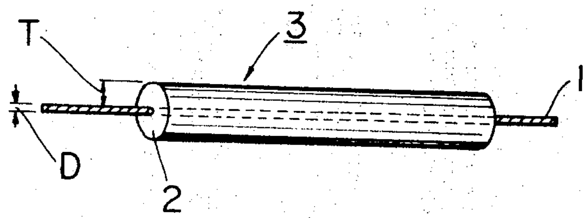
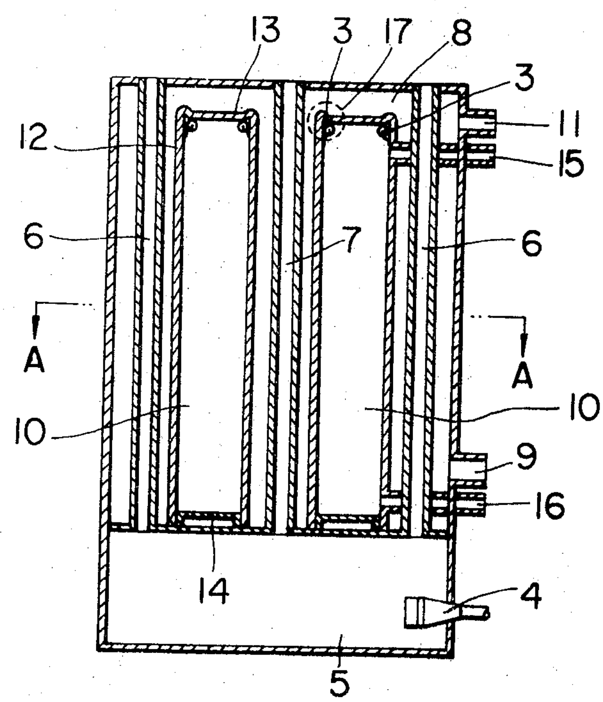
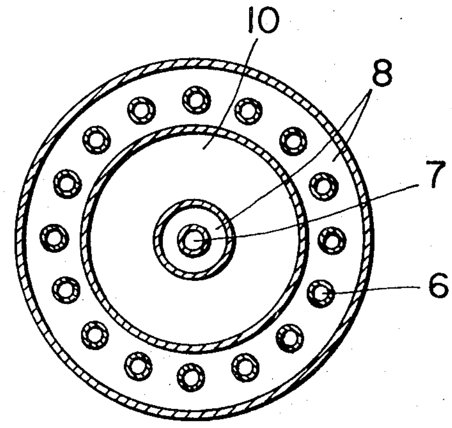
Fig·1



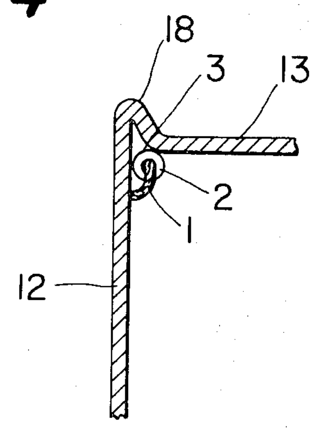
Fig·2



Fig·3



Fig·4



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MATERIAL FOR PREVENTING CREVICE CORROSION

Yoshihisa Mizutani, and Isao Ohba, Nishinomiya, and Takeshi Misaki, Ikeda, and Harumi Satoh, Hirakata, Japan, assignors to Nippon Yakin Kogyo Company Limited, Tokyo, Japan

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ABSTRACT OF THE DISCLOSURE

Sacrificing anode for preventing crevice corrosion to be caused in stainless steel container or boiler is constituted by coating a core wire of rod-shaped chromium series or chromium-nickel series stainless steel with aluminum or aluminum alloy, the ratio of the thickness of said coated layer to the diameter of said core wire being 0.5 to 10.

The present invention relates to a sacrificing anode for preventing crevice corrosion, and particularly, a sacrificing anode to be applied for preventing crevice corrosion in a stainless steel container or tank. Recently, water boilers and heat exchangers used in chemical plant and home have used stainless steel in view of corrosion prevention, but crevice corrosion of stainless steel tank often occurs in water environment containing an impurity (Cl ion, etc.). Namely, the stainless steel container or tank is manufactured by bending and welding a stainless steel plate, and the chlorine ion in water concentrates in the gaps and the concentration of oxygen in the gaps decreases. Consequently, an electrochemical crevice corrosion occurs in the gaps as well as pitting and stress corrosion cracking. This crevice corrosion is an important problem in the above described apparatus.

