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METHOD AND APPARATUS UTILIZING AN ELECTROLYTE FOR DETECTING HOLIDAYS IN METALLIC COATING ON PIPE

Filed March 27, 1967 2 Sheets-Sheet 1

Fig. 1

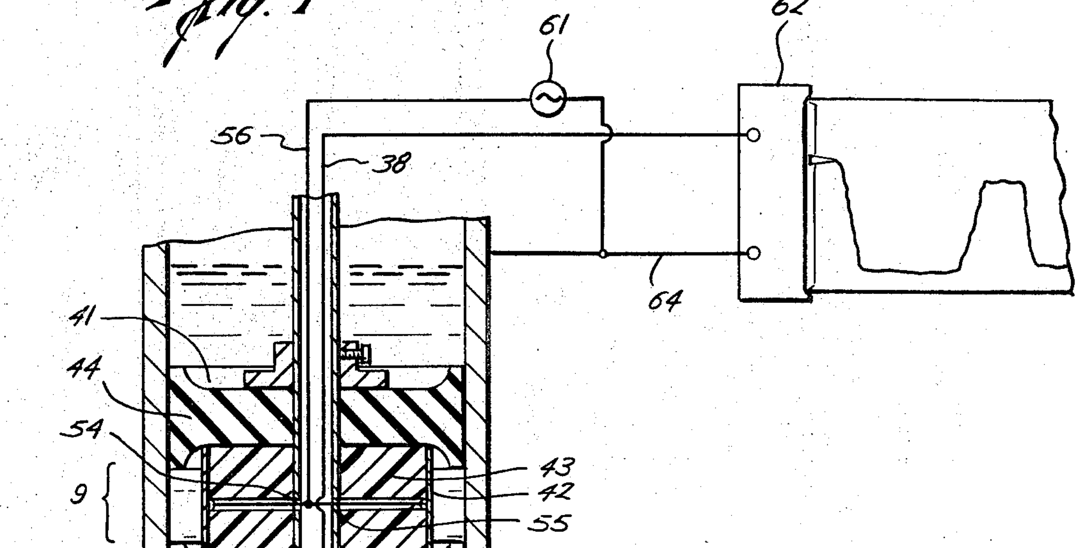
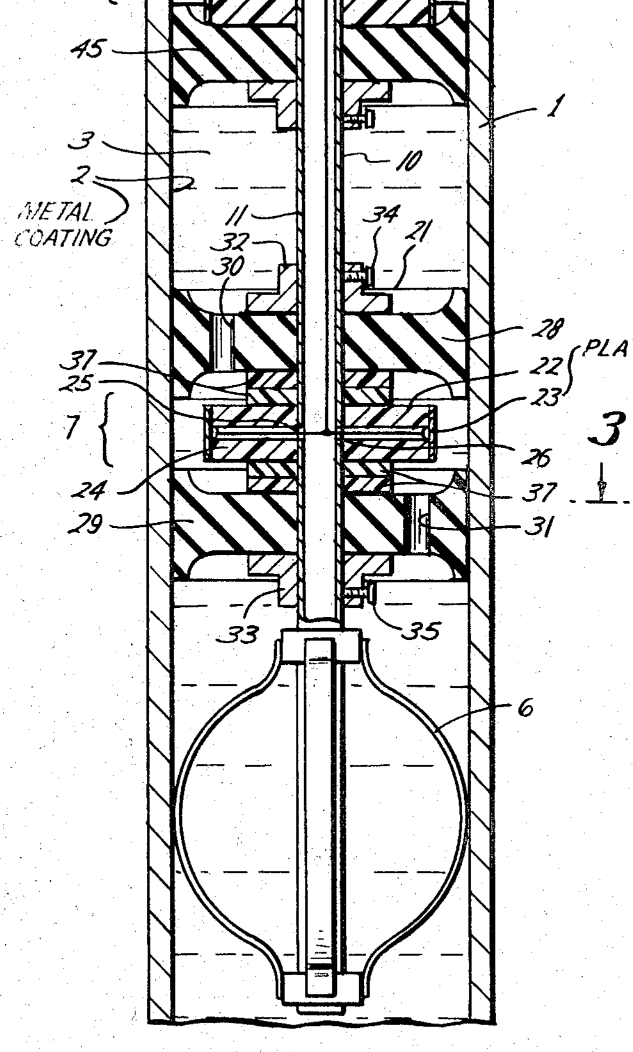
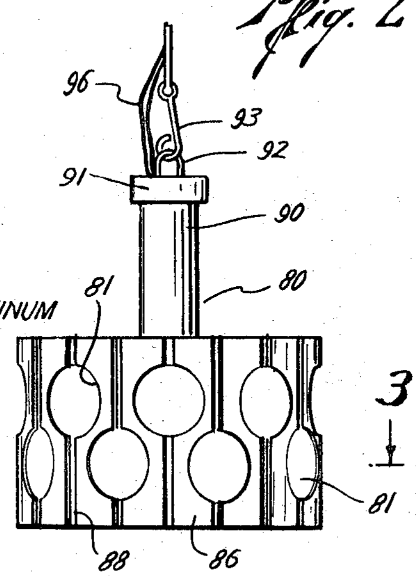



