

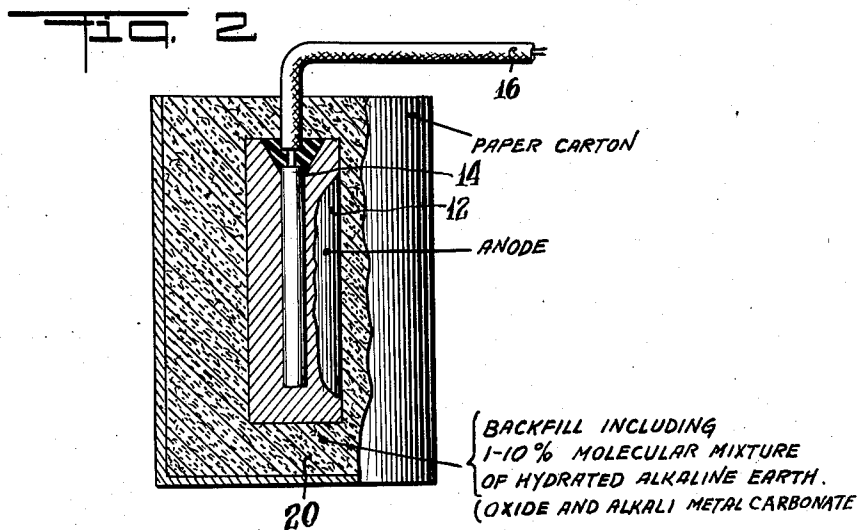
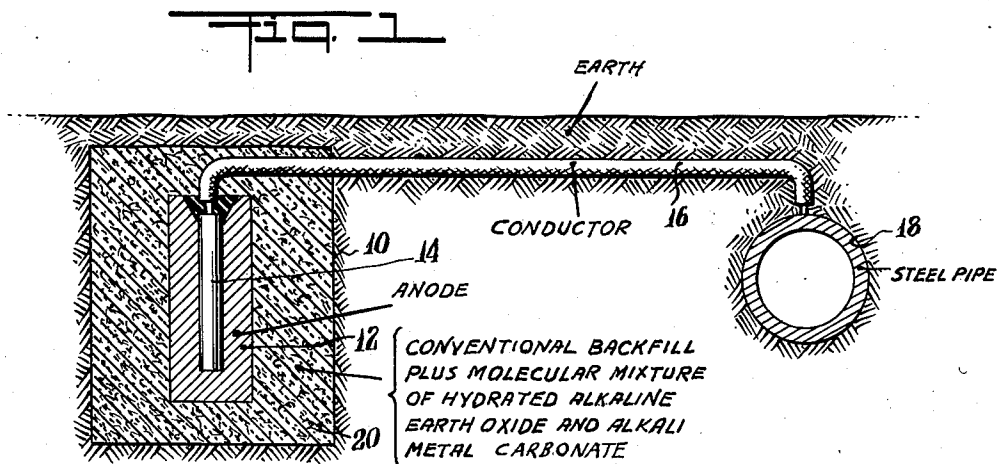
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ANODE BACKFILL

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ANODE BACKFILL

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This invention relates to backfills for use in the galvanic protection of underground corrodible metal structures such as pipe lines, steel structures and the like and to protection systems utilizing them.

Underground structures such as pipe lines, oil well tubing, steel structures and the like, have been afforded cathodic protection by employing galvanic systems including burying anodes of a metal electronegative to the structure, ordinarily magnesium, aluminum or zinc, in the vicinity of such structures and electrically connecting them thereto. The structure is thus rendered cathodic to its soil environment by means of the flow of current from the anode to the structure and, accordingly, corrosion due to electrolysis is greatly minimized. It is desirable when so utilizing such anodes to bury them in prepared backfills designed particularly to control the chemical nature of the anode environment and thereby maintain perfect contact of the anode with the earth.

The ideal backfill for such anodes should have the property of being wetted rapidly, easily and thoroughly by ground waters, should be capable of retaining moisture during dry spells and should maintain a substantially constant volume under varying weather conditions in order that the backfill does not swell and then shrink away from the anodes. In addition, the backfill should be free from splits and dry areas, should have the property of maintaining a smooth texture for even or non-localized current distribution at the surface of the metal anode thereby providing uniform consumption of the anode during its current production. Additionally, the backfill should have good electrolytic conductivity and yet should not be so soluble as to be leached away. In addition, the backfill material must not polarize the anode unduly or form impervious coatings thereon.