The object of the present invention is to solve the above described fault and we pronounce a sacrificing anode capable of preventing the crevice corrosion in the crevice in stainless steel container or tank.

That is, the above described crevice corrosion is an important problem in water boilers or heat exchangers made of stainless steel plate and as the means for solving this problem, a variety of processes for preventing the corrosion have been proposed.

The sacrificing anode according to the present invention is a composite metal rod in which stainless steel is used as a core wire and the cover metal is aluminum or aluminum alloy. This composite metal uses stainless steel wire as the core wire and therefore jig to be used for fitting a commercial sacrificing anode is not needed and such wire can be easily fitted by an easy method, for example, spot welding. Furthermore, if aluminum alloy wire (uncomposite metal) is used, alumina is formed on the surface and the contact resistance increases and an efficiency of corrosion preventing current is low.

In this composite metal according to the present invention, stainless steel is used in the core wire, so that the contact resistance decreases and the efficiency of corrosion preventing current is high.

When an uncomposite metal is used, corrosion occurs locally and commercial anode is separated from the fitted position and the corrosion preventing effect lowers, while when the sacrificing anode of the present invention is used, such fault does not occur and an excellent result can be obtained.

The shape of this composite metal may be triangle, square, star and the like other than circular shape depend-

ing upon the shape of the portion to prevent corrosion attack.

The manufacture by drawing is most preferable and for the purpose, the suitable dimension of the cross-section to extrude into cylindrical or rod shaped sacrificing anode has been studied and it has been found that when the ratio of the thickness of aluminum (coating metal) to the diameter of the cross-section of chromium series or chromium-nickel series stainless steel core wire is 0.5 to 10, the drawing can be effected most preferably. When said ratio is more than 10, the dimension of the cross-section of the composite metal wire is too large and the drawing cannot be effected satisfactorily, while when said ratio is less than 0.5, the thickness of aluminum material layer is too thin and the corrosion preventing effect is lost in a short time.

The present invention will be explained in more detail hereinafter.

For a better understanding of the invention, reference is taken to the accompanying drawings, wherein:

FIG. 1 is a perspective view of the sacrificing anode of the present invention;

FIG. 2 is a cross-sectional view of a water boiler fitting the sacrificing anode of the present invention;

FIG. 3 is a cross-sectional view of the boiler shown in FIG. 2 taken on line A—A; and

FIG. 4 is an enlarged view of the gap portion in FIG. 2.

Referring to FIG. 1, when the tank is made of 18–8 series stainless steel, 18–8 series stainless steel wire **1** is used as the core wire and is coated with aluminum or aluminum alloy **2**. In this case, as mentioned above, the rod-shaped material to be used as the core wire must be the same quality as the material composing the container or boiler and when the boiler is made of 18–8 series stainless steel plate, the core wire is composed of 18–8 series stainless steel. Because, if the container or boiler and the core metal are not the same metal, the core metal is not favorably welded to the container or boiler and further if there is the stainless steel core wire **1**, even if aluminum coating material **2** is corroded locally, the effect can be kept by the presence of the core wire **1** until the aluminum coating material is completely consumed.

In order to combine the aluminum material **2** and 18–8 series stainless steel core wire **1**, it is most preferable that molten aluminum material is casted around the 18–8 series stainless steel core wire to form a cast. Then the resulting cast is drawn to form the composite sacrificing anode **3** as shown in FIG. 1. The ratio (T/D) of the thickness (T) of the aluminum coating layer **2** to the diameter (D) of 18–8 series stainless steel core wire is about 0.5 to 10 based on the above described reason and within this range, the ratio is selected properly considering the condition of the loation to be fitted and the like.

FIGS. 2 and 3 show the water boiler wherein the sacrificing anode of the present invention is fitted on the boiler, the structure of which is well known.

