Oct. 17, 1967 W. I. CLARK ETAL 3,347,768

ANODIC PROTECTION FOR PLATING SYSTEM

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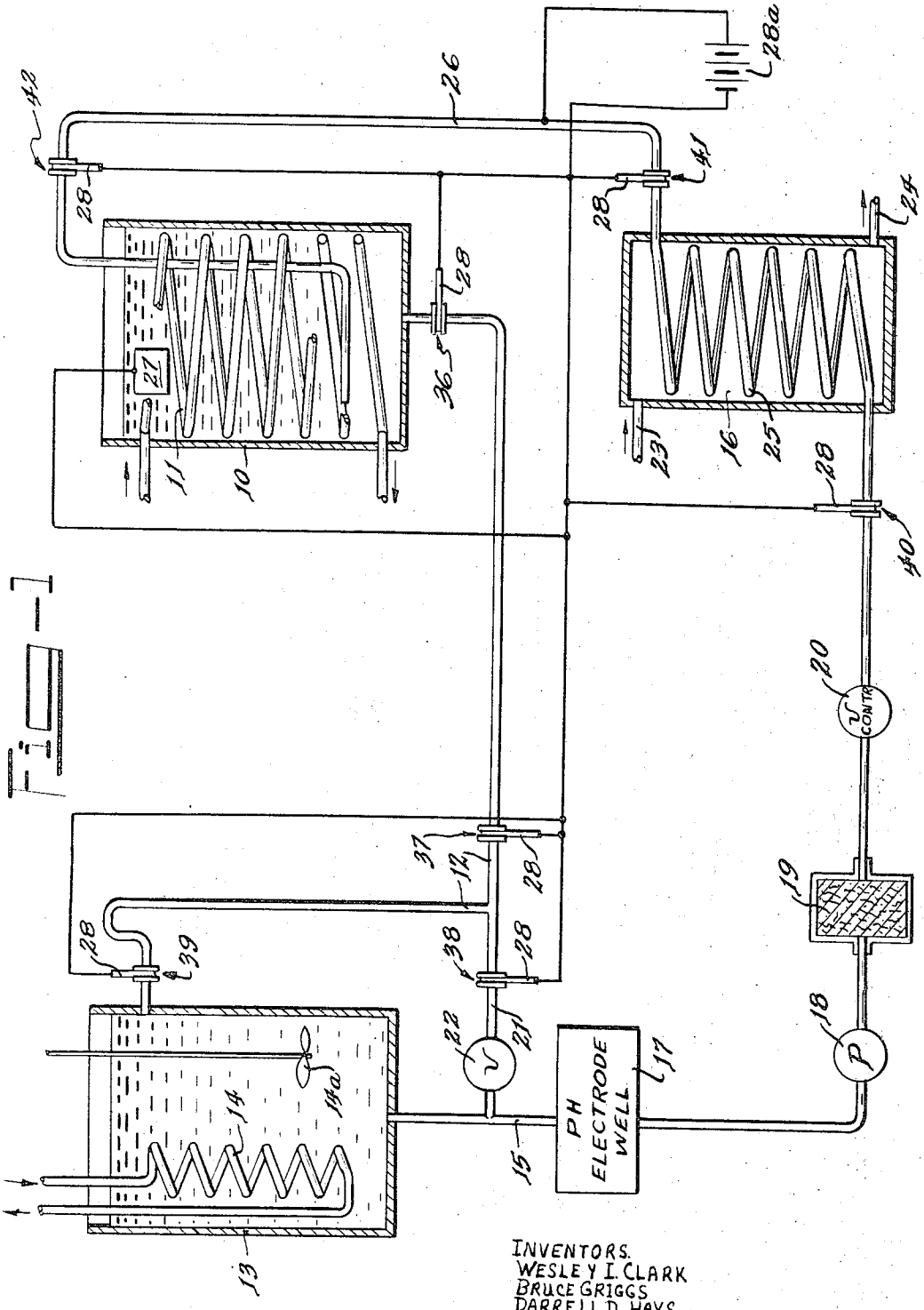


