

United States Patent

[11] 3,594,706

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[45]	Patented	July 20, 1971
[73]	Assignee	Thomas & Betts Corporation Elizabeth, N.J.

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[54] GROUND CONNECTOR
14 Claims, 14 Drawing Figs.

[52]	U.S. Cl.	339/114, 339/278 C
[51]	Int. Cl.	H01r 13/20
[50]	Field of Search	339/114, 278 C; 136/3, 181

[56] **References Cited**

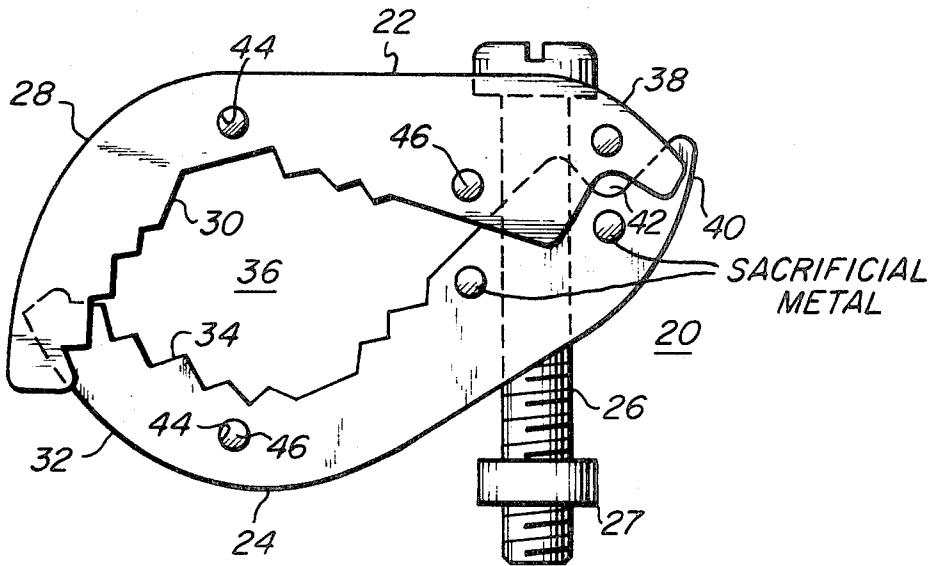
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2,679,032	5/1954	Thomas, Jr. et al.....	339/246
2,901,723	8/1959	Kolb	339/114
3,018,317	1/1962	Salis	136/181

FOREIGN PATENTS

869,413	11/1941	France	339/114
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ABSTRACT: The disclosure is directed to devices for protecting the ground connection between a conduit and a grounding conductor wherein the ground connector, conductor and conduit may be of dissimilar materials. The invention consists of the use of sacrificial metals functionally united with the ground connector in such a manner as to prevent, or greatly minimize, corrosion caused by galvanic action. The ground connector is fabricated, according to the various embodiments of the invention, to contain sacrificial metals placed in the external surface of the connector, placed with the connector, with exposure to the outer surface thereof, or impregnated directly into the connector with access from the outer surface to such sacrificial metal contained therein. The basic concept of operation of the clamp, in each of these configurations is that the electrolyte such as salt water, bathes, at the same time, the connector, the conductor, the conduit and sacrificial metal. The configuration of the connector is so chosen as to facilitate such uniform bathing of the materials involved.



