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3,074,828

EXOTHERMIC HEATED METAL FOR HEAT TREATING AND FORMING

Harry M. Griffin, Chesterfield, Mo., and August R. Savu, New York, N.Y., assignors to McDonnell Aircraft Corporation, St. Louis, Mo., a corporation of Maryland
No Drawing. Filed Feb. 1, 1960, Ser. No. 5,594
9 Claims. (Cl. 148—13.1)

The present invention relates to a method of heating sheets, bodies and the like, particularly metal objects, and to compositions for achieving this result.

Presently when metal objects are heat treated, they first are heated in a liquid bath such as a heated salt bath, or suitable furnace, and then tempered, quenched, treated or the like in a separate tank, or by some suitable chilling means. This process not only is expensive of space and labor, but also the metal object cools in the time that it leaves the heat bath until it reaches the quench tank. The cooling is not uniform, in that the edges cool faster than the center and the quenching does not give a uniform product. The same is true of present forming methods wherein the object to be formed is heated in a bath and then transferred to a press or the like for forming. The non-uniform cooling has deleterious effects on the properties of the final formed object.

The present invention provides a method of heating metal prior to treatment or forming which obviates the hereinbefore mentioned difficulties. An object of the present invention is to provide a method of and compositions for heating metal. Another object is to provide a method of metal forming. Still another object is to provide a method of heat treating only a portion of an object. Another object is to provide a method of heating and forming metal wherein the outer edges of the metal remain at substantially the same temperature as the center as the object is moved from the heating area to the forming area.

Still another object is to provide a method of treating a metallic object such as a sheet or the like wherein the heating and forming or quenching occur consecutively in the same area.

Another object is to provide novel compositions which when applied to metal and ignited, heat the metal to a desired predetermined temperature.

Another object is to provide a method of heating metal which is more economical than present methods.

Still another object is to provide exothermic compositions which when coated on metal objects and burned impart desired predetermined temperatures to the metal object.

These and other objects and advantages will become apparent hereinafter.

The present invention provides a method of heating metal prior to forming or heat treatment. The invention further consists in the compositions hereinafter described and claimed for use in the present process.

In the present invention, an exothermic or heat producing inflammable composition (more fully disclosed hereinafter) is applied in a desired thickness to a metal object which is to be formed or treated. The composition is ignited near the center of the area covered by the composition so that it burns toward the periphery and thereby heats the object uniformly. The center of the object retains heat and since the outer edges are heated last, they also stay at the desired temperature while the object is moved to a quench or forming machine.

The inflammable composition can be applied to the metal by spraying, by a brush or roller, or if the sheet is very thin, a printing process can be used. Successive coats of material can be applied to build up the layer to

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the desired thickness. The thickness of the various compositions is dependent upon the time of burning desired, which in turn controls the temperature to which the metal is heated. In other words, the thicker the composition the longer it burns and the higher the temperature which is induced into the metal. The temperature of the heated metal object must be high enough for forming or heat treating, and it must be below the melting point of the particular metal to which it is applied. Preferably, the objects are treated with compositions which will induce temperatures of from about 300° F. to about 1100° F. in the object.

The most desirable burning rate is about 1 linear foot per second, to prevent explosion and provide rapid heating. This enables the center of the coated area to remain hot while the coat burns toward the outside edges.

The composition can be ignited at any suitable temperature, but for safety purposes it is desired that the ignition temperature be above that of a wood or paper flame. The quenching and forming steps can take place in any suitable manner which is presently known to the art. The method of substantially instantaneous quenching shown in U.S. Patent No. 2,838,788 is the preferred quenching method.

The present composition includes a metal powder and a carrier, as an igniter and/or a suitable vehicle. The preferred compositions include a metal powder and both an igniter and a vehicle, particularly a major portion of a metal powder and a minor portion of an igniter together with sufficient vehicle to form a thick pasty consistency.

The metal powders suitable are aluminum, magnesium, titanium and titanium hydride. Powdered magnesium is preferred because it ignites and burns better than other metallic powders. Also magnesium is non-sparking, has a lower melting point than other metal powders, and presents no toxicity hazards. To facilitate burning, the metals should be 325 mesh or finer.

The most suitable igniter is gunpowder, while other commercially available igniter and fuse materials are sold by Universal Match Corporation of St. Louis, Missouri, and others.

The vehicle which is most suitable is clear nitrate dope similar to the material sold for use in the construction of model airplanes. Other vehicles that may be used to give varying temperatures in the metal include collodion, rubber cement, water and wet paper towels, lacquer thinner, Johnson's #111 lubrication wax, and materials from the Dennis Chemical Company, St. Louis, Missouri, known as Flame Adhesive, and Ignition Coatings F350-119A and F350-119B. It is desirable that the vehicle be water soluble, particularly when magnesium powders are used, since water enhances the burning action of magnesium.

