

Oct. 1, 1957

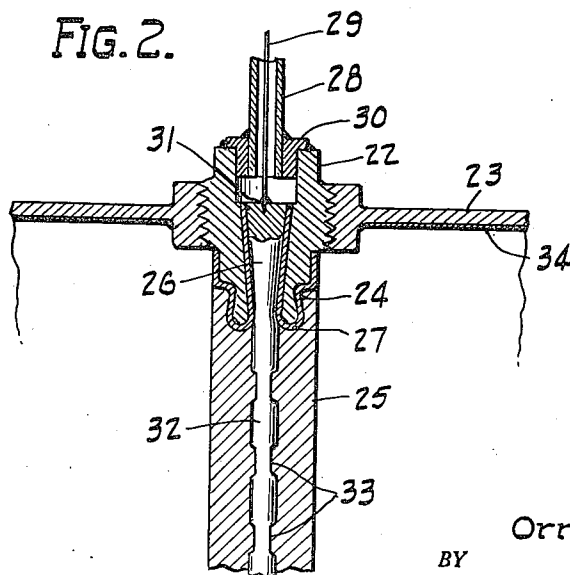
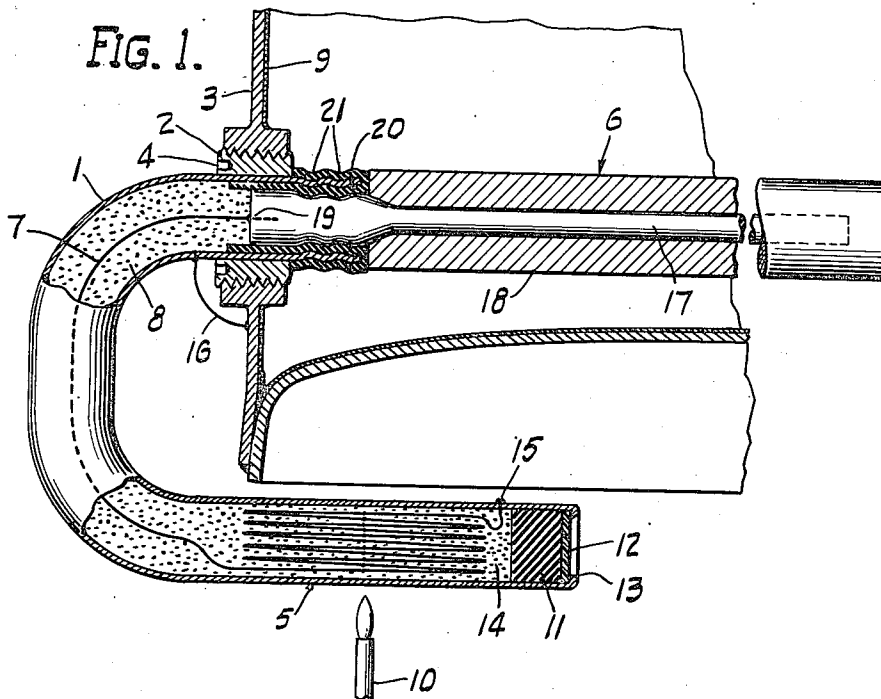
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2,808,373

THERMOPILE-ANODE STRUCTURE

Filed July 3, 1953

2 Sheets-Sheet 1



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FIG. 3.

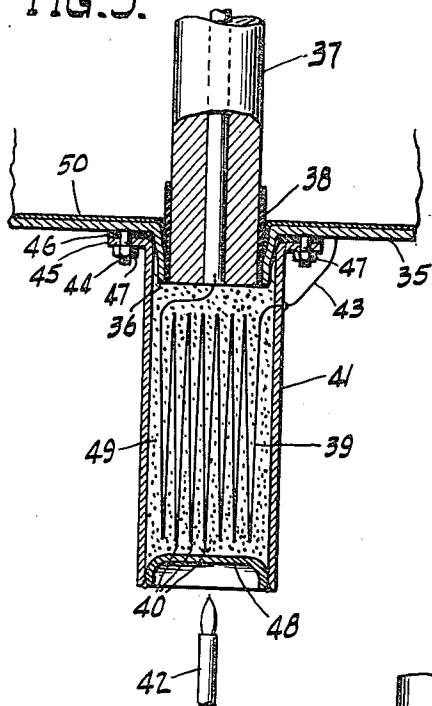


FIG. 4.

