

Aug. 7, 1951

R. F. HADLEY

2,562,906

PRIMARY CELL CONSTRUCTION

Original Filed Aug. 6, 1947

Fig. 1

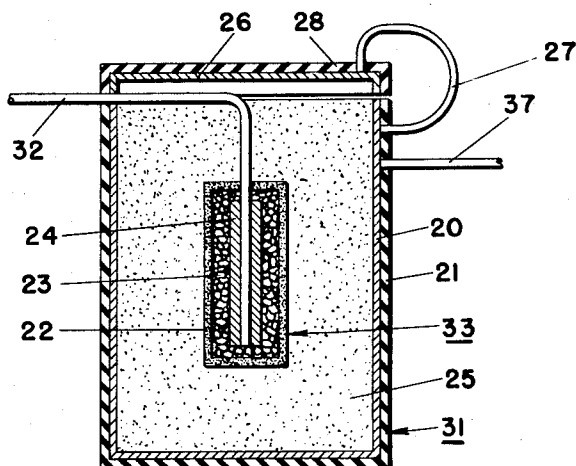


Fig. 2

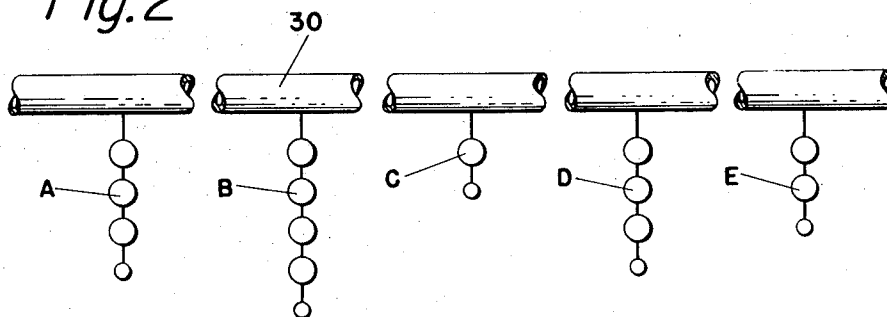
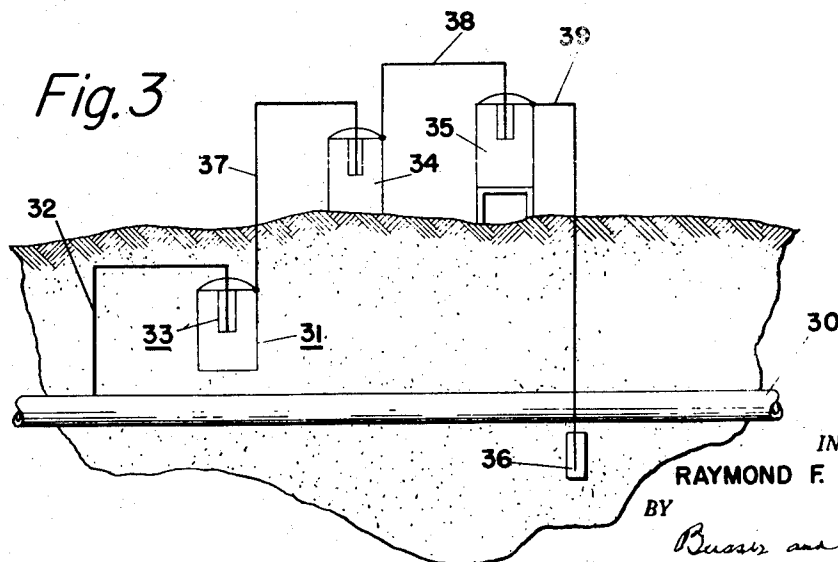


Fig. 3



INVENTOR.
RAYMOND F. HADLEY

BY

Bussis and Harding

ATTORNEYS

UNITED STATES PATENT OFFICE

2,562,906

PRIMARY CELL CONSTRUCTION

Raymond F. Hadley, Drexel Hill, Pa., assignor to
Sun Oil Company, Philadelphia, Pa., a corpo-
ration of New Jersey

Original application August 6, 1947, Serial No.
766,675. Divided and this application Septem-
ber 10, 1948, Serial No. 48,593

4 Claims. (Cl. 136—100)

1

This invention relates to an improved primary cell and more particularly to a primary cell for use in combating electrolysis in underground structures.

The present application is a division of my application, Serial No. 766,675, filed August 6, 1947, for preventing electrolysis of underground structures.