Fig. 2



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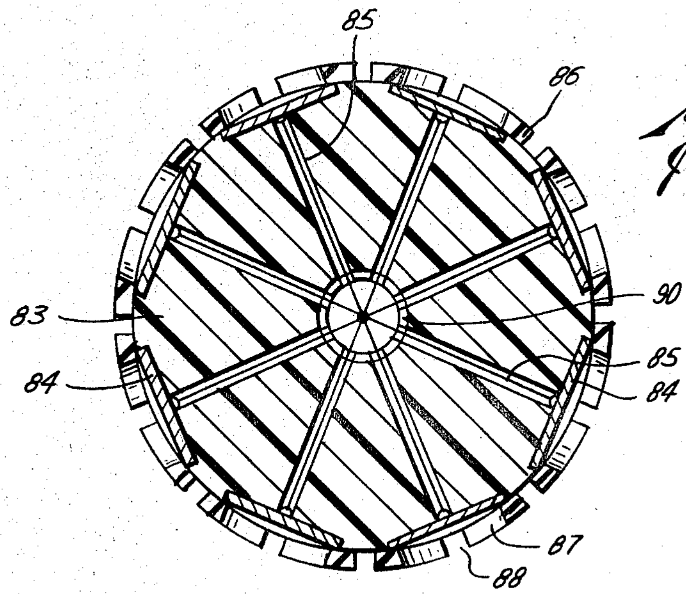


Fig. 3

Fig. 4

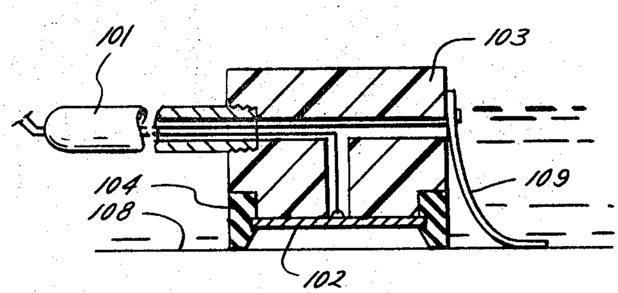
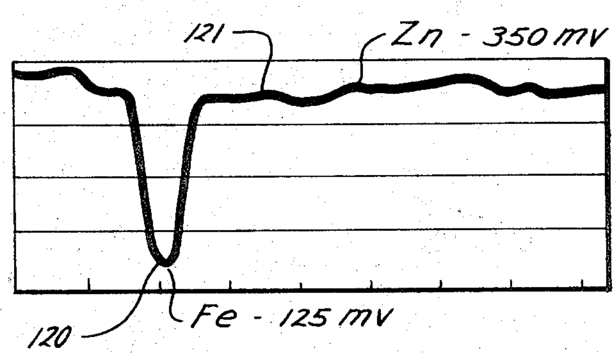


Fig. 5



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METHOD AND APPARATUS UTILIZING AN ELECTROLYTE FOR DETECTING HOLIDAYS IN METALLIC COATING ON PIPE

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ABSTRACT OF THE DISCLOSURE

To detect holidays larger than a predetermined size in the metallic coating on the interior of the metal pipe, an electrode is disposed within the pipe with an electrolyte to initiate electrochemical action between the electrode and a selected area within the pipe. The portion of the pipe being inspected is depolarized prior to inspection. Then an electrode insulated from electrochemical action with the metallic coating in other than the selected area, is made to electrochemically scan the metallic coated surface. The electrochemical action between the electrode and the metallic coating on the pipe creates a potential between the electrode and the pipe. By sensing deviations of this potential from that of similarly constituted cells where the condition of the coating is known, the presence of holidays may be detected. Moreover, by varying the size of the selected area of the pipe exposed to electrochemical action, the system may be made to discriminate between holidays of different sizes.