Various mixtures of clays, bentonites and calcium or sodium sulfates have been utilized as backfill materials with galvanic metal anodes and these mixtures do not have all of the ideal properties that a backfill mixture should have. More particularly, these mixtures are disadvantageous in that they absorb water very slowly and the backfill preparations are not compact after such absorption, that is, such backfill preparations are not free from splits and dry areas and do not have a smooth texture. Accordingly, these backfill preparations do not permit a full development of galvanic current for several days after installation and many times a full development is never realized. For example, due to hydration and immense swelling of bentonite and bentonitic clays, a water block may be and many times is formed near the

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top of the backfill column and in some instances wetting to the bottom is never realized, the dry areas contributing to imperfect contact between the anode and the soil and thereby resulting in localized current output from the anode. In addition, such backfill preparations shrink unduly during dry weather and thereby markedly increase the electrical resistance of the anode circuit at such times.

Accordingly, it is a prime object of our invention to provide a backfill for use as an anodic environment in cathodic protection systems which backfill is readily and thoroughly wetted in a minimum of time and which is substantially of constant volume irrespective of its moisture content.

It is still a further major object of our invention to provide such a backfill which is rapidly wetted by ground water and which provides a smooth texture to the anode surface thereby providing even or non-localized current distribution.

There are several methods of installation which have been employed and are well known by the art. Usually the metal anode is placed in a vertical hole and is spaced from the top, bottom and sides, the anode backfill serving the purpose of maintaining desired contact between the anode and the earth. Conventionally, the backfill is placed around the metal anode by (a) mixing the backfill in a form of slurry and pouring it into position surrounding the metal anode; (b) the powdered backfill is placed dry around the anode and water is then poured on top of the backfill to wet it and thereby form contact between the anode and the surrounding soil; and (c) the backfill may be packaged in a sack together with the galvanic anode, the entire unit being placed in the hole and wet by pouring water upon it.

The disadvantages of conventional backfills are pointedly displayed by the above methods of installation in that while a slurry produces uniform initial contact with the anode, it requires mixing equipment and many of such backfills are mixed with difficulty, particularly those containing a high percentage of bentonite, which forms lumps which are cumbersome to remove. In those methods of installation in which water is poured on top of the backfill, due to hydration and immense swelling of the bentonite and bentonitic clays, a water block is formed near the top of the backfill column and, in some instances, wetting to the bottom is never realized, the dry areas contributing to imperfect contact between the anode and the soil thereby resulting in localized current output from the anode.

From the standpoint of installation the mixing of a slurry is less satisfactory than other methods because of the expense and need of equipment for such mixing. With respect to placing the backfill without prior mixing with water, we have tested a number of conventional anode backfill preparations to determine their relative ability of water absorption, the time required for such absorption and their compactness, that is their freedom from splits and dry areas after such absorption. The procedure of our tests was as follows: a 25 ml. graduate was filled to the 19 ml. mark with the dry backfill preparation and 10 ml. of distilled water was poured on this column of backfill and the time and amount of penetration was noted. The results of these tests are embodied in the following Table I.

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TABLE I

Formula	Components	Remarks
1.-----	75 parts bentonite, 25 parts Gypsum, 10 parts Texas Native Clay.	63% Penetration in 5 hours, Total Penetration in 24 hours, Sticky.
2.-----	10 parts bentonite, 5 parts Gypsum, 4 parts Sodium Sulfate, 3 parts Fuller's Earth.	15.8% Penetration 4 hrs., 31.6% Penetration 24 hrs., 37% Penetration in 48 hrs.
3.-----	100 parts Texas Native Clay.	Sticky, Uneven material, Dry Spot.
4.-----	100 parts Fuller's Earth-----	15.8% Penetration in 1.5 hrs., Split.
5.-----	1 part Ammonium Sulfate, 10 parts Bentonite, 5 parts Gypsum, 4 parts Sodium Sulfate.	21% Penetration in 1 hr., 31.6% Penetration 3 hrs., 47% Penetration in 24 hrs., 63% Penetration in 48 hrs.
6.-----	75 parts Coarse Gypsum, 20 parts bentonite, 5 parts Sodium Sulfate.	15.8% Penetration 5 hrs., 26% Penetration 24 hrs.
7.-----	50 parts Coarse Gypsum, 50 parts Clay.	14.5% Penetration 2.75 hrs., Split formed.
8.-----	75 parts Bentonite, 25 parts Gypsum, 1.06 parts Soda Ash, 1.2 parts Mono-Sodium Phosphate.	26% Penetration 24 hrs., 31.6% Penetration in 48 hrs.
9.-----	20 parts Texas Clay, 75 parts Molding Plaster, 5 parts Sodium Sulfate.	Total Penetration in 3 3/4 hours.
10.-----	20 parts Texas Clay, 5 parts Sodium Sulfate.	6% Penetration in 16 hrs.