The principal object of the invention is to provide a galvanic type cell for electrical connection in series to build up the electromotive forces to a value sufficient to reduce or eliminate the corrosive deterioration of buried metallic structures.

An additional object is to disclose a galvanic type cell which can be used under conditions of high resistivity soils or circuits where the cells now employed by the art are unsatisfactory due to limited voltage and limited currents available from the presently used half-cells.

Another object is to provide a galvanic type primary cell for use in the control of electrolytic action the components of which have a long functional life and, consequently, need infrequent replacement. This is possible because the anodic electrode of this primary cell can be operated at a higher current density and, hence, at a higher efficiency than is possible when the anodic electrode is used as a half-cell placed directly in the soil, or separated from the soil by its particular chemical back-fill environment, which is the present practice in the art this primary cell is designed for use. Under present practice, the half-cells, if more than one is used, have always been connected in an electrical parallel circuit.

A further object is to construct a galvanic type primary cell cheaply so that upon completion of the corrosive deterioration of the cathodic electrode its removal and replacement can be made inexpensively.

It is recognized that improved galvanic type half-cells have made their appearance from time to time. The more successful of these are of the porous type with a metal anode rod inserted in an electrolytic solution. These are connected in parallel to the metallic structure requiring protection and control the electrical charge thereon by discharging a direct electrical current into the surrounding earth. When it is desired to increase the potential difference between the subsurface metallic structure and the earth as a result of the operation of these half-cells it is necessary to add additional half-cells in parallel to the metallic structure. Until the present invention it has not been possible to materially increase the electromotive force of the galvanic

2

half-cells except in so far as the solution potential of the anodic electrode may be enhanced through the use of a more suitable anodic metal electrode for the half-cells or through the use of more suitable chemical backfill environments, since the physical structure and design of the galvanic half-cells heretofore used prevented the coupling of cells of this type in series. The application of a coating of suitable electrical properties to the subsurface structure to be protected is also extensively used to increase the potential difference between the subsurface structure and the soil when using galvanic type half-cells. The use of such a coating is also to be recommended when using the galvanic type primary cell of this invention. It is therefore a primary object of this invention to disclose a primary cell of unique structure and to illustrate the method of protecting underground metallic structures through the flexible use of such primary cells to meet the demands of any corrosion circuit existing upon the subsurface metallic structure to be protected.

The invention is illustrated in the accompanying drawings in which:

Figure 1 is a cross-section of the primary cell, Figure 2 is a series circuit involving the invention,

Figure 3 is a diagram illustrating several applications of the invention.

Figure 1 shows a cross-section of the primary cell which is used as the primary series element in this disclosure. If buried in the earth, a metallic container 20 is covered externally with a suitable insulating material 21, such as coal tar enamel, asphalt mastic, glass, ceramic, plastic, etc. having satisfactory electrical insulating properties to prevent the metallic container electrode from discharging current to the surrounding earth in which it may be buried or be in contact. A galvanic type half-cell indicated by the inclusive numeral 33 comprises a casing or container 22 of a porous type to bind or confine a prepared chemical anodic depolarizer 23 around a galvanic anode 24 usually of a metal such as magnesium, aluminum or zinc or any metal or substance anodic to the cathodic element structure of the primary cell. The depolarizer 23 used with the customary magnesium anodic electrodes now employed in the art are Bentonite clay and gypsum, magnesium oxide and magnesium sulphate, Bentonite clay, gypsum and sodium sulphate, magnesium oxide, etc. For aluminum anodic electrodes such prepared depolarizers may consist of kaolin and sodium chloride, magnesium chloride and modified magnesi-

um oxide, etc. For zinc anodic electrodes such prepared depolarizers may consist of gypsum, gypsum and calcium chloride, gypsum and sodium chloride, zinc oxide and zinc chloride, etc. The above depolarizers for each specific anode electrode are used to varying degrees in the art and represent satisfactory depolarizers as recently reported in the literature. The outer casing 22 enclosing the anodic electrode and anodic depolarizer is designed to admit moisture and to assist electrical action and is often a cloth, paper, cardboard, or unglazed earthenware container. The description of the anodic electrode, together with its prepared chemical environment and container, described as a component of the primary cell, applies equally well to the earth half-cell anodic electrode 36, illustrated in Figure 3, where it is used as a grounding element, to be described later.