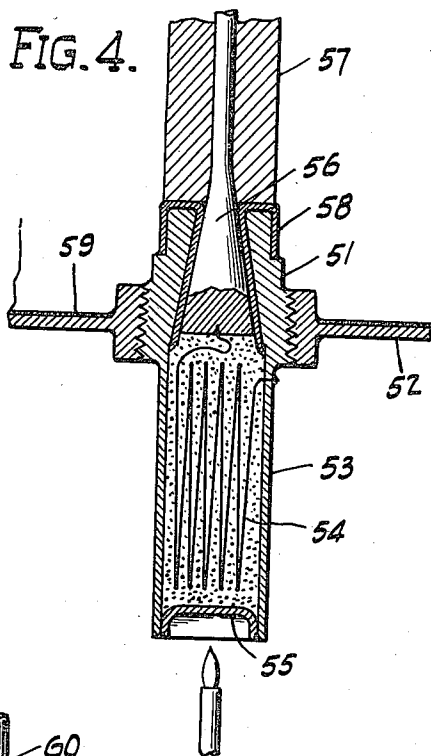
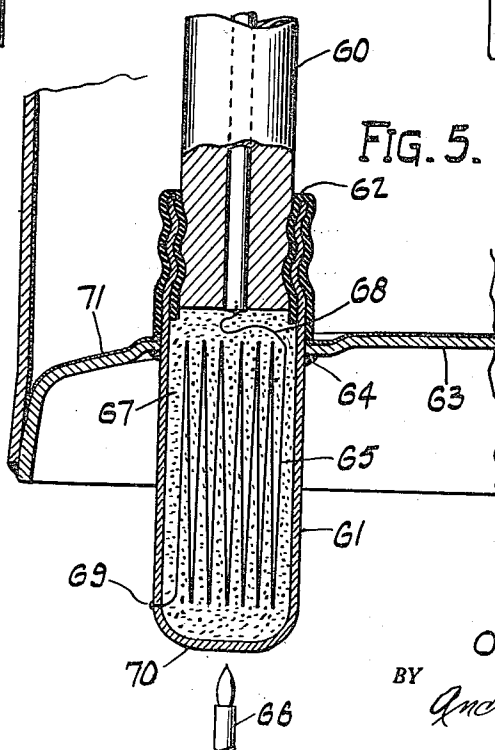


FIG. 5.



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THERMOPILE-ANODE STRUCTURE

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Application July 3, 1953, Serial No. 365,798

7 Claims. (Cl. 204—196)

This invention relates to a thermopile-anode device employed to prevent corrosion of a metallic structure for holding fluids and particularly has reference to a unit which is sealed against loss of liquid therethrough from such structure and against leakage of injurious atmospheres into the thermopile chamber.

One object of the invention is to provide a compact combined thermopile-anode unit which can be readily fabricated and conveniently applied to a tank or vessel to protect the metallic surfaces from corrosion.

Another object is to provide a thermopile-anode device which is sealed to the tank or other structure to prevent leakage of liquid to the atmosphere from the structure to which it is assembled.

A further object is to provide an anode attached to a support by a medium which electrically insulates and bonds and seals the respective parts together.

A further object is to provide a combined thermopile-anode unit constructed to prevent the electrically insulating medium bonding and sealing the parts of the unit together from being under tension.

Another object is to provide a thermopile-anode construction, which eliminates relative movement of the anode with respect to the plug support should an impact or other force be encountered during transit or use.

A further object is to provide a hermetically sealed chamber surrounding the thermopile; a major function of which is to prevent loss of the liquid from the anode chamber should the electrically insulating seal fail.

A further object is to provide a thermopile-anode device wherein the thermopile is sealed from contact with fumes, air, and carburizing atmospheres.

Cathodic protection of metal surfaces of water heaters or other structures for the prevention or retardation of corrosion can be accomplished by inserting an anode into the conducting liquid confined in the container and making the metal or alloy of the container the cathode. The container is made sufficiently cathodic by applying a superimposed potential from a generator to the metallic or non-metallic anode and the container. The present invention is directed to a protection unit in which a thermopile is employed to superimpose a potential between the tank or other structure and the anode. The thermopile consists of a series of thermocouples arranged to generate a flow of current when a temperature differential is established between the hot and cold junctions of the pile.

To minimize the electric energy required of a thermopile unit, it is preferable to protect the major portion of the container with a suitable electrically insulating coating.

