Feb. 17, 1948. A. B. MacTAGGART ET AL 2,435,973

METHOD OF AND MEANS FOR PROVIDING CATHODIC PROTECTION OF METALLIC STRUCTURES

Filed Aug. 19, 1941 4 Sheets-Sheet 1

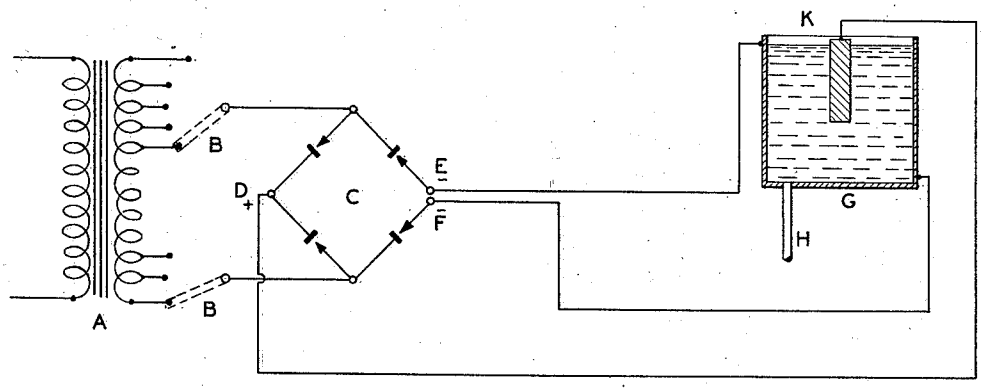


FIG. 1.

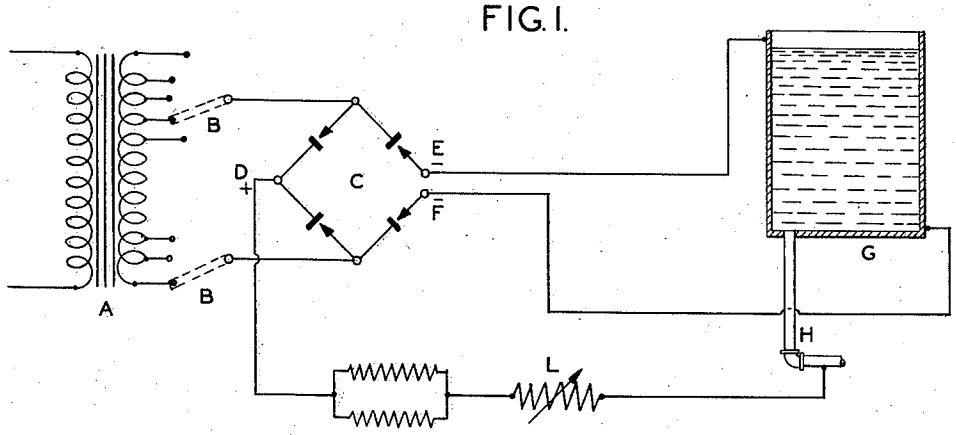


FIG. 3.

