July 10, 1962 W. T. BRYAN ETAL 3,043,765

ANODE FOR CATHODIC PROTECTION SYSTEM

Filed Feb. 27, 1958

FIG-1

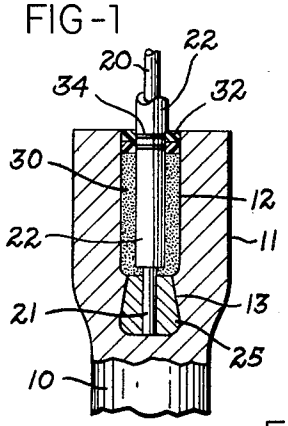


FIG-3

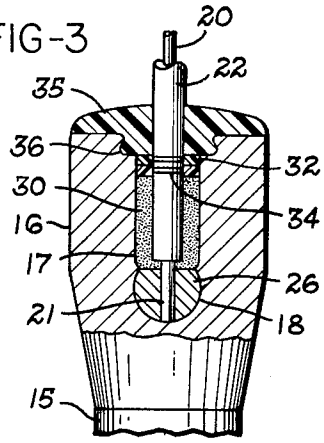


FIG-2

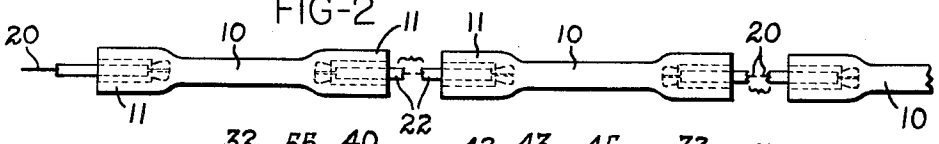


FIG-4

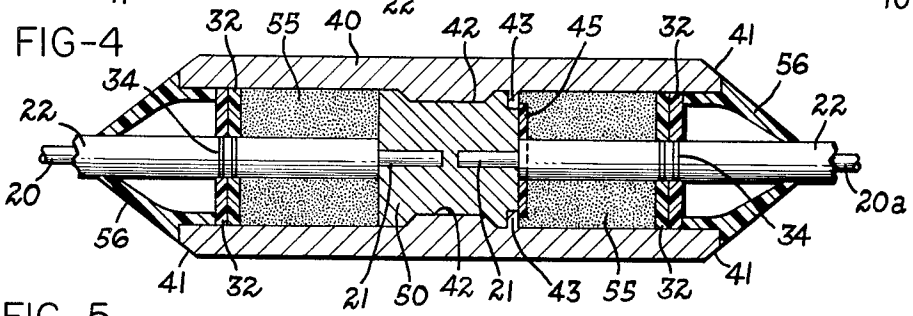


FIG-5

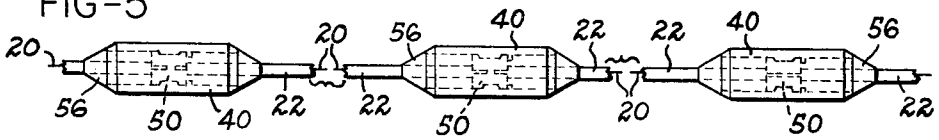


FIG-6

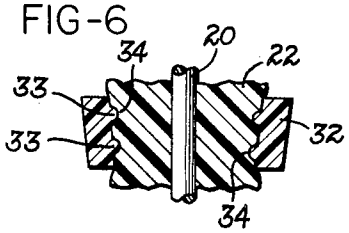


FIG-7

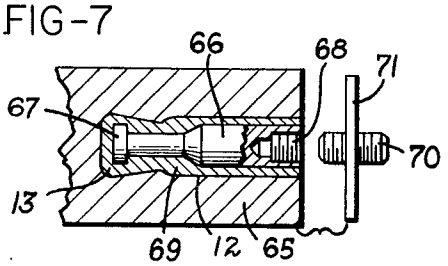
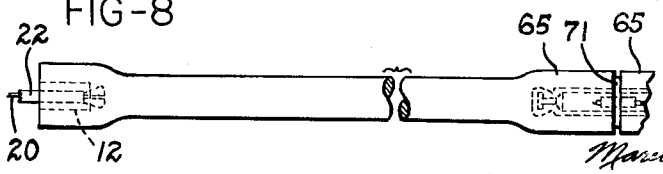