From the above table it is manifest that only two of the compounds tested were completely penetrated with water. Of these mixtures Formula 1 showed complete penetration in 24 hours and Formula 9 showed complete penetration in three and three-quarters hours. Many of the mixtures formed splits or gumbo or sticky masses.

From the above table it is manifest that the conventional backfills are not satisfactory in that they do not absorb water readily and completely in a minimum of time and provide an even texture to the anode surface.

In overcoming the disadvantages of the prior and conventional backfill mixtures, we have provided a chemical reaction which unexpectedly in combination with the normal and conventional backfill components, rapidly and thoroughly wets the backfill by adsorption and provides an even texture to the anode surface. The compositions of our invention consist essentially of intimate mixtures of conventional backfill materials in combination with substantially molecular proportions of a hydrated alkaline earth oxide and an alkali metal carbonate. By substantially "molecular proportions" of hydrated alkaline earth oxide and an alkali metal carbonate is meant a mixture consisting substantially of one mole of hydrated alkaline earth oxide for each mole of alkali metal carbonate. The mixture may or may not include water of crystallization and the molecular mixture on wetting yields an insoluble alkaline earth carbonate and water soluble alkali metal hydroxide, the latter serving the purpose of an electrolyte. The amount of mixture of hydrated alkaline earth oxide and alkali metal carbonate in molecular proportions used in combination with the conventional backfill materials depends upon the materials utilized and also upon the resistivity of the soil adjoining the metal anode and we have found that a fraction of from about one percent to about ten percent or more of the final hydroxide concentration is satisfactory for our purpose. Holloway, on page 117, Cathodic Protections Symposium, 1949, published by the National Association of Corrosion Engineers in an article by H. W. Walquist and H. M. Fanett, indicates that a water soluble alkali metal hydroxide increases the current output efficiency of an anode.

Accordingly, it is a still further and major object of our invention to provide a backfill mixture consisting essentially of conventional backfill materials in combination with a mixture of ingredients in molecular proportions whereby total and rapid penetration may be obtained by a chemical reaction.

It is a still further and important object of our invention to provide a backfill mixture which increases the current output efficiency of the anode in addition to providing a non-localized current output thereof.

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It is a feature of our invention that the water soluble alkali metal hydroxide is added after installation of the backfill when the material is wet by water thereby avoiding the dangers and expense attendant the handling of highly corrosive substances, such as caustic soda.

Our invention is particularly adapted for use with buried pipe lines and, accordingly, an example of the invention for the purpose of disclosure will be explained with reference thereto and with further reference to the accompanying drawing, in which like reference characters designate like parts throughout the several views, and in which:

Fig. 1 is a schematic vertical section showing one manner of using our backfill in the cathodic protection of a buried pipe line, and

Fig. 2 is a vertical section through a packaged backfill containing an anode.

The compositions of the invention consist essentially of intimate mixtures of conventional backfill materials with a mixture in molecular proportions of hydrated alkaline earth oxide and alkali metal carbonate. Of the conventional backfill materials used these materials may be either ground finely, such as a powder grind, or may be relatively coarse. That is, the conventional grinds and backfill materials known to the art are operable in our invention. In addition, some inert substance, such as sand or the like, may be incorporated in our new backfill compositions; however, such fillers are not necessary and may be omitted.

The following examples of our invention illustrated for the purpose of disclosure have been found satisfactory in which molecular proportions of alkaline earth oxide and an alkali metal carbonate were added to the conventional backfill materials. The test procedures used in the following examples were the same as those used in connection with Table I.

Example 1

To 7.5 parts of bentonite and 2.5 parts of gypsum, 1.06 parts of soda ash and .74 part of lime were added. A total penetration was obtained in one hour and the backfill mixture had a smooth texture.