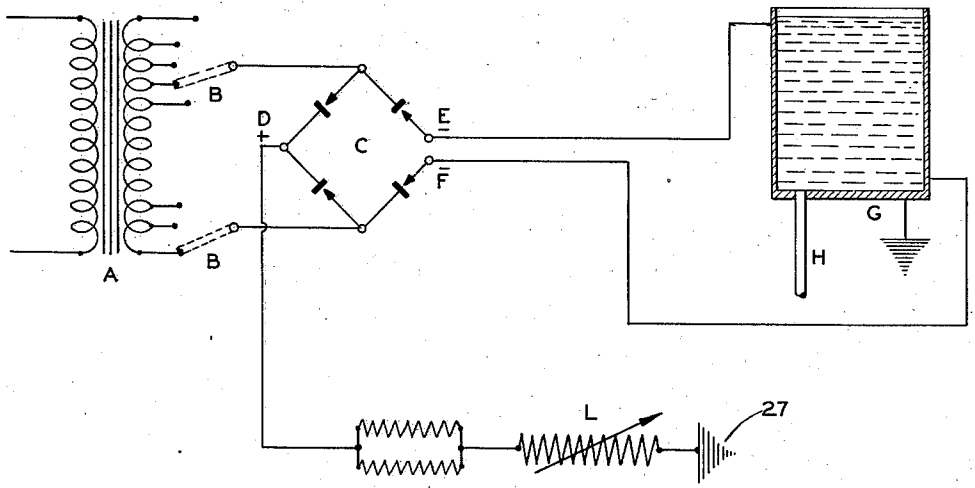


FIG. 7.

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METHOD OF AND MEANS FOR PROVIDING CATHODIC PROTECTION OF METALLIC STRUCTURES

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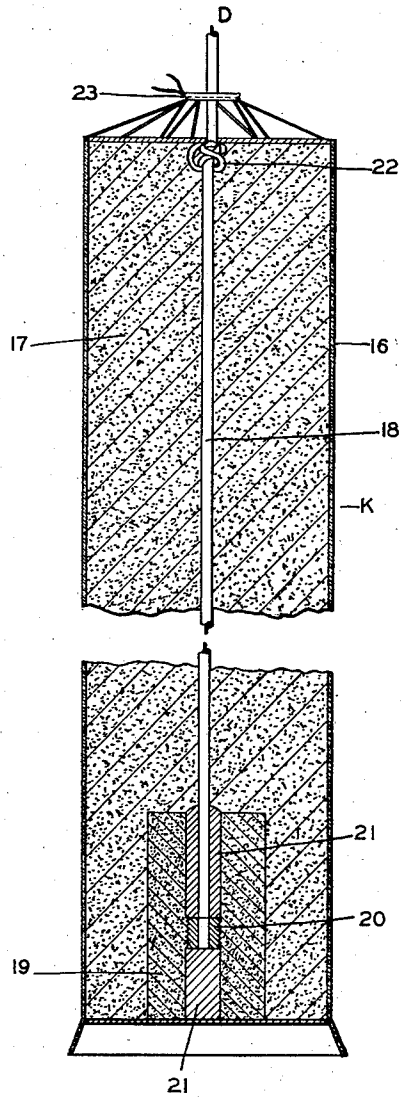


FIG.2.

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METHOD OF AND MEANS FOR PROVIDING CATHODIC PROTECTION OF METALLIC STRUCTURES

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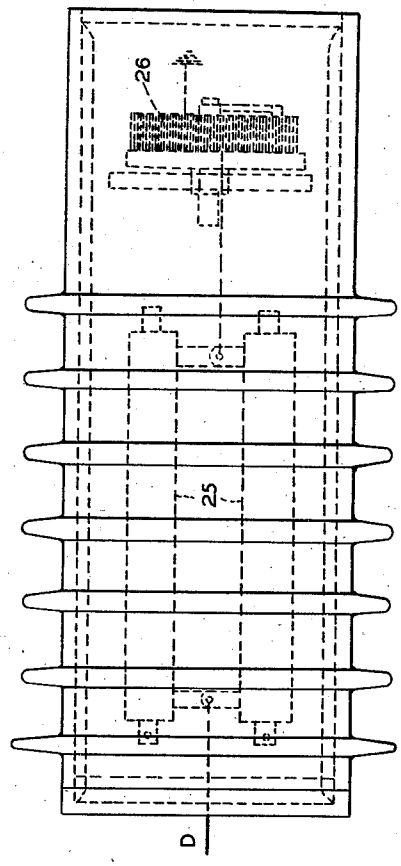


FIG. 4.