BACKGROUND OF THE INVENTION

This invention relates to a novel method and apparatus for detecting discontinuities in a metallic coating on a metallic substrate. More specifically, this invention provides the method and apparatus which can be easily arranged to detect discontinuities or holidays in the metallic coating on the interior of a metal pipe, and further can be arranged to discriminate between holidays of different size to give the operator an indication of the severity of coating damage in any particular area of the pipe.

A particular problem to which the novel process and apparatus of the instant invention may be directed is that of testing metallic coatings of the type applied to the internal walls of oil well pipe or casing, or underground conduit for the transport of chemicals and the like.

Coatings on the interior of pipe have been found necessary to protect the metal of the pipe from corrosive chemical attack caused by substances with which it would ordinarily be in contact, and also to protect the metal substrate from the corrosive effects of electrolysis due to cathodic currents which may be developed between the surrounding medium and the substrate metal.

For example, in oil wells, piping is provided most often with an interior coating of plastic or a like organic substrate to protect the metal substrate from chemical combination with fluids passing through the pipe. However, in instances where corrosion by electrochemical attack is a prime consideration, it has been effective to coat the interior of the pipe, such as of steel, with a coating of zinc which affords cathodic protection for the steel substrate.

The smallest pinhole or crack in an organic coating of a pipe transporting a potentially corrosive fluid must be detected since corrosion of the substrate will proceed through the smallest organic coating imperfection. However, a zinc coating will provide cathodic protection for the steel substrate of a pipe even in those instances where

there are minor scratches or scars exposing the substrate. Accordingly, when such metallic coatings are used, it is of primary concern to detect not minor imperfections in the coating, but to detect only exposed areas of such size that the coating no longer affords corrosion protection.

Many methods have been used to inspect pipe even in its position in a borehole. For example, the method most often employed to inspect an organic coating is called the resistance method and is illustrated in U.S. Pat. 3,106,677. In short, this method involves placing a probe in contact with the pipe and trying to detect when a circuit is completed between the probe and the substrate beneath the organic coating, thus indicating a pinhole or crack in the coating. However, this is a go and no-go method which cannot discriminate between sizes in the holidays. Nuclear techniques such as measuring the backscatter of a beam of gamma rays or beta particles reflected off the coating or radioactively activating the coating and detecting the energy spectrum of the energy emanating from the coating may be employed, but the former method has serious limitations in inspecting a pipe filled with fluid or drilling mud, while the latter presents a safety hazard due to the generation of radioactive isotopes.

SUMMARY OF THE INVENTION

There is accordingly provided by the instant invention a novel method and apparatus for detecting the imperfections or holidays in the metallic coating on a metallic substrate. The novel method and apparatus of this invention affords the operator the ability to discriminate between holidays of varying sizes and also may conveniently be employed to inspect the pipe which is full of fluid such as drilling mud.

The general technique which is employed in the novel method and apparatus of this invention may be said to be half cell potential measurement. The invention involves electrochemically establishing the potential between an electrode and a metallic-coated substrate, restricting the electrochemical action with the electrode to a specific selected area of the metallic-coated substrate, and sensing and comparing the potential created by the electrochemical action of the electrode with the metallic-coated substrate with a predetermined value of potential characteristic of the electrochemical cell containing the electrode and the metallic-coated substrate in various stages of corrosion. Of course, this reference cell must use the same electrolyte as is employed down hole in actually obtaining measurements.

The fluid standing in a borehole pipe in most conditions is somewhat ionic in character, and consequently, will initiate electrochemical action with the metallic-coated substrate to at least a minor extent in virtually all cases. This electrochemical action results in the polarization of the substrate caused by buildup of ions resulting from the electrochemical action on the substrate. For example, if ions in the fluid having a cathodal relation with the metallic coating were present and the fluid contained a measure of water to function as an electrolyte, a buildup of hydroxyl ions would occur on the metallic coating. The presence of such polarization would hamper the potential measurement employed in the inspection technique of the instant invention, and accordingly, the metallic-coated substrate is preferably depolarized prior to inspection. Depolarization may be effected by simply imposing an alternating current between an electrode in the fluid and the metallic-coated substrate to effectively drive the polarized ions off the substrate. Accordingly, in its most preferred embodiment, the instant novel method includes depolarizing the metallic-coated substrate prior to inspection by use of, for example, an alternating current.