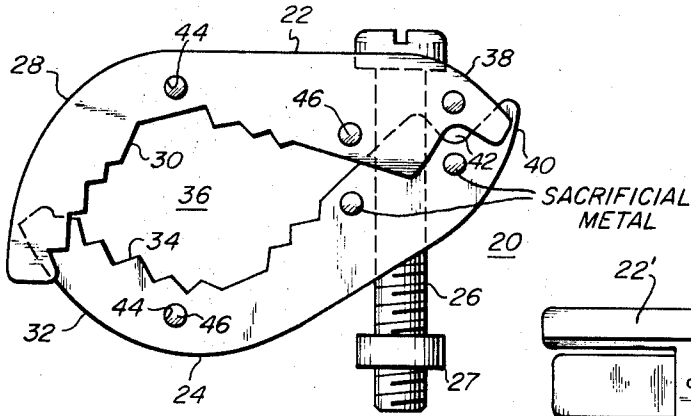


FIG. 1

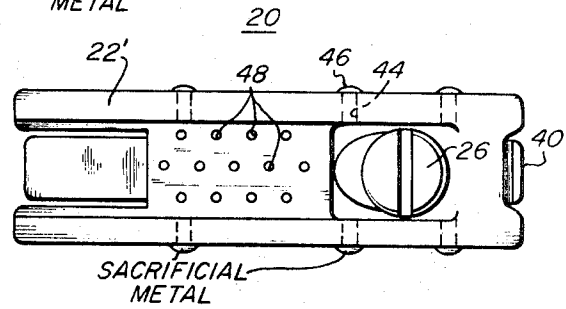


FIG. 2

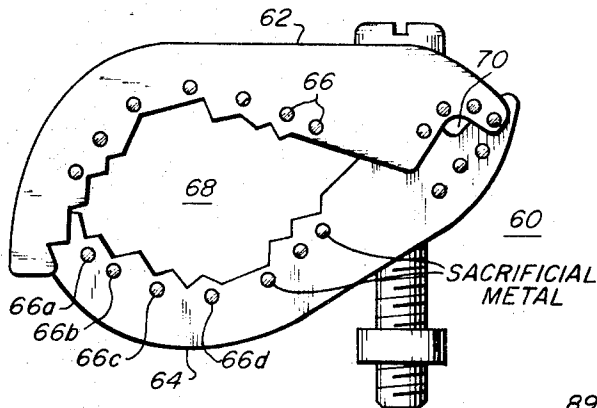


FIG. 3

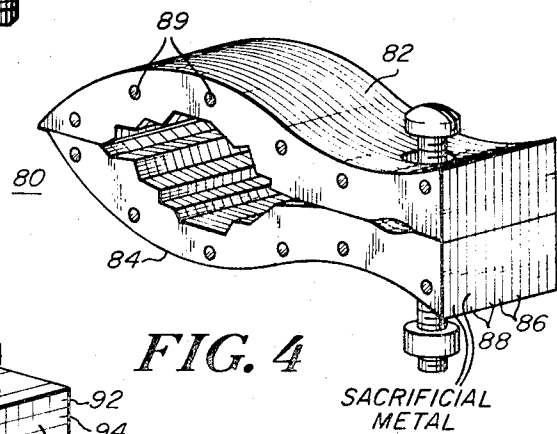


FIG. 4

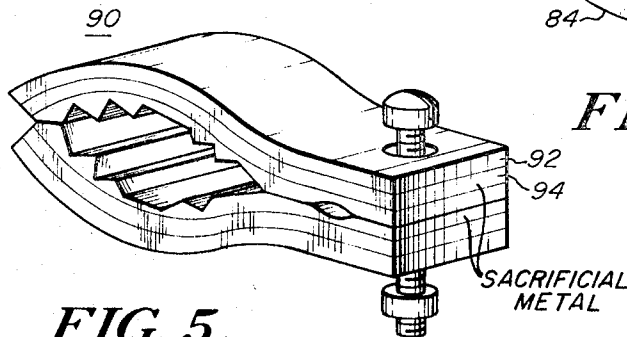


FIG. 5

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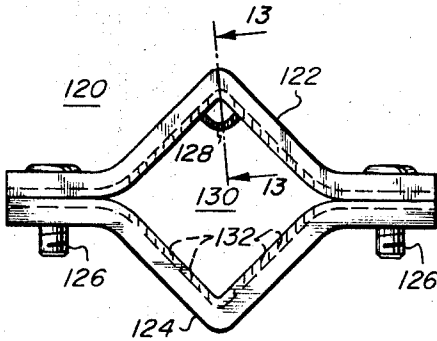


