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SELF-REGULATING CATHODIC PROTECTION SYSTEM

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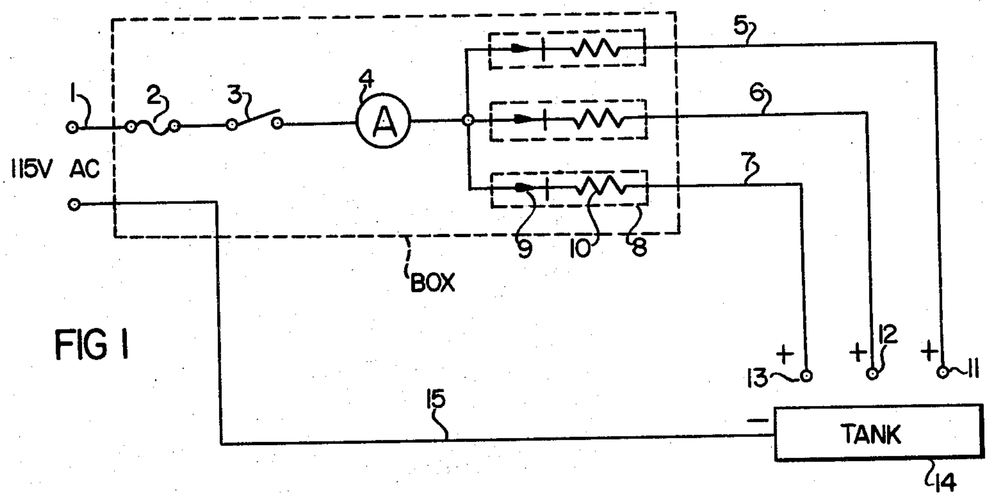

FIG 1

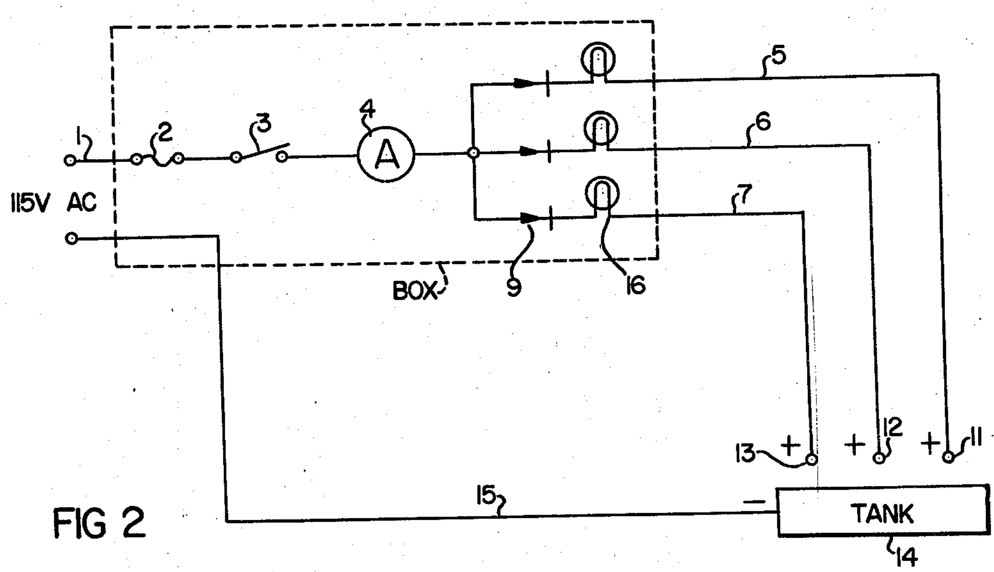

FIG 2

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SELF-REGULATING CATHODIC PROTECTION SYSTEM

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This invention relates as indicated to a self-regulating cathodic protection system, and more particularly to a relatively inexpensive protection system adapted to be installed in conjunction with the underground gasoline storage tanks at service stations and the like.

There have been two principal methods for providing cathodic protection to underground metal structures such as tanks, pipe lines and the like, each method having certain advantages and certain disadvantages. When employing the galvanic anode type of protective system utilizing the natural galvanic voltage developed between the anode and the protected structure, the current requirements are ordinarily small and the current generated by such galvanic anode may ordinarily be between 30 and 150 millivolts and is inversely proportional to the resistivity of the electrolyte. Accordingly, the higher the resistivity, the lower the current output.