The instant invention also provides a novel apparatus for inspecting the metallic coating on the interior of pipes, and for inspecting metallic coating on flat surfaces, which comprises an electrode, preferably a nonpolarizing electrode, such as platinum, and a barrier means suitable for restricting and holding electrolyte between said electrode and a selected area of the metallic-coated substrate. In particular embodiments, the novel apparatus of this invention is also provided with a depolarizing electrode to depolarize the metal-coated substrate prior to inspection, and is also provided with means by which the electrochemical action may be restricted to an area of preselected size to enable the method and apparatus to respond to holidays of a predetermined minimum size.

BRIEF DESCRIPTION OF THE DRAWINGS

The instant invention will be more particularly understood with reference to those specific embodiments illustrated in the accompanying drawings.

FIG. 1 is a sectional view of a device in accordance with this invention shown in position in a vertically disposed pipe.

FIG. 2 is an elevational view of a detecting device in accordance with the second embodiment of this invention.

FIG. 3 is a cross-sectional view of the detecting device of FIG. 2 along line **3—3**.

FIG. 4 is a partial, cross-sectional view of a further embodiment of a device in accordance with this invention adapted for manual manipulation.

FIG. 5 is a strip recorder record of an inspection performed with the novel devices of this invention showing peaks indicating exposure of the substrate.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The novel method of the instant invention involves establishing electrochemical action between the metallic-coated substrate to be inspected and an inspecting electrode, and comparing the potential generated by this electrochemical action with the potential similarly constituted electrochemical system wherein the condition of the coating is known. The metallic substrate beneath the coating, if exposed by erosion or by holidays in the coating, will enter into the electrochemical reaction and will result in the variance of the generated potential. This variance is functionally related to the amount of substrate exposed, i.e., the extent of coating erosion or the size of the holidays.

If the metallic coating on the substrate material of an object is affording rather complete electrochemical protection for the substrate, and if the surface area of the metallic coating is relatively large, the electrochemical potential between the metallic coating and the inspecting electrode will be approximtaely that to be expected between the respective metals of the coating and the electrode, even though there may be pinholes or small holidays in the metallic coating. However, if the surface area of the portion of the object being inspected is decreased to an extent where the area of the exposed substrate, i.e., holidays, forms a significant portion of the surface area being inspected, a potential will be measured which is different from that which was measured when the surface area was substantially completely covered with the protective metallic coating.

Thus, since the potential variance caused by a holiday is also functionally related to the relative amount of coating and substrate exposed to electrochemical action, it is necessary to restrict the electrochemical action of the coating with the inspecting electrode to a known area of the coating. This may be accomplished by confining at least a portion of the available electrolyte between the

inspecting electrode and the desired area of metallic-coated substrate, and insulating the remaining portions of the inspecting electrode from the electrochemical action. By decreasing the selected area of metallic substrate exposed to electrochemical action, the instant novel method may be made sensitive to holidays of lesser size. Accordingly, by selecting the amount of surface exposed to the electrode, the instant novel method may be rendered effectively insensitive to holidays smaller than a predetermined threshold size.

Particularly in those cases wherein the novel method of this invention is employed to inspect the metallic coating on the internal walls of pipe, it has been found that polarization on the coating presents a problem to effective establishment of the electrochemical action. Most often, pipe is employed to conduct fluids which contain metallic ions which can establish an electrochemical action with the coating. This electrochemical action can result in a buildup of ions on the coating surface, which ions may impede subsequent electrochemical action by the coating. Furthermore, the buildup of ions on the coating destroy the predictability of the potential which will be generated between the coating and the inspecting electrode, since the degree of polarization in any particular area of the pipe can hardly be determined by the inspecting operator.

For example, in a zinc-coated steel pipe, ions having a cathodal relation to zinc such as ions within the pipe in an aqueous ionic solution would produce a buildup of hydroxyl ions on the zinc. Thus, it is preferred in many cases to depolarize the coating prior to inspection. This may be accomplished by imposing an alternating current between the coating and an electrode through the electrolyte in the pipe. The alternating nature of the current tends to drive the ionic buildup on the coating back into solution with the electrolyte, thus exposing the coating for inspection.

The instant novel method will be more thoroughly understood with reference to its application in inspecting the metallic coating in pipe employing the apparatus embodiments illustrated in the drawings.

Referring now to FIG. 1, there is shown a novel apparatus **10** in accordance with this invention disposed down hole in a steel pipe **1** which has a zinc coating **2** on its interior surface. The pipe is filled with an ionic drilling mud **3** which surrounds all the portions of the apparatus **10**. Ionic drilling muds which are known in the art are suitable as electrolytes for the inspection procedure, and are preferred in those instances wherein inspections are to be carried on during a continuing drilling operation.