FIG-8



INVENTORS

WILLIAM T. BRYAN &
JOHN L. ARWINE

BY Marschal, Bechel, French & Bugg

ATTORNEYS

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ANODE FOR CATHODIC PROTECTION SYSTEM

William T. Bryan and John L. Arwine, Dayton, Ohio, assignors to The Duriron Company, Inc., Dayton, Ohio, a corporation of New York

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13 Claims. (Cl. 204—196)

This invention relates to cathodic protection systems for combating and inhibiting corrosions in metallic structures subjected to electrolytic corrosive action in the surrounding medium in which they are installed and, more particularly, to anode structures for such cathodic protection systems.

Structures such as metal pipe lines, underground cables and conduits, metal tanks and steam pipes, metal piers, etc., may be subjected to substantial and expensive electrolytic corrosion as installed beneath the surface of the ground, in sea water, under streams, and/or otherwise in contact with an electrolytic medium or environment. Such corrosive action may result from electrolytic cell action through the surrounding medium in which the metallic structure becomes anodic with respect to another object or another part of the same structure so that metal in the structure is actually electrochemically removed from those portions of the structure which are anodic with respect to another element of the electrolytic cell, and, since such anodic areas are frequently small by comparison to the cathodic object or area, a high current density may result at the anode causing rapid failure of the structure.

One method of combatting such corrision is to provide adjacent the corrosive structure a so-called cathodic protection system in which an anode is provided in electrolytic cell relation with the structure to be protected and a suitable electric current is impressed to maintain the anode anodic with respect to the structure to be protected thereby avoiding electrochemical removal of material from the structure. Such a cathodic protection system and apparatus therefor is described in the application of Walter A. Luce and Marselio G. Fontana, Serial No. 440,448 filed June 30, 1954 now abandoned, and the continuation-in-part copending application thereof, Serial No. 667,808, filed June 25, 1957, now abandoned, in which the use of a high silicon iron casting is disclosed for the protecting anode as providing increased anode life and enhanced electrolytic and electrochemical characteristics for impressed current cathodic protection systems.

Esecially with the cathodic protection of extended subterranean pipe lines and electrical cables, as well as with large metal piers, and the like, it is desired that the cathodic protection system itself have as long a life as possible to reduce maintenance problems, etc. In such systems, of course, the action of the impressed current in the cathodic protection of a metal structure may accelerate or enhance the possibility of corrosive destruction of the protecting anode and its appurtenant wiring. It has been found, particularly, that the point of connection of the wiring leads to the protecting anode are especially subjected to electrolytic corrosion, as well as are such "weak links" in the protection and as points of juncture of two anodes, etc.

It has also been discovered that optimum electrochemical characteristics of either anode materials or interconnecting wiring may be inconsistent with the mechanical strength and/or electroconductive characteristics of various materials. For example, a specific high silicon iron of desired electrochemical and anticorrosion characteristics for an anode may have such high brittleness, lack of machine ability, and poor tensile or impact strength as to be, alone impractical to withstand or conform to the physical requirements of some installations

and/or metallurgically ill-suited to electrical connection with a lead wire in a manner which will protect the point of connection from excessive corrosion and failure in a shorter time than the expected and desired anode life.

With such high silicon iron anodes, some difficulty may be experienced in the manufacture thereof if it is attempted to incorporate into the anode body an insert or other connecting piece of a metal which may be machinable or susceptible to a soldered lead wire connection. For example, attempting to incorporate directly such an insert as the high silicon wire casting is made may lead to difficulties in positioning the insert precisely into the mold cavity to be cast into the anode.

Similarly, providing an accurately dimensioned cored recess in the anode body for the later insertion of a connection device may well increase the practical difficulty in producing the cast anodes on a commercial scale.