When employing the impressed current type of cathodic protection system, an external D.C. source is utilized to energize the anodes, and this type of system is ordinarily employed where the current requirements are relatively large or where the resistivity is too high for galvanic anodes to function effectively. Ordinarily, such impressed current systems are designed with a minimum capacity of 10 amperes and the current derived from an impressed current anode is a function of the soil resistivity and of the voltage to which the D.C. source is set to operate.

Although each of the systems briefly identified above has been employed extensively and successfully, they each possess practical limitations, particularly in situations where the current requirements are small. In a galvanic anode system, the limitations derive from the fact that the current generated by a galvanic anode is dependent upon the resistivity of the environment. Accordingly, before designing and installing such a system, it becomes necessary to measure such resistivity and, even then, it is often difficult to predict accurately the current output inasmuch as the soil resistivity can vary considerably even in short distances. The usefulness of such galvanic anodes is often limited to low resistivity environments because the current generated in a higher resistivity environment may not be sufficient to provide protection. On the other hand, in very low resistivity environments, the galvanic anodes may disintegrate within a relatively short period of time. When galvanic anodes are employed, it is accordingly necessary to employ skilled personnel to make periodic and rather frequent checks of the functioning of the system since determination of whether the anodes are still functioning effectively cannot be made by unskilled personnel.

In view of the foregoing, it is a principal object of this inveniton to provide a self-regulating cathodic protection system which will require a minmum of preparaton and investigation prior to installation.

It s a further object to provide such system which is adapted to be checked by unskilled personnel such as a gasoline filling station attendant, for example, to determine whether it is continuing in full and effective operation.

Still another object is to provide such protective system which will be effective under widely varying conditions of use.

Other objects of the invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the varous ways in which the principle of the invention may be employed.

In said annexed drawing:

FIG. 1 is a circuit diagram showing a preferred self-regulating cathodic protection system in accordance with the invention; and

FIG. 2 shows a modification thereof.

As shown in FIG. 1, a box is provided having leads adapted to be plugged into an existing 115 volt A.C. line, one lead **1** having a fuse **2**, a switch **3** and an ammeter **4** in series connected to a plurality of lines (in this case three) **5**, **6** and **7** in parallel. Each of such latter lines has removably plugged therein a can such as **8** containing a silicon diode rectifier **9** and a resistor **10**.

Each of lines **5**, **6** and **7** leads to a respective anode **11**, **12** and **13** buried adjacent the gasoline tank **14** which is to be protected. Such tank is itself connected to line **15** constituting the other lead connected to such 115 volt A.C. current source.

The plug-in cans **8** will preferably be provided with the well-known radio tube base to facilitate ready replacement. In a typical installation, the silicon diodes employed may be 400 P.I.V., 1.0 ampere diodes and the resistors **10** may be 500 ohm, 25 watt resistors. The output from each half wave diode will be 50 volts D.C. The ammeter **4** may desirably be calibrated to show the number of lines in operation so that if there should be a failure of a diode **9** or resistor **10**, the ammeter reading will be decreased accordingly and it will only be necessary to check and replace a corresponding can **8** to return the system to full operation.

In the alternative system illustrated in FIG. 2, an identical arrangement of components is employed except that an electric lamp **16** may be utilized with each of the lines **5**, **6** and **7** in conjunction with the diode **9** in place of the simple resistor **10**. Such lamps will then signal the failure of an associated diode as well as serving as resistors themselves. Of course, whenever a lamp goes out, it will be necessary first to check the lamp itself before replacing the diode.

Since an imposed current is employed, the anodes **11**, **12** and **13** may be of high silicon iron or graphite and are therefore very long-lived. In a typical installation, the current derived from any given anode will be 100 milliamperes D.C. plus or minus 10%. This substantially constant current is obtained by reason of the fact that the fixed resistor **10** placed in series with each diode **9** has at least ten times the value of the resistance between an anode and the protected structure such as buried gasoline tank **14**. Ordinarily, the resistance between an anode and the protected structure is less than 10 ohms. Since, as above indicated in the example given, the fixed resistor **10** is 500 ohms and the output from the half wave diode rectifier is 50 volts D.C., the anode-to-tank resistance can be as high as 50 ohms (much greater than is ordinarily found in practice) and the current output will still deviate less than 10% from 100 milliamperes D.C. Thus, if a particular application should require 800 milliamperes for protection, it is merely necessary to install 8 anodes with a corresponding unit containing 8 plug-in cans. The output from each anode is small in magnitude and is therefore similar to that which can be expected when employing a galvanic anode system and consequently undesired exposure of other neighboring structures is negligible. The resistivity of the electrolyte in which the anodes are submerged has a negligible effect on the current output.

