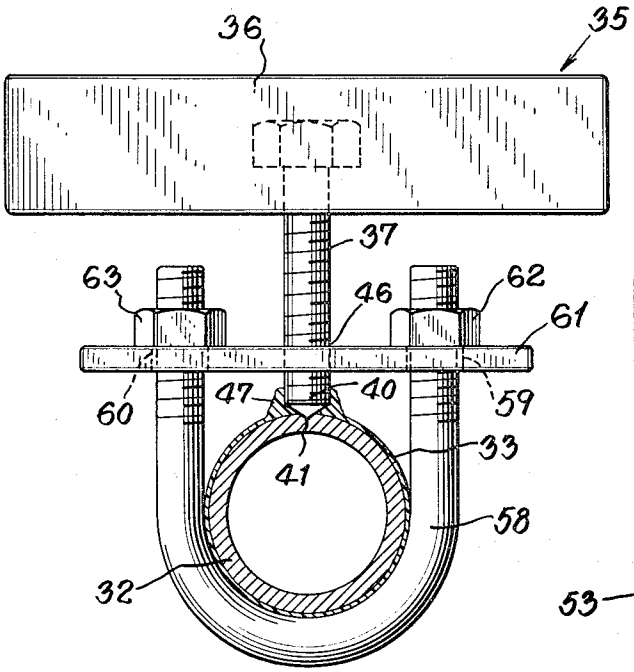


Fig. 6.

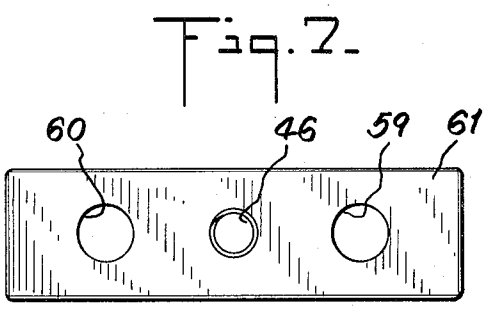


Fig. 7.

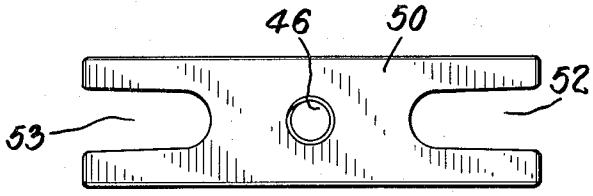


Fig. 8.

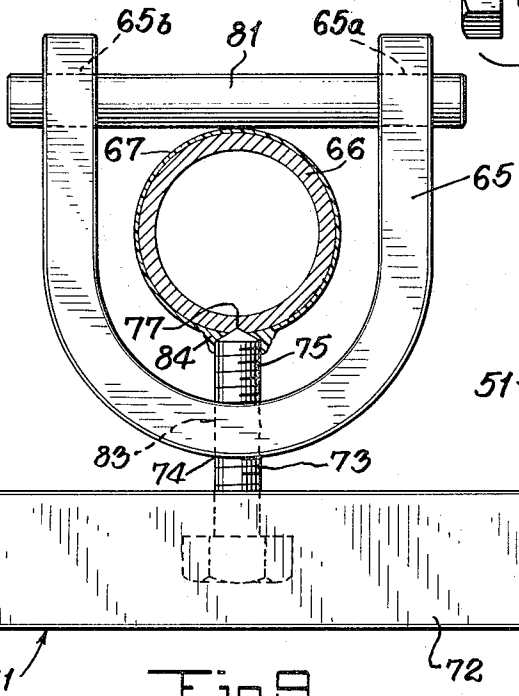


Fig. 9.

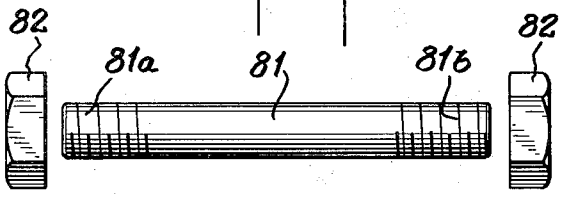


Fig. 10.

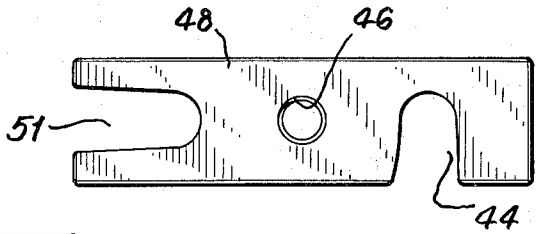


Fig. 11.

CATHODIC PROTECTION ANODE CLAMP ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to sacrificial cathodic protection of metallic objects and more particularly to a new and improved sacrificial anode clamp assembly for cathodically protecting against corrosion metallic objects in contact with an electrolyte.

2. Statement of the Prior Art

The regulations of the U.S. Department of Transportation governing the transportation of natural gas and other gas by pipe line now require gas utility companies to cathodically protect and coat all new steel gas lines going underground or under water, and also require the companies to cathodically protect all existing gas lines located in corrosive environments. This means that gas companies must excavate around pipe lines and install anodes on existing lines of all sizes including service lines which connect the gas main in the street to the customer's facility, i.e., home, factory, etc.