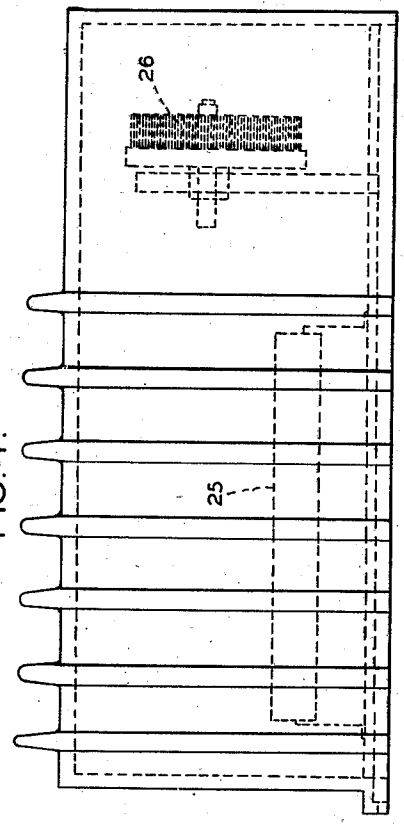


FIG. 5.

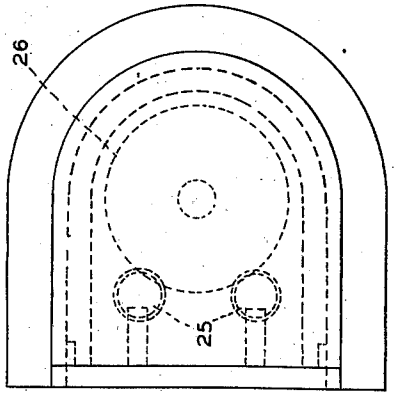


FIG. 6.

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METHOD OF AND MEANS FOR PROVIDING CATHODIC PROTECTION OF METALLIC STRUCTURES

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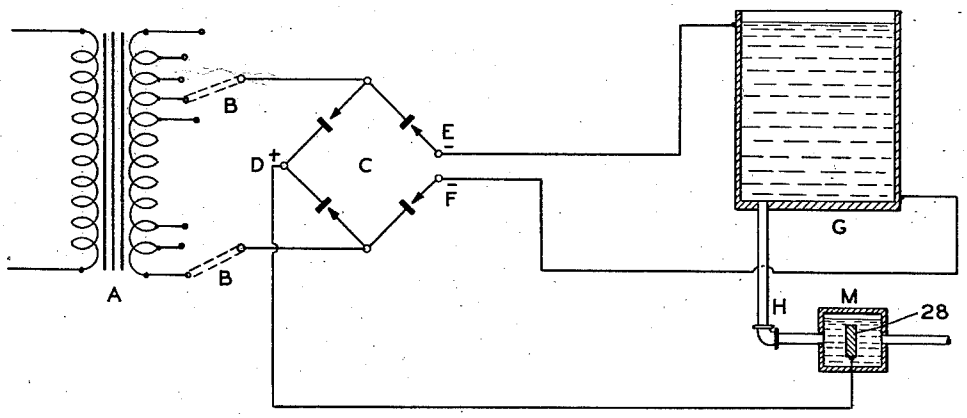


FIG.8.

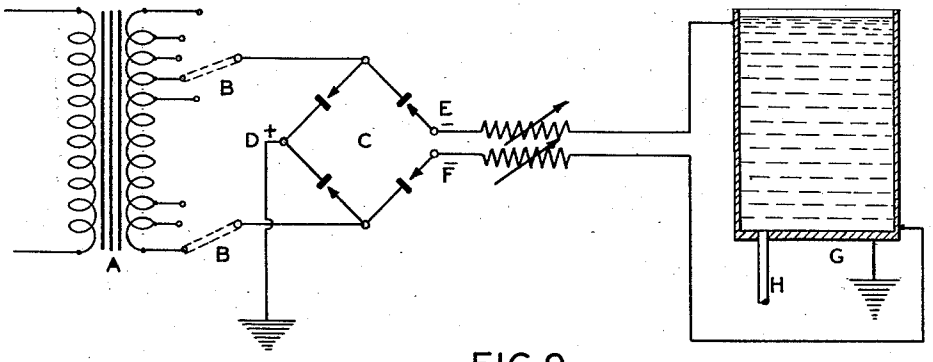


FIG.9.