According to this invention, however, structures are provided for the electrical and mechanical connection of the anodes in a cathodic protection system to provide both electrical and chemical insulation of the electric connection against corrosion, etc., as well as increased mechanical strength at the point of connection as required, and structures according to this invention are also advantageously susceptible to mass producing the anode castings in and with standardized electrical connection means yet without the necessity for accurately cored portions of the casting and without the necessity of using separate inserted connecting members for the lead wire yet with the provision of means for the utilization of an interlocking machinable insert in the standardized production device should this expedient be desirable.

One object of this invention is to provide, in an electrode of the character described, a protective electrical connection for connecting the electrode to a lead wire and protecting the connection from corrosion attack, all in the absence of the use of a separate connecting element or insert yet while providing an interlocking connection having mechanical or tensile strength sufficient to maintain the lead wire connected to the anode under tensile conditions as may be encountered in use which tend to pull the lead wire out of or away from connection with the anode.

Another object of this invention is to provide, in an electrode of the character described, a standardized connecting structure either for mechanically joining one electrode to another utilizing a machinable connecting device inserted into the electrode or for making an adequately strong electrical and mechanical connection in the absence of a separate insert between the electrode and a lead wire therefor.

A further object of this invention is to provide, in an electrode of the character described and formed of a material unsuited for machined or welded or soldered mechanical or elemental connections to a wire or a separate connecting element, or means for the interlocking mechanical and electrical connection of a lead wire to the electrode without a separate connecting structure, which means will withstand the disruptive tensile forces to which such connection is subjected in use, and including provision for insulating said connection both electrically and mechanically within the electrode to protect the connection from corrosive contact with fluid media in which the electrode and the connection are subjected in use.

Still another object of this invention is to provide, in electrodes of the character described, connecting means for interconnecting a plurality of electrodes with each other and/or with one or more lead wires to produce an electro-conductive juncture which will withstand the tensile and other mechanical disruptive forces to which it is subjected in use and yet which is provided without the necessity of separate connecting devices.

A still further object of this invention is to provide, in electrodes of the character described, connecting means for interconnecting a plurality of electrodes with each other and/or with one or more lead wires to produce an electroconductive juncture which will withstand the tensile and other mechanical disruptive forces to which it is subjected in use and yet which is accomplished by a standardized connecting structure cast into the electrode body for use both in the case where a lead wire is connected to the electrodes and in the case where the electrodes are mechanically rigidly connected together by an interposed rigid connecting element.

Other objects and advantages of this invention will be apparent from the following description, the accompanying drawing, and the appended claims.

In the drawing,

FIG. 1 is a view partially in longitudinal section through a connection of the lead wire to an electrode embodying this invention;

FIG. 2 is a plan view of a plurality of electrodes connected together by lead wires for a cathodic protection system embodying this invention;

FIG. 3 is a view similar to FIG. 1 illustrating a modification of a lead wire connection and insulating structure embodying this invention;

FIG. 4 is a view in longitudinal section of a further form of electrode embodying this invention and adapted to be connected to a lead wire intermediate the extreme ends thereof;

FIG. 5 is a somewhat diagrammatic view of the electrodes of FIG. 4 connected to a lead wire at various points therealong;

FIG. 6 is a detailed fragmentary view on an enlarged scale of a plastic compression closure washer as part of the electrical and chemical insulating means of structures embodying this invention and as shown in FIGS. 1, 3, and 4;

FIG. 7 is a fragmentary longitudinal section of a connection structure embodying this invention and adapted to connect a plurality of anodes rigidly together; and

FIG. 8 is a view in elevation partly broken away of a form of electrode embodying this invention and including in one end thereof the rigid connection of FIG. 7.