In general, the thermopile and the anode of the invention comprise a unit so constructed that the anode portion of the unit is attached, within the tank or other structure to be protected, to a support which is welded to or otherwise secured to the wall of the structure. The anode is electrically insulated from the support by a

suitable material such as vitreous enamel or a rubber-like composition to confine electrical conduction between the anode and the tank to that flowing through the conducting liquid. The insulation between the anode and the support may also serve to bond the respective parts together mechanically and to seal the joint between the parts against passage of fluids. A thermopile is employed in a circuit with the positive lead connected with the anode and the negative lead connected with the tank to provide a cathodic protection current which flows from the anode and through the water in the tank to the tank wall. The thermopile is disposed within a casing or chamber which is hermetically sealed to protect the thermopile from the surrounding atmosphere. The hermetically sealed chamber is associated with the tank at the opening through which the positive lead from the thermopile is connected to the anode such that the hermetically sealed construction of the thermopile chamber prevents passage of fluid from the anode chamber through the thermopile chamber and into the outer space should the electrically insulating seal become damaged for any reason or should the anode corrode away. The thermopile portion of the unit is hermetically enclosed within a metallic chamber which is preferably sealed to the anode support.

The thermopile chamber also serves the additional function of keeping out air and other gases or injurious matter from contact with the thermopile conductors.

Other objects of the invention will appear hereinafter in connection with the following description of the drawings illustrating several embodiments of the invention.

In the drawings:

Figure 1 is a view, partly in section and partly in elevation, of a totally enclosed combined anode thermopile unit;

Fig. 2 is a cross-sectional view of an anode and supporting plug illustrating another embodiment of the invention;

Fig. 3 is a sectional view of an embodiment of the anode thermopile device wherein the thermopile chamber is detachably connected to the anode support;

Fig. 4 is a view of a combined anode thermopile unit and supporting plug illustrating another embodiment of the invention; and

Fig. 5 is a view in section illustrating another embodiment of the unit.

Referring to the drawings and particularly Figure 1, there is illustrated a thermopile-anode unit comprising a fluid-tight hermetically sealed metal casing 1 supported by an externally threaded plug 2 which is attached to wall 3 of a container to be protected from corrosion by a liquid, not shown, therein. The plug 2 may be constructed with notches 4 for reception of a suitable wrench for attaching the plug to the wall 3. A thermopile 5 is housed in the outwardly extending portion of the casing 1. The inner end of casing 1 supports an anode 6 within the tank to be protected. The anode 6 and thermopile 5 are connected by an electrical conductor 7 which extends within casing 1 and is externally insulated from the casing by suitable electrically insulating material 8. Conductor 7 connects the positive terminal of thermopile 5 to anode 6 to carry thereto the current generated by the thermopile.

The wall 3 is preferably provided with a suitable electrically insulating coating 9; for example, vitreous enamel, to protect the major portion of the wall from corrosion and therefore minimize the electrical energy required of the thermopile 5. Cathodic protection is utilized, as hereinafter described, to prevent corrosion of the exposed metallic areas arising because of defects in the coating.

Casing 1 is preferably formed of an elongated thin

metal tube of a heat resistant, chromium-bearing alloy or the like. The casing 1 is also preferably flexible in order that the thermopile's hot junction may be positioned adjacent a suitable heating element, such as pilot flame 10.

The outer end of casing 1 is hermetically sealed to prevent the approach of injurious foreign matter to the thermopile 5 and also, in the case of need, to prevent the loss of liquid from the tank therethrough. The end of the casing 1 is hermetically sealed preferably by the insertion of a compressed pliable seal 11 within the end of the casing as disclosed in my co-pending application entitled, "Sealed Thermopiles," Serial No. 349,696, filed April 20, 1953, now Patent No. 2,768,424. The seal 11 is held in position by a disc 12 over which the end of the casing 1 is crimped as at 13. The seal 11 may be compressed by swaging the casing 1 upon the seal or by other suitable means as by forcing the seal 11 into the end of the casing.

The casing 1 is brazed or otherwise secured to the plug 2 so that its open end projects a suitable distance beyond the plug to support the anode 6 as subsequently described. Although the plug 2 is illustrated and described as being attached to the tank by means of threads, it may be otherwise attached as by welding or brazing. A quantity of sand 14, or the like is preferably disposed between the outer end of the casing 1 and the thermopile 5 to further electrically insulate the thermopile and to confine the wires of the thermopile against movement.

