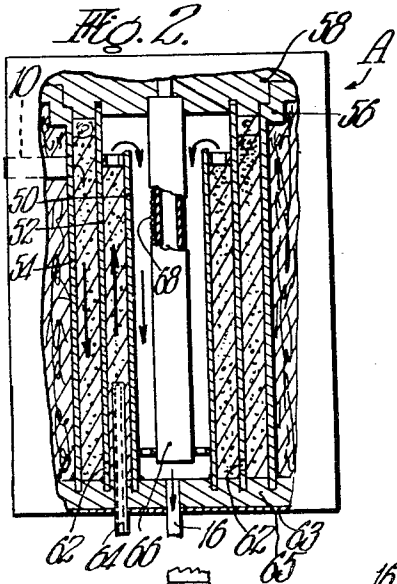
Oct. 3, 1933. V. T. MALCOLM 1,929,392

METHOD OF TREATING METAL ALLOYS

Filed April 24, 1933

Fig. 2.



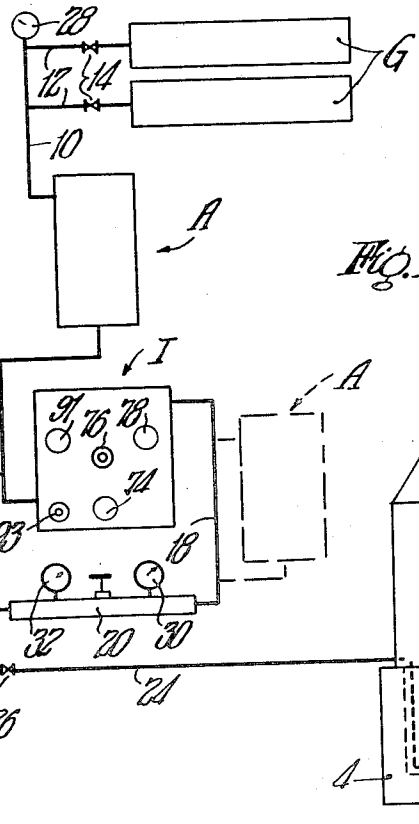


Fig. 1.

Fig. 4.



Fig. 3.

INVENTOR.

BY Vincent T. Malcolm.

Walter C. Ross.

ATTORNEY.

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METHOD OF TREATING METAL ALLOYS

Vincent T. Malcolm, Indian Orchard, Mass., assignor to The Chapman Valve Manufacturing Company, Indian Orchard, Mass., a corporation of Massachusetts

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6 Claims. (Cl. 148—16)

This invention relates to improvements in apparatus for and methods of treating metal alloys to provide hardened surfaces therefor.

The principal objects of this invention are directed to improvements in methods and apparatus for supplying substantially active nitrogen to a fused salt bath for treating alloy metals such as steels and the like to provide hardened surfaces therefor. According to special features of the invention it is possible to treat relatively low-price steels so that they will have the desirable characteristics of more expensive or special steels, and the desired surface-hardening effects may be brought about at extremely low cost.

I have discovered that it is possible to obtain very favorable results when relatively inexpensive steels are used by supplying a suitable hardening bath with active nitrogen. That is to say, when a sufficient amount of active nitrogen is supplied the bath, I have found that relatively inexpensive steel may be treated to provide hardened surfaces in a comparatively short space of time which are equal, if not superior, to what may be expected of more expensive steels. Therefore, my invention is directed to the provision of a novel method and apparatus adapted to supply the necessary and desired amount of active nitrogen to the hardening bath for the treatment or surface-hardening effects.

Various novel features and advantages of the invention will be more fully hereinafter referred to in connection with the accompanying description thereof. The novel method of the invention may be carried out by means of various forms of apparatus but one form of an apparatus which has been found to be satisfactory for the purpose of the invention is hereinafter described and shown in the accompanying drawing, wherein:

Fig. 1 is a diagrammatic elevational view of an apparatus adapted for carrying out the novel method of the invention.

Fig. 2 is a sectional elevational view through the dissociator unit of the invention.

Fig. 3 is an elevational sectional view through the ionizer unit of the invention with an electrical diagram associated therewith, and

Fig. 4 is a plan view of the central electrode of the ionizer unit.

Referring now to the drawing more in detail the novel apparatus and method of the invention will be fully described.

As previously stated, one of the objects of the invention is to provide a supply of active nitrogen to a hardening bath in which the alloy is being treated. This is desirable for the best hardening effects and makes it possible to operate on relatively inexpensive materials and obtain the desired hardness in a relatively short time and in that way provide material having hardened surfaces at extremely low cost.

To supply nitrogen for the bath, I employ a nitrogen-containing gas, such as ammonia. Before it is delivered to the bath, it is subjected to certain reactions in accordance with the invention as will presently appear so that substantially free active nitrogen enters the bath for its function in connection with the hardening operation.

In some instances, it may be desired to employ the features of the invention in connection with dry-hardening operations, but in disclosing the invention it will be described in connection with a so-called wet process wherein objects to be treated are immersed in a fused salt bath which is heated to bring about the hardening effect.