It is of course, well known to cathodically protect metallic objects in an electrolyte, for example metallic pipe buried in moist earth, against electrolytic corrosion by means of sacrificial anodes. The sacrifical anodes, which comprise bars or other shapes of zinc, magnesium, aluminum, their alloys, or other metals having a higher order in the electromotive series than the metal of the object to be protected, are electrically connected to the metallic pipe or other object. The electrical current produced by galvanic action acts to neutralize the natural currents produced on the metal surface of the pipe or other object to be protected, with the result electrolytic corrosion of the metallic pipe or other object is eliminated or materially reduced while the sacrificial anode is slowly dissipated or sacrificed.

Sacrifical anodes have usually been installed heretofore by making a "hot" connection of the anode wire to the pipe by brazing, welding or soldering. Although the "hot" connection installation has been satisfactory in certain respects, such installation requires the use of special tools and a skilled workman. Further such "hot" connection installation is a relatively complicated installation, and leaves room for improvement from the standpoint of reducing the costs and time required for such installation. Moreover, considerable explosion and fire danger is involved in welding a "hot" connection to pipe of existing pipeline installations for combustible gas or other combustible fluid.

U.S. Pat. No. 3,553,094 discloses a device for electrically connecting a sacrificial anode to a pipe to be cathodically protected, the device including a non-rigid, flexible, thin fastening band which is looped circumferentially about the pipe. The flexible fastening band holds an electrically conductive U-shaped contact member, which rests on its side on the pipe surface, against the pipe by passing through an aligned pair of cutout openings in the contact member or, in another embodiment, by passing over a pair of cutout notches in the contact member. The contact member has a pair of extension members embedded in a sacrificial body, the sacrificial anode being cast about the extension members to embed same. The contact member has a plurality of sharp, unthreaded projections extending from its lower edge. Upon tightening the flexible band which holds the contact member against the pipe, the contact member is urged against the pipe with greater force whereby the unthreaded projections pierce the outer protective organic or inorganic coating on the pipe and bite into the pipe to provide a metal-to-metal electrical contact. Although the device may be satisfactory in certain respects for cathodically protecting a metal pipe, it does not have the durability and ruggedness from a mechanical strength standpoint for prolonged below-ground use. This lack of durability and ruggedness, the presence of which is important for prolonged life, is due primarily to the thin, non-rigid, flexible, fastening band. Further, this device cannot make a "deep" penetration of steel pipe, i.e., get as good or as deep a bite into the pipe with its projections as is achieved by the threaded conductive member of the present invention, to provide the electrical contact.

OBJECTS OF THE INVENTION

One object of this invention is to provide for the installation of a sacrificial anode for the cathodic protection of previously installed or new metallic objects in an electrolyte, for example metallic pipe in the ground, which requires only a minimum of simple tools usually available in any tool kit and an unskilled workman, and which is rugged and durable and a long-lasting installation.

Another object of this invention is to provide for the installation of a sacrificial anode for cathodically protecting metallic pipe or other objects in an electrolyte, which does not require a "hot" connection of the anode to the pipe or object, and which does not require special tools and a skilled workman.

A further object is to provide a new and improved sacrificial anode-clamp assembly for cathodically protecting metallic pipe or other objects in an electrolyte, which clamp assembly has the properties of good mechanical strength, durability and ruggedness and hence is not subject to premature failure of the clamp assembly coponents.

A still further object is to provide a new and improved sacrificial anode clamp assembly which is relatively simple and inexpensive to install.

An additional object is to provide a new and improved sacrificial anode clamp assembly the installation of which on pipe lines transporting combustible gases or liquids is not accompanied by serious explosion and fire hazard.

Additional objects and advantages will be apparent as the invention is hereinafter described in more detail.

BRIEF SUMMARY OF THE INVENTION

The cathodic protection anode assembly of the present invention comprises a corrosible metallic object to be cathodically protected, for example a ferrous metal pipe, disposed in an electrolyte, for example the ground. Rigid, substantially non-flexible clamp means are disposed about the corrosible metallic object, such clamp means including one or more rigid, substantially non-flexible clamp members and means securing the clamp member about the corrosible metallic object. A sacrificial anode including a body of sacrificial anode metal is held or retained spaced apart from corrosible metallic object by a threaded, electrically conductive member of substantial length, for example a metallic

bolt or screw, embedded at one end portion thereof in the sacrificial anode body. The opposite end portion of the electrically conductive member is threaded and has a penetratable terminal end. A correspondingly threaded hole or aperture is provided in the clamp means. The threaded end portion of the conductive member is threadedly engaged through the threaded aperture in the clamp means with its penetratable terminal end contacting the metal of the metallic object and thereby providing an electrical contact between the electrically conductive member, e.g., the bolt or screw, and the metallic object. The anode sacrificial body is secured in the assembly as a member of the assembly by virtue of being secured at the opposite end portion of the threaded conductive member, e.g. the bolt or screw, due to the embedding of such opposite end portion of the conductive member in the anode sacrificial body. The term "embedded" is used herein in a broad sense in referring to the threaded, electrically conductive member, e.g., the bolt, screw or pin, which is embedded at one end portion thereof in the sacrificial anode body, to include not only the embedding or securing of such electrically conductive member in the anode body by casting the anode body about its end portion but also any other suitable means or way for fixing or securing such electrically conductive member by its end portion in the sacrificial anode body.