Thermopile 5 is preferably formed with the hot junctions at the center thereof as in my co-pending application entitled, "Method of Making a Thermopile," Serial No. 349,697, filed on April 20, 1953. In general, a composite conductor is formed by welding together alternate equal lengths of two wires of different composition. The composite conductor is wrapped with layers of glass thread. The thermopile 5 is then made by folding the composite wire back and forth at every other weld to form a thermopile with the hot junctions at the center and cold junctions at both ends. The folded thermopile is bundled or rolled and then wrapped with glass thread or glass cloth before insertion in the tube made by the casing 1. After the thermopile is positioned in the casing 1, the latter is preferably swaged to a smaller diameter to thoroughly compact the insulation between the elements of the thermopile and between the thermopile and the casing to prevent shorting of the thermopile elements and to confine the wires of the thermopile against movement.

The casing is exposed to a source of heat in the region of the hot junctions of thermopile 5 by such means as the pilot burner 10.

The negative terminal of thermopile 5 is preferably grounded to the casing 1 as by weld 15, although it may extend from the casing and be connected directly to the wall 3. As previously stated, the positive terminal is connected to anode 6 by electrical conductor 7 which is insulated with suitable material.

If the thermopile is grounded to the casing 1, as illustrated in Figure 1, it may be desirable to electrically connect thermopile protection casing 1 directly with wall 3 by other means, as for example, a wire 16 which leads from casing 1 to wall 3, because of the possibility of loss of good electrical contact between supporting plug 2 and wall 3.

Anode 6 comprises an insert rod 17 of iron, stainless steel or other suitable conductor which may be round or square or of other shape. The outer portion of anode 6 is formed of zinc, carbon or other suitable material 18 which is die cast, extruded, or otherwise formed around insert rod 17. In case carbon or the like is used for the anode material 18, rod 17 is preferably knurled to lend mechanical support to the carbon and to accomplish good electrical contact. Insert rod 17 in practice is galvanized or tinned, if cast zinc is used as the outer

portion, so that a mechanically strong and electrically perfect bond is obtained. The anode may be otherwise constructed; the above described anode being the preferred construction.

The positive terminal of the thermopile 5 is welded, brazed, soldered, or otherwise electrically connected to the rod 17 as by joint 19. A predetermined quantity of insulating material 8 is compacted in the casing 1 around the conductor 7, as previously noted.

A sleeve 20 of vinyl chloride plastic, neoprene, or other suitable rubber-like material is disposed between the inner end of casing 1 and the anode 6 to seal the joint therebetween against leakage of fluid and to electrically insulate the casing 1 from the anode 6. The sleeve 20 permits the maintenance of an adequate potential difference between the anode and the container by the thermopile in order to provide cathodic protection of the container. The sleeve 20 is preferably reinforced with a fabric-like material to prevent continued flow of the sleeve under pressure and temperature. The body of the anode may be formed with a series of annular corrugations 21 on the portion of the anode extending within the casing in order to provide a strong mechanical lock therebetween when the end of casing 1 is swaged or crimped onto sleeve 20 and anode 6. Sleeve 20 is preferably folded back over the exterior of casing 1 to minimize the current flow through the electrolyte between anode 6 and casing 1.

In the event that sleeve 20 should fail, the liquid electrolyte would flow into the interior of the casing 1 but would not be able to escape farther due to the hermetically sealed outer end of casing 1, as previously described. It is important to seal the unit in this manner since the thermopile and anode may be employed with pressure bearing tanks or containers which must operate without a liquid leak for long periods of time. The thermopile 5 is at the same time sealed against contact from sulphur fumes, air, and carburizing gases which might cause serious deterioration.

Since casing 1 can be made flexible, it may be bent to locate the thermopile portion thereof in a position adjacent heating element 10. Within the scope of this invention, the casing 1 may have the portion surrounding the conductor 7 further reduced in cross-section; rather than having the casing 1 of a uniform cross-section as shown.

Fig. 2 illustrates another type of anode and plug construction. In this construction the plug 22 is threaded into wall 23 of a structure, as in Figure 1. The portion of plug 22 extending within the structure to be protected, however, is shaped with an annularly recessed exterior surface as at 24 to mechanically lock the cast anode 25 to the vitreous enameled plug. The plug 22 has a central opening extending therethrough with the inner protruding portion preferably tapered to receive a correspondingly tapered core 26. Vitreous enamel 27 coats the surface of plug 22 to electrically insulate the core 26 and the cast anode 25 from the plug 22 and also to bond and seal the plug 22 to core 26.