FIG. 1

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Fig. 2

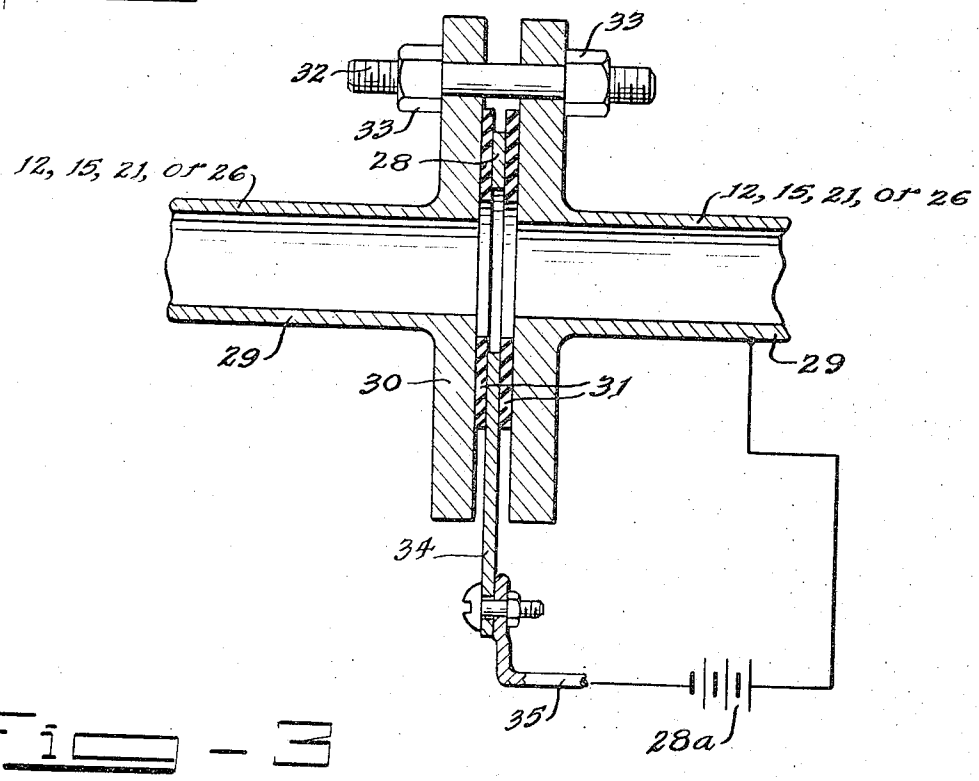
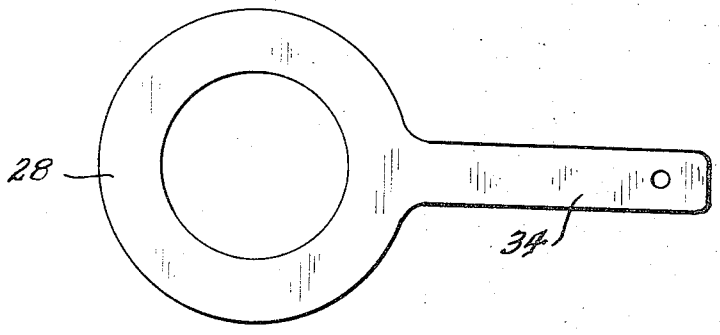


Fig. 3



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United States Patent Office 3,347,768 Patented Oct. 17, 1967

3,347,768

ANODIC PROTECTION FOR PLATING SYSTEM

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Filed Jan. 29, 1965, Ser. No. 429,187
6 Claims. (Cl. 204—196)

This invention relates to a continuously regenerated plating system in which nickel is deposited by the "electroless" system. More specifically, the invention relates to the electrolytic passivation of certain surfaces in the system.

In systems of the above type, stainless steel, rather than nonmetallic materials, has been employed for the containment equipment, because of its superiority in heat transfer. The disadvantage is that the stainless-steel surfaces must frequently be treated with warm nitric acid, which forms and maintains a surface film that is not catalytic to the plating reaction. Nitric-acid passivation of stainless steel is effective in preventing an unwanted plating reaction, but is both time-consuming and expensive, because it must be applied often.

It is known to carry out continuous electroyltic passivation of a stainless steel tank in a batch system for the "electroless" plating of nickel.

We have discovered that electrolytic passivation of stainless-steel surfaces may be employed in a complete, continuously regenerated system for the "electroless" plating of nickel.

In the drawings:

FIG. 1 is a diagrammatic view of the novel system of the present invention;

FIG. 2 is a fragmentary sectional view showing the use of a cathode plate between sections of pipe in the system; and

FIG. 3 is an elevational view of the cathode plate.

As shown in FIG. 1, a plating tank 10 contains a plating solution, which is heated by a steam coil 11. The bottom of the plating tank 10 is connected by a pipe 12 with an upper portion of a cooler regenerator tank 13. The solution in the tank 13 is cooled by a cooling-water coil 14. An agitator 14*a* extends into the solution in tank 13. A pipe 15 extends from the bottom of the cooler regenerator tank 13 to a heat exchanger 16, by way of a pH electrode well 17, a pump 18, a filter 19, and an automatic-flow-control valve 20 A by-pass pipe 21, controlled by a valve 22, connects the pipe 12 and the pipoe 15 ahead of the pH electrode well 17.

At the heat exchanger 16, which is operated by steam entering through an inlet 23 and leaving through an outlet 24, the pipe 15 is connected with one end of a coil 25 located in the heat exchanger. The other end of the coil 25 is connected with a pipe 26, which extends through the top of the plating tank 10 and opens into a region near the bottom thereof.