It will be seen from the foregoing that the cathodic protection system of this invention is relatively inexpensive, is very simple to install and simple to maintain. Any partial failure is immediately signaled and may be corrected by unskilled personnel. Even if the conductivity of the soil in which the protected structure and anodes are buried should change rather drastically, between wet and dry periods for example, this will have an unimportant effect on the protection afforded such structure by the system since the system is self-regulatory to minimize fluctuations. The system is long-lived since high silicon iron or graphite anodes may be employed rather than galvanic anodes which distintegrate and yet there is no danger of developing excessive current flow which might lead to damage of adjacent buried metallic installations such as water pipes and the like.

By employing the protective system of this invention, it is feasible safely to provide the minimum current flow which will protect the buried structure (and at the same time avoid damage to other adjacent structures) since there will be no danger of a substantial drop in such flow as operating conditions change. The number of anodes is selected to provide the total current required and the current to each anode is automatically maintained substantially constant at all times. Each anode is on a separate cable (contrary to usual practice) so that any individual failure is readily localized and identified, but all are monitored in a single unit. When using the signal lamps **16**, it is not necessary also to employ the ammeter **4** but the FIG. 1 system will ordinarily nevertheless be preferred. Other known variable impedance rectifiers may also be employed. The system may be used for underwater as well as underground installations.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I therefore particularly point out and distinctly claim as my invention:

1. A self-regulating cathodic protection system for underground metal storage tanks and the like comprising a plurality of corrosion-resistant anodes buried adjacent but out of contact with such tank, an alternating current source, individual lines in parallel connected to said anodes and said source, a line connected to such tank as the cathode and to said source, a readily removable plug-in can connected into each said individual parallel line containing a silicon diode rectifier and a resistor in series in said line, an ammeter in series between said source and all said parallel lines, and a switch in series between said source and all said parallel lines.

2. The system of claim 1, wherein all said resistors are of equal resistance, and said ammeter is calibrated in increments corresponding thereto.

3. A self-regulating cathodic protection system for underground metal storage tanks and the like comprising a plurality of high silicon iron anodes buried adjacent but out of contact with such tank, individual electric cables connected to said respective anodes adapted to be connected in parallel to a 115 volt alternating current source, an electric cable connected to such tank as the cathode and also adapted to be connected to such source, readily removable plug-in cans respectively connected with each said individual parallel cable and each containing a 400 P.I.V., 1.0 ampere silicon diode rectifier and a 500 ohm, 25 watt resistor in series with the corresponding anode and such current source, and a single ammeter in series with such source and all said parallel cables, said ammeter being calibrated to indicate the number of anodes in operation.

4. A self-regulating cathodic protection system for underground metal storage tanks and the like comprising a plurality of corrosion-resistant anodes buried adjacent but out of contact with such tank, an alternating current source, individual lines in parallel connected to said anodes and said source, a line connected to such tank as the cathode and to said source, a silicon diode rectifier and a signal lamp in series in each said parallel line.

5. A cathodic protection system for objects subject to corrosion comprising a plurality of corrosion-resistant anodes submerged in an electrolyte likewise contacting such object, said anodes being disposed adjacent but out of contact with such object, individual electric cables connected in parallel to said respective anodes, an individual resistor in series with each said individual anode, each said resistor being of equal value, an individual current rectifier in series with each said individual resistor, each said rectifier being of equal value, a single ammeter in series with said parallel cables, and a cable connected to such objects as cathode, said latter cable and said ammeter being adapted for connection to an alternating current source.

6. The system of claim 5, wherein said resistors are lamps.

7. A cathodic protection system for objects subject to corrosion comprising a plurality of corrosion-resistant anodes submerged in an electrolyte likewise contacting such object, said anodes being disposed adjacent but out of contact with such object, individual electric cables connected in parallel to said respective anodes, an individual resistor in series with each said individual anode, each said resistor being of equal value, an individual current rectifier in series with each said individual resistor, each said rectifier being of equal value, and a cable connected to such object as cathode, said latter cable being adapted for connection to the negative pole of an alternating current source and said rectifiers being adapted for connection to the positive pole of such source.

8. A cathodic protection system for objects subject to corrosion comprising a plurality of anodes submerged in an electrolyte likewise contacting such object, said anodes being disposed adjacent but out of contact with such object, individual electric cables connected in parallel to said respective anodes, an individual resistor in series with each said individual anode, each said resistor having a value much in excess of the resistance between the corresponding said anode and such object, whereby fluctuations in such latter resistance will produce only small changes in current flow, and a cable connected to such object as cathode, said cables being adapted for connection to corresponding poles of an electric current source.

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