The fuel is ignited by a burner **4** and burned in a combustion chamber **5** and the formed gas is discharged upwardly from the water boiler through smoke tubes **6** and **7**, which are arranged concentrically in the casing **8**. Hot water containing a sufficient amount of a boiler compound is introduced into the casing **8** through an inlet **9** and circulated in the casing **8** and during the circulation, the hot water is heated through the wall surface of the tubes **6** and **7** by the combustion gas. The heated water heats the fluid in a chamber **10** and flows out from an outlet **11** and returns to the inlet **9**. The chamber **10** containing the fluid to be heated is made of 18–8 series stainless steel and is constituted with a cylinder **12**, upper and lower covers **13**, **14** and into the chamber **10**, the fluid is charged from an inlet **16** and discharged from an outlet **15** while being heated.

The sacrificing anode of the present invention is fitted in a gap of the welded portion in the chamber **10** of the water boiler and the fitting manner is shown in FIG. 4 by an enlarged view. That is, both the ends of the cylinder **12** are welded to the upper cover **13** and the lower cover **14** and in the vicinity of the gap in the welded portion **18**, both the ends of the core wire of the sacrificing anode are welded to the stainless steel cylinder **12** by TIG welding.

In order to confirm the effect of the sacrificing anode according to the present invention, a practical test for comparing water boilers fitted with the sacrificing anode according to the present invention with other water boilers was effected. Water boilers used as a control have the same structure as the water boiler shown in FIGS. 2 and 3. In the test, water is circulated and heated in the water boiler and the crevice corrosion was examined. The obtained result is shown in the following.

EXPERIMENT NO. 1

Water boiler: Water boiler is fitted with no sacrificing anode.
Test period: 1 month
Corrosion: Pitting and stress corrosion cracking were observed at the gap **17** in the chamber **10** shown in FIG. 2. Particularly, the cylinder **12** was perforated by corrosion. Such corrosion was also formed in 3 portions on the upper cover **13**.

EXPERIMENT NO. 2

Water boiler: Water boiler is fitted with the sacrificing anode according to the present invention. The coating material **2** is that shown in JIS 1100 (Aluminum, purity 99.00% upper; ASTM 990A; B.S. 1B; DIN Al 99), and the core wire **1** is 18–8 (2ϕ) stainless steel.
Test period: 3 years
Corrosion: There were no problems after the boiler was used for 3 years. Particularly, after the boiler was used for 3 years, the potential difference was 300 mv. at a water temperature of 85 to 90° C. This value was substantially the same as the value just before the boiler was used.

EXPERIMENT NO. 3

Water boiler: Water boiler is fitted with the sacrificing anode according to the present invention. The coating material **2** is that shown in JIS 5056 (Aluminum alloy; mg 5.2%, Mn 0.1%, Cr 0.1%, balance Al; B.S. N6; DIN AlMg 5), and the core wire **1** is 18–8 (2ϕ) stainless steel.
Test period: 3 years
Corrosion: There were no problems after the boiler was used for 3 years. Particularly, after the boiler was used for 3 years, the potential difference was 300 mv. at a water temperature of 85 to 90° C. This value was substantially the same as the value just before the boiler was used.

EXPERIMENT NO. 4

Water boiler: Water boiler is fitted with an aluminum sacrificing anode in the center of the chamber **10**.
Test period: 6 months
Corrosion: There were no problems after the boiler was used for 1 month. However, after 6 months, corrosion similar to that in Experiment No. 1 was formed at the gap **17** in FIG. 2, and the cylinder **12** is perforated by corrosion.

EXPERIMENT NO. 5

Water boiler: Sacrificing anode consisting of mild steel core wire coated with aluminum coating material is arranged near the gap, and the mild steel core wire is welded to the stainless steel boiler.
Test period: 13 months
Corrosion: The result is superior to Experiment Nos. 1 and 4. However, after 13 months, aluminum on the surface of the sacrificing anode was consumed and the corrosion occurred at the gap **17** in FIG. 2. Welded portion of the mild steel core wire to the stainless steel chamber **10** was corroded.

Test conditions of the above described Experment No. 1 to 5 are as follows.

Operation time of water boiler: 8 hours/day
Temperature of circulating water containing a boiler compound: 90 to 95° C. at the outlet **11** of FIG. 2.