The above described system is operated by placing a plating solution containing a water-soluble nickel salt, a hypophosphite, and a buffering agent in plating tank 10 and heating the solution with steam in heating coil 11. The article to be plated, for example, an aluminum-jacketed nuclear-fuel element, is dipped into the solution for a suitable time to obtain a thin, adherent, corrosion-resistant coating of nickel thereon. The plating solution is continuously regenerated by circulating the solution from plating tank 10 through cooler regenerator tank 13 where make-up chemicals are added, and filter 19 to heat exchanger 16, and then to plating tank 10. The process thus described is conventional in the art. As

has been pointed out a problem arises, because the solution plates out on the tanks and pipes and this problem has not been completely overcome in accordance with the prior art practice of passivating the metal with nitric-acid wash.

According to the present invention, however, this problem has been completely overcome by immersing a stainless-steel sheet 27 in the solution in plating tank 10 and inserting a plurality of stainless-steel ring inserts 28 into the pipes 12, 21, 15, and 26 while insulating the inserts from the pipes and making the said metal sheet 27 and ring inserts 28 cathodic with respect to the tanks 11 and 13 and pipes. This is accomplished by connecting the sheet 27 and the ring inserts 28 to the negative side of a 12-volt battery 28*a*, and the pipes 12, 21, 15, and 26, and tanks 10 and 13 to the positive side of said battery.

As shown in FIG. 2, each of pipes 12, 21, 15 and 26 which are of stainless steel, is formed of sections 29 having outwardly extending flanges 30. Between each pair of adjacent flanges 30, one of the ring inserts 28 is clamped and is insulated therefrom by a pair of Teflon rings 31. The flanges 30 are secured to one another by bolts 32 and nuts 33. The bolts electrically connect the pipe sections 30. The inner diameter of the ring insert 28 is greater than that of the Teflon rings 31 and that of the pipe sections 29. The inner diameter of the Teflon rings 31 is greater than that of the pipe sections 29. The outer diameter of the flanges 30 is greater than that of the Teflon rings 31 and that of the ring insert 28, except for a tail 34 so that the bolts 32 extending through the flanges 30 clear the Teflon rings 31 and the ring insert 28. The outer diameter of the ring insert 28, except for the tail 34 which is attached to an electrical connector 35 leading to the battery 28*a*, is less than the outer diameter of the Teflon rings 31. The ring inserts 28 are located at some seven regions of the pipes 12, 21, 15, and 26, identified as regions 36, 37, 38, 39, 40, 41, and 42. Region 36 is in pipe 12 just below plating tank 10. Region 37 is in pipe 12 adjacent its connection with by-pass pipe 21. Region 38 is in pipe 21 adjacent its connection with pipe 12. Region 39 is in pipe 12 adjacent the cooler regenerator tank 13. Region 40 is in pipe 15 adjacent the heat exchanger 16. Region 41 is in pipe 26 adjacent the heat exchanger 16. Region 42 is in pipe 26 adjacent the plating tank 10. All these regions 36 to 42 are located in the plating solution where the temperature of the solution is above 60° C. and therefore is likely to plate out on the tanks 10 and 13 and pipes 12, 21, 15, and 26. This is in contrast with the plating solution throughout the length of pipe 15 and associated parts, where, except adjacent the heat exchanger 16, the plating solution is at a temperature of 60° C. or below and therefore is not likely to plate out.

Any plating action thereby occurs on the said metal plate 27 or ring inserts and not on the surface of the tank 11 and 13 or pipes 12, 21, 15, and 26. The plate 27 can be removed and replaced while the ring inserts need not be removed, since any nickel thereon is removed when the system is periodically cleaned by flushing the system with nitric acid. The following specific example illustrates application of the present invention.

Example

A plating solution which is 0.10 molar in nickel sulfate, 0.3 molar in sodium hypophosphite, and 0.3 molar in lactic acid having a pH of 4.40 to 4.45 was employed and plating was carried out at a temperature determined by plate deposition rate which was maintained at 0.5 mil/hr. Bath operating temperatures ranged from 85° C. on a new bath to 93° C. on an aged bath. The plating solution is continuously circulated through the system at a rate of 4 gallons per minute. It is first pumped to cooler

regenerator tank 13 where the solution is cooled to a temperature of 60° C. and the chemicals utilized in the nickel-plating reactions are replenished. 2M nickel sulfate, 6M sodium hypophosphite, and 8M sodium hydroxide to control pH are employed. No additions of lactic acid are necessary. From the tank 13 the plating bath is pumped through filter 19, coil 25 in heat exchanger 16, where the temperature of the solution is increased to plating bath temperature, and back into the plating tank 10.