In the drawing, there is represented at 2 and 4 hardening furnaces which may consist of hardening pots or tanks, 6 and 8, suitably associated with combustion compartments. At G is represented a tank or tanks containing a gas, such as ammonia, having nitrogen as an important element. The nitrogen-containing gas is caused to flow from the tanks G to the furnaces, 2 and 4.

Ordinarily when ammonia gas is delivered directly to the furnace, it is necessary to deliver very large amounts in order that the desired amount of active nitrogen be passed into the fused salts. According to this invention, as will appear, certain amounts of ammonia gas will provide a greater proportion by volume of active nitrogen than has heretofore been possible.

The bath employed in the pots, 6 and 8, will preferably consist of fused salts containing more or less nitrogen such as a bath including cyanide salts which, as is well known, contain nitrogen. With such salts it is desirable to operate within a temperature range from 950 to 1700 degrees F., while a temperature of 1400 degrees F., has been found to be especially satisfactory.

It will be appreciated that the nitrogen constituent of the bath is dissipated in the treating operation and it is to replenish the dissipated nitrogen supply that the invention in its broad aspect is directed. As the ammonia gas leaves the tank, it is subjected to dissociating and ionizing or activating reactions. Preferably this is done by electrolytic activating and dissociation so as to dissociate and disunite the hydrogen and nitrogen constituents of the ammonia. The gas may flow from the tanks, G, to a dissociator unit and then

through an activator unit and thence to the furnace or furnaces. If preferred, the activator unit may be nearest the furnace. This will depend on conditions.

As shown in Fig. 1, a dissociating unit, A, is connected to the tanks, G, by pipes 10 and 12, with suitable valves, 14, to facilitate the flow of gas from the tanks. An activator or ionizing unit, I, is connected to the dissociator by means of a pipe, 16. A pipe, 18, connects the ionizer to a conduit, 20, and by pipes, 22 and 24, the conduit is connected to the furnaces with valves 26 associated with said pipes.

As will be seen, the gas flows from the tanks through the dissociator, into the ionizer or activator and thence to a furnace or furnaces. Gauges, 28 and 30, for indicating pressure and a gauge, 32, for indicating the flow of the gas are provided.

When desired, the dissociator may be connected as shown by the dash lines instead of as shown by full lines.

The ionizer or activator unit will now be described. There are provided a hollow outer metallic shell, 36, and an inner hollow electrode member, 38, which are suitably associated by an insulating base and cap, 40 and 42, respectively.

The cylinder, 36, is connected to one side of a high voltage line by a connector, 44, and the central electrode, 38, is connected to the other side of said line as indicated by 46. The upper part, 37, of the central electrode is preferably star-shaped, as shown in Fig. 4, to provide a multiplicity of points, 41. When these parts, 36 and 38, are subjected to high voltage there is, of course, a tendency for a sparking action therebetween but according to my invention the amperage used is preferably such as to avoid sparking. The inlet pipe, 16, connects the central member either to the tank or the dissociator while the pipe, 18, connects the cylinder to adjacent apparatus such as the conduit, 20, or the dissociator.

Ammonia gas from a tank or the dissociator passes upwardly within the central electrode, 38, and outwardly through tangential openings, 39, therein and then upwardly between the star member, 37, and shell, 36. The amperage is preferably about .2 at 10,000 or 12,000 volts so that there is produced a glow, or corona effect around the star, as distinguished from an arc. As the ammonia gas passes upwardly between the star and shell, it is acted upon by the electrical action or is charged to bring about an activating and ionizing effect of the gas, thus electrolytically dissociating or disuniting the hydrogen and nitrogen constituents of the gas and maintaining the dissociation thereof.

The dissociated hydrogen and nitrogen may then pass directly from the ionizing unit into the bath and, since the nitrogen constituent is substantially active nitrogen, there is delivered to the bath from a given volume of ammonia gas a much larger amount of nitrogen by volume than could be delivered thereto without the ionizing reaction.

It has been discovered that by the ionizing reaction it is possible to provide approximately four volumes of active nitrogen from one volume of the original gas. Not only, therefore, does the ionizing make it possible to deliver larger amounts of nitrogen but the nitrogen is free from the restraining effects of other elements so that it may perform its desired functions in the bath with the utmost efficiency.

The dissociating unit A will now be described with reference to Fig. 2. A plurality of tubes 50, 52 and 54 are arranged concentrically. The lower ends of the tubes are suitably fixed to a lower header 65. The upper ends of tubes, 54 and 52, are associated with an upper flange, 56, and plate 58 while the tube 50 terminates below the member 58. The whole may be enclosed in a suitable case.

A suitable catalyst to be described is carried between the cylinders or tubes as shown and suitable insulating material surrounds the outer cylinder or tube. Openings, 62, are provided in the lower end of tube 52 and a tube 64 extends between tubes 50 and 52 for receiving a thermocouple unit.