The present invention is applicable to any metal object or sheet, but is particularly suited to treating pure titanium and magnesium alloy sheets in the aircraft industry. The preferred composition includes eight parts of 325 mesh magnesium powder and one part gunpowder mixed with enough clear nitrate dope to form a thick paste. When this composition is applied to a titanium sheet 0.040" thick in a 1/8" coating and ignited, the temperature of the treated side reaches 1100° F. and the untreated side reaches a temperature of 900-1000° F.

The coatings can be applied to one or to both sides of the object to be heated. Furthermore, if only a portion of an object is to be heat treated, the composition can be applied to that portion only. This is suitable in providing hardened bearing areas which presently require insert bushings or the like.

The temperatures are measured with Tempil-sticks ranging in temperature from 300° F. to 1100° F.

In the following examples, the inflammable composition

tions are coated on titanium sheet 0.040" x 3" x 6" and magnesium alloy sheet 0.032" x 3" x 6". As mentioned, the invention is applicable to heating other objects, particularly metallic objects, but the titanium and magnesium sheets were used for convenience.

The following examples are intended to illustrate certain practical formulations, however certain modifications of these examples can be utilized with different metals and different temperatures.

Example 1

Magnesium powder (150 microns) is mixed with collodion and brushed on titanium panel, ignited with a match, and water is sprayed on the burning magnesium. The temperature on the uncoated side of the panel is from 500 to 700° F.

Example 2

Magnesium powder (150 microns) is spread generously on a titanium panel, water is poured on the panel and the water and powder are stirred to make a slurry. The coating is ignited by an oxy-acetylene flame. The magnesium powder burns vigorously, and a temperature of 1100° F. is induced on the coated side of the panel, and a temperature of 1000° F. is induced on the uncoated side of the panel.

Example 3

8 parts of magnesium powder (150 microns) plus 1 part of gunpowder are mixed with enough rubber cement to form a slurry and applied by brush to one side of a titanium panel. Water is sprayed on the ignited magnesium powder and results in temperatures of 300° F. and 500° F. on the uncoated and the coated sides of the panel respectively.

Example 4

8 parts of magnesium powder (150 microns) plus 2 parts of gunpowder are mixed with enough rubber cement to form a thick paste, applied by brush to one side of a titanium panel, and ignited by an oxy-acetylene flame. The magnesium burns slowly inducing temperatures of 300° F. to 500° F. in the panel.

Example 5

4 parts of magnesium powder (150 microns) plus 1 part of gunpowder are mixed with enough dope to form a thick paste, applied by brush to one side of a titanium panel, and ignited by an oxy-acetylene flame. The rather slow burning time is 5 minutes resulting in temperatures of 900° F. on uncoated side of the panel and 1100° F. on the coated side.

Example 6

Magnesium powder (150 microns) is mixed with enough rubber cement to form a slurry and brushed on one side of a magnesium panel in a layer 0.010" thick. When the coating is burned, the temperature on the coated side of the panel is 300° F.

Example 7

A wet piece of paper towel is placed on one side of a magnesium panel, the panel is then dipped in magnesium powder (150 microns), and ignited by an oxy-acetylene flame. The magnesium powder burns slowly, resulting in temperatures of 300° F. and 500° F. Burning also leaves a black residue on the panel which is easily removed with soap and water.

Example 8

Two pieces of paper towel are thoroughly wetted and placed on each side of a titanium panel. The panel is dipped in a can of magnesium powder (150 microns), tapped to knock off the excess magnesium powder, and ignited by an oxy-acetylene flame. The magnesium powder burns very vigorously and rapidly. The temperature on the bottom side of the panel is 1000° F., and the temperature on the top side is 1100° F.

Example 9

One part of magnesium powder (150 microns) is thoroughly mixed with 1 part of a carrier (Igniter of Universal Match Corporation) and brushed on one side of a titanium panel in a coating approximately $\frac{1}{32}$ " thick, dried for $\frac{1}{2}$ hour, fused and ignited with a fuse match. The composition burns very vigorously and rapidly, and the temperature on the uncoated side of the panel is 1000° F.

Example 10

A thin coat (.010") of a mixture of 1 part magnesium powder (150 microns) and 1 part of a carrier (Igniter of Universal Match Corporation) is applied by brush to one side of a titanium panel, dried 15 minutes, and ignited with oxy-acetylene flame. The temperature on the coated side of the panel is 500° F.

Example 11

A $\frac{1}{32}$ " coating of 1 part of magnesium powder (150 microns) and 1 part of a carrier (Igniter of Universal Match Corporation) is applied by brush to one side of a titanium panel, dried for $\frac{1}{2}$ hour, and ignited by means of oxy-acetylene flame. The temperature on the coated side of the panel is 700° F., while the temperature on the uncoated side of the panel is 600° F.

