Government of India, The Patent Office, 214, Acharya Jagadish Bose Road, Calcutta-17. Complete specification No.143437 dated 7th April 1975. Application and Provisional specification No.2351/Cal/1974 dated 29th October 1974. Acceptance of the complete specification advertised on 26th November 1977.

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"A PROCESS FOR THE PRODUCTION OF A GALVANIC ANODE BASED ON COMMERCIALLY PURE ALUMINIUM SURROUNDED BY A BACK-FILL WHICH DOES NOT PASSIVATE ALUMINIUM".

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Rafi Marg, New Delhi-1, India, an Indian registered body incorporated under the Registration of Societies Act (Act XXI of 1860).

The following specification describes the nature of this invention:-

This is an invention by Dr. NARAYANASWAMI SUBRAMANYAN, Scientist, Dr. SUBRAMANIA VENKITAKRISHNA AYYAR, Scientist and SRI VESUDEVA SASTRI KAPALI, Senior Scientific Assistant, all of the Central Electrochemical Research Institute, Karaikudi, Tamil Nadu, India, all Indian citizens.

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This invention relates to improvements in or relating to the use of aluminium as galvanic anode for cathodic protection of buried structures.

Hitherto it has been proposed that for the use of aluminium as galvanic anode for cathodic protection, a back-fill consisting of sodium chloride or a mixture of sodium chloride, calcium hydroxide and a small amount of calomel is used or that a special of alloy of aluminium and zinc is used.

These are open to the objections: (i) In neutral chloride medium, aluminium is likely to get passivated and cease to function as galvanic anode (ii) the use of calomel is not desirable and (iii) the use of a special alloy will involve the establishment of separate units for its manufacture.

The object of this invention is to obviate these disadvantages by a process in which commercial grade aluminium is surrounded by a medium which does not permit the passivation of the anode and avoids the use of calomel.

To these ends, the invention broadly consists of a process of using commercial grade aluminium which is surrounded by chemicals containing suitable ingredients to generate an alkaline medium in situ.

The following is an example in illustration of the invention:

Anode - Commercial aluminium 2 S grade

Chemicals consisting of	%
Calcium hydroxide	50
Calcium chloride	12.5
Sodium chloride	12.5
Sodium carbonate	25

and Tri-sodium citrate	5% of the above mixture
and Filler(clay,bentonite etc.)	10% of the above mixture

The following are among the main advantages of the invention:

i)Commercial grade aluminium manufactured in our country can be employed as such, as galvanic anode for cathodic protection.

ii)the back-fill is made up of inexpensive and common chemicals which are indigenously available(iii)the aluminium anode in the specified back-fill has a good driving voltage equal to that of magnesium, namely,650 millivolts for protecting steel structures and is not significantly polarised.

Dated this 19th Day of October, 1974.

Sd/-
Asstt.Patent Officer,
Council of Scientific & Industrial Research.

143437

THE PATENTS ACT, 1970

COMPLETE SPECIFICATION

(Section 10)

A PROCESS FOR THE PRODUCTION OF A GALVANIC ANODE BASED ON COMMERCIALLY PURE ALUMINIUM SURROUNDED BY A BACK-FILL WHICH DOES NOT PASSIVATE ALUMINIUM".

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Rafi Marg, New Delhi-1, India, an Indian registered body incorporated under the Registration of Societies Act (Act XXI of 1860).

The following specification particularly describes and ascertains the nature of this invention and the manner in which it is to be performed:-

This is an invention by Dr. NARAYANASWAMI SUBRAMANYAN, Scientist, Dr. SUBRAMANIA VENKATAKRISHNA IYER, Scientist, and VASUDEVA SASTRI KAPALI, Senior Scientific Assistant, all of the Central Electrochemical Research Institute, Karaikudi, Tamil Nadu India, all Indian citizens.

This invention relates to a process for the production of a galvanic anode based on commercially pure aluminium surrounded by a back-fill which does not passivate aluminium and has particular reference to an improvement in or relating to the use of aluminium as galvanic anode for cathodic protection of buried steel structures.