FIG. 6

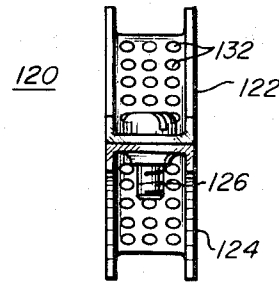


FIG. 7

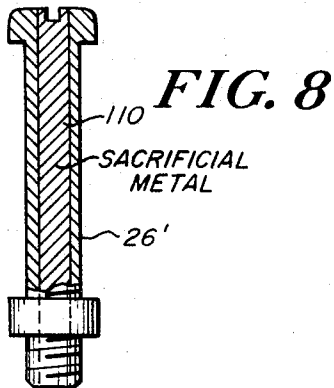


FIG. 8

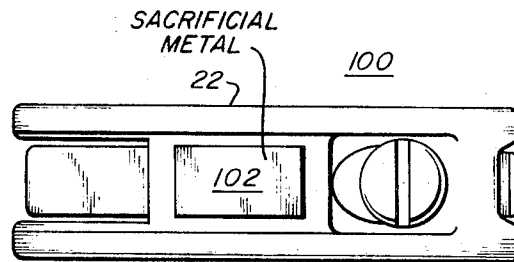


FIG. 9

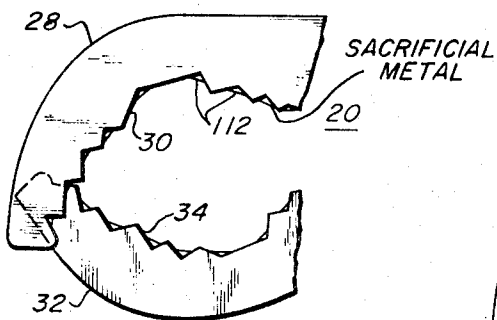


FIG. 10

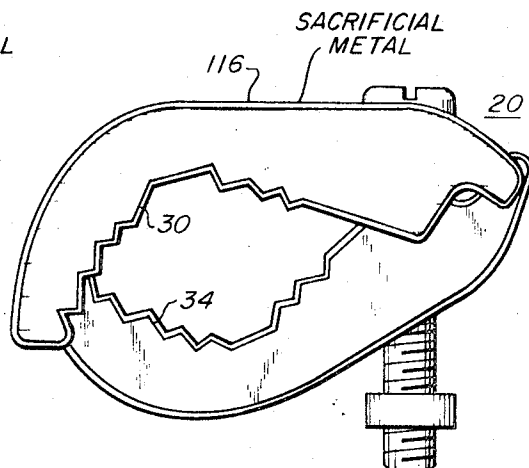


FIG. 11

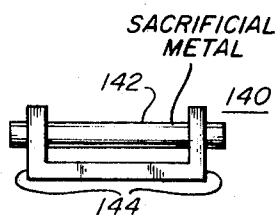


FIG. 12

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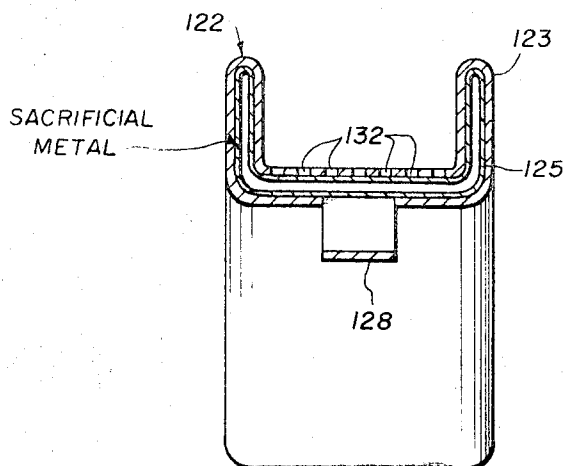


FIG. 13

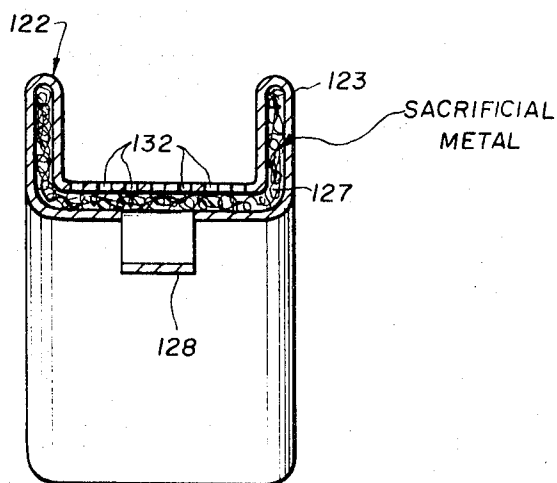


FIG. 14

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GROUND CONNECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention finds utility in the field of grounding electrical conductors, or metallic raceways. Further, it may be used in any situation where it is desired to couple together two conductors of dissimilar metals in the presence of an electrolyte such as salt water or the like.