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METHOD OF AND MEANS FOR PROVIDING CATHODIC PROTECTION OF METALLIC STRUCTURES

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Application August 19, 1941, Serial No. 407,444

13 Claims. (Cl. 204—147)

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This invention relates, as indicated, to methods of and means for providing cathodic protection against corrosion of metallic structures.

A primary object of the invention is to provide a method of cathodic protection against rusting, pitting and corrosion of metallic containers of, or metallic structures immersed in aqueous electrolytes, which method in one form includes the external application of resistors of any nature, incandescent or otherwise, either by attaching said resistors to such metallic containers or structures, or by remote means of inclusion of said resistors in a cathode protection circuit, with or without the use of anodes or electrodes in the contained or surrounding aqueous electrolyte.

A further object of the invention is to utilize such metallic containers and submerged structures in a unidirectional pulsating current circuit which is obtained from rectified A. C. circuits, in such a manner that the said metallic bodies are sufficiently electronegative to the contained or surrounding electrolyte to oppose the tendency of such metals to go into solution.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims; the annexed drawings and the following description setting forth in detail certain means and one mode of carrying out the invention, such disclosed means and mode illustrating, however, but a few of various ways in which the principle of the invention may be used.

In said annexed drawings:

Fig. 1 is a diagrammatic view of a conventional circuit embodying the principal features of the invention;

Fig. 2 is a cross-sectional view of an electrode which has been especially designed for use in the circuit shown in Fig. 1;

Fig. 3 is a diagrammatic view of a modified form of circuit;

Figs. 4, 5 and 6 are respectively plan and side elevation and end elevation views of the resistances used in the circuit of Fig. 3;

Figs. 7, 8, and 9 show other modifications of the cathodic protective circuit.

Referring more particularly to Fig. 1 of the drawings, A designates a step-down transformer having means of obtaining variable reduced secondary voltages from tap switches B. Lines from the tap switches are connected to the full wave dry plate bridge rectifier C, which is shown as embodying four half-wave rectifiers connected in modified bridge arrangement providing two negative terminals and which accordingly changes the alternating current to a pulsating unidirectional current.

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The local connection between the half-wave rectifier units at the negative side of the dry plate rectifier is removed, and connections are made from the separate negative poles E and F, respectively, one to a point adjacent the top of the metallic container G and the other to a point adjacent the bottom of the container, remote from the first point. The positive line D from the rectifier is connected to the electrode (anode) K which is immersed in the water or other liquid in the container G. The container is usually provided with a conduit H which serves to conduct to and/or from the container the liquid with which the container is usually filled.

By the foregoing shift of connections, the metallic container G becomes the connection between half-wave units of the rectifier, and, so long as current is supplied to the rectifier from a source of alternating current, the metallic container is and remains the negative side in a pulsating D. C. circuit. The half-wave rectifier units as shown provide a half-wave rectification in opposite directions from each end of the dry plate rectifier and the half-wave unidirectional pulsations are imposed upon spaced points of the metallic container.

It has heretofore been customary to employ as the anode K a carbon or graphite rod, since these materials are chemically inactive and were therefore considered as best adapted for the purpose. However, oxygen evolving at the anode ultimately disintegrates the anode to such an extent that any means of suspending the anode eventually fails.

In order to overcome this, we have designed an anode, the construction of which is clearly shown in Fig. 2 of the drawings. Referring to this figure, it will be seen that the anode K comprises an outer tube or coating 16 of glass fabric, in tubing form, filled with a granulated or powdered carbon or graphite 17, within which is embedded a core 18 of insulated wire which serves the dual function of supporting or suspending the anode and of conducting current from the line D to the lower end of the electrode. Within the lower end of the anode is a centrally disposed tube 19 of graphite, within which a brass plug 20 is disposed and sealed in place by means of a melting compound 21, the wire 18 being brazed to the plug 20. A strain relief 22 is placed upon the wire 18 adjacent the upper end of the latter, and a drawstring 23 then provides a means

of tying the casing 16 to the wire 18 above said strain relief. In this manner, a closed tube of glass fabric is provided, containing all of the elements necessary to the anode, as well as a means of suspending the latter. Any disintegration that occurs merely effects a gradual settling of the granules within the glass tube and such granules cannot be emitted from the tubing so as to result in disintegration of the anode. Such an electrode is practically indestructible.