Example 12

Four parts of magnesium powder and 1 part of gunpowder are mixed with enough Dennis flame adhesive and thinner to make a pasty consistency and brushed on one side of a titanium panel, fused and ignited. The composition burns with the issuance of large yellow flame and black smoke, and induces a temperature on the uncoated side of the panel of 500° F.

Example 13

One part of magnesium powder (150 microns) and 1 part of titanium powder are mixed thoroughly with lubricating wax, applied to one side of a titanium panel, dried, and ignited by means of an oxy-acetylene flame. The composition burns with sufficient heat to induce temperatures of 500° F. on the coated side of the panel and 300° F. on the uncoated side of the panel.

The foregoing examples show compositions which can be used to heat metal bodies to desired predetermined temperatures particularly temperatures of from about 300° F. to about 1100° F.

After the panels have been heated in the foregoing examples, the panels can be formed in any desired forming machine, or they can be quenched, treated or the like. Particularly, the heated panels can be substantially instantaneously quenched in an apparatus as shown in U.S. Patent No. 2,838,788.

Since most metal powder particles are covered with an insulating medium of molecular dimensions, they can accumulate frictional electricity. Therefore, shielding or grounding measures should be exercised when utilizing the present invention to prevent fire or explosion of the major mass of metal powder.

Also some of the compositions burn with the emission of thick smoke and fumes and suitable safety provisions should be made for the elimination of these.

This invention is intended to cover all changes and modifications of the examples of the invention herein chosen for purposes of the disclosure, which do not constitute departures from the spirit and scope of the invention.

We claim:

1. A method of heat treating metal objects comprising the steps of positioning a metal object coated with an inflammable composition in a treatment tank, burning off the composition leaving the metal object at a desired temperature level for heat treating, and quenching the metal in the same tank in which it is heated.

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2. A method of heat treating sheet titanium metal including the steps of coating the sheet titanium with an inflammable composition, said composition including about eight parts powdered 325 mesh magnesium, about one part gunpowder, and enough clear nitrate dope to make a thick paste, positioning the coated sheet in a treating tank, burning the composition to heat the sheet titanium to a desired predetermined temperature of from about 300° F. to about 1100° F., and substantially instantaneously quenching the heated sheet titanium.

3. A method of forming metal including the steps of burning off a film of an inflammable composition coated on the metal to heat the metal to a temperature substantially below its melting point, and forming the heated metal.

4. A method of forming sheet metal comprising the steps of coating the sheet metal with a film of an inflammable composition, burning off the composition to heat the metal to a forming temperature substantially below its melting point, and forming the heated metal.

5. A method of forming sheet titanium metal including the steps of coating the sheet titanium with an inflammable composition, said composition including about eight parts powdered 325 mesh magnesium, about one part gunpowder and enough clear nitrate dope to make a thick paste, positioning the coated sheet in a forming machine, igniting the composition at the approximate center thereof, burning the composition from the center outwardly toward the outer periphery of the sheet at the rate of about 1 linear foot per second to maintain the entire sheet at about the desired predetermined forming temperature, and forming the heated sheet.

6. A method of heat treating metal including the steps of burning off a film of an inflammable composition previously coated on the metal to heat the metal to a temperature substantially below its melting point, and thereafter substantially instantaneously quenching the heated metal.

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7. A method of heat treating metal objects comprising the steps of coating a metal object with an inflammable composition, positioning the coated object in a treatment tank, burning off the composition to raise the temperature of the object to a desired level for heat treating, and substantially instantaneously quenching the metal object in the same tank in which it is heated.

8. A method of forming sheet metal including the steps of coating a metal sheet with an inflammable composition, positioning the coated sheet in forming apparatus, igniting the coated sheet, burning off the inflammable composition to heat the sheet to forming temperature in the forming apparatus, and forming the heated sheet in the forming apparatus.

9. The method defined in claim 8 wherein the sheet metal is titanium.

References Cited in the file of this patent

UNITED STATES PATENTS

20	Re. 13,219	Chapman	Mar. 21, 1911
	934,711	Chapman	Sept. 21, 1909
	1,077,827	Fuller	Nov. 4, 1913
	1,799,945	Beck	Apr. 7, 1931
	1,815,691	Wilson	July 21, 1931
25	1,849,056	Crawley	Mar. 15, 1932
	2,138,023	Buzzard et al.	Nov. 29, 1938
	2,337,314	Deppeler	Dec. 21, 1943
	2,464,210	Cadwell	Mar. 15, 1949
	2,500,097	Soffel	Mar. 7, 1950
30	2,680,063	Shapiro	June 1, 1954
	2,791,816	Pletsch	May 14, 1957
	2,816,012	Walton	Dec. 10, 1957
	2,889,238	Long et al.	June 2, 1959
35	2,898,253	Schneider et al.	Aug. 4, 1959

FOREIGN PATENTS

463,511	Great Britain	Apr. 1, 1937
568,453	Great Britain	Apr. 5, 1935