2. Description of the Prior Art

In the prior art it was well known that conductors would be generally grounded to cold water pipes composed of copper or copper based alloys. The material of the ground connector, used to ground the conductor, was generally also of copper or a copper based alloy or might be of a ferrous metal. The conductors commonly employed were copper. Some corrosion existed between the copper conductor, or water pipe, and a ferrous ground connector. However, a good enough service life was generally available so that little concern had to be given to the corrosion of the various metals involved. However, with the introduction of aluminum conductors the problem of galvanic corrosion greatly increased. Present day connectors, of copper or ferrous metals, commonly employed to ground aluminum conductors to copper, or copper based alloys, were found to readily disintegrate in a salt spray atmosphere and within a short time to provide an unreliable electrical connection between such conductors and the conduit or raceway. Corrosion of the aluminum ground conductor, of course, broke the ground connection and corrosion of the conduit, or raceway, and ground connector provided a poor electrical connection therebetween or resulted in deterioration of the ground connector to a degree where it no longer could hold the conduit or raceway.

SUMMARY OF THE INVENTION

The present invention overcomes the difficulties noted above with respect to prior art grounding connectors and clamps by providing an improved grounding connector and clamp which resists the corrosive effects due to the use of dissimilar metals in corrosive, electrolyte environment. The present ground connector, or clamp, provides sacrificial metals which will be preferentially corroded in the presence of a corrosive, electrolyte environment such as salt spray to permit the increased life of such grounding connections. Various techniques are disclosed herein to include sacrificial metals within the structure of the ground connector itself. In first embodiments, holes are placed within the structure of the ground connector and slugs, or a wool, of a sacrificial metal are inserted therein. In further embodiments, additional apertures are provided in the surface of such a treated connector in order to increase the exposure of the sacrificial metal by capillary action from exposed surfaces of the clamp. In further embodiments, counter galvanic cells are established to provide a counterelectromotive force in order to overcome the galvanic current effect of the corrosion of the components of the grounding clamp, conduit and conductor. Further, sacrificial metal may be laminated within the structure of the clamp itself, or within the structure of the fastening devices used to fasten the portions of the clamp together and to fasten the clamp to the conductor and conduit. In further embodiments, plating may be used upon the surface of the clamp, or the clamp may be fabricated of a porous material such as powdered metal, and infiltrated with a sacrificial metal retaining sufficient porosity to expose sacrificial metal to moisture collected upon the surface of the clamp. It is therefore an object of this invention to provide an improved electrical connection in the presence of an electrolyte atmosphere.

It is another object of this invention to provide an improved grounding clamp containing sacrificial metal to protect the clamp and the components assembled thereto.

It is still another object of this invention to provide an improved grounding clamp containing sacrificial metals to insure

the continued electrical conductivity of the clamp and its associated components.

It is still another object of this invention to provide an improved grounding clamp wherein sacrificial metals are integrated into the structure of the clamp itself.

Other objects and features of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principles of the invention, and the best modes which have been contemplated for carrying them out.

BRIEF DESCRIPTION OF THE DRAWING

In the drawings in which similar elements are given similar reference characters:

FIG. 1 is a side elevation of a grounding connector constructed in accordance with the concepts of the invention.

FIG. 2 is a top plan view of a modification of the connector of FIG. 1.

FIG. 3 is a side elevation of a further modification of the connector of FIG. 1.

FIG. 4 is a side perspective view of another form of a connector constructed in accordance with the concepts of the invention.

FIG. 5 is a side perspective of yet another embodiment of the invention.

FIG. 6 is a side elevation of a further form of connector constructed in accordance with the concepts of the invention.

FIG. 7 is a front elevation of the connector of FIG. 6.

FIG. 8 is a front elevation in section of a fastening device to be employed with an alternative form of the connector.

FIG. 9 is a top plan view of the connector showing a further modification thereof.

FIG. 10 is a side elevation of the jaw portion of the connector of FIG. 1 modified according to a further embodiment of the invention.

FIG. 11 is a side elevation of yet another embodiment of the connector constructed in accordance with the concepts of the invention.

FIG. 12 is a front elevation of a portion of a connector constructed in accordance with the concepts of the invention.