By "back-fill", we mean "the environment which surrounds the anode and fills back the space created in the pit dug for placing the anode in the soil". By "galvanic anode, we mean an anode which, when placed in the environment and externally connected by electric wire to the structure to be protected, generates electric current". By "gel-forming substance", we mean a "substance which swells up in the presence of water and retains water like gelatin".

Hitherto it has been proposed that for the use of aluminium as galvanic anode for cathodic protection, a backfill consisting of sodium chloride or a mixture of sodium chloride, calcium hydroxide and a small amount of calomel is used. The anode is a special alloy of aluminium and zinc.

These are open to the following objections: (i) In neutral sodium chloride medium, aluminium is likely to get passivated and ceases to functh as galvanic anode (ii) the use of calomel is not desirable since it is a toxic substance and may get incorporated into the subsoil waterand through it in the vegetation on the location and since it is a costly substance, and (iii) the use of a special alloy will involve the establishment of separate units for its manufacture.

The main object of this invention is to obviate these disadvantages by a process by which a highly alkaline medium is produced in situ in the back-fill favouring effective utilisation of even commercial grade aluminium as galvanic anode.

The main point underlying the invention is that a highly alkaline medium which does not favour wasteful self-corrosion is generated in situ around the aluminium anode by employing a back-fill containing suitable ingredients, which can be kept around the anode and can be activated by moistening.

By producing an alkaline environment in situ around the anode, a high negative potential, namely -1.55 V with reference to copper/copper sulphate electrode is obtained and the polarisation of the anode is avoided even upto an anode current density of 10 mA/cm^2.

According to the present invention, there is provided a process for the production of a galvanic anode as herein defined based on commercially pure aluminium surrounded by a back-fill as herein defined which does not passivate aluminium by (i) casting of aluminium with a central iron core in a suitable shape and size as required, (ii) surrounding the anode by the back-fill either in a cloth bag or in a pit prepared under the soil characterised in that a highly alkaline medium, namely sodium hydroxide, is produced in situ and wasteful corrosion of aluminium is reduced by using a back-fill comprising sodium carbonate, calcium oxide or hydroxide, calcium chloride, tri-sodium citrate and a moisture retaining ingredient like clay or gel forming substance, as herein defined.

Commercial grade aluminium may be used as anode. Aluminium scrap of not less than 99% purity may be used as anode after casting the same into suitable shape and size. The backfill may be used as a packing around the anode. The backfill is periodically replenished or replaced so as to get the full service of the anode.

Thus, ingredients in solid form are incorporated in the back-fill so as to produce sodium hydroxide containing corrosion inhibitive substances (calcium and citrate) in situ.

The provision for the production of a strong alkali namely sodium hydroxide in situ in the back-fill which also contains a corrosion inhibitive combination which reduces appreciably the self-corrosion of aluminium without interfering with the useful galvanic corrosion, the anode material namely the commercial grade aluminium and the composition and the nature of the back-fill are the novelty of the process.

In the invented process of cathodic protection, aluminium is used as a galvanic anode with a back-fill, packed or otherwise (i.e. unpacked) wherein commercial grade aluminium of 99% purity is surrounded by a back-fill consisting of sodium carbonate, calcium

oxide or hydroxide, sodium chloride, tri-sodium citrate and a moisture retaining ingredient like clay or a gel-forming substance so that sodium hydroxide is produced in situ and wasteful corrosion of aluminium is reduced when the back-fill is moistened.

The anode can be made of even scrap aluminium and the back-fill can be periodically replenished or replaced to get full service from the aluminium anode.

The accompanying diagram is of the galvanic anode installation for cathodically protecting underground steel structures.

Figure 1 : Packaged Anode

1. Anode
2. Packaged back-fill
3. Soil
4. Connection to the structure

Figure 2 : Anode with back-fill introduced into the trench

1. Anode
2. Back-fill
3. Soil
4. Connection to the structure
5. Auger hole

Example :

Performance of the aluminium anode with backfill as compared to other galvanic anodes is given in table-I.