It is necessary that the electrically conductive member, e.g., bolt, screw or pin, be threaded for purpose of securing or locking the sacrificial anode body in the assembly, by engagement with the threads of a threaded aperture of a clamp means.

A moisture-excluding seal of an electrical insulating, substantially water-insoluble material is disposed about the locus or point of contact of the terminal end portion of the electrically conductive member, e.g., bolt or screw, and the metallic object. The seal is an essential element of the anode clamp assembly of this invention to obtain satisfactory results over a prolonged period, for the reasons it prevents moisture from reaching the electrical contact of the electrically conductive member, e.g., the bolt or screw, with the metallic object being cathodically protected. Due to the absence of the moisture at the electrical contact, high electrical resistance at such contact does not occur and good electrical contact is thereby maintained to enable essential flow of current from the metallic object to the sacrificial anode, via the contact and electrically conductive member. The presence of moisture at the contact point can result in the formation of anodic or cathodic films, or corrosion with the attendant deposition of the corrosion reaction products. This would result in such contact being poor or unsatisfactory, which could result in inoperability of the sacrificial cathodic protection.

The term "corrosible" as used herein in referring to the metallic object to be cathodically protected or being cathodically protected by this invention means a metallic object susceptible to being corroded or eaten away when disposed in an electrolyte, for example moist earth or sea or brackish water, unless it is cathodically protected against the corrosion.

The anode clamp assembly of this invention is utilizable for protecting metallic objects against corrosion which are buried in the ground or immersed in water. In addition to protecting metallic pipes, any other corrosible metallic object or structure such as, for example, pilings, beams, buried containers, off-shore drilling rig legs, etc. can be cathodically protected by this invention. Indeed any metallic object or article which is corrosible can be protected against corrosion by this invention. And it is not necessary that the metal of the metallic object to be cathodically protected by this invention be a ferrous metal, inasmuch as objects, articles and structures of metals other than ferrous metal, such as, for example aluminum and copper, can be cathodically protected against corrosion by this invention.

In installing the anode clamp assembly herein on metallic objects buried beneath the ground, for example on a pipe of an existing pipeline, it is necessary to excavate a hole, trench or ditch about the pipe of sufficient dimensions to enable a workman to install the parts of the anode clamp assembly about the pipe. For installing the anode clamp assembly on a corrosible metallic object submerged in water, for example a pipe of an existing pipeline located in part at least under water, it will usually be necessary to send a diver down beneath the water surface to make the installation. For installing the anode clamp assembly on new metallic objects, e.g., pipes of a pipeline, to be buried in the ground or immersed beneath the surface of water, the anode clamp assembly may be installed on the pipe prior to lowering the pipe into the ground or beneath the water or the anode clamp assembly may be installed on the pipe after it has been lowered into the ground or beneath the water.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a section taken on line **1—1** of FIG. **2**;

FIG. **2** is a front elevational view of the anode clamp assembly shown in FIG. **1**;

FIG. **3** is a side elevational view of another embodiment of the anode clamp assembly herein;

FIG. **4** is a plan view of the securing bar employed in the anode clamp assembly of FIG. **3**;

FIG. **5** is a plan view of a securing bar in accordance with still another embodiment;

FIG. **6** is a side elevational view of an anode clamp assembly in accordance with a different embodiment of the invention;

FIG. **7** is a plan view of a securing bar utilizable in the anode clamp assembly of FIG. **6**;

FIG. **8** is a plan view of a securing bar utilizable in the anode clamp assembly of FIG. **6**;

FIG. **9** is a side elevational view of an anode clamp assembly in accordance with still another embodiment;

FIG. **10** shows another form of the securing bar utilizable in the assembly of FIG. **9**, the nuts being removed from the threaded opposite end portions of the securing bar or bolt; and

FIG. **11** is a plan view of a securing bar utilizable in the anode clamp assembly of FIG. **6**.

DETAILED DESCRIPTION OF THE DRAWINGS

Like reference characters denote like parts in the several figures of the drawings.

Referring to FIGS. **1** and **2**, corrosible metallic pipe **15**, for example of ferrous metal, e.g., steel, buried in the ground, has a thin continuous or substantially continuous coating **16** of an electrical insulating, organic, substantially water-insoluble, plastic material such as,