It has been definitely determined that, in order to keep a steel water tank from rusting, it is desirable that a potential be applied from an external source as a negative potential of 2 volts are more at the surface of the tank, and the voltage drop across the water must be estimated so that the proper E. M. F. can be supplied at the source. It has further been found that it is necessary to maintain a current flow of 3 amperes for every 10,000 square feet of submerged surface of metal.

After the necessary potential and amperage requirements for a given metallic container have been ascertained, the aforesaid method of providing cathodic protection for the container can be placed in effect, the potential and amperage requirements being set for the installation by means of suitable electrical measuring instruments.

Moreover, no type of submerged anode, regardless of its nature, could possibly be expected to withstand the action of ice formation, and it accordingly becomes expedient to provide some means for obviating such electrodes. And, the container can have a negative potential impressed upon it without necessity of any immersed electrode by making the container a part of the circuit and providing suitable voltage-drop conditions. To that end, we have used a combination of resistors, fixed and variable, externally applied, such combinations becoming the positive side of a unidirectional pulsating current circuit and the metallic container the negative side of such circuit. Several types of such resistors are available and they consist of resistance of any nature, incandescent or otherwise, whereby a properly regulated current flow can be maintained.

We use such combinations of resistors for the purpose of applying a load to complete the circuit and regulate a current flow. These can be placed on a metallic container at any point, or they may be grounded on connecting water pipes, or directly to a ground rod of any nature, whereby the current will ultimately return through the metallic container which is serving as the negative connector between units of the rectifier and the negative side in the unidirectional pulsating circuit.

A typical form of such a circuit, embodying a resistance potential-drop which substitutes an anode, is illustrated in Figs. 3, 4, 5 and 6 of the drawings. Referring to these figures, and particularly Fig. 3, it will be seen that the circuit is identical with that shown in Fig. 1, but that instead of the anode K, the resistance potential-drop L is used in the line D, the line from the end thereof being grounded on the conduit H which leads to the metallic container G. This has the advantage of eliminating immersed electrodes. Figs. 4, 5 and 6 illustrate one type of potential drop, consisting of a fixed resistance 25 and a variable resistance 26 suitably housed in a protecting casing. It may be expedient, however, to use an illuminated or incandescent resistor in place of that shown.

In that form of the invention shown in Fig. 7, the circuit is identical with that shown in Fig. 3, but the line from L, instead of being connected to the conduit H, is grounded as at 27.

In that form of the invention shown in Fig. 8, the circuit is similar to that of Fig. 1, but the line is connected to an anode 28 which is placed in a chamber M, in any conduit, such as the conduit H, which leads to the metallic container of the electrolyte.

In that form of the invention shown in Fig. 9, the line D is grounded, and such ground shall be to some remote point in electrical conductor contact with the metallic container G. Variable or fixed resistors are provided in the negative lines E and F for adjusting the current flow.

While the method has been described more particularly with reference to the cathodic protection of elevated water tanks, it is to be understood that it may be applied to other structures, such as steel water tanks on the ground and in the ground, to pressure tanks, gas holders, filter beds, boilers, condensers and any other type of metallic equipment containing an electrolyte.

Other modes of applying the principle of our invention may be employed instead of the one explained, change being made as regards the means and the steps herein disclosed, provided those stated by any of the following claims or their equivalent be employed.

We therefore particularly point out and distinctly claim as our invention:

1. The method of protecting a corrodible metallic structure against deterioration in contact with an aqueous electrolyte, which comprises connecting such structure at spaced points with plural negative poles of a source of direct electric current alternately supplied in low frequency to said poles, while maintaining a positive pole of such source in electrical connection with such structure.