The novel device of this invention may also be employed to inspect pipeline disposed horizontally by similarly providing an electrolyte filling the pipe and employing novel devices of this invention.

Support column **11** is a tubular member disposed centrally in apparatus **10** and serves to support the various elements of the apparatus. In addition, the interior of support column **11** provides a conduit for the electrical leads to the electrodes as will be discussed below. On the lower portion of support column **11** is mounted the inspection portion **21** of the apparatus. The upper part of support column **10** mounts the depolarizing portion **41** of the device. A centralizer **6** located at the lower end of support column **11** serves to stabilize the device down hole.

The inspecting portion **21** of the apparatus in FIG. 1 comprises an inspecting electrode **22** which is constructed of a band of platinum **23** encircling the electrode mounting disc **24**. Platinum is preferred for use as the inspecting electrode in many instances regardless of the metallic nature of the coating in the substrate since it polarizes only very slowly and since it acts as a gas electrode when in a cathodal relation with the coating and is not eroded by electrochemical action. Platinum is also extremely resistant to chemical corrosion and is substantially chemically inert to most conditions which will be encountered.

Steel has been used as an electrode with satisfactory results until polarization occurs, generally after about thirty minutes.

Electrode mounting disc **24** is a short, cylindrical member composed of hard rubber, fluorocarbon polymer, or a like electrochemically inert substance. The platinum electrode strip is affixed to the outer periphery of disc **24** using, for example, a resin bonding agent, Leads **25** and **26** extend radially from within support column **11** through disc **24** to make contact with the platinum electrode **23.** Of course, if desired, only one lead to the platinum electrode need be employed.

Mounting disc **24** extends radially to a point proximate the pipe wall which is the surface to be inspected. Such a design is preferred since it disposes the electrode close to the surface with which the electrode is to establish electrochemical action thus minimizing the resistance of the electrolyte therebetween.

Above and below electrode mounting disc **24** are spacing washers **37** outside of which are wipers **28** and **29.** The wipers **28** and **29** are resilient rubber or the like which snugly fit within pipe **1** and serve to isolate the electrochemical action of the platinum electrode with a short axially extending section **7** of the pipe. The wipers serve to maintain electrolyte in an electrochemical cell relation between the pipe and the electrode **22.** Small holes **30** and **31** in the wipers may be provided to permit passage of the fluid in the pipe past each wiper as the entire apparatus is pulled upwardly through the pipe. Position supports **32** and **33**, equipped with setscrews **34** and **35** which are tightened against the support column to fix the position supports in place, hold each wiper against the spacing washers. The number and size of spacing washers will of course determine the spacing of wipers **28** and **29**, and accordingly, the size of the area of coating viewed by the electrode. Generally, a cell about five inches in height is satisfactory, and the wipers should be so spaced. Spacing washers **37** may be adapted to merely slide over the support standard **11** to provide the desired separation of the wipers **28** and **29.** The spacing washers **37** are also composed of an electrochemically inert material such as plastic or rubber. Other spacing techniques may be employed and if desired apparatus may be provided to render the spacing controllable from the surface when the apparatus is down hole.

Above the inspection portion of the apparatus is the depolarizing portion **41.** Since inspection of pipe can be most effectively accomplished by drawing the apparatus **10** upwardly through the pipe, the depolarizing portion in this location can perform its function immediately prior to the inspection of the pipe.

Depolarizing electrode **42** is a thin metal band around the depolarized or electrode mount **43** which is composed of plastic or rubber. In the depolarizing cell, the choice of electrode material is not so important as for the inspection cell, since electrode polarization is not a problem. The same metal as the coating metal may be used, or another metal such as steel can be employed. It is preferred to select a metal which does not freely liberate ions in order to minimize the frequency of replacement and also to minimize interference which such ions might cause in the inspection cell below. Indeed, the depolarizing electrode may be a solid metal piece but inasmuch as it is desirable again to place the outer electrode surface proximate the pipe wall, a large solid metal electrode would produce excesses in weight and expense, and accordingly, the cylindrical depolarizer electrode mount **43** is employed to hold the depolarizer electrode in the same manner as the inspecting electrode is held on its mount **24.** Leads **54** and **55** make contact with the depolarizer electrode and are fed up the interior of support standard **11** to the surface.