Referring to the drawing, in which like reference characters refer to like parts throughout the several views thereof, the end portion of an anode **10** is illustrated in FIG. 1 as applied particularly to a cast iron anode of generally elongated cylindrical shape and having a high silicon content (for example, of the order of 12% to 15% silicon in the cast iron) and sufficiently high to render the cast iron anode **10** too hard or brittle to be susceptible to machining and/or soldering or welding operations. Anode **10** is illustrated as having an enlarged end portion **11** and a recess **12** of generally cylindrical configuration formed in the enlarged end portion **11**. Recess **12** is satisfactorily formed by being cast into anode **10** during the process of manufacture of the anode, as, for example, by having a sand core of the desired shape in the mold in known manner.

The innermost portion **13** of recess **11** is formed as an undercut or otherwise in a manner so that a fusible material poured thereinto to fill completely portion **13** of recess **12** will, upon solidification, positively interlock against withdrawal therefrom. As illustrated in FIG. 1, this interlocking inner portion **13** of recess **12** may satisfactorily be formed in a frusto-conical configuration. Satisfactory results are also obtained, according to this invention, as illustrated in FIG. 3 where a generally cylindrical anode **15** is provided with an enlarged end portion **16** in which there is a cored recess **17** of generally cylindrical configuration having an innermost portion **18** for the aforementioned interlocking of a fusible material therein but with the portion **18** being formed in a generally spherical configuration rather than the frustro-

conical configuration of portion **13** of recess **12** illustrated in FIG. 1.

As will be understood, anodes embodying this invention may be immersed in sea water or fresh water (as in a water tank or standpipe) or immersed or embedded in damp soil or a so-called backfill adjacent to the structure which it is desired to protect by the cathodic protection system embodying electrodes according to this invention. Since anodes of this invention are particularly adapted for use in so-called "impressed current" cathodic protection systems, it is required that a lead wire or other insulated electrical connector be electrically and mechanically connected to the anode. As is well understood, such electrical connectors may be formed of a material different from the anode material itself, most frequently copper wire, and, because of the electro-chemical difference between the copper of the lead wire and the anode material, among other reasons, the connection of the lead wire to the anode forms what might be described as the "weakest link of the chain" in terms of the susceptibility of the entire system to the electrochemical corrosion. Thus, if the connection between the copper lead wire and the high silicon iron anode is accessible to the electrolytic surrounding medium in which the anode is disposed, corrosion of this connection and of the anode at this connection will be accelerated to a point where failure of the entire system may well result long before the useful life of the anode itself is expended.

Furthermore, in such cathodic protection systems, the anode itself may be mechanically suspended or supported from the lead wire and/or the anode may be installed or pulled into its operative position (for example, through a conduit or duct in which cables or pipes which it is desired to be protected are disposed) so that, in addition to a firm electrical connection, a strong mechanical connection between the lead wire and the anode is advantageous. Similarly, such connection should be both electrically and, as noted, chemically insulated from the surrounding medium.

Such features and advantages are provided by this invention, as illustrated in FIG. 1, for example, by recess **12** with the interlocking portion **13** being cast into the anode **10**. The connection between anode **10** and a lead wire **20** is formed by baring the end **21** of the lead wire **20** from the electrical insulating layer **22** therearound as indicated and inserting the bared end **21** of the lead wire **20** into the undercut portion **13** of recess **12** in the end **11** of anode **10**. With lead wire **20** so positioned, lead or some other readily fusible material having appropriate electroconductive characteristics is melted and poured into recess **12** around lead wire **20** so that, when the lead solidifies upon cooling, a lead plug **25** will be formed in undercut portion **13** of recess **12** solidly uniting lead wire **20** with anode **10** for the electrical circuit, and, because of the undercut or frustro-conical or dove-tail configuration of portion **13** of recess **12**, the solidified lead plug **25** will also anchor or affix wire **20** mechanically solidly into the recess **12**. As will be understood the bared end **21** of lead wire **20** is preferably tinned prior to the introduction of lead into the recess, and, as will also be understood, such materials as babbit metal, solder, and other similar low-melting alloys may be utilized satisfactorily to form a firm and strong electrical and mechanical connection between lead wire **20** and anode **10** entirely within the anode in recess **12** and removed from the outer or exposed end of anode **10**.