2. The method of protecting a corrodible metallic structure against deterioration in contact with an aqueous electrolyte, which comprises connecting such structure at spaced joints with plural negative poles of a source of direct current alternately supplied in low frequency to said poles, and connecting a positive pole of said source through a resistance with such structure at still another point.

3. The method of protecting a corrodible metallic structure against deterioration in contact with an aqueous electrolyte, which comprises connecting such structure at spaced points with plural negative poles of a source of direct current alternately supplied in low frequency to said poles, while maintaining a positive pole of such source in electrical connection with such structure through the medium of the liquid therein.

4. The method of protecting a corrodible metallic structure against deterioration in contact with an aqueous electrolyte, which comprises connecting such structure at spaced points with plural negative poles of a source of direct current alternately supplied in low frequency to said poles, while maintaining a positive pole of such source in electrical connection with such structure through the medium of a resistance ground circuit.

5. The method of protecting a corrodible metallic structure against deterioration in contact with an aqueous electrolyte, which comprises connecting such structure at spaced points with plu-

ral negative poles of a source of direct current alternately supplied in low frequency to said poles, while maintaining a positive pole of such source in electrical connection with such structure through the medium of a ground circuit including an adjustable resistance.

6. The method of protecting a corrodible metallic structure against deterioration in contact with an aqueous electrolyte, which comprises connecting such structure at two spaced points with the respective independent negative terminals of two half-wave rectifiers having independent negative terminals and a common positive terminal and being supplied by alternating current, while maintaining the common positive terminal of such rectifiers in electrical connection with such structure.

7. The method of protecting a corrodible metallic structure against deterioration in contact with an aqueous electrolyte, which comprises connecting such structure at two spaced points with the respective independent negative terminals of two half-wave rectifiers having a common positive terminal and independent negative terminals and being supplied by alternating current, while maintaining the common positive terminal of such rectifiers in electrical connection with such structure through the medium of the liquid therein.

8. The method of protecting a corrodible metallic structure against deterioration in contact with an aqueous electrolyte, which comprises connecting such structure at two spaced points with the respective independent negative terminals of two half-wave rectifiers having a common positive terminal and independent negative terminals and being supplied by alternating current, while maintaining the common positive terminal of such rectifiers in electrical connection with such structure through the medium of a resistance ground circuit.

9. The method of protecting a corrodible metallic structure against deterioration in contact with an aqueous electrolyte, which comprises alternately impressing in low frequency at spaced apart points on such structure electric pulsations consisting of electro-negative potential pulsations, while including in circuit therewith liquid in contact with such metallic structure.

10. The combination with a corrodible metallic structure, of means for protecting the same against deterioration in contact with an aqueous electrolyte, comprising half-wave rectifiers supplied by alternating current and having their independent negative poles connected respectively to spaced points on said structure, and their common positive pole also being in circuit with said structure.

11. The combination with a corrodible metallic structure, of means for protecting the same against deterioration in contact with an aqueous electrolyte, comprising a circuit of half-wave rectifiers supplied by alternating current and having a common positive terminal and independent negative terminals, conductors connecting the respective negative terminals with spaced points on said structure, and the common positive terminal of said rectifiers having independent electrical connection with said structure.

12. The combination with a corrodible liquid-containing metallic structure, of means for protecting the same against deterioration in contact with an aqueous electrolyte, comprising half-wave units supplied by alternating current and having a common negative positive terminal and independent negative terminals, conductors connecting the respective negative terminals with spaced points on said structure, and the common positive terminal of said rectifiers being electrically connected with said structure through the medium of the liquid therein.

13. The combination with a corrodible liquid-containing metallic structure, of means for protecting the same against deterioration in contact with an aqueous electrolyte, comprising half-wave rectifiers supplied by alternating current and having a common positive terminal and independent negative terminals, conductors connecting the respective negative terminals with spaced points on said structure, and the common positive terminal of said rectifiers being electrically connected with said structure through the medium of a resistance ground circuit.

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