Wipers **44** and **45** are positioned above and below the depolarizer electrode **42**, and restrict the action of the depolarizer cell to transverse area **9** of the pipe. Again, position supports **46** and **47** having setscrews, secure the wipers in place on the support standard **11.** Slots in the outer periphery of the wipers may be provided to permit passage of fluid past the wipers as the apparatus is lifted through the pipe. It is not necessary to provide means for varying the distance between wipers **44** and **45** in the depolarizer cell, but it will be noted that the depolarizer cell is slightly larger in the longitudinal direction in the inspection cell to ensure the completeness of the depolarizing function.

Leads **54** and **55** from depolarizer electrode **42** connect to wire **56** which extends upwardly through support standard **11** to the surface. Lead **56** is connected to alternating current generator **61**, and the circuit is completed by connecting the alternating current generator to pipe **1.** Accordingly, an alternating current is imposed across that portion of the electrolyte in area **9** of the pipe between the depolarizer electrode and the metallic coating, thus depolarizing that portion of the pipe.

Leads **25** and **26** from the inspecting electrode **22** are connected to wire **38** which is connected at the surface to a suitable circuit capable of measuring the potential generated in the inspection cell. In FIG. 1, the circuit is functionally illustrated and wire **38** is shown connected to one terminal of the strip chart recorder of a type capable of generating a permanent record corresponding to the potential generated in the inspection cell. Of course, any suitable circuitry may be employed to sense the inspecting cell potential, for example, the inspecting cell may be balanced against the voltage of a similarly constituted reference cell on the surface wherein the condition of the metallic coating is known. The other terminal of strip chart recorder **62** or of the sensing circuit employed is connected to pipe **1** by means of wire **64.**

The use of a strip chart recorder such as **62** enables generation of a permanent record whereby after the inspection procedure is completed, the areas of corrosion in the pipe may be readily located and repaired as desired.

Referring now to FIGS. 2 and 3, there is shown a novel device **80** in accordance with this invention in a second embodiment. Generally, the desirably detectable level of corrosion of a coating in a given pipe will be predetermined, and since the threshold level of detectability is functionally related to the size of the selected area viewed by the inspecting electrode, it is possible in many instances to construct an inspection device wherein the size of the area viewed by the inspecting electrode is fixed. Thus, device **80** is provided with two sets of circular apertures **81** around its periphery at two different levels, such that the apertures on the upper and lower levels scan overlapping paths along the interior surface of a pipe. Thus, the entire surface of the pipe is viewed by an inspecting electrode.

Device **80** is composed of an electrochemically inert body **83** having flat, circular sheets **84** of electrode material, FIG. 3, such as platinum, disposed around its periphery at two levels in the said overlapping relation. Leads such as **85** pass through body **82** making contact with each of the electrode plates. A wiping collar **86** of resilient electrochemically inert material such as rubber is then positioned around body **82** such that the circular holes **87** in the wiping collar **86** expose the platinum electrode plates. Grooves **88** in the outer wiping collar surfacer, or if desired, holes through body **82** serve to permit passage of liquid past the unit as it is drawn through a pipe since the wiping collar will be adapted to snugly fit the pipe interior.

The unit is also mounted on a support standard **90** through which the electrical leads from the electrodes may be conducted. At its upper portion, support standard **90** is capped such as by a threaded cap **91** which is provided with an eye **92** which may be engaged by a hook **93** suspended from a cable. A similar arrangement may be employed to suspend the device of FIG. 1. The electrical leads **96** from the electrode may then be wrapped around the cable and conducted to the sensing devices employed. It can be appreciated that a depolarizer cell may be added to device **80** using a bilevel construction similar to that employed in the inspection portion. Alternatively, a depolarizer as in FIG. 1 can be used.

FIG. 4 illustrates a hand operable device in accordance with this invention which may be employed to inspect the coating on flat surfaces. Handle **101** is provided at one end with an electrode **102**, for example, a platinum disc mounted on the lower surface of head **103** composed of plastic or a like electrochemically inert material. Gasket **104** fits snugly over the shoulder **105** of head **103** such that the lowest surface of gasket **104** may be pressed against the surface to be inspected thus isolating the electrochemical action of the electrode to that area of the surface defined by the interior area of the gasket. Spring **109** maintains electrical contact with surface **108** to complete the circuit. Handle **101** may be pivotally connected to head **103** to permit ready manual manipulation of the device and facilitating placement of the device against any surface. The electrical leads are conducted from the electrode **102** through handle **101** to a suitable sensing device. It is preferred when employing the sensing device illustrated in FIG. 4 to flood the surface being inspected with an electrolyte such that the liquid will fill the space between electrode **102** and the surface to be inspected within gasket **104**. However, if desired, a paste or slurry-like electrolyte may be employed by filling the volume around the electrode **102** inside gasket **104** with a slurry-like electrolytic substance. It is usually difficult to establish effective electrolytic contact with all portions of a coating when such a slurrylike electrolyte is employed. Preferably, such pastelike electrolytic substances are thixotropic in nature since such substances improve the contact with the surface to be inspected.