Tube 28, through which passes the insulated lead 29 from the positive terminal of a thermopile, not shown, is supported in cap 30 by brazing or otherwise securing it to the annular opening in cap 30. Tube 28 is sealed to a suitably enclosed thermopile casing, not shown, to provide a secondary seal as described in Figure 1. The lead 29 is bonded to core 26 as by weld 31. The cap 30 is soldered, brazed or otherwise secured to the upper portion of the opening in plug 22 such that the tube 28 does not contact the core 26 and such that a tight joint is formed between the plug 22 and the cap 30.

The cast anode 25 is preferably attached to the insert rod 32 in a manner similar to that described with respect to Figure 1. The insert rod 32 is illustrated as an extension of core 26. The cast metal fills up the area provided by the recession of the plug 22, as at 24. The

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rod 32 may be flattened intermittently along its length as at 33 to key the rod and cast metal together. The construction of the inner end of plug 22 also helps to key the plug and cast metal together and thus prevent turning or severance thereof.

As previously described with respect to Figure 1, the wall 23 is preferably provided with a suitable electrically insulating coating 34.

Fig. 3 illustrates an embodiment of the invention in which a thermopile chamber is detachably sealed to the wall of the tank about the opening wherein the anode is supported.

The tank wall 35 is provided with a tubular extension 36 to support the anode 37. The tubular extension 36 is swaged upon the anode 37 with an insulating and sealing material 38 of neoprene, vinyl chloride plastic or other suitable rubber-like material disposed therebetween. As previously described with respect to Figure 1, the insulating material is preferably reinforced with a fabric-like material to prevent continued flow of the insulating material under operating pressure and temperature. Although described as being supported within the tank by annular extension 36, the anode may be otherwise secured within the opening as by a threaded plug. The anode 37 must be insulated from the tank wall and the opening sealed against leakage therethrough.

The thermopile 39 is preferably constructed in accordance with the disclosure of my co-pending application entitled, "Method of Making a Thermopile," Serial No. 349,697, filed April 20, 1953. The hot junctions 40 of the thermopile 39 are positioned adjacent the outermost end of a tubular chamber 41.

A pilot burner 42 is shown for purposes of illustration as the source of heat for raising the temperature of the hot junctions 40.

The positive terminal of thermopile 39 is electrically connected to anode 37 and the negative terminal is electrically connected to the chamber 41. The chamber 41 is in electrical connection with the tank wall 35 as by conductor 43 so that a potential difference is set up between anode 37 and tank wall 35.

The chamber 41 may be attached to the tank wall 35 about the annular extension 36 as by stud bolts 44 extending through flange 45 of the chamber. A sealing material 46 is disposed between the tank wall and the chamber so that when the nuts 47 are tightened on bolts 44 the chamber 41 is hermetically sealed to the tank wall 35.

The outer end of the chamber 41 is hermetically sealed in any desired manner which permits heating of the thermopile 39. For purposes of illustration, the chamber 41 is sealed by an inverted cup-shaped plug 48 which is welded or otherwise secured to the inner surface of tube 41.

Glass fiber or granules 49 or the like fills the chamber 41 about the thermopile 39, and insulates the thermopile elements against electrical shorting to the casing or to one another and confines the thermopile elements against relative movement.

The wall 35 is preferably provided with a suitable electrically insulating coating 50, as previously described for the embodiments of the invention illustrated in Figures 1 and 2.

Fig. 4 illustrates another embodiment of the invention in which the thermopile, anode and supporting plug are provided in a very compact, package unit.

Plug 51 is provided on its external surface with a threaded portion to be thereby tightly secured to tank wall 52. The assembly might otherwise be mechanically held in place and sealed as by bolting into a gasket or it might be brazed or welded or attached in any other manner to provide a liquid seal.

An annular projection 53 extends outwardly from plug 51 to form a socket which receives the thermopile 54. The annular projection 53 is preferably swaged down

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upon thermopile 54 to thoroughly compact the insulating material as previously described. A cap 55 is welded or otherwise secured into place to close the outer end of plug 53.

The thermopile 54 has its positive terminal connected to the anode core 56 and its negative terminal connected to the plug 51 to provide a potential difference between the anode and the tank wall 52.