Also, as indicated in FIG. 3, a similar connection is formed in the recess of the illustrated embodiment with the provision of a solid plug **26** of lead or other readily fusible metal filling the spherical portion **18** of recess **17** to unite the bared end **21** of lead wire **20** both mechanically and electrically with the main body of anode **15**.

After lead wire **20** is so leaded in place, the remaining portion of recess **12** or **17** is preferably filled with a non-solidifying insulating plastic mastic, as indicated at **30** to

protect and insulate electrically and chemically the leaded connection of lead wire 20 with lead plug 25 or 26 and anode 10 or 15. One satisfactory material for the plastic insulating mass 30 is "Ozite," an asphalt base caulking compound.

After introduction of mastic 30 into the recess 12 or 17, a firm and water-tight closure of the recess is made by the insertion thereinto of one or more plastic compression washers 32 which fit into the recess and around the electrical insulating layer 22 of lead wire 20. Preferably such washers 32 have an outside diameter just larger than the diameter of recess 12 for a forced fit thereinto compressing the plastic material of washers 32. As indicated more particularly in FIG. 6, the outer surfaces of washers 32 may advantageously be tapered to enhance the compression effect, and, also as noted in FIG. 6, the inside surface of washers 32 preferably include one or more compression rings 33 provided so that, when washers 32 are fitted around the outer insulating layer 22 of lead wire 20 and compressed into recess 12 or 17 in the anode, compression rings 33 will embed themselves into the outer plastic insulating coating 22 of lead wire 20 to enhance the water-tight nature of the closure of the outer end of recess 12 or 17.

As noted in FIG. 3, and as particularly adapted for submersion in sea water for extended periods as, for example, to protect cathodically sea water installations such as metal piers and the like, a further protective closure may be provided over the end of the anode as by, for example, a plastic cap 35 applied over and around compression washers 32 and lead wire 20. In such situations, a further undercut or dove-tail recess 36 may be advantageously cast into the outer end 16 of anode 15 to provide a positive mechanical anchor for the plastic cap 35. Satisfactory results are obtained if compression washers 32 are formed of polyethylene plastic and, in instances when the outer plastic cap 35 is utilized, a satisfactory material for the formation thereof is epoxy resin.

As will be understood, the foregoing arrangement of lead wire connection into an anode constructed to embody or for practicing this invention may be either the connection of a lead wire from one end only of the anode or, indeed, may be the type of connection illustrated in FIG. 2 in which a plurality of anodes are connected together with lead wires in between. Even with such connections and the lead wires in between, still one can produce anodes with the standardized recess 12 or 17 and with the undercut portion 13 or 18 for any particular lead wire connection as may be desirable.

As a further embodiment of an anode according to this invention and particularly adapted to having a plurality of such anodes strung on a wire to be pulled through a conduit or other type of arrangement whereby a long cable is desired to be cathodically protected, the type of anode of FIG. 4, may be advantageously provided. In this arrangement there is provided an anode body 40 of the same high silicon content as with the anodes 10 or 15. Anode 40 is cast in the general form of a cylindrical piece of pipe, with, however, certain particular arrangements in accordance with this invention. Anode 40 is provided in an essentially elongated cylindrical shape with the inside thereof being essentially hollow, with chamfered edges being preferably provided at 41. An indent 42 is provided generally midway between the ends of anode 40, as also is an annular abutment or indent 43 for purposes hereinafter to be disclosed.

With the generally cylindrical form of anode 40 and including its high silicon content and protuberances 42, as well as annular protuberances 43 longitudinally spaced from proturberance 42, the particular anode is electrically connected and chemically insulated as follows.

A lead wire 20, including electrical insulation 22 is bared of the insulation for a portion of the end thereof 21. A plastic insulating washer 45 is, accordingly, slipped over the end of lead wire 20, or, for purposes of specific illustration, that portion of lead wire 20 designated in the drawings as a lead wire 20*a*, and, preferably, the hole in the inside of washer 45 is of such diameter as will accommodate lead wire 20 and its layer of insulation 22 thereon. Washer 45 is, as will be understood, of a diameter sufficiently large to transcend the annular opening left by the annulus 43 cast into anode 40.