e.g. an epoxy coating, over substantially its entire external surface. Instead of the epoxy coating, coating **16** may be of another insulating, substantially water-insoluble, organic plastic material such as, for example, an asphalt base enamel, coal tar base enamel, epoxy-coal tar coating, a tape wrap, e.g. a polyvinyl chloride or polyethylene tape wrap, suitable for use in a corrosive environment, or of synthetic polymers applied by fluidized bed processes, extrusion or by other suitable application procedures. Coating **16** can, if desired, be a thick coating or layer. By the term "plastic" as used herein in referring to the electrical insulating, substantially water-insoluble material of the thin or thick coating, for example coating **16,** on the surface of the corrosible metal object, for example metallic pipe **15,** is meant a readily shapeable or deformable material having such insulating and water-insolubility properties. Clamp **17** is disposed about pipe **15** and consists of a one piece, rigid, substantially non-flexible, generally C-shaped clamp member **18** preferably of a ferrous metal, e.g., malleable iron. Sacrificial anode **19** includes mass **20** of sacrificial anode metal, e.g., zinc, a sacrificial zinc alloy, magnesium alloy or aluminum alloy. Electrically conductive, metallic bolt **21** of, for example, ferrous metal, e.g., steel, is embedded at one end in sacrificial anode body **20,** by anode body **20** being cast about the bolt end portion including head **22.** The longitudinal axis of bolt **21** is normal or substantially normal to the plane of the surface of sacrificial anode body **20.** The intermediate and opposite end portions **24** and **25** respectively of bolt **21** are threaded and the end portion of the bolt has sharp, penetratable terminal end **26** of conical shape. Alternatively, sharp, penetratable terminable end **26** of bolt **21** can be of cup shape wherein the terminal end **26** has a generally concave or "cup-like" depression or cavity surrounded by a penetratable circular ridge which makes a circular line contact with the coating **16.** Such bolts having the conical shape or cup shape terminal end are readily obtainable in commerce. Less preferably, the bolt **21** may have a flat or substantially flat, penetratable terminal end, the flat-ended bolts also being readily obtainable in commerce.

Seal **27** is provided about the threaded end portion of bolt **21** including its penetratable, terminal end **26** and the point of contact of the bolt penetratable end **26** with the metallic pipe **15.** Seal **27** is an essential element in the cathodic protection anode clamp assembly of this invention for obtaining satisfactory performance of the cathodic protection system over a prolonged period, by reason of providing a moisture-excluding, anti-corrosive, continuous seal or barrier about the threaded end portion of bolt **21** and the point of contact of the bolt penetratable sharp end **26** with the metallic pipe **15.** Consequently a satisfactory metal-to-metal electrical contact is maintained between the bolt **21** and pipe **15.** Maintenance of a satisfactory electrical contact between the bolt **21** and pipe **15** as cathode is essential for operability of the cathodic protection system as the return flow of electrical current from pipe **15** is through end **26** of bolt **21** and through the end and intermediate portions **25** and **24** respectively of bolt **21** and the remainder of bolt **21.** In the absence of seal **27,** satisfactory electrical contact may not be maintained between metal pipe **15** and bolt **21** for the reasons moisture which reaches the contact tends to cause high electrical resistance at the contact. Seal **27** is formed by rotating threaded bolt **21** having penetratable terminal end **26** through internally threaded aperture **28** in the upper portion of clamp member **18,** with the sharp, penetratable terminal end **26** of the bolt **21** penetrating electrically insulating, organic, substantially water-insoluble, plastic coating **16** on pipe **15.** In penetrating plastic coating **16,** the sharp terminal end **26** of the bolt displaces the organic plastic material of coating **16** outwardly and upwardly along the diverging conical surface of the bolt end **26** with such displacement being uniformly 360° around the bolt conical end **26.** As a result, the relatively thick barrier or seal **27** is automatically formed and extends continuously about the point of contact of the bolt end **26** with pipe **15,** with the seal **27** being symmetrical and of uniform thickness at any given point of the seal in transverse section and being a continuous barrier or seal to the inward passage of moisture to the contact. On the contrary, with the device of U.S. Pat. No. 3,553,094, the penetration of a plastic coating by the sharp, projections of the device would result in nonuniform displacement of the coating material with the coating material being displaced upwardly and outwardly only along the two diverging opposite edges and not along the two parallel opposite faces. Consequently, relatively thick seal portions would be formed only adjacent the two diverging opposite edges and not about the entire circumferential extent of the projection. Due to the absence of the relatively thick seal or barrier extending continuously around the entire circumferential extent of the projection, the probability of moisture reaching the contact of the projection with the metallic pipe or other object being protected is much higher than is the situation with the continuous seal of the present invention wherein this probability is small or remote. Bolt **21** also serves to retain the anode clamp assembly about pipe **15.**

When the metallic pipe or other metallic object to be protected is not coated with any electrically insulating, organic, plastic coating, the moisture-excluding seal can be formed in all embodiments of this invention by applying the insulating organic, water-insoluble plastic material, e.g., the coal-tar base enamel, asphalt base enamel or epoxy coating with a trowel, putty knife, brush or other suitable tool about the point or locus of contact of the electrically conductive member, e.g., the bolt or screw, with the metal of the pipe. A tape wrap can also be applied manually about the point of contact of the electrically conductive member with the metal of the pipe. Bolt **21** bites into the external surface of metallic pipe **15** with the penetratable terminal end of the bolt penetrating a material distance, typically one thirty-second inch, into the metal of pipe **15** and sufficiently to assure penetration of any oxide layer or passive layer formed on the surface of the pipe. Consequently, a satisfactory electrical contact is made between the metal of bolt **21** and the metal of the pipe. However the sharp projections of the device of U.S. Pat. No. 3,553,094 do not penetrate into the metal of the metallic object to be protected to the extent that the threaded electrically conductive member, e.g., bolt or screw of the present invention, penetrate into the metal of such metallic object, with the result the sharp projections of the device of U.S. Pat. No. 3,553,094 might not penetrate a thick passive layer that may be formed on the surface of the metallic object.