Referring now to FIG. 5, there is shown a reproduction of a typical strip chart recording showing the response of a device in accordance with this invention to a bare area of the coating in a zinc-coated pipe. The strip recording shown in FIG. 5 is a reproduction of a recording obtained employing a device of the type illustrated in FIG. 4. A platinum electrode was employed in the device and drilling mud having a pH of 11 was used as the electrolyte. In conducting this test, there was employed a zinc-coated pipe having a bare band three inches in width where the zinc coating was purposely not applied. The detector device was drawn longitudinally along the inner pipe surface and produced the downward peak at **120** upon encountering the bare patch in the pipe coating. The electrochemically generated output of the device decreased from 350 millivolts when the device was over the zinc coating (indicated by region **121** on FIG. 5) to 125 millivolts when over the bare patch as reflected by downward peak **120**.

In carrying out the novel method of the instant invention using the apparatus of FIG. 1, the apparatus is first lowered through the pipe containing an electrolytic liquid. Lowering of the device may be accomplished by simply attaching a weight to the bottom portion of the device and slowly paying out the cable as the device sinks to the pipe. When the unit arrives at the desired level the alternating current circuit for the depolarizer cell is completed and the sensing circuit for the inspection cell is activated. The apparatus is then slowly pulled upwardly through the pipe, either with the lowering weight attached or leaving the lowering weight down hole to be subsequently retrieved. The signal variance corresponding to a bare patch in the coating will remain for the time that the electrode is opposite the bare patch. The relation between the rate of movement of the apparatus and the strip chart recording will afford a permanent record of coating quality for the portion of the pipe inspected.

To calibrate this holiday detector, for inspection of for example, a zinc-coated steel pipe, it is necessary to have an electroplated zinc-coated calibration standard made of the same steel as will be inspected. This calibration standard will have known sized uncoated areas to be detected with the inspection probe before making an inspection run using the same electrolyte that will be present in the pipe to be inspected. The chart recorder is then adjusted using the zinc coating at the zero level and adjusted for the highest potential difference of the bare steel.

What is claimed is:

1. A device for inspecting a metallic coating on the interior of the pipe, wherein the metallic coating and the material of the pipe are electrochemically dissimilar, said device comprising:

a first electrode electrochemically dissimilar to said metallic coating and spaced therefrom for establishing electrochemical action with said metallic coating on the pipe,

barrier means fixed in position with respect to said first electrode for maintaining an electrolyte in contact with said first electrode and with a selected axially short section within said pipe to restrict to said selected section electrochemical action established between said first electrode and the selected section,

means for moving said first electrode and barrier means axially with respect to said pipe to change the location of said selected section, and

means connected to said first electrode for sensing variations in electrochemical potential between said first electrode and said selected section of the pipe.

2. The device of claim **1** and further including a second electrode fixed in position relative to said first electrode and adapted to traverse said metallic coating prior to said first electrode,

means for maintaining an electrolyte in contact with said second electrode and a second axially short section within said pipe to restrict electrolytic action between said second electrode and said pipe to said second selected section, and

means for imposing an alternating current between said second electrode and said second section of the pipe.

3. A device for inspecting a metallic coating on the interior of a pipe which comprises:

a support column adapted to be disposed coaxially within said pipe,

a platinum electrode mounted on one portion of said support column,

barrier means comprising nonconducting wipers fitting snugly within said pipe and affixed to said support column above and below said platinum electrode to maintain an electrolyte between said platinum electrode and a first selected axially short section of said pipe and to restrict electrochemical action with said electrode to said selected section,

a second electrode mounted on a different portion of said column,

second barrier means comprising nonconducting wipers affixed to said column above and below said second electrode to maintain an electrolyte between said second electrode and a second selected axially short section of said pipe,

means for imposing an alternating current between said second electrode and said second selected section of said pipe,

means for moving said support column longitudinally with respect to said pipe to move said first electrode toward said second selected section of the pipe, and

means for sensing the electrochemical potential developed between said platinum electrode and said first selected section of said pipe.