The pH of the circulating bath is continuously measured with electrodes in pH electrode well 17. The output signal from a pH recorder operates a metering pump which proportions the three chemical addition streams into the regenerating tank.

A current of 40 ma./ft.^{2} was found to be sufficient to prevent the deposition of nickel on the stainless steel tank and pipes. Inspection shows no deposit of nickel on the stainless steel pipes and tanks but a heavy coat of nickel on the ring inserts and stainless plate.

In a preliminary experiment the electrolytic protection was disconnected and the solution heated to 95° C. A large amount of foam formed after about 1 hour at temperature. Inspections of the system showed that nickel had plated out on the interior of the tanks and pipes. It is thus evident that the electrolytic protecting system is necessary to the operation of the system.

It is understood that the invention is not to be limited by the details given herein but that it may be modified within the scope of the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a continuously regenerated system for depositing nickel plate by chemical reduction in an aqueous solution, comprising a metal plating tank, a cooler regenerator tank, a heat exchanger, and metal pipes for conveying the solution from the plating tank to the cooler regenerator tank, from the cooler regenerator tank to the heat exchanger, and from the heat exchanger to the plating tank; the combination therewith, of a metal sheet immersed in the plating tank, a plurality of metal ring inserts applied to the pipes so as to be insulated therefrom, two inserts being applied adjacent to the inlet and outlet of the plating tank, another insert being applied adjacent the inlet to the cooler regenerator tank, still another insert being applied between the last-mentioned insert and the insert adjacent the outlet of the plating tank, two inserts being applied adjacent the inlet and outlet of the heat exchanger, means for connecting the negative side of a direct-current source to the metal sheet and to the ring inserts, and means for connecting the positive side of the direct-current source to the pipes and thereby also to the metal plating tank.

2. In the system as specified in claim 1, the pipes being formed of sections having outwardly extending flanges at their adjacent ends, each of the ring inserts being located between a pair of adjacent flanges, a pair of insulating rings applied on opposite sides of the ring insert between the same and the flanges, the inner diameter of each ring insert being greater than the inner diameter of the associated pipe sections, the outer diameter of each ring insert being less than the outer diameter of the associated flanges on the pipe sections, the said flanges being attached and electrically connected to one another by bolts located radially outward of the associated ring insert.

3. In the system as specified in claim 2, the pipes and ring inserts being formed of stainless steel.

4. In a continuously regenerated system for depositing nickel plate by chemical reduction in an aqueous solution, comprising a metal plating tank, a cooler regenerator tank, a heat exchanger, a first metal pipe for conveying the solution from the plating tank to the cooler regenerator tank, a second metal pipe for conveying the solution from the cooler regenerator tank to the heat exchanger, a third metal pipe for conveying the solution from the heat exchanger to the plating tank, and a metal by-pass pipe connecting the first and second pipes; the combination therewith, of a metal sheet immersed in the plating tank, a plurality of metal ring inserts applied to the pipes so as to be insulated therefrom, two inserts being applied to the third and first pipes adjacent to the inlet and outlet of the plating tank, another insert being applied to the first pipe adjacent the inlet to the cooler regenerator tank, still another insert being applied to the first pipe adjacent its connection with the by-pass pipe, still another insert being applied to the by-pass pipe adjacent its connection with the first pipe, two more inserts being applied to the second and third pipes adjacent the inlet and outlet of the heat exchanger, means for connecting the negative side of a direct-current source to the metal sheet and to the ring inserts, and means for connecting the positive side of the direct-current source to the pipes and thereby also to the metal plating tank.

5. In the system as specified in claim 4, the pipes being formed of sections having outwardly extending flanges at their adjacent ends, each of the ring inserts being located between a pair of adjacent flanges, a pair of insulating rings applied on opposite sides of the ring insert between the same and the flanges, the inner diameter of each ring insert being greater than the inner diameter of the associated pipe sections, the outer diameter of each ring insert being less than the outer diameter of the associated flanges on the pipe sections, the inner diameter of the insulating rings being less than that of the associated ring insert and greater than that of the associated pipe sections, the outer diameter of the insulating rings being greater than that of the associated ring insert and less than that of the associated flanges on the pipe sections, the said flanges being attached and electrically connected to one another by bolts located radially outward of the associated ring insert and the insulating rings.

6. In the system as specified in claim 5, the pipes and ring inserts being formed of stainless steel.

References Cited

UNITED STATES PATENTS

1,592,175	7/1926	Boyd	204—196
1,825,477	9/1931	Reichart	204—196
2,076,422	4/1937	Zimmerer et al.	204—196
2,193,667	3/1940	Bary	204—196
2,377,792	6/1945	Lawrence et al.	204—196
2,762,767	9/1956	Mosher et al.	204—196
3,208,927	9/1965	Hutchison et al.	204—147

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