In this way, washer 45 is placed over the bared end of one lead wire, for example, 20*a*, and this lead wire, with the washer 45 thereon, is inserted into one end of anode 40. With this lead wire 20*a* and the washer 45 thereon in place, inside of anode 40 and with the washer 45 bearing against annular protuberance 43, another end of a lead wire 20, bared at 21 of its insulating material 22, is inserted from the opposite end of anode 40. With both lead wires in place, a quantity of lead or solder or babbit metal or other fusible material is poured in from the left end of anode 40 to form, upon cooling, a solid plug uniting the bared ends 21 of the two leads, which are preferably previously tinned, to anode 40. As will be understood, of course, the projection 42 aids in the mechanical anchoring and maintenance of the two lead wires 20 and 20*a* in the anode 40 through the help of the lead or babbit metal or solder plug. In the foregoing operations, as will be understood, washer 45, interfitting with the annulus 43 cast or cored into the internal diameter of anode 40, forms an abutment against which the lead or other readily fusible material can be poured from the left end of anode 40 (as viewed in FIG. 4) to form the solid block 50 uniting the various lead wires in anode 40.

After the leaded joint is formed in anode 40 to unite mechanically, and as well as electrically, the lead wires therein the remainder of anode 40 is filled with plastic mastic, as with the interior of recesses 12 or 17, about a lead wire connection thereinto. After the interposition of a mastic mass 55, compression washers 32 are interfitted into the anode 40, as such washers are interfitted into the outer end recesses 12 or 17, it being understood that a variance of diameter may, indeed, be achieved but, the compression washers are, essentially the same as those washers 32 for interfitting into the outer end recesses 12 or 17, and including the compression rings 33 which bite or otherwise impress themselves into the outer circumference or surface of the plastic insulating layer 22 around electrical conductors 20 and 20*a*, as indicated at 34, in much the same way as is achieved in FIGS. 1, 3, and 6.

Since anode 40—or the entire structure as diagrammatically illustrated in FIG. 4—is primarily adapted for pulling through a conduit or other constricted space, the ends of anode 40 outwardly of the compression washers 32 are closed by a generally conical cap 55 which may, satisfactorily be of polyethylene plastic and which may satisfactorily interfit, as indicated in FIG. 4, with the end portions of anode 40 as well as with and around the insulating layer 22 of lead wire 20. It should be noted, however, that the electrical and chemical and electrochemical insulation of the joint within anode 40 is, by and large, accomplished by the plastic mastic mass 55 and compression washers 32, rather than by the plastic cap 56 which, indeed, is, because of its conical shape, rather more a mechanical guide for pulling anode 40 through whatever conduits or ducts in which it may be disposed than any electrochemical or electric insulating means. In this connection it should be noted that slant or slope of conical cap 56 is, preferably, correlated with the chamfered surface 41 on the ends of anode 40.

As illustrated in FIG. 5, a plurality of anodes 40 are illustrated as being strung upon or interconnected with, according to this invention, an elongated lead wire 20 to provide, as heretofore discussed, the cathodic protection anode structure which may be pulled through a conduit or duct or other arrangement to include the various benefits and advantages of an anode constructed for incorporation into the lead wire 20 intermediate the ends thereof, as illustrated diagrammatically in FIG. 4.

In some installations, such as, for example, the cathodic protection of tall standpipes or water tanks, it may be desired to connect a plurality of anodes or anode segments rigidly together to form one long anode. A satisfactory structure embodying this invention for accomplishing such rigid connection is illustrated in FIG. 7 as having a recess **12** with an undercut or interlocking portion **13** cast into the end of an anode **65**. An insert connector **66** is provided of a metal which is readily machineable, and is formed having a diameter somewhat less than the smallest diameter of recess **12** with at least one interlocking protuberance or projection such as **67** or other irregular exterior surface. In this illustrated embodiment, the outer end of insert **66** has a tapped bore **68** therein.