Ammonia gas passes through pipe 10 into the unit, flows downwardly between tubes 52 and 54 upwardly between tubes 52 and 50 and downwardly through tube 50 and out the pipe 16. It will be noted that the gas passes through the catalyst.

A tube 66 depends from the member 58 and is preferably hollow and made from silica or some equally suitable material. This has associated therewith one or more windings 68 which when connected to a source of electrical energy will bring about a heating of the gas.

As the gas passes through the unit the heating thereof together with the action of the catalyst will dissociate or disunite the hydrogen and nitrogen of the ammonia gas so that the nitrogen element is active for its effects in the bath. The catalyst employed is preferably prepared in this way.

The oxides of iron, aluminum and potassium are strongly reduced by the action of a stream of hydrogen and then ground in benzine and mixed with paraffine. The resultant mixture is then spread over pieces of pumice placed in the dissociator. By this procedure, the catalyst as a whole is porous so as to permit the gas to flow therethrough and effect the most efficient reaction.

As previously stated, it is desired that the parts 36 and 38 of the activator be included in a circuit of relatively high potential with the amperage maintained at about .2. This may be accomplished in the manner shown in Fig. 3.

The circuit including connections 44 and 46 may be coupled by means of a transformer 70 to a supply circuit 72 so that a higher voltage is established in the secondary circuit which includes the activator than prevails in the supply or primary circuit 72.

The electrical apparatus including the ionizer may be carried within a casing for convenience in manipulation and operation and may take various forms to operate for the purpose intended.

A resistance or rheostat 74 is in series with a side of circuit 72 to control current and a switch 76 provides a means for cutting the current in and out. A light or signal 78 is, by means of connections 80 and 82, arranged to indicate when the switch 76 is closed and the rheostat is in operation. This indicates that the ionizer is in operation.

As has been stated, it is desirable to operate the ionizer without sparking. This is accomplished by adjusting the rheostat 74. Should sparking occur, however, a relay 86 closes a switch 87 connected by 88 and 90 to circuit 72. This circuit includes a signal or light 91 and when energized the operator is warned so that he may make the necessary rheostat adjustments to overcome sparking.

A switch 93 is provided in association with 88 and 90 which may be called a test switch. When closed with the arm of the relay in proper position the light or signal 91 is operated to indicate the relay is operating properly.

It will be observed that as the ammonia gas passes through the dissociator unit that the hydrogen and nitrogen of the gas are dissociated or disunited so that the nitrogen is in a substantially free active form. This, as stated, is accomplished by subjecting the gas to heat and passing it through the catalyst whereby the nitrogen is in a free and substantially pure state for its reaction with the salts of the bath. The ionizer or activator furthers the dissociation reaction and functions to activate the nitrogen.

Having described the invention in the form at present preferred what I now desire to claim and secure by Letters Patent of the United States is:

1. The method of treating steel objects which consists in, immersing the objects in a fused salt bath including cyanide salts, subjecting a flow of ammonia gas to the action of an ionizing electrical discharge to disunite the gas into the hydrogen and nitrogen constituents thereof and immediately passing the same into said bath whereby the nitrogen constituent enters the bath as substantially free nitrogen.

2. The method of treating steel objects which consists in, immersing the objects in a fused salt bath including cyanide salts, subjecting a flow of ammonia gas to the action of an ionizing electrical discharge to disunite the gas into its constituents, hydrogen and nitrogen, immediately passing the same into said bath whereby the said nitrogen constituent enters the bath as substantially free nitrogen, and maintaining said bath within a temperature range of from 950 to 1700 degrees F.

3. The method of treating steel objects which consists in, immersing the objects in a fused salt bath including cyanide salts, subjecting a flow of ammonia gas to electrolytic ionization to disunite the hydrogen and constituents thereof, immediately passing the same into said bath whereby the said nitrogen constituent enters the bath as substantially free nitrogen, and maintaining said bath at a temperature of approximately 1400 degrees F.

4. The method of treating steel objects which consists in, immersing the objects in a fused bath of nitrogen-containing salts, subjecting a flow of ammonia gas to electrolytic ionization to disunite the hydrogen and nitrogen constituents thereof and immediately passing the same into said bath whereby the nitrogen constituent enters the bath as substantially free nitrogen.

5. The method of treating steel objects which consists in, immersing the objects in a fused bath of nitrogen-containing salts, subjecting a flow of ammonia gas to electrolytic ionization to disunite the hydrogen and nitrogen constituents thereof, immediately passing the same into said bath whereby the nitrogen constituent enters the bath as substantially free nitrogen, and maintaining said bath within a temperature range of from 950 to 1700 degrees F.

6. The method of treating steel objects which consists in, immersing the objects in a fused bath of nitrogen containing salts, subjecting a flow of ammonia gas to the action of electrolytic ionization to disunite the hydrogen and nitrogen constituents thereof, passing the same into said bath whereby the nitrogen constituent enters the bath as substantially free nitrogen, and maintaining said bath at a temperature of approximately 1400 degrees F.

VINCENT T. MALCOLM.