Electrically conductive set screw **29** of metal, e.g. ferrous metal, is threadedly engaged through internally threaded aperture or hole **30** in clamp member **18** and also penetrates insulating, organic plastic coating **16** on metal pipe **15** to provide metal-to-metal electrical contact between pipe **15** and screw **29.** Set screw **29** provides another path of electrical current flow from pipe **15** back to anode **19,** the current flow being through screw **29,** clamp member **18** and bolt **21** to the body **20** of sacrificial anode metal. When set screw **29** is employed for this additional electrical contact purpose, clamp member **18** must be of an electrically conductive material, e.g. ferrous metal. The use of set screw **29** is an optional feature which can be omitted, if desired.

With reference now to FIG. **3,** corrosible metallic pipe **32,** for example of ferrous metal, buried in the ground has a thin continous coating **33** of an electrically insulating substantially water-insoluble, organic plastic material, e.g., an epoxy coating, or of another such coating material previously disclosed herein, over substantially its entire external surface. Rigid, substantially non-flexible, generally U-shaped clamp member **34** is positioned about pipe **32.** Clamp member **34** has outwardly flared end portions **34***a* and **34***b* and is a one piece member preferably of ferrous metal, e.g., steel. Sacrificial anode **35** comprises body or mass **36** of sacrificial anode metal, e.g., zinc, a sacrificial zinc alloy, magnesium alloy or aluminum alloy. Metal bolt **37,** for example of ferrous metal, e.g., steel, of substantial length is embedded at its head end **38** in sacrificial anode body **36,** by being cast in place in anode body **36.** The intermediate and opposite end portions **39** and **40** respectively of bolt **37** are threaded, and the end portion **40** of the bolt has penetratable terminal end **41** of conical shape.

Bar **43,** shown also in FIG. **4,** serves to secure U-shaped clamp member **34** about metallic pipe cathode **32.** Bar **43** has a channel or slot **44** in one end portion thereof extending inwardly into the bar a material distance from a side edge of the bar, channel or slot **45** at the opposite end portion of the bar extending inwardly into the bar a material distance from an opposite side edge thereof, and a threaded hole or aperture **46** located intermediate slots **44** and **45.** Slots **44** and **45** have entrance openings of larger width than the diameters of the legs of U-shaped clamp member **34** to facilitate entry thereinto of the legs of clamp member **34,** whereas the intermediate and lower portions of slots **44** and **45** have widths which are narrower than the widths of the entrance openings of the U-shaped clamp member legs. The legs of U-shaped clamp member **34** are inserted in the entrance opening of slots **44** and **45** of securing bar **43** and bar **43** is then turned to bring the clamp member legs as far as possible into slots **44** and **45.** By reason of outwardly flared end portions **34***a* and **34***b* of the legs of clamp member **34,** and bar **43** engaged with the clamp member legs, the clamp member **34** is secured about pipe **32.** The depth or inward extension of each of slots **44** and **45** is ordinarily equal to or greater than the radius of each leg of clamp member **34** just below the outwardly flared ends **34a** and **34b** of clamp member **34,** to assure retention of the clamp member legs within slots **44** and **45.** Threaded hole **46** in bar **43** is of a diameter corresponding to that of the threaded portion of bolt **37,** and threaded bolt **37** (embedded in sacrificial anode body **36**) is threadedly engaged by turning through threaded hole **46** to bring its penetratable terminal end, which is usually in the form of a sharp-edged cup point or a cone-shaped point, into metal-to-metal contact with metal pipe **32.** Bar **43** is of generally rectangular shape, as shown, and is a metallic bar, for example of ferrous metal, e.g., steel.

Seal **47** is provided about the end portion **40** of bolt **37** including its penetratable, terminal end **41** and the point or locus of contact of the bolt's end **41** with the metal pipe **32.** Seal **47** is an essential element for satisfactory performance of the cathodic protection system over a prolonged period, inasmuch as this seal provides a moisture-excluding, anticorrosive, continuous barrier about the threaded end portion of bolt **37** and the locus or point of contact of the bolt's penetratable end **41** with the metal pipe **32.** Consequently, a satisfactory metal-to-metal electrical contact is maintained between the bolt **37** and pipe **32.** The maintenance of a satisfactory electrical contact between bolt **37** and pipe **32** as cathode is essential for satisfactory operability of the cathodic protection system as hereinbefore disclosed, inasmuch as the return flow of electrical current from metallic pipe **32** is by way of end **41** of bolt **37** and through the end and intermediate portions **40** and **39** respectively of bolt **37** and the remaining portions of the bolt **37.**