Again referring to Figure 1, the anodic electrode, anodic chemical environment and container for the same, indicated by the inclusive number 33, described in detail above, is approximately centered in the metallic container 20 and a chemical environment or cathodic depolarizer 25 designed to prevent or minimize cathodic polarization is packed into the intervening space between the cathodic electrode and anodic chemical depolarizer container. The cathodic chemical environment 25 is of such type so as to prevent cathodic polarization or the formation of films of high electrical resistance on the surface of the cathodic electrode, which in the case of this primary cell is the metallic container. The cathodic chemical environment is designed to cause appreciable corrosion of the cathodic container, due to local corrosion of the inside surface of the cathodic container electrode, in the event the primary cell electrical circuit is not completed. The current of the primary cell will, however, retard or minimize the corrosive deterioration of the cathodic container due to the electrical current collected by the surface of the cathode element. The cathode polarization voltage, if permitted to increase to an amount equal to, or nearly equal to, the terminal potential difference of the galvanic primary cell, will nullify the usefulness of the cell for the cathodic protection of subsurface metallic structures. By test the most suitable chemical cathodic environments thus far found for iron or steel cathodic containers, where anodes of the magnesium, aluminum or zinc, etc. types, as described above, are used, are potassium monobasic phosphate (K_2HPO_4), sodium monobasic phosphate (Na_2HPO_4), sodium fluoroborate ($NaFBO_4$), sodium chloride ($NaCl$) and calcium sulphate ($CaSO_4$). These environments may be mixed with Bentonite clay, kaolin or other inert materials to reduce the activity of the "whole-cell" within economic limits.

A lid 26 of a material similar to that used for the metallic cathodic containers is electrically attached to the body of the container by means of an insulated wire 27 thus enabling the lid to also act as an additional cathodic surface, the lid being placed on the top of the cell as shown. Suitable insulation 28 similar to the insulation already described for protecting the external surface of the cathodic container of the primary cell is also applied to the external surface of the lid 26 to protect it from the action of the surrounding earth as in the case of the body of the container. The lid is not fastened down securely, but is allowed to fit loosely thereby

permitting ground water to enter the primary cell to maintain a moist environment of low electrical resistance and, also, to hasten the electrical action. Although iron or steel has been selected for the metallic cathodic container as it is cheap and readily available, any element which is electro-positive to zinc, magnesium and aluminum will be satisfactory.

It is fully realized that the corrosive action set up within the primary cell may, in time, destroy the metallic container and its consequent usefulness in the series circuit where it is used and, hence, will necessitate replacement. By selecting a metallic container of suitable wall thickness and by carefully selecting the cathodic chemical environment 25 the current delivered by the several primary cells and the anodic electrode half-cell 36 (Figure 3) may be maintained at a reasonable and useful value for mitigating the corrosion of subsurface metallic structures. Inasmuch as there is no appreciable electrical mutual coupling between the elements of several different primary cells as disclosed, it is possible to install these cells or a series of them on top of the ground, or insulated from the ground by other means of insulation as well as in the ground as disclosed above. If placed above ground the externally applied insulating material 21 and 28 may be eliminated except where the ground is contacted as on the base of the container. It is, however, required that the galvanic anode electrode 36 (Figure 3) which completes the series circuit and to which we have referred as an earth half-cell element be buried in the earth thereby releasing the full accumulated potential of the several primary cells connected in series. The use of the galvanic primary cell which consists of an anodic electrode half-cell and a cathodic electrode half-cell, insulated from the surrounding earth, permits the linkage of an indefinite number of such cells in series resulting in the increase of the electromotive force which can be generated for use in any given area.

Figure 2 shows several series circuit groups of primary cells A, B, C, D and E cooperating over a long distance to protect the subsurface structure 30, which in this example is illustrated as a pipe line, buried in the earth and subjected to varying degrees of corrosive action. The flexibility of the system for increasing the cathodic correct density of the structure to be protected as required by the local corrosive conditions is shown by the number of cells in each group A, B, C, D and E.

A typical series, such as D (Figure 2), is shown diagrammatically in cross-section in Figure 3. The subsurface metallic structure 30 is shown buried beneath the surface of the earth and connected to the first primary cell 31 of the series by an insulated conductor 32 leading to the anodic electrode 33 of the first galvanic type primary cell. The prior art has termed the anodic electrode 33 when buried directly in the earth, or separated from the same with a suitable chemical environment, a "galvanic half-cell." The remaining primary cells 34 and 35 of the series are connected by insulated conductors 37, 38 and 39 attached to the cell container of the leading cell and to the anodic electrode of the following primary cell. The final anodic electrode of the series comprises an anodic half-cell 36 similar in structure to the anodic electrode 33 of the primary cell except that it is constructed directly in the earth, either with or without a

suitable chemical environment to enhance its operation in completing the electrical circuit to the subsurface metallic structure 30 in the selected area. The construction and installation of the anodic half-cell 36 is in accordance with the accepted practices now employed in the art. Although it is shown in Figure 3 that one or more of the primary cells may be buried in the earth, rest on top of the earth or be insulated from the earth, it is equally satisfactory for all of the primary cells to be buried in the earth, rest on top of the earth or be insulated from the earth as local conditions may require.