In the above described test, the water boiler was operated for 8 hours per day, and the corroded state of the boiler was observed. The temperature of circulating water at the inlet **9** was 85 to 90° C. and that at the outlet **11** was 90 to 95° C. The temperature of water to be heated a the inlet was room temperature and that at the outlet was 80 to 85° C. The water to be heated was adjusted to a Cl ion concentration of 100 p.p.m. by adding NaCl to city water.

As seen from the above description and the above described test, crevice corrosion often occurs at the gap of the welded portion in the stainless steel container or boiler, and the corrosion develops rapidly depending upon the water to be treated and the life of the container or boiler is shortened. In such a case, it is effective for preventing the crevice corrosion to fit aluminum or aluminum alloy sacrificing anode. However, such means still has defects as shown in the above Experiment No. 4. Moveover, particular caution is required in order to fit the aluminum or aluminum alloy single component sacrificing anode to the gap, because aluminum and aluminum alloy themselves are dissolved out partly or wholly and broken, whereby they are separated from the container or boiler.

Further, when a sacrificing anode is prepared by surrounding a mild steel core wire with aluminum or aluminum alloy, and the core wire is welded to the tank of water boiler (Experiment No. 5), the sacrificing anode cannot be easily and strongly fitted to the tank by the welding, and further the mild steel core wire itself and the welded portion are preferentially corroded.

On the other hand, when stainless steel is used as a core wire instead of mild steel, the above described drawbacks which occur in the use of mild steel, can be obviated. That is, in the sacrificing anode according to the present invention, stainless steel is used as the core wire, and aluminum or aluminum alloy is used as the coating material. The sacrificing anode of the present invention is produced by adhering the coatitng material around the core wire by mechanical means, such as pressing and the like; by casting the coating material around the core wire and then drawing the resulting cast; or by coating the surface of the core wire with the coating material and then drawing the resulting mass. The thus obtained sacrificing anode can be fitted to the stainless steel boiler by welding the core wire to the boiler, and consequently the welded portion is not corroded and has a high efficiency of corrosion preventing current.

However, when the aluminum or aluminum alloy coating material is adhered around the sainless steel core wire by mechanical means, such as pressing, the potential difference between the sacrificing anode and the boiler is apt to lower. Because, fine gaps are formed between the core wire and the coating material and a contact resistance appears between the core wire and the coating material due to the presence of Cl ions in the water to be heated. Accordingly, preferable sacrificing anode is one produced by casting the aluminum or aluminum alloy coating material around the stainless steel core wire and then drawing the resulting cast or by coating the surface of the stainless steel core wire with the aluminum or aluminum alloy coating material and then drawing the resulting mass.

As described above, since the core wire of the sacrificing anode according to the present invention is made of the same series stainless steel as that of the boiler, even if the sacrificing anode is fitted to the boiler by spot welding, corrosion due to the potential difference caused in the boiler does not occur, and the boiler can be used for a long period of time. For example, when a mild steel core wire is used as shown in the above described Experiment No. 5, corrosion occurs in the welded portion of the mild steel core wire to the stainless steel boiler. Particularly, when mild steel and stainless steel are welded, the mechanical property and the corrosion resistance of the welded metal are naturally deteriorated.

What is claimed is:

1. An apparatus having crevice corrosion preventing means comprising: a housing adapted to being used in a water environment and composed of a chromium series or chromium-nickel series stainless steel, said housing having at least one crevice or gap therein subjected to corrosion; and a sacrificing anode consisting of a core wire made from the same stainless steel as said housing and a surrounding sheath of aluminum or aluminum alloy, said sacrificing anode being located in the vicinity of said crevice or gap in the housing, said stainless steel core wire being in contact with the stainless steel surface of the housing, the ratio of the thickness of said sheath to the diameter of said core wire being about 0.5 to 10.

2. The apparatus of claim **1** in which said housing is a water boiler.

3. The apparatus of claim **1** in which said housing is a heat exchanger.

4. The apparatus of claim **1** in which the molten aluminum or aluminum alloy is cast around the stainless steel core wire and then the resulting cast is drawn to obtain the stainless steel core wire coated with aluminum or aluminum alloy.

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