Referring to FIG. **5,** bar **55** can be utilized in place of bar **43** in the anode clamp assembly of FIG. **3.** Slot **44** of bar **55** is of similar configuration or shape to slot **44** of bar **43** of FIG. **3.** Hole or aperture **56** in the opposite end portion of bar **55** is unthreaded and is of somewhat larger diameter than a leg of U-shaped clamp member **34,** of FIG. **3.** Aperture or hole **46,** located intermediate slot **44** and unthreaded hole **56,** is threaded and of a diameter corresponding to the diameter of the threaded portion of bolt **37,** shown in FIG. **3,** and bolt **37** is threadedly engaged through threaded hole **46** in bar **55** by turning to bring its penetratable terminal end into metal-to-metal contact with metal pipe **32.** Bar **55** is of ferrous metal, e.g., steel. The slot **44** of bar **55** has an entrance opening of materially larger width than the diameter of each leg of U-shaped clamp member **34** to facilitate entry of the leg into the slot, whereas the intermediate and more inwardly portions of such slot are of narrower width in the direction toward the interior of the bar than the width of the entrance opening.

In a further embodiment of the invention shown in FIG. **6,** the anode clamp assembly is substantially identical to the clamp assembly shown in FIG. **3** herein except that both legs of rigid, substantially non-flexible, generally U-shaped clamp member **58** have threaded, straight end portions which are unflared and which are inserted through holes or apertures **59** and **60** of bar **61,** shown also in FIG. **7.** The legs of clamp member **58** are secured to bar **61** by nuts **62** and **63** threaded onto the threaded end portions of the legs of clamp member **58.** Holes **59** and **60** in bar **61** are unthreaded and of slightly larger diameter than the diameter of each leg of U-shaped clamp member **68.** Aperture or hole **46** located between unthreaded holes **59** and **60** is threaded and of a diameter corresponding to the diameter of the threaded portion of bolt **37,** shown also in FIG. **3,** and cast in situ in sacrificial anode **35** comprising sacrificial anode body **36.** Anode **35** with its bolt **37** embedded therein is secured in the assembly similarily as in the anode clamp assembly of FIG. **3** hereinbefore disclosed, viz. by bolt **37** being threadedly engaged by

turning through hole **46** until its penetratable terminal end, which is usually a sharp-edged cup point or a cone shaped point, penetrates the continuous coating **33** of electrically insulating, substantially water-insoluble, organic plastic material over ferrous metal pipe **32** and into metal-to-metal contact with metal pipe **32.**

Seal **47** is provided about the end portion **40** of bolt **37** including its penetratable terminal end **41** and the point or locus of contact of the bolt end **41** with the metal pipe **32.** Seal **47** is also an essential element of the anode clamp assembly of this embodiment of the invention for satisfactory performance of the cathodic protection system over a prolonged period, inasmuch as this seal provides a moisture-excluding, anticorrosive, continuous barrier about the threaded end portion of bolt **37** and the point or area of contact of the bolt's penetratable sharp end **41** with the metal pipe **32.** Consequently a satisfactory metal-to-metal electrical contact is maintained between the bolt **37** and pipe **32.**

Alternatively, securing bar **48,** shown in FIG. **11,** or bar **50,** shown in FIG. **8,** can be utilized in place of bar **61** in the anode clamp assembly embodiment of FIG. **6.** Bar **48,** shown in FIG. **11,** has channel or slot **44** in one end portion thereof extending inwardly of the bar a material distance from a side edge of the bar, channel or slot **51** in the opposite end portion of the bar extending inwardly of the bar a material distance from the end edge thereof, and threaded hole or aperture **46** located intermediate slots **44** and **51.** Bar **50,** shown in FIG. **8,** has channel or slot **52** in one end portion thereof extending inwardly of the bar a material distance from the end edge thereof, channel or slot **53** in the opposite end portion thereof extending inwardly of the bar a material distance from the opposite end edge thereof, and threaded hole or aperture **46** intermediate slots **52** and **53.** Slots **44** and **51** of bar **48** and slots **52** and **53** of bar **50** each have an entrance opening of materially larger width than the diameter of each of the legs of U-shaped clamp member **58** to facilitate entry of the legs in the slots, whereas the intermediate and more inwardly portions of each such slot in the direction toward the interior of the bar are of a width which is narrower than the width of the entrance opening and is only slightly larger in width than the diameter of each leg of the U-shaped clamp member **34.** Further each of such slots of bars **48** and **50** have a depth or inward extension which are ordinarily equal to or greater than the radius of each leg of the U-shaped clamp member **34.**