The primary cell, as described, may be readily adapted for use in any area and under a variety of conditions. The subsurface metallic structure to be protected may be divided into a number of sections, each insulated from the other and so proportioned as to be electrolytically controlled by a predetermined number of cells in series. In cases such as this, the resistance to earth of the structure beneath the ground is made the controlling factor and can be so adjusted as to be fully protected by a series of primary cells. Where linear subsurface structures, such as pipe lines which extend over long distances, are to be protected, series groups of those primary cells may be placed at intervals along the pipe line to act as voltage boosters to maintain a preserving electromotive force over the entire length of the pipe line.

The primary cells and the method of connecting them in series to meet the demands of any given area, as described herein, permits the reduction of the number of electrical connections to be made to the subsurface structure. Such a practice uses the insulating coating on a subsurface metallic structure to greater advantage by maintaining a voltage on the pipe line rather than by-passing it where two or more connections are made. Under present practices, a subsurface structure insulated by coating materials of high electrical resistance in areas where appreciable direct current earth gradients exist is often protected by numerous galvanic cells operating in parallel and connected to the structure at several points. The disclosed primary cell, especially designed for the electrolytic protection of underground metallic structures, insures better protection at reduced cost and maintenance than has been possible in the use of half-cells as now practiced.

I claim:

1. An electric primary cell to generate direct electrical current for use in preventing the electrolytic destruction of underground metallic structures and adapted to be connected in series with like cells, comprising an anodic half-cell including a magnesium electrode, a depolarizer surrounding said electrode, and a porous casing enclosing said magnesium electrode and the depolarizer; a cathode consisting of a container insulated on ground contact surfaces and adapted to enclose said anodic half-cell therein constructed of a metal cathodic to said magnesium anode, and a cathodic depolarizer filling said container and covering the anodic half-cell.

2. An electric primary cell to generate direct

electrical current for use in preventing the electrolytic destruction of underground metallic structures and adapted to be connected in series with like cells comprising an anodic half-cell including an aluminum electrode, a depolarizer surrounding said electrode, and a porous casing enclosing the electrode and depolarizer; a cathode consisting of a container insulated on ground contact surfaces and adapted to enclose said anodic half-cell therein constructed of a metal cathodic to said aluminum anode, and a cathodic depolarizer filling said container and covering the anodic half-cell.

3. An electric primary cell to generate direct electrical current for use in preventing the electrolytic destruction of underground metallic structures and adapted to be connected in series with like cells comprising an anodic half-cell including a zinc electrode, a depolarizer surrounding said electrode, and a porous casing enclosing the electrode and depolarizer; a cathode consisting of a container insulated on ground contact surfaces and adapted to enclose said anodic half-cell therein constructed of a metal cathodic to said zinc anode, and a cathodic depolarizer filling said container and covering the anodic half-cell.

4. An electric primary cell adapted to generate direct electrical current for use in preventing the electrolytic destruction of underground metallic structures and adapted to be connected in series with like cells, comprising a metallic container insulated on ground contact surfaces, an electrode anodic to said container positioned therein, an anodic depolarizer surrounding said electrode, a cathodic depolarizer surrounding the anodic depolarizer and substantially filling the container, and electric conductors in electrical connection respectively with the anodic electrode and with the metallic container, the first adapted for connection with an underground metallic structure requiring protection and the other adapted for connection with the anodic electrode of a primary electric cell similar to that above defined.

RAYMOND F. HADLEY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,267,349	Smith	May 1, 1918
2,291,739	McGrath	Aug. 4, 1942
2,346,640	Anthony	Apr. 18, 1944
2,422,046	Ruben	June 10, 1947

FOREIGN PATENTS

Number	Country	Date
156,171	Great Britain	Mar. 31, 1922

OTHER REFERENCES

Vinal et al.: Circular #79, Bur. Stds. (1923), p. 7.
 Hart et al.: "Corrosion," June 1945, pp. 68-9.
 A. I. E. E., Am. Std. Defs. of Electrical Terms (1942), p. 186.