The thermopile 54 is preferably constructed with the hot junctions at one end as disclosed in my co-pending application entitled, "Method of Making a Thermopile," Serial No. 349,697, filed April 20, 1953, referred to in the description of Fig. 2.

The end of plug 51 supporting the anode 57 within the tank is provided with a tapered opening to receive core 56. Vitreous enamel 58 or the like lines the joint therebetween to electrically insulate the anode core 56 from plug 51 and also to bond and seal the plug 51 to core 56. The vitreous enamel 58 extends back over the inner end of the plug 51 to insulate anode 57 from the plug. The anode 57 is cast or otherwise secured about the extension of core 56 as previously described with respect to Fig. 2.

The tank wall 52 is preferably provided with an electrically insulating coating 59, as shown in the previously described embodiments of the invention.

Fig. 5 is similar to Fig. 4 in providing a thermopile and anode in a single compact unit. For purposes of illustration anode 60 is of zinc or carbon and is secured and sealed to the metallic protection tube or plug 61 by a rubber-like material 62 as was described with respect to Figure 1 wherein the rubber-like material 62 is compressed between tube 61 and anode 60 and then folded back over the inner end of the tube. The compressing of rubber-like material 62 is accomplished by swaging the inner end of tube 61 down against the rubber-like material and anode. Tube 61 is secured to wall 63, as by weld 64 to anchor and seal it in place or it may be threaded or otherwise attached to the wall.

Thermopile 65 is confined in the outer end of protection tube or plug 61 which is exposed to a pilot flame or other source of heat 66. As in Fig. 4, tube 61 is preferably swaged down upon thermopile 65 to hold it in place and to prevent movement therebetween. Glass granules 67 or the like insulate thermopile 65 from the closed end of tube 61 and anode 60. The positive terminal of thermopile 65 is connected to anode 60 by wire 68 for carrying current to the anode. The negative terminal of thermopile 65 is bonded and sealed to the protection tube 60 as by weld 69.

The tube 61 is preferably formed by deep drawing a blank to provide a one-piece tube having a generally curved outer end 70. With this construction, there are no welds which may be damaged by impingement of the pilot flame used for heating the thermopile.

As in the previously described embodiments of the invention, the tank wall 63 is preferably provided with a suitable electrically insulating coating 71.

In the embodiments illustrated in the drawing, the enamel in Figs. 2 and 4 and the rubber-like material in Figs. 1, 3 and 5 provide a seal to prevent the electrolyte surrounding the anode from leaking into the thermopile chambers. A second or precautionary seal is provided by the hermetically sealed protection chamber encasing the thermopile. In the event the anode corrodes away, liquid will not escape from the structure since the unit is hermetically sealed against loss of liquid by the second or precautionary seal. This hermetically sealed protection chamber also serves to prevent air and combustion gases from contacting the thermopile.

The invention as applied to a water heater operates in the following manner. Referring to Figure 1 by way of example, the hot junction end of the thermopile is heated by the pilot flame of the water heater or by other means such as an electrical heating element. Electricity flows from the positive terminal at the thermopile to the

anode which is immersed in the water of the tank to be protected from corrosion. The water conducts the current from the anode to the metallic exposures on the wall 3 of the water heater tank; these exposures serve as cathodes. From these exposures the current returns through the tank to the negative terminal of the thermopile. The combined potential produced by the thermopile and the anode serves to accomplish complete or partial protection of the metallic exposures on the tank interior from corrosion.

The hermetically sealed thermopile and anode unit is a compact structure designed for long service. The thermopile unit is readily assembled with the structure to be protected. The insulating seal serves to support and insulate the anode during shipping, installation and operation. The seal construction not only protects the parts against deterioration by air and gases but it also provides a double seal to prevent fluid leakage from the structure to the atmosphere.

Various embodiments of the invention may be employed within the scope of the following claims.

I claim:

1. A thermopile-anode device for the cathodic protection of a tank in contact with corrosive liquid, which comprises a chamber secured within an opening in said tank with a hermetic junction therebetween, an anode supported within the corrosive liquid by said chamber, insulating and sealing material disposed between said anode and said chamber to electrically insulate the anode from direct electrical contact with the chamber and to prevent liquid leakage from said tank into said chamber, a thermopile within said chamber having a positive terminal electrically connected to said anode and a negative terminal electrically connected to said tank, and a thoroughly compacted insulating material within said chamber to prevent shorting of the thermopile elements and to confine the thermopile elements against relative movement.