Composition of backfill	(Weight - %)
Calcium hydroxide	50
Calcium chloride(anhydrous)	0 to 12.5
Sodium chloride	12.5 to 25
Sodium carbonate	25
Trisodium citrate	5% of mixture
Filler	10% of mixture

The main advantages of the invention are (i) commercial grade aluminium manufactured in our country can be employed as such as galvanic anode for cathodic protection (ii) The backfill is made up of inexpensive and common chemicals which are indigenously available (iii) The aluminium anode in the specified backfill has a good driving voltage equal to that of magnesium and is not significantly polarised.

TABLE - I

PERFORMANCE OF THE ALUMINIUM ANODE WITH BACKFILL AS COMPARED TO OTHER GALVANIC ANODE- BACKFILL COMBINATIONS.

Sr. No.	Nature of anode material	Composition of back-fill	Open circuit potential of anode with respect to $Cu/CuSO_4$ electrode	Closed circuit potential of anode with respect to $Cu/CuSO_4$ electrode (at 1-5 mA/cm^2)	Anode Efficiency in (%).	Current capacity of the anode in (amp.hour/lb)	Driving potential when cathode is kept at -0.85 V $Cu/CuSO_4$
1.	Magnesium	Calcium sulphate Sodium sulphate, Santonite	-1.55 V	-1.5 V	30 - 50	300 - 500	650 mV
2.	Zinc	-do-	-1.1 V	-1.1 V	90	335	250 mV
3.	Aluminium (High purity Aluminium 95% + Zn 5%) an alloy.	Lime, Salt, Calomel	-1.1 V	-1.1 V	39 to 53	500 - 725	250 mV
4.	Aluminium (Commercial Grade 99% purity developed in CECRI).	Lime, Salt, Sodium Citrate, Sodium carbonate	-1.55 V	-1.5 V	30 to 50	450 - 700	650 mV

Summary :

This invention is directed towards employing commercial aluminium as galvanic anode for cathodic protection of buried steel structures in such a way that it is kept in an active state by an alkaline environment which is produced in situ by the chemical action of suitable ingredients in the backfill. For this purpose, the backfill contains sodium carbonate and calcium hydroxide and on being moistened, alkali is produced in the backfill. The presence of calcium and citrate aids in reducing wasteful corrosion.

Noteworthy Feature :

A process by which sodium hydroxide is produced in situ and wasteful corrosion of aluminium used as galvanic anode for cathodic protection is reduced by a backfill for the anode consisting of sodium carbonate, calcium oxide or hydroxide, calcium chloride, trisodium citrate and a moisture retaining ingredient like clay or a gell forming substance.

The following are the new results achieved by the invention :

a) Conditions favourable for the use of commercial grade aluminium are created, avoiding the use of special alloys containing zinc or mercury.

b) The cost of the commercial grade aluminium is much lower than that of the alloys, since the latter require special methods of production.

c) The chemicals employed in the backfill are easily available and are cheap.

d) The new galvanic anode - backfill combination is quite comparable to the hitherto used magnesium anodes as far as the open circuit potential and anode efficiency are concerned. Further the polarisation behaviour of the new aluminium back-fill combination is far superior to that of the usual magnesium/back-fill combination.

WE CLAIM :-

1. A process for the production of a galvanic anode as herein defined based on commercially pure aluminium surrounded by a back-fill as herein defined which does not passivate aluminium by (i) casting of aluminium with a central iron core in a suitable shape and size as required (ii) surrounding the anode by the back-fill either in a cloth bag or in a pit prepared under the soil characterised in that a highly alkaline medium, namely sodium hydroxide, is produced in situ and wasteful corrosion of aluminium is reduced by using a back-fill comprising sodium carbonate, calcium oxide or hydroxide, calcium chloride, tri-sodium citrate and a moisture retaining ingredient like clay or gel forming substance, as herein defined.

2. A process as claimed in claim 1 wherein commercial grade aluminium is used as anode.

3. A process as claimed in claim 1 or 2 wherein aluminium scrap of not less than 99% purity is used as anode after casting the same into suitable shape and size.

4. A process as claimed in any of the preceding claims wherein the backfill is used as packing around the anode.

5. A process as claimed in any of the preceding claims wherein the backfill is periodically replenished or replaced so as to get the full service of the anode.

6. A process for the production of a galvanic anode based on commercially pure aluminium surrounded by a back-fill which does not passivate aluminium substantially as herein before described.

Dated this 21st Day of March, 1976.