Referring now to FIG. **9** showing still another embodiment of the invention, rigid, substantially nonflexible, generally U-shaped clamp member **65** is positioned about corrosible pipe **66** of ferrous metal buried in the ground. Pipe **66** has a thin continuous coating **67** of an electrically insulating, substantially water-insoluble, organic plastic material, e.g., an epoxy resin, or of another such coating material previously disclosed herein, over substantially its entire external surface. U-shaped clamp member **65** of metal, e.g., ferrous metal, for example steel, has legs having axially aligned holes or apertures **65***a* and **65***b*, which are circular in transverse cross section and of a diameter slightly larger than the diameter of securing bar **81** and which extend through the entire thickness of the legs of clamp member **65.** Bar **81** also of metal, for example ferrous metal, e.g., steel, is inserted through apertures **65***a* and **65***b* in the legs of clamp member **65.** If desired, bar **81** can be curved in its center portion to conform to the contour of the outer diameter of pipe **66.** The opposite end portions of bar **81** can be unthreaded or, alternatively, threaded as designated at **81***a* and **81***b* in FIG. **10.** Nuts **82** are threaded on the opposite ends of bar **81,** after insertion of bar **81** through apertures **65***a* and **65***b*, when bar **81** has the threaded end portions. Sacrificial anode **71** comprises body or mass **72** of sacrificial anode metal, e.g., zinc, a sacrificial zinc alloy, magnesium alloy or aluminum alloy. Bolt **73** of metal, for example ferrous metal, e.g., steel, of substantial length is embedded at an end portion thereof in sacrificial anode body **72,** usually by being cast in place in anode body **72.** The intermediate and opposite end portions **74** and **75** of bolt **73** are threaded and end portion **75** of the bolt has penetratable terminal end **77** which usually has the form of a sharp-edged cup or a cone shaped point.

Sacrificial anode **71** is secured in the assembly by threading by turning bolt **73** (embedded in anode **71**) through internally threaded hole **83** in clamp member **65.** Bolt **73** is threadedly engaged through hole **83** until its penetratable, terminal end **77** penetrates the continuous coating **67** of electrical insulating material on pipe **66** to make metal-to-metal electrical contact with pipe **66.**

Moisture-excluding continuous barrier or seal **84,** is formed about the end portion of bolt **73** including its penetratable terminal end **77** and the point or locus of contact of the bolt end **77** with metal pipe **66.** The seal is an essential element of the assembly for the reasons previously disclosed herein.

The clamp member and securing bar of the anode clamp assemblies of this invention can be fabricated of any suitable material having sufficient strength characteristics. Thus the clamp and securing bar can be fabricated of a non-metallic material, for instance a synthetic polymer, e.g., epoxy, nylon or polyester. Instead of a non-metallic material, the clamp and securing bar can be fabricated of metal, e.g., ferrous metal, for instance malleable iron, cast iron or steel; or a nonferrous metal, e.g., copper, copper base alloy, e.g., brass or bronze, aluminum, or aluminum base alloy.

The electrically conductive member, e.g., bolt or screw, of the anode clamp assemblies herein can be fabricated of any suitable electrically conductive material, ordinarily metal. The metal is exemplified by ferrous metal, e.g., steel; copper or aluminum. Such material of the conductive member, e.g., the screw or bolt, should of course be of sufficient hardness to penetrate the electrically insulating, organic, plastic coating or layer on the external surface of the pipe or other corrosible metal article to be cathodically protected. When a passive layer or film of oxide or other material is present on the metal of the pipe or other corrosible metallic object beneath the electrically insulating coating, which is usually the situation, the material of fabrication of the conductive securing member, bolt or screw should also be of sufficient hardness to penetrate the passive layer or film and also to bite into and penetrate a material distance, typically one thirty-second inch, into the metal of the metallic object, so as to make satisfactory metal-to-metal electrical contact with the metal of the pipe or other corrosible metal article.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

When the pipe or other corrosible metal object being cathodically protected is of ferrous metal, the clamp member, conductive member, e.g., bolt or screw, and securing bar are preferably also of ferrous metal.

Preferably the clamp members of the anode clamp assemblies herein are coated, when of metal, with a continuous or substantially continuous, electrically insulating, substantially water-insoluble coating, which may be a thick or thin coating, to avoid expending the sacrificial anode to protect the clamp. The material of such coating is exemplified by an epoxy coating, a coal tar base enamel, and an asphalt base enamel. The threaded conductive member, e.g., bolt or screw, and the securing bar, when fabricated of metal, of the anode clamp assemblies herein are preferably also coated with a thick or thin continuous or substantially continuous electrically insulating, substantially water-insoluble coating which may be a thick or thin coating, for example of a coating material disclosed immediately supra, also to avoid expending the sacrificial anode to protect these parts. The conductive member, e.g., bolt or screw, when so coated should be coated after installation of the anode clamp assembly. The only bare metal in the anode clamp assemblies of the preferred embodiment of this invention is the mass or body of sacrificial metal of the sacrificial anode per se.

When the clamp member, conductive member, e.g., bolt or screw, and securing bar of the anode clamp assemblies of this invention are fabricated of different metal than that of the pipe or other corrosible metal object being cathodically protected, the metal of the clamp member, conductive member, e.g., screw or bolt, and securing bar is preferably less noble than the metal of the pipe or other corrosible metallic object being protected.

The pipe or other cathodic metallic object which is cathodically protected in accordance with this invention, preferably has the continuous or substantially continuous coating or layer of the electrical insulating, organic, substantially water-insoluble plastic material previously disclosed herein over its external surface. Such coating can be a thick or thin coating with the thick coating being of typical thickness of 90 mils., and the thin coating of typical thickness of 8 mils. In addition, the coated pipe may be spirally wrapped or wound with a suitable outer wrapper, for example, of coal tar- or asphalt-saturated asbestos or rag felt, or of a saturated glass felt or fabric.