Example 2

To 10 parts of bentonite and 5 parts of gypsum, including 4 parts of sodium sulfate, 2.12 parts of soda ash and 1.48 parts of lime were added. This backfill composition showed a total penetration in one hour with a smooth texture.

Example 3

To 20 parts of Texas clay and 75 parts of molding plaster, 2.12 parts of soda ash and 1.48 parts of lime were added. A total penetration was produced in 25 minutes, the composition having a smooth texture.

Example 4

As a further example of our invention a composition comprising essentially 75 percent molding plaster, 17.4% bentonite, 4.3% barium hydroxide and 3.3% potassium carbonate showed a total penetration in one and one-half hours with a smooth texture.

Example 5

As a still further example of our invention a composition consisting essentially of 30 parts molding plaster, 7 parts bentonite, 1.98 parts potassium carbonate and 1.48 parts calcium hydroxide showed a total penetration in 31 minutes with a smooth texture.

It should be noted that in all tests the results were independent of the mesh size of the particles and that while mixtures in molecular proportions of the hydrated alkaline earth oxide and alkali metal carbonate were used, any mixture thereof may be used, the excess of either being soluble and providing no subversive effects. However, substantially molecular proportions are preferable.

The method of using our new backfill is illustrated in Fig. 1 in which 10 is a hole in the earth that is dug to receive the anode 12, the latter being generally cylindrical. Conventionally, a central iron core 14 is provided for the anode 12 to which is secured the electrical conductor 16 connected to the buried steel pipe 18 which is desired to be protected against corrosion. Our novel backfill composition 20 is disposed about the anode 12 in the earth cavity 10 and the backfill is thoroughly wetted down. As indicated heretofore total penetration is produced rapidly and thoroughly and an even texture is provided by means of the chemical reaction of the molecular mixture of hydrated alkaline earth oxide and alkali metal hydroxide, the bed of backfill being in firm contact with the earth and the anode.

In making the installation the cavity 10 is dug and the backfill is tamped around the anode 12, the electrical conductor 16 then being secured to the anode. Ordinarily, the backfill 20 is then wetted thoroughly. Thus an electric current flows from the anode 12 in the conductor 16 to the steel pipe 18 thereby rendering the latter cathodic and protecting it against corrosion.

An optional manner of installing the backfill and anode is illustrated in Fig. 2, which is in all respects similar to that of Fig. 1 except that the anode and backfill are placed in a water permeable paper carton, the entire unit being placed in a cavity in the earth dug for the purpose.

In field use of our backfill compositions it is manifest that the amount of backfill material and the relative percentage of molecular proportions of hydrated alkaline earth oxide and alkali metal hydroxide, and in addition the number and size of anodes, will depend upon the required cathodic protection of a particular pipe line or other structure and such may be determined by engineering calculations well known to the art.

While we have spoken of aluminum, magnesium and zinc anodes, any conventional galvanic anode may be utilized, including alloys thereof and the invention is applicable to protecting any underground structure of any corrodible metal cathodic to the anode used. Moreover, our invention is operable with any of the conventional backfill materials known to the art.

While we have given several examples of embodiments and uses of our invention for the purpose of disclosure we intend to be limited only by the spirit of the invention as defined by the appended claims.

We claim:

1. An anode backfill for cathodic protection of buried corrodible structures comprising, a major portion of gypsum, a minor portion of bentonite and not substantially exceeding 10 percent by weight of a mixture of hydrated alkaline earth oxide and alkali metal carbonate in substantially molecular proportions.

2. A packaged anode for use in cathodic protection of structures comprising, a water permeable container having an anode therein provided with means for connecting an electrical conductor thereto, and an anode backfill surrounding and in intimate contact with the anode, said anode backfill characterized by being rapidly and thoroughly wetted and having a substantially even texture, said anode backfill consisting essentially of a mixture of hydrated alkaline earth oxide and alkali metal carbonate in substantially molecular proportions and additional backfill material or materials not subversive of the above characteristics.

3. A cathodic protection system for underground structures comprising, an anode cathodic to the structure buried in the earth in the vicinity thereof and electrically connected thereto, said anode being surrounded by and in intimate contact with an anode backfill, said anode backfill characterized by being rapidly and thoroughly wetted and having a substantially even texture, said anode backfill consisting essentially of a mixture of hydrated alkaline earth oxide and alkali metal carbonate in substantially molecular proportions and additional backfill material or materials not subversive of the above characteristics.

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