In assembling the connection, insert **66** is inserted into recess **12** and lead or solder or babbit metal or other readily fusible metal is poured into the recess surrounding and enveloping insert **66** to form upon cooling and solidification a solid plug **69** which rigidly interlocks and maintains insert **66** in recess **12**. With such structure, then, a threaded lug **70**, preferably provided with a plastic insulating washer **71**, unites two such anodes or anode segments **65** by screwing them together end to end with lug **70** engaged in tapped bore **68** in inserts **66**, and, upon screwing two such segments tightly together, washer **71** is compressed therebetween to form an insulating closure for each of the recesses **12** in each such anode segments as illustrated in FIG. 8. In this way, any number of anode segments **65** can be screwed together in end-to-end relation to form a composite anode of the length desired. As indicated in FIG. 8, the end anode segment of such a composite arrangement has a lead wire **20** affixed into the recess **12** therein as, for example, by the connection shown in FIG. 1.

According to this invention, then, structures are provided for connecting lead wires or rigid connectors into electrodes of the character described notwithstanding the fact that such electrodes may be made of a material which cannot satisfactorily or readily be machined or welded or soldered, and means are also provided for insulating such connections both electrically and chemically from contact with the surrounding medium in which the anode and the connection may be placed. Furthermore, considering the various types of anodes to which connection is to be made, the forms and structures embodying this invention provide for producing standardized anodes with a standard recess readily cast into the end thereof so that a single form of recess can be used whether it is subsequently desired to connect the lead wire to the anode as in FIG. 1 or a rigid connector as in FIG. 7. Because of the interlocking nature of the lead plugs **25**, **26**, **50**, and **69** in the undercut or protruding portions **13**, **18**, and **42** of the various recesses for the insertion of bared ends **21** of the lead wires **20** or irregularly shaped inserts **66** thereinto, a mechanical juncture is formed of adequate mechanical strength to withstand any pulling or tensile forces to which the anodes may be subjected in use, it being understood that, in actual practice, the bared ends **21** of lead wires **20** may be curved or askew or irregular positioned within the various recesses rather than being symmetrically positioned therein as shown in the drawings for illustrative purposes.

While the forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. An anode construction for a cathodic protection system of the character described having a plurality of anodes connected in spaced relation along a lead wire with said connections having sufficient mechanical strength for said lead wire with said anodes connected therealong to be pulled through a conduit and the like for the cathodic protection of structures adjacent said conduit, comprising in combination a generally cylindrical hollow main anode body, an annular constriction within said anode body intermediate the ends thereof for interlocking engagement with a fusible plug therein, a pair of lead wire segments inserted into opposite ends of said anode body into juxtaposition adjacent said constriction, a fusible plug in said anode body and formed of a metal lower melting than said anode body and mechanically and electrically connecting both said lead wire segments with said anode body through said constriction therein forming an electrical connection therebetween and a mechanical connection resistant to longitudinal tensile forces tending to separate either of said lead wire segments from said body, plastic insulating means around said wires and said connections and outwardly spaced therefrom longitudinally of said anode body forming a watertight closure electrically and chemically insulating said connection of said lead wire segments to said anode body and said fusible plug from a surrounding medium in which said anode may be disposed.

2. An anode construction for a cathodic protection system of the character described having a plurality of anodes connected in spaced relation along a lead wire with said connections having sufficient mechanical strength for said lead wire with said anodes connected therealong to be pulled through a conduit and the like for the cathodic protection of structures adjacent said conduit, comprising in combination a generally cylindrical hollow main anode body, an annular constriction within said anode body intermediate the ends thereof for interlocking engagement with a fusible plug therein, a pair of lead wire segments inserted into opposite ends of said anode body into juxtaposition adjacent said constriction, a fusible plug in said anode body and formed of a metal lower melting than said anode body and mechanically and electrically connecting both said lead wire segments with said anode body through said constriction therein forming an electrical connection therebetween and a mechanical connection resistant to longitudinal tensile forces tending to separate either of said lead wire segments from said body, an annular inward projection in said anode body and spaced from said constriction, assembly washer means on one of said lead wire segments for interfitting a closure with said annular projection forming a limiting mold for the formation of said fusible plug within said anode, plastic insulating means around said wires and said connections and outwardly spaced therefrom longitudinally of said anode body forming a watertight closure electrically and chemical insulating said connection of said lead wire segments to said anode body and said fusible plug from a surrounding medium in which said anode may be disposed.