FIG. 13 is a front elevation, in section, of upper clamping member 122 of FIG. 6 taken along the line 13-13.

fig. 14 is a front elevation, in section, of an upper clamping member similar to that shown in FIG. 6 taken along a line such as 13-13 in FIG. 6.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to FIG. 1 there is shown a connector 20 constructed in accordance with the concepts of the invention. Connector 20 has an upper clamping member 22 and a lower clamping member 24 and is fastened together by means of a fastening device such as bolt 26 and nut 27. The details of the connector 20 itself are more fully described in U.S. Pat. No. 2,679,032, issued May 18, 1954, to G. C. Thomas, Jr. et al., entitled Ground Clamp, and assigned to the assignee of the instant invention. Upper clamping member 22 terminates in a jaw portion 28 which has a plurality of teeth 30 about its inner surface. Similarly, lower clamping member 24 has a jaw portion 32 with teeth 34 about the inner surface thereof. When assembled, jaw portions 28 and 32 provide a cavity 36 for the receipt therein of a conduit, raceway, pipe or the like (not shown). At the opposite end of the upper clamping member 22, from the jaw portion 28, is a tail portion 38 and similarly there is a tail portion 40 at the end of lower clamping member 24 at the end opposite from jaw portion 32. Between the tail end portions 38 and 40 there is formed a cavity 42 for the receipt therein of an electrical conductor (not shown). To assemble the connector 20 the nut 27 is loosened and the jaws 28 and 32 are placed about a conduit (not shown) and the bared portion of a conductor (not shown) is inserted within the cavity 42. The nut 27 is then tightened upon the bolt 26 in order to insure a good contact between the clamp, or connector 20, and such conduit and conductor.

The clamps 20 are generally constructed of copper, a copper based alloy or a ferrous metal; the conduit, pipes or raceway may also be of copper, a copper based alloy, or steel and the ground conductor may be either copper or aluminum. It is well known that in the presence of an electrolyte, such as salt water, corrosion will occur upon the least noble, or more anodic, of the respective metals in the galvanic series and this corrosion may cause the destruction of the ground conductor, the clamp 20 or may cause the building up of a layer of salts at the connection between the jaws 28 and 32 of clamp 20 and the conduit to which it has been attached such that a poor mechanical and electrical connection therebetween results. Corrosion will destroy the metal lowest in the galvanic series of those present. For the purposes of this description only a portion of the galvanic series will be set forth. Considering copper as the most noble, or most cathodic, of the metals involved and magnesium as the least noble, or most anodic, the series includes in decreasing order of nobility; copper, brass, tin, lead, lead and tin solders, ferrous metal, cadmium, aluminum, chromium, zinc, magnesium alloys and magnesium. Thus in an assembly of a copper pipe, a copper base metal clamp 20 and an aluminum ground conductor, the aluminum will be corroded first. If the clamp 20 was fabricated from a ferrous metal and the raceway, or conduit, was also fabricated from ferrous metals, such as steel, the presence of an aluminum ground conductor also results in the corrosion of the aluminum before that of the ferrous metals. This is all based upon the premise that the electrolyte uniformly bathes and contacts each of the respective metals involved. It has been found that the presence of a further metal, lower in the galvanic series than the metals of the clamp 20, the conductor and the conduit, present in or on the clamp 20 and similarly bathed by the electrolyte will preferentially be corroded, or sacrificed, and thus protect the remaining metals of the assembly.

To provide such a sacrificial metal a number of apertures, or holes, 44 are conveniently placed about the upper clamping member 22 and the lower clamping member 24 close to the positions of the recess 42, to accept the grounding conductor and the recess 36 arranged to engage the conduit. Each of the apertures, or holes 44, may then be filled with a plug of a sacrificial metal such as cadmium, aluminum, chromium, zinc, a magnesium alloy or magnesium, such as at 46. The particular sacrificial metal chosen will be dependent upon the respective materials of the clamp 20, the grounding conductor placed in the recess 42 and the conduit placed in the recess 36. If the grounding conductor is aluminum, the clamp 20 and the conduit are either copper, a copper based alloy or a ferrous metal and then the sacrificial metal placed in the hole 44 can be chromium, zinc or magnesium. However, should the conductor be copper and the clamp 20 and conduit made of either copper, a copper based alloy or ferrous metal then the sacrificial metal inserted into the holes 44 can be cadmium, aluminum, chromium, zinc, magnesium alloy or magnesium. The sacrificial metal plug, as at 46, may be a solid metal plug or as an alternative may be made of finely divided sacrificial metal particles in a carrier such as glycerine or it may be a fabric soaked in glycerine with particles of the sacrificial metal placed thereon. The only limitation is that there be sufficient exposure of the sacrificial metal to a surface of the clamp 20 so that moisture present can readily contact the sacrificial metal.