If desired, a plurality, i.e., two or more, of the clamp assemblies of this invention can be employed and are within the spirit and scope of this invention. In this event, a sacrificial anode body would be utilized which would ordinarily be of substantially greater dimensions than the anode body utilized when a single clamp assembly is utilized.

What is claimed is:

1. A cathodic protection anode clamp assembly comprising a corrosible metallic object to be protected disposed in an electrolyte, clamp means positioned at least partially about the metallic object, the clamp means including at least one rigid, substantially non-flexible clamp member, and means securing the clamp member at least partially about the metallic object, a sacrificial anode including a body of sacrificial anode metal retained spaced apart from the corrosible metal object by a threaded, electrically conductive member of substantial length embedded at one end portion thereof in the sacrificial anode metal body, the opposite end portion of the conductive member being threaded and having a terminal end capable of penetrating any oxide layer on the surface of the corrosible metal object to assure electrical contact with the metal of the corrosible metal object, a correspondingly threaded hole in the clamp means, the conductive member threaded portion being threadedly engaged through the threaded hole in the clamp means with its terminal end contacting the metal of the corrosible metallic object to provide electrical contact between said conductive member and the metallic object, and a moisture-excluding seal of electrical insulating material disposed about the locus of contact of the conductive member terminal end with the metallic object.

2. The assembly of claim **1** wherein the threaded conductive member terminal end penetrates a material distance into the metal of the corrosible metallic object.

3. The assembly of claim **2** wherein a substantially continuous, protective coating of electrically insulating, organic, plastic material is provided on the external surface of the metallic object.

4. The assembly of claim **3** wherein the clamp member is a rigid, substantially non-flexible, generally C-shaped member, and the threaded hole is through an end portion of said generally C-shaped member.

5. The assembly of claim **4** wherein another threaded hole is in that end portion of the generally C-shaped member opposite that of the said threaded hole, and a threaded electrically conductive member having a penetratable terminal end is threadedly engaged through said another threaded hole in the C-shaped member with its terminal end penetrating the electrical insulating coating on the metallic object to contact the metal of the metallic object and provide an additional electrical contact between said threaded conductive member and the cathodic metal object.

6. The assembly of claim **3** wherein the clamp member is a rigid, substantially non-flexible, generally U-shaped member, the legs of said U-shaped member each having an outwardly flared end portion, and the securing means is a bar having a slot in one end portion thereof, a slot in the opposite end portion thereof, and the threaded hole is through a portion of the bar intermediate the slots, one of said slots extending inwardly of the bar a substantial distance from a side edge thereof and the other slot extending inwardly of the bar a substantial distance from a side edge thereof at the opposite side of the bar, the outwardly flared end portions of the U-shaped member legs engaging the slots in the bar opposite end portions whereby the clamp member is secured about the cathodic metal object.

7. The assembly of claim **3** wherein the clamp member is a rigid, substantially non-flexible, generally U-shaped member, the legs of said U-shaped member each having an externally threaded, non-flared end portion, and the securing means is a bar having an aperture in one end portion thereof, an aperture in the opposite end portion thereof, and the threaded hole is through a portion of the bar intermediate the apertures, the threaded, non-flared end portions of the U-shaped member legs extending through the apertures in the bar

opposite end portions, and nuts threadedly engaging the threaded end portions of the legs whereby the clamp is secured about the metallic object.

8. The assembly of claim **3** wherein the clamp member is a rigid, substantially non-flexible, generally U-shaped member, the legs of said U-shaped member each having an externally threaded, non-flared end portion, and the securing means is a bar having a slot in one end portion thereof, a slot in the opposite end portion thereof, and the threaded hole is through a portion of the bar intermediate the slots, one of said slots extending inwardly of the bar a substantial distance from a side edge thereof and the other slot extending inwardly of the bar a substantial distance from an end edge thereof, the threaded, non-flared end portions of the U-shaped member legs extending through the slots in the bar opposite end portions, and nuts threadedly engaging the threaded end portions of the legs whereby the clamp member is secured about the metallic object.

9. The assembly of claim **4** wherein the clamp member is a rigid, substantially non-flexible, generally U-shaped member, the legs of said U-shaped member each having an externally threaded nonflared end portion, and the securing means is a bar having a slot in one end edge thereof, another slot in an opposite end edge thereof, and the threaded hole is through a portion of the bar intermediate the slots, each slot extending inwardly of the bar a substantial distance from the end edge thereof, the threaded non-flared end portions of the U-shaped member legs extending through the slots in the bar opposite end portions, and nuts threadedly engaging the threaded end portions of the legs whereby the clamp member is secured about the metallic object.

10. The assembly of claim **3** wherein the clamp member is a rigid, substantially non-flexible, generally U-shaped member, and the threaded hole is through a substantially horizontal portion of the generally U-shaped member intermediate the ends of its legs.

11. The assembly of claim **1** wherein the threaded electrically conductive member is a bolt.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,803,012 Dated April 9, 1974

Inventor(s) George W. Kurr

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 41, "coponents" should read -- components --; line 65, -- the -- should be inserted after "from" and before "corrosible". Column 13, line 21, "4" should be deleted and -- 3 -- substituted therefor.

Signed and sealed this 17th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents