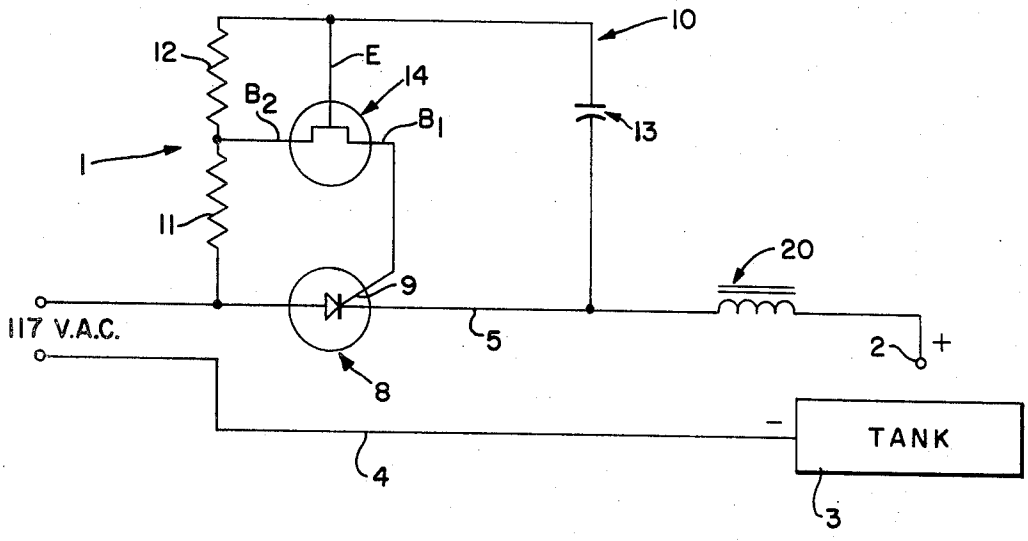
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CATHODIC PROTECTION SYSTEM

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CATHODIC PROTECTION SYSTEM

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ABSTRACT OF THE DISCLOSURE

A self-regulating cathodic protection system for underground metallic objects such as gasoline storage tanks wherein a substantially constant direct current is created between an anode array and the tank even under variable soil conditions, the system including automatic discontinuation of power for component or circuit failure. A series inductor and SCR energize each anode of the array, the SCR being triggered by an unijunction transistor in an RC timing circuit operative within each cycle of the power source.

The present invention relates generally, as indicated, to a protective system and, more particularly, to certain improvements in self-regulating cathodic protection systems especially of the type shown and described in U.S. Letters Patent No. 3,143,670, granted to Bernard Husock on Aug. 4, 1964.

In such prior patent, there is disclosed a relatively simple and inexpensive impressed current cathodic protection system which is adapted to produce a substantially constant current at any given anode despite fluctuations in the load resistance between the anode and a structure to be protected, such as a gasoline tank, by placing a fixed resistor having a resistance at least ten times as great as the resistance between the anode and protected structure in series with a rectifier for converting a typical 115 volt A.C. source to direct current. Because the resistance of the fixed resistor is quite high as compared to the maximum change in resistance that might occur in the electrolyte between the anode and protected structure from wet to dry periods or for other reasons, it has been found that the current output will always deviate less than 10 percent.

Thus, by employing the protective system of the aforementioned Husock patent, it is possible to provide the minimum current flow which will protect the buried structure, since there is no danger of a substantial drop in such flow as operating conditions change. However, in some instances it is desirable to eliminate most of the heat which is generated by the resistors for longer component life and still provide the constant current output at the anodes despite fluctuations in the load resistance between the anodes and structure being protected, which is a principal object of this invention.

Another object is to provide an improved cathodic protection system with novel means for regulating the voltage output at the anodes.

Still another object is to provide a cathodic protection system of the type indicated with means for regulating the current output at the anodes.

A further object is to provide such a protective system with novel means for automatically shutting the system off when there is an interruption in the flow of current, thus eliminating any possibility of sparking around the protected structure should a break occur in the circuit.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the 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 a certain illustrative embodiment of the invention, this being indicative, however, of but one of the several ways in which the principles of the invention may be employed.

In such annexed drawing there is shown a schematic circuit diagram of a preferred form of protective system in accordance with the present invention.

The protective system disclosed herein by way of example is generally indicated at **1** and is shown connected in a typical installation to an anode **2** buried adjacent but out of contact with a metal gasoline tank **3** or the like subject to corrosion. Current for the protective system **1** may be supplied from an external 117 volt A.C. source connected to the lines **4** and **5**. The line **4** leads to the tank **3** which is the cathode. The line **5**, on the other hand, is connected to the anode **2** through a silicon-controlled rectifier **8** which when triggered by current supplied to its control gate **9** produces a pulsating half-wave unfiltered direct current. However, until a current signal of the correct magnitude is provided at the control gate **9**, the SCR **8** will not conduct at all.

For supplying the gate signal, the protective system **1** incorporates a phase shifting network **10** which includes two resistors **11** and **12** and a capacitor **13** connected in series across the SCR **8**, and a unijunction transistor **14** whose base B2 and emitter E are connected across the resistor **12** and whose base B1 is connected directly to the control gate **9** of the SCR.

The resistor **11** is merely a bias or dropping resistor for maintaining the peak voltage which is applied to the unijunction transistor **14** within a safe level for the transistor. In this particular example, the resistor **11** is a 20K ohm, 1 watt, 5 percent tolerance resistor.

The capacitor **13** is charged through the resistor **12** until the emitter E voltage reaches the peak point voltage, which is the point at which the voltage across the capacitor **13** rises above the voltage between the emitter E and the base B2 of the transistor **14**, causing the transistor **14** to fire and trigger the SCR **8** through the base B1 and gate **9**. Thus, the capacitor **13** causes a D.C. potential to be established between the base B2 and base B1 of the transistor **14**. When the transistor **14** is fired, the capacitor **13** is then discharged through the output circuit at the anode **2**.

The function of the resistor **12** is to determine the amount of current output of the transistor **14** at the base B1 which is supplied to the gate of the SCR **8**. By varying the amount of resistance of the resistor **12**, the amount of current flow through the unijunction transistor **14** may be varied, the higher the resistance of the resistor **12**, the more current flowing through the unijunction transistor with consequent higher voltage through the SCR, and vice versa.

Once the SCR **8** is conducting, however, it will supply a voltage of a substantially constant magnitude at the anode **2**, and will continue to supply such constant voltage until the current flow through the SCR is interrupted. Thus, as soon as the SCR **8** has been triggered, the gate **9** has no further effect on the SCR and cannot turn the device off. However, when the SCR circuit is opened, the SCR **8** will no longer provide a D.C. output. This is particularly advantageous where the structure being protected contains a flammable product such as gasoline, since if the lines of the system are accidentally cut, the SCR **8** will immediately cause the system to go off, thus eliminating any possibility of sparking around the gasoline tank **3**.

The protective system **1** of the present invention has other advantages as well. Due to the construction of the SCR **8**, for example, it requires much less driving power

than even a typical power transistor, which permits the system to operate at a very low temperature for longer component life. Moreover, with this system any desired low voltage output of a substantially constant magnitude may be produced at the anode **2**, it only being necessary to change the value of the resistor **12** to achieve the desired voltage output, the higher the resistance of the resistor **12**, the higher the voltage output and vice versa.

For leveling out the pulsating direct current output provided by the SCR **8**, a choke coil **20** may be inserted in the line **5** in series between the SCR **8** and anode **2**. As is well known, a choke coil will regulate current to a limited extent due to its tendency to prevent current from building up or dying down.

As fully discussed in the aforementioned Husock patent, even though most structures require more than 100 milliamperes for protection, it is preferred that the output from each anode **2** be of this approximate magnitude to guard against any undesired exposure of neighboring structures. Accordingly, a plurality of anodes **2** with associated components must be used for a particular application to provide the amount of current needed for protection.

A 100 milliamperes D.C. output at 100 ohms load resistance may be provided with this system by using a 20K ohm, 1 watt, 5 percent tolerance resistor **11**; a 2.7K ohm, 1 watt, 5 percent tolerance resistor **12**; and a 0.1 microfarad, 200 w.v. D.C., 10 percent tolerance capacitor **13**. The choke **20** may be a 1.5 henry, 200 milliampere D.C., 75 ohm coil. In actual practice, it has been found that this particular system will produce an output of from 0 to 134 milliamperes over a 0 to 400 ohm load range.

From the above discussion, it can now be seen that the protective system of the present invention is of a unique construction, capable of producing a substantially uniform voltage output of any desired low magnitude with good current regulation while creating almost no heat for longer component life. Moreover, should a break occur anywhere in the system, it will automatically shut off, thus completely eliminating any danger of sparking in the vicinity of the structure being protected.

Other modes of applying the principles 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 protective system for objects subject to corrosion comprising at least one anode to be submerged in an electrolyte in which such object is located closely adjacent but out of contact with such object, a source of alternating current power, a lead for carrying electric current connected to said anode, a choke coil connected in series with said lead, a silicon-controlled rectifier connected in series with said choke coil and said power source, a pair of resistors and a capacitor connected in series across said silicon-controlled rectifier, a unijunction transistor, said unijunction transistor comprising a pair of base elements and an emitter, one of said base elements and said emitter being connected across one of said resistors which is nearest said capacitor, said other base element being connected directly to the control gate of said silicon-controlled rectifier, and a second lead adapted to be connected from said power source to such object as the cathode.

2. The protective system of claim **1** wherein there are a plurality of said anodes with associated silicon-controlled rectifiers, resistors, capacitors, choke coils and transistors connected thereto as aforesaid.

3. A protective system for underground metal storage tanks and the like comprising a source of alternating current power, an anode adapted to be buried adjacent but out of contact with such tank, a choke coil connected at one end to said anode, a silicon-controlled rectifier having anode, cathode and gate electrodes, said cathode electrode connected to the other end of said choke coil and said anode electrode connected to said power source, a unijunction transistor for triggering said silicon-controlled rectifier, said transistor having base one, base two and emitter electrodes, the base one electrode being connected directly to said gate electrode for supplying triggering current to said silicon-controlled rectifier, a line connecting said power source and such tank for completing an electrical circuit, a phase-shift network in series connection between said source of power and the other end of said choke coil, said network being operative only with continuity of such circuit for providing set-point voltage to said transistor in each cycle of the power source for triggering said silicon-controlled rectifier.

4. A protective system as set forth in claim **3** wherein said network comprises first and second resistors and a capacitor in series connection, said first resistor being connected to said source of power and the base two electrode of said transistor, said second resistor being connected between the base two and emitter electrodes of said transistor, and said capacitor being connected between the emitter electrode and said choke coil whereby a voltage sufficient to energize said transistor is developed across said condenser in each cycle of said power source when current flows through said choke coil.

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