When the clamp 20 is used in the horizontal position, as shown in FIG. 2, the electrolyte will be able to contact all parts of the assembly including the sacrificial metal 46, however, when the clamp 20 is used in a horizontal position as shown in FIG. 1 it may be possible that none of the electrolyte will contact sacrificial metal 46 within the holes 44. To insure that such contact will be made between the electrolyte and the sacrificial metal 46, a series of apertures 48 is placed in modified upper clamping member 22' and a lower clamping member 24', shown in FIG. 2, extending to the sacrificial metal 46 in holes 44 such apertures 48 will insure that the electrolyte will reach the sacrificial metal plugs 46 within the

holes 44 by capillary action. The sacrificial metal 46 will thus be contacted by the electrolyte despite the fact that the clamp 20 is held in a horizontal position.

Each of the plugs 46 in the aperture, or holes, 44 are of the same sacrificial metal. A further form of the connector provides both sacrificial metal and a counterelectromotive force generating system as shown in the modified clamp 60 of FIG. 3. In clamp 60, upper clamping member 62, and lower clamping member 64, are provided with a plurality of apertures 66 into which different sacrificial metals are alternatively placed. For example, in apertures 66a and 66c zinc may be placed whereas apertures 66b and 66d will contain copper. Assuming a copper pipe will be placed within the recess 68 between clamping members 62 and 64 and an aluminum conductor is placed in the recess 70 between the tails of the clamping members 62 and 64a, counterelectromotive force will be established between the zinc in the apertures of 66a and 66c, etc. and the copper placed in the apertures 66b, 66d, etc. such as to oppose the electromotive force generated as a result of the corrosive effects of the aluminum conductor. Ideally, the counterelectromotive force produced between the copper and zinc sacrificial plugs will exactly balance or buck out the electromotive forces produced by the corrosive effects upon the aluminum conductor. However, should this be insufficient, or should it vary, then the zinc plugs are available to be sacrificed preferentially to the aluminum conductor. A similar cancellation of the electromotive forces produced as a result of corrosion is also achieved in the connector 80 of FIG. 4. Each of the clamping members, that is the upper clamping member 82 and the lower clamping member 84, are fabricated from a number of layers. Each of the laminates 86, of, for example, steel, will be alternated with a laminate 88 of a sacrificial metal; for example, zinc. The laminates 86 and 88 are held together by fasteners such as rivets 89. With the clamp 80 attached to a copper pipe and an aluminum conductor, there will be generated in the presence of an electrolyte a counterelectromotive force in the direction of the laminates 86 and 88. This force will be at right angles with the galvanic current generated as a result of the corrosion of the aluminum conductor. As was stated above, with respect to FIG. 3, should the current generated by the laminates 88 and 86 be insufficient to neutralize and equalize the galvanic currents generated due to corrosion, then the zinc laminates 88 will be sacrificed preferentially to the destruction, or corrosion, of the aluminum conductor. The clamp 90, as shown in FIG. 5, may be built up so that the laminates are arranged in parallel with the direction of the conduit and conductor opposed to the perpendicular manner shown with respect to FIG. 4. The clamp 90, of FIG. 5, also employs steel laminates 92 alternated with zinc laminates 94 to produce a counterelectromotive force perpendicular to the galvanic force which will exist between the clamp 90, the copper pipe and the aluminum wire. Again, should the counterelectromotive force be insufficient to balance out the galvanic currents then the sacrificial laminates 94 of zinc will be available for the corrosive conductor.

Turning now to FIG. 9 there is shown a clamp 100 generally like that shown in FIG. 1. However, the apertures 44 and sacrificial plugs 46 are omitted. Instead, placed upon the top of the upper clamping member 22, and also atop the lower clamping member 24 (not visible in FIG. 9) is a slug of sacrificial metal 102 which can conveniently take the form of a brand tag, or label or other device affixed to the surfaces. Another manner in which the sacrificial metal may be introduced into the clamp is by means of a plug 110, of sacrificial metal, placed within a modified fastening bolt 26' as is shown in FIG. 8. Modified bolt 26' will be arranged such that the plug 110 is accessible both from the head and bottom sections of the bolt 26'. Further, the sacrificial metal may be introduced within the jaw portion 28 and 32 of the connector 20, as is shown in FIG. 10. The sacrificial metal may take the form of a foil 112 employed to fill the roots of the teeth 30 and 34 but leaving exposed the crowns of the respective teeth. This is done so that the sacrificial metal will have no part in

the mechanical interconnection between the clamp 20 and a conduit, in that the deterioration, or loss, of the sacrificial metal would otherwise endanger the mechanical connection therebetween. The foil 112 may be initially placed over the entire surface of the teeth, then by heat, pressure, or a combination of both, the foil may be removed from the crown portions of the respective teeth 30 and 34 and left within the root portions. In FIG. 11, the entire surface of grounding connector 20 of FIG. 1, is shown to be plated with a plating 116 of sacrificial metal. The plating may be kept relatively thin in the region of the teeth 30 and 34 to minimize any loosening of the clamp 20 as a result of the loss of the plating 116 in the area of the teeth 30 and 34.