4. The device of claim **3** having a strip chart recorder for permanently recording said electrochemically developed potential.

5. The device of claim **3** wherein said platinum electrode comprises a band of platinum disposed circumferentially about a cylindrical electrode mount composed of electrochemically inert material, said cylindrical mount having a diameter slightly less than the diameter of said pipe to maintain said platinum strip proximate the interior wall of said pipe.

6. Apparatus for inspecting a metallic coating on the interior of a pipe which comprises:

a cylindrical electrochemically inert electrode mount,
a first set of platelike electrodes disposed peripherally around the lower portion of said electrode mount,
a second set of platelike electrodes disposed peripherally around the upper portion of said electrode mount,
said electrodes in said second set being circumferentially staggered with respect to said electrodes in said first set,
a resilient nonconductive wiping collar disposed around said electrode mount and having holes therein to expose said electrodes in said first and second set, said wiping collar fitting snugly within said pipe to maintain electrolyte between said electrodes and the inner surface of said pipe,
means for moving said device longitudinally within said pipe, and
means for sensing variations in electrochemically developed potential between said electrode and the inner surface of said pipe.

7. A method for inspecting for discontinuities in the internal surface of a metallic coated metal pipe, wherein the metallic coating and the metal pipe are electrochemically dissimilar, said method comprising the steps

filling said pipe with a fluid electrolyte,
depolarizing the inner surface of the metallic coated pipe by establishing an alternating current between a first electrode disposed within the pipe and the internal surface of the pipe,
establishing an electrochemical action involving a second electrode disposed within the pipe and the internal surface of the coated pipe to produce an electrochemical potential therebetween,
confining said electrochemical action to a selected area of the internal surface so that any discontinuities of a given size in said metallic coating will have a desired influence in determining said electrochemical potential,
moving said second electrode axially through said pipe to change the location of the selected area of the internal surface which is exposed to electrochemical action with said electrode, and
sensing said electrochemical potential established between said electrode and the internal surface of the pipe.

8. A device for inspecting for holidays a coating on a coated metallic substrate wherein said coating and said substrate are electrochemically dissimilar, said device comprising

a first electrode electrochemically dissimilar to said substrate and spaced from said coated substrate for establishing electrochemical action with said metallic substrate,
said electrode being small in area relative to said coated substrate,
barrier means disposed closely on opposite sides of said electrode and extending to said coated substrate for restricting any electrochemical action between said electrode and said substrate to a narrow section of said substrate bounded by the barrier means,
means for filling the region between the barrier means with an electrolyte to permit electrochemical action to be established between said electrode and only a narrow section of the substrate exposed to said electrolyte,
means for moving said electrode and said barrier means together relative to said coated substrate to change the narrow section of coated substrate which is exposed to the electrolyte between the barrier means, and
means for sensing electrochemical potential established between said electrode and the substrate as the electrode and barrier means move relative to the coated substrate.

9. The device of claim 8 and further including means for substantially removing any electrolytic polarization on the coating or substrate of said narrow section immediately prior to moving said electrode and barrier means thereover.

10. The device of claim 9 where said means for substantially removing any electrolytic polarization comprises a second electrode spaced from said coated substrate and disposed in fixed spaced relation to said first electrode in the direction of movement of the first electrode and barrier means relative to the coated substrate,

said second electrode being movable with the first electrode,
means for maintaining an electrolyte in contact with said second electrode and with a second section of said coated substrate to restrict electrolytic action between said second electrode and said substrate to said second section, and
means for imposing a depolarizing electrical potential between said second electrode and said second section, thereby to electrolytically depolarize any portion of the substrate in the second section that is subject to said electrolytic action.

11. A method for inspecting the metallic coating on the interior surface of a pipe for holidays, wherein said metallic coating and the material of said pipe are electrochemically dissimilar, said method comprising the steps of

establishing an electrochemical potential between said metallic coating on the pipe and an axially short electrode that is disposed within and spaced from said coating,
confining said electrochemical action at a given time to an axially short section of said coated pipe that is radially spaced from said electrode,
moving said electrode and the confined electrochemical action longitudinally relative to the pipe to change the location of the axially short section of the coated pipe that is subject to said electrochemical action with said electrode, and
sensing variations in electrochemical potential between said electrode and the coated pipe caused by holidays in the coating of the pipe.

12. The method claimed in claim 11 and including the step of substantially removing electrolytic polarization on the inner surface of the axially short section of coated pipe immediately prior to establishing said electrochemical potential.

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GERARD R. STRECKER, Primary Examiner

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