2. In the cathodic protection of a metallic container for a corrosive liquid, a thermopile-anode device extending through an opening in said container, which comprises a plug with an opening therethrough secured within the opening in said container with a hermetic junction therebetween, an anode extending from within the opening in said plug into the liquid within the container, electrically insulating and sealing material disposed between said anode and said plug to electrically insulate each from the other and to seal the joint therebetween, a thermopile electrically connected between said anode and said container to cause a current flow from said anode to said container through said liquid, a metallic casing communicating with the opening in said plug and attached to said plug with a hermetic junction therebetween, said thermopile being housed within said metallic casing, and thoroughly compacted insulating material within said casing to prevent shorting of the thermopile elements and to confine the thermopile elements against relative movement.

3. A thermopile-anode device for the cathodic protection of a metallic tank for liquid storage, which comprises a plug tightly secured within the wall of said tank, said plug being provided with an opening therethrough, an anode extending from said plug into said tank and projecting within said plug a substantial distance with a complementary tapered joint therebetween, vitreous enamel disposed between said anode and said plug along the lines of extent therebetween to bond the plug and anode together, and to electrically insulate them from direct electrical contact and to seal the joint therebetween against liquid leakage, a thermopile electrically connected between said anode and said tank to cause a current flow from said anode through said liquid to said tank, a tubular casing having its outer end hermetically sealed encasing said thermopile, means to attach said casing to said plug with a hermetic joint therebetween, and thoroughly compacted

insulating material within said housing to prevent electrical shorting of the elements and to confine the thermopile elements against relative movement.

4. In a thermopile-anode device for cathodically protecting a metallic tank containing a corrosive liquid, which comprises a tubular member extending through an opening in the tank wall with a liquid-tight joint therebetween, an anode extending from within said tubular member into said corrosive liquid, a thermopile housed within said tubular member, said thermopile having a positive terminal in electrical connection with said anode and having a negative terminal in electrical connection with said tank, a rubber-like material disposed between said anode and said tubular member to seal the joint therebetween and to prevent shorting of said anode to said tank, and sealing means to hermetically seal the outer end of said tubular member to prevent liquid leakage from said tank to the atmosphere in the event said rubber-like material fails and to prevent the approach of injurious foreign matter to said thermopile from the surrounding atmosphere.

5. In a thermopile-anode device for preventing corrosion of a metallic tank containing a corrosive liquid, a hollow plug member tightly secured within a wall of said tank, said member extending outwardly for a substantial distance to form a tubular chamber, an anode secured within said hollow plug member and extending therefrom within the tank, vitreous enamel fused to the surface of said anode and said plug in the joint therebetween to secure the anode to the plug and to seal the joint therebetween and to electrically insulate the anode from said plug, a thermopile disposed within the outwardly extending portion of said member and connected in circuit with said anode and said tank to cause a current flow from said anode through said liquid to said tank, a thoroughly compacted electrically insulating material disposed within said plug member to prevent shorting of the thermopile elements and to confine the elements against relative movement, and means to hermetically seal the outer end of said plug member to prevent leakage to and from the atmosphere therethrough.

6. In a thermopile-anode device for preventing corrosion of a tank containing a corrosive liquid, a hollow plug tightly secured to the wall of said tank and projecting inwardly within said tank, said inwardly projecting portion being annularly recessed on its outer circumference along a line slightly removed from the innermost end, a metallic anode cast about the end of said plug and into the recessed portion thereof, vitreous enamel fused to said plug and said anode along the joint line therebetween, a thermopile having a positive terminal connected to said anode and a negative terminal connected to said tank, a metallic casing with said thermopile disposed therein, said casing having an opening communicating with said plug, and a hermetic junction between said casing and said plug to prevent leakage to or from the atmosphere.

7. A thermopile-anode structure for the cathodic protection of a metallic container for corrosive liquids, comprising a thermopile casing secured to the wall of the container at coinciding openings in the casing and the container wall, an anode extending into said container from said coinciding openings and adapted to contact the corrosive liquid in the container, a thermopile within a chamber provided in said thermopile casing and electrically connected to said anode through said openings and to said container wall, and electrically insulating means supporting said anode in said openings and sealing said openings to hermetically separate the thermopile chamber from the inside of the container.

References Cited in the file of this patent

UNITED STATES PATENTS

88,285	Farmer	Mar. 30, 1869
2,698,291	Andrus	Dec. 28, 1954