Turning now to FIGS. 6, 7, 13 and 14 there is shown still another clamp 120 constructed in accordance with the concepts of the invention. Clamp 120 is constructed of an upper clamping member 122 and lower clamping member 124 held together by fastening means 126. A nut may be applied, or, the apertures through the lower clamping member 124 may be threaded for receipt of the fasteners 126 therein. Extending from the top clamping member 122 is a loop 128 for receipt therein of a grounding conductor. Upper clamping member 122 and lower clamping member 124 are so formed that a generally rectangular recess 130 exists therebetween for receipt of a conduit therethrough. The upper clamping member 122 and the lower clamping member 124 are formed in a generally U-shaped form with upstanding sides bending away from the position of the conduit when the clamp 120 is installed upon such conduit. The loop 128 will be crushed between the conduit and the upper clamping member 122 when the clamp 120 is tightened about a conduit thus trapping the grounding conductor therein. The upper clamping member 122, and lower clamping member 124, may be formed from a selectively perforated external tube 123 of steel and an internal tube 125 of zinc, the assembled tubes (see FIG. 13) being formed to the generally U-shape shown in FIG. 7. In practice the zinc tube 125 will be placed inside of a selectively perforated steel tube 123 when both are in a generally circular state and then formed into the shape shown in FIGS. 6 and 7 by suitable dies in presses (not shown). If desired to maintain a spacing between the opposite walls of tube 125 a suitable mandrel may be employed as well known in the art. Alternatively, the steel outer tube 123 of the clamp 120 may be filled with a zinc powder in an appropriate carrier, or may be filled with a zinc wool 127 (see FIG. 14) or any other one of the appropriate sacrificial metals. The clamp 120 just described is formed by using a selectively perforated steel tube 123 having a generally circular cross section. A suitable mandrel (not shown) is inserted in the tube 123 and it is formed in the generally U-shaped cross section shown. The zinc wool 127 is then inserted within the steel tube 123 and the ends thereof are sealed. Then the tube 123 is formed into the shape of the connector as is better seen in FIG. 6. In a similar fashion zinc powder in a suitable carrier may be placed in the partially formed tube 123 before the ends are sealed and tube 123 formed into the final connector shape. A within of apertures 132 extend from the outer steel tubing to the internal cavity of the steel tube to expose the sacrificial metal therein, whether in tubular form or in generally fill form. In this manner, moisture reaching the outer surface of the clamp 120 is conducted to the sacrificial metal therein by capillary action. Alternatively, as is shown in FIG. 12 an upper clamp member 140 may be formed in the general shape of the upper and lower clamping members 122 and 124 respectively of FIGS. 6. Instead of having a further tube, or fill material, of sacrificial metal within the tube which constitutes the clamping member 140 a slug 142 of sacrificial metal may be placed through appropriate apertures in the upstanding arms 144 to the clamping member 140. The lower clamping member may be similarly constructed. The clamp 20 of FIG. 1 may also be formed of a porous material such as a powdered metal and the sacrificial metal in the form of a powder infiltrated into the clamp structure. The clamp 20 structure will be mechanically

strong enough to make the desired connection and the infiltrated sacrificial metal powder will merely fill the pores in the clamp structure.