Sd/-
Patent Officer,
Council of Scientific and Industrial Research.

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No. 143437. Nº OF SHEETS:-1

NO. 3391/cal/74 Cont. Specn. SHEET Nº:-1

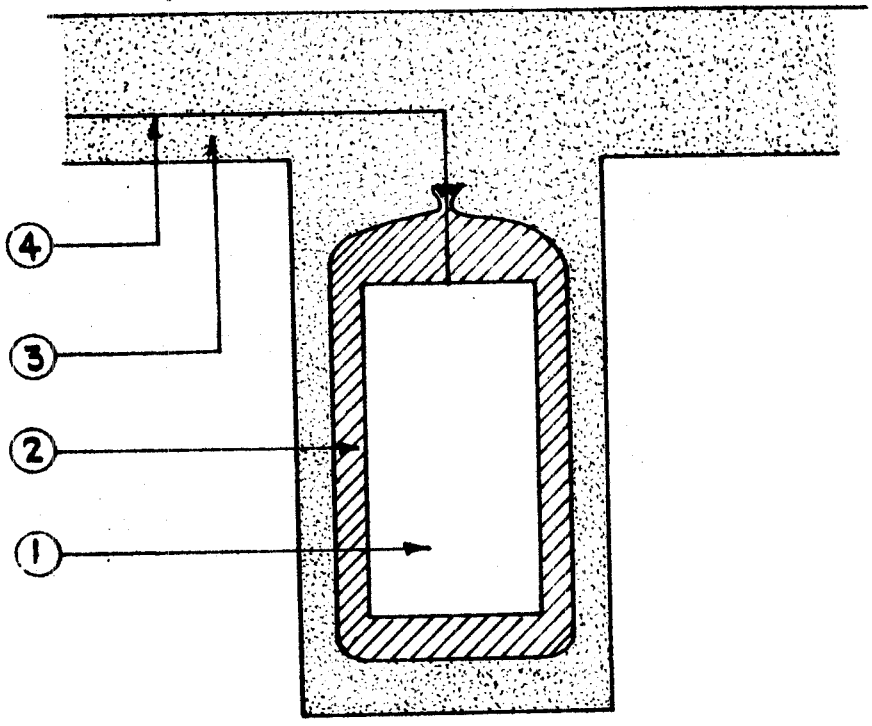

FIGURE-1

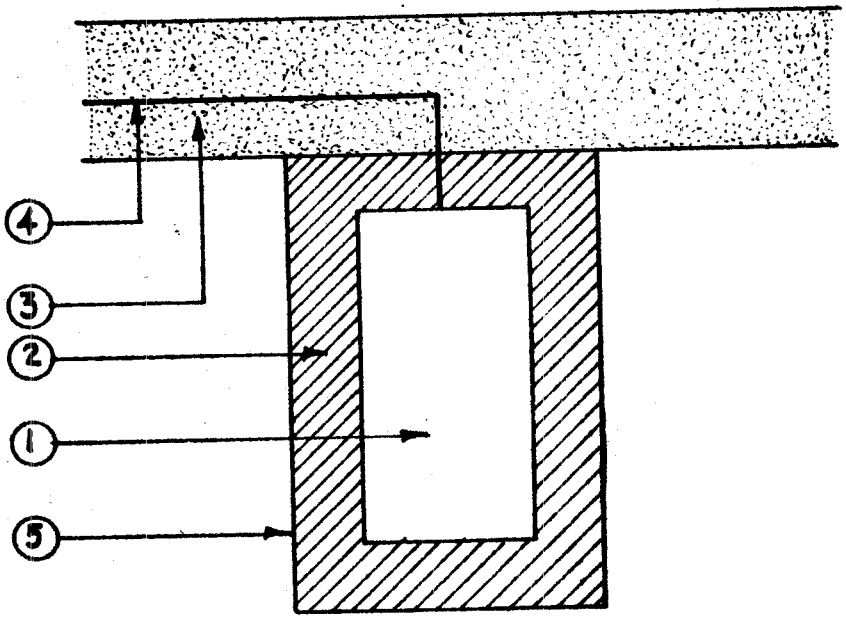

FIGURE-2

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