3. An anode construction for a cathodic protection system of the character described having a plurality of anodes connected in spaced relation along a lead wire with said connections having sufficient mechanical strength for said lead wire with said anodes connected therealong to be pulled through a conduit and the like for the cathodic protection of structures adjacent said conduit, comprising in combination a generally cylindrical hollow main anode body, an annular constriction within said anode body intermediate the ends thereof for interlocking engagement with a fusible plug therein, a pair of lead wire segments inserted into opposite ends of said anode body into juxtaposition adjacent said constriction, a fusible plug in said anode body and formed of a metal lower melting than said anode body and mechanically and electrically connecting both said lead wire segments with said anode body through said constriction therein forming an electrical connection therebetween and a mechanical connection resistant to longitudinal tensile forces tending to separate either of said lead wire segments from said body, and end closure means forming a watertight joint around said lead wire segments electrically and

chemically insulating said connection from a surrounding medium in which said anode is disposed and forming beveled guide means facilitating pulling said anode through said conduit.

4. An anode construction for a cathodic system of the character described, comprising in combination a metal anode body portion, an elongated axial recess cast into an end of said anode body portion, an electrical conductor leading out of said recess for providing electrical and mechanical connection of said anode into said cathodic protection system, a transverse constriction in said recess and spaced from both inner and outer ends thereof for aiding in mechanically connecting said conductor to said anode body portion, said recess having outwardly of said constriction a substantially uniform cross-section substantially larger than the transverse dimension of said electrical conductor, a fusible plug of a metal lower melting than said metal anode body and formed in said recess interlocked therein with said constriction and engaging and electrically and mechanically connecting said conductor to said anode body portion in said recess, and plastic closure and insulating means closing the outer end of said recess around said electrical conductor effecting a watertight closure of said recess for electrically and chemically insulating said connection of said conductor to said anode in said recess.

5. An anode construction as recited in claim 4 in which said metal anode body portion is formed of high silicon cast iron having hard and brittle properties rendering it unsusceptible to ready machining.

6. An anode construction as recited in claim 4 in which said electrical conductor is a flexible electric wire with a layer of plastic insulation therearound except where said wire engages said fusible plug in said recess.

7. An anode construction as recited in claim 6 in which said plastic closure and insulating means includes a resilient pressure washer tightly fitted into the outer end of said recess and around said layer of insulation on said wire.

8. An anode construction as recited in claim 6 in which said plastic closure and insulating means includes a mass of plastic insulating material packed into said recess around said wire and outwardly of said constriction and said fusible plug engaging said wire in said recess.

9. An anode construction as recited in claim 8 which also includes a plastic washer closing the outer end of said recess around said wire for retaining said mass of insulating material packed in said recess.

10. An anode construction as recited in claim 4 in which said plastic insulating and closure means includes a plastic cap covering substantially the entire end surface of said anode body portion around said conductor.

11. An anode construction as recited in claim 10 in which said anode body portion includes means cast thereinto adjacent the outer end of said recess for anchoring said plastic cap thereto.

12. An anode construction as recited in claim 4 in which said mechanical and electrical connection between said conductor and said anode body also includes a machinable insert of a metal different from both said anode body and said lower melting fusible plug, said insert being substantially smaller than said recess and being interlocked in said recess by said fusible plug and said constriction, and means in said insert for connecting said conductor thereto.

13. An anode construction as recited in claim 12 in which said insert includes projecting surfaces for firm interlocking engagement with said fusible plug in said recess and cooperating with said constriction therein for interlocking firmly into said recess.

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