It should be noted that in most of the embodiments described above that the sacrificial metal takes no part in the mechanical connections of the clamp with respect to the conductor, or conduit. This is done in order to insure the integrity of the mechanical connection by insuring that the loss of the sacrificial metal will not interfere with the mechanical connection between the clamp and the conductor and conduit. It should also be noted that the sacrificial metal is placed in such a manner that it will be exposed to the electrolyte which bathes the remaining portion of the system, namely, the clamp, the conduit, and the conductor. In the embodiment of FIG. 11 wherein the entire surface of the grounding connector 20 is plated with a plating 116, the loss of the plating 116 in the area of teeth 30 and 34 will have little effect on the mechanical union because of the thinness of the plating 116 and because in practice the tightening of the connector to a pipe will rupture the plating of teeth 30 and 34 and cause contact between the basic metal of the connector 20 and the pipe in the areas of teeth 30 and 34. Some decrease in the mechanical bond may occur in the connector 90 of FIG. 5 due to loss of the sacrificial laminates 94. However, the basic coupling is still achieved by the steel laminates 92 and should provide a good contact until they themselves are partially destroyed.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to the preferred embodiments, it will be understood that various omissions and substitutions and changes of the form and details of the devices illustrated and in their operation may be made by those skilled in the art, without departing from the spirit of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

I claim:

1. A clamp for coupling a conductor to a conduit wherein there are at least two dissimilar metals present in said conductor, conduit and clamp, said clamp comprising: a first clamping member; a second clamping member; coupling means engaging said first and second clamping members to couple said first and second clamping members to said conduit and conductor and sacrificial metal members coupled to first and second clamping members in a position adjacent to but not forming part of the coupling contact areas between said clamp, conduit, and connector whereby the metals of said clamp, conductor and conduit are protected.

2. A clamp, as defined in claim 1, wherein said sacrificial metal members are slugs positioned in said first and second clamping members.

3. A clamp for coupling a conductor to a conduit wherein there are at least two dissimilar metals present in said conductor, conduit and clamp, said clamp comprising: a first clamping member; a second clamping member; said first and second clamping members each have a plurality of holes therein; coupling means engaging said first and second clamping members to couple said first and second clamping members to said conduit and conductor; and sacrificial metal wool inserted into said plurality of first holes whereby the metals of said clamp, conductor and conduit are protected.

4. A clamp, as defined in claim 3, wherein said first and second clamping members each have a plurality of second holes communicating with said first plurality of holes and extending from an outer surface of said first and second clamping members.

5. A clamp, as defined in claim 1, wherein said sacrificial metal members are slugs attached to the surface of each of said first and second clamping members.

6. A clamp, as defined in claim 1, wherein said first and second clamping members each have a plurality of first and second holes arranged alternately in each of said first and second clamping members and said sacrificial metal members are first and second metal types respectively, said first metal

types being positioned in said plurality of first holes and said second metal types being positioned in said plurality of second holes.

7. A clamp, as defined in claim 1, wherein said first and second clamping members are each fabricated of laminated layers and said sacrificial metal members are laminate layers alternated with those of said first and second clamping members.

8. A clamp, as defined in claim 7, wherein said laminates of said first and second clamping members and said sacrificial metal members extend in a direction perpendicular to the direction of said conduit in said clamp.

9. A clamp, as defined in claim 1, wherein said first and second clamping members are hollow and have a plurality of holes extending from the outer surface thereof to the hollow portion therein and said sacrificial metal members are placed within said hollow portions of said first and second clamping means.

10. A clamp, as defined in claim 1, wherein said first and second clamping members each have tooth regions adjacent the coupling between said clamp and said conduit and said sacrificial metal members are disposed in the roots of each of

said teeth of said first and second clamping members.

11. A clamp, as defined in claim 1, wherein said sacrificial metal members are platings of sacrificial metal upon the surfaces of each of said first and second clamping members.

12. A clamp, as defined in claim 1, wherein said first and second clamping members are fabricated of powdered metal and are porous and said sacrificial metal members are sacrificial metals infiltrated into the powdered metal of said first and second clamping members.

13. A clamp, as defined in claim 1, wherein said conductor is made of aluminum; said clamp and conduit are made of metals selected from a group of metals consisting of ferrous metals and copper and said sacrificial metal members are selected from the group of metals consisting of chromium, zinc, and magnesium.

14. A clamp, as defined in claim 1, wherein said conductor is made of copper; said clamp and conduit are made of metals selected from a group of metals consisting of ferrous metals and copper and said sacrificial metal members are selected from the group of metals consisting of cadmium, aluminum, chromium, zinc and magnesium.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,594,706

Dated July 20, 1971

Inventor(s) Thomas Julio Sotolongo

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

Column 4, line 56, after "corrosive" insert -- effects
of the environment rather than destroy the aluminum --

Column 5, line 58, delete "within" and insert -- series --

Column 6, line 20, after "connector insert -- 20 --

Signed and sealed this 16th day of May 1972.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents