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(54) **Platinium containing coating compositions for gas turbine engines**

(57) A waterborne platinum coating composition includes, in an exemplary embodiment, about 20 weight percent to about 40 weight percent of a platinum powder, about 0.5 weight percent to about 5.0 weight percent of a polymeric binder, less than about 1.0 weight percent of a surfactant, and about 55 weight percent to about 80 weight percent of water. All weight percents are based on the total weight of the coating composition.

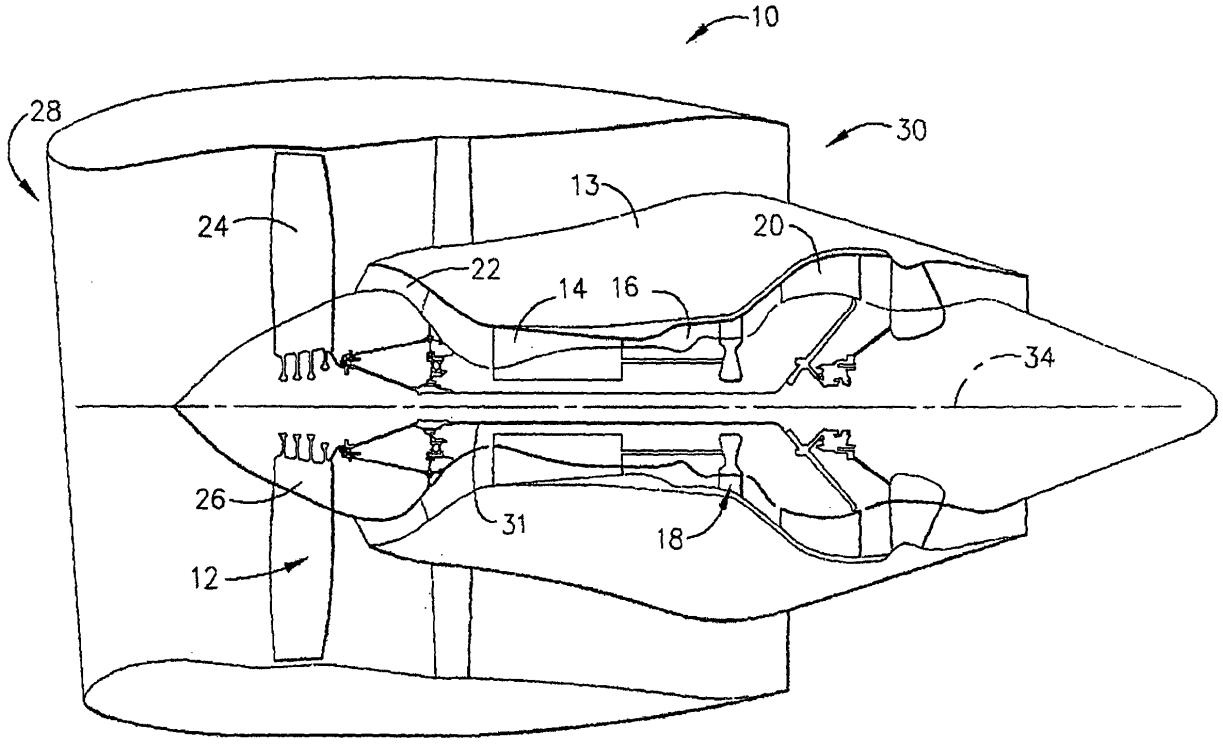


FIG. 1

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Description

[0001] This invention relates generally to gas turbine engines, and more particularly, to platinum coatings for components of gas turbine engines.

[0002] Gas turbine engines typically include high and low pressure compressors, a combustor, and at least one turbine. The compressors compress air which is mixed with fuel and channeled to the combustor. The mixture is then ignited for generating hot combustion gases, and the combustion gases are channeled to the turbine which extracts energy from the combustion gases for powering the compressor, as well as producing useful work to propel an aircraft in flight or to power a load, such as an electrical generator.

[0003] Some gas turbine engine components, for example, turbine airfoils, are coated with platinum aluminide (PtAl) diffusion coatings for high temperature oxidation and corrosion protection. Typically to form the platinum aluminide coating, these components are first platinum electroplated. Platinum electroplating is a capital investment intensive process. Electroplating is a multiple step process including cleaning, etching, electroplating, several rinse operations, and drying. The chemical processing equipment is expensive that requires a large capital expenditure, and occupies valuable manufacturing floor space. Additionally, electroplating chemicals are often hazardous and the plating operation must meet stringent requirements for air and wastewater emissions. The high cost of the equipment, the large amount of floor space, and the associated environmental concerns causes the platinum plating operation to be a batch operation. Typically in a manufacturing facility only one chemical processing system is provided for within in a budget and floor space of an existing manufacturing shop. This chemical process system must be isolated physically from the main manufacturing floor space in order to monitor and control the environmental emissions from the facility.

[0004] A batch electroplating operation in a physically separated and dedicated electroplating system is counter to the current manufacturing trend to lower production cost and inventory count by arranging processing equipment within a "cell" for each product line. The theory of cellular manufacturing dictates that one operator or team of operators has within the cell all the manufacturing equipment necessary to completely process and finish a part. Each part is processed individually and quickly. Cellular manufacturing works well for parts that have low to medium production rates, for example, turbine airfoils. However, batch operations, like platinum electroplating, where the part must be removed from the cell, leads to parts waiting in a queue and accumulating into sufficient batch sizes for processing. The benefits of cellular manufacturing have been lost because inventory must accumulate and processing times increase.

[0005] In one aspect of the present invention, a waterborne platinum coating composition is provided. The coating composition includes about 20 weight percent to about 40 weight percent of a platinum powder, about 0.5 weight percent to about 5.0 weight percent of a polymeric binder, less than about 1.0 weight percent of a surfactant, and about 55 weight percent to about 80 weight percent of water. All weight percents are based on the total weight of the coating composition.

[0006] In another aspect, a gas turbine engine component is provided. The component includes an outer surface, and a platinum coating composition deposited on the outer surface to form a platinum layer. The platinum coating composition includes about 20 weight percent to about 40 weight percent of a platinum powder, about 0.5 weight percent to about 5.0 weight percent of a polymeric binder, less than about 1.0 weight percent of a surfactant, and about 55 weight percent to about 80 weight percent of water. All weight percents are based on the total weight of the coating composition.

[0007] In another aspect, a method of forming a platinum aluminide diffusion coating on a gas turbine engine component is provided. The method includes the steps of coating at least a portion of an outer surface of the component with a waterborne platinum coating composition to form a platinum coating layer, heating the component from about 1700°F to about 2000°F to thermally decompose the coating composition and form a platinum diffusion coating on the outer surface of the component, and exposing the platinum diffusion coating to an aluminum-containing gas composition to form a platinum aluminide diffusion coating. The waterborne platinum coating composition includes about 20 weight percent to about 40 weight percent of a platinum powder, about 0.5 weight percent to about 5.0 weight percent of a polymeric binder, less than about 1.0 weight percent of a surfactant, and about 55 weight percent to about 80 weight percent of water. All weight percents are based on the total weight of the coating composition.

[0008] Various embodiments and aspects of the present invention will now be described in connection with the accompanying drawing, in which:

Figure 1 is schematic illustration of a gas turbine engine.

[0009] A waterborne platinum coating composition for use on gas turbine engine components is described below in detail. The waterborne platinum coating composition can be used to deposit a layer of platinum on the outer surface of a component of a gas turbine engine instead of the more costly and capital expense intensive process of electroplating. A platinum diffusion coating is easily formed on the gas turbine engine components by thermally decomposing the platinum coating deposited by the waterborne platinum coating composition. The platinum diffusion coating can then be converted to a platinum aluminide (PtAl) diffusion coating for high temperature oxidation and corrosion protection.

[0010] Referring to the drawings, Figure 1 is a sche-

matic illustration of a gas turbine engine 10 that includes a fan assembly 12 and a core engine 13 including a high pressure compressor 14, and a combustor 16. Engine 10 also includes a high pressure turbine 18, a low pressure turbine 20, and a booster 22. Fan assembly 12 includes an array of fan blades 24 extending radially outward from a rotor disc 26. Engine 10 has an intake side 28 and an exhaust side 30. In one embodiment, the gas turbine engine is a GE90 available from General Electric Company, Cincinnati, Ohio. Fan assembly 12 and turbine 20 are coupled by a first rotor shaft 31, and compressor 14 and turbine 18 are coupled by a second rotor shaft 32.

[0011] During operation, air flows through fan assembly 12, along a central axis 34, and compressed air is supplied to high pressure compressor 14. The highly compressed air is delivered to combustor 16. Airflow (not shown in Figure 1) from combustor 16 drives turbines 18 and 20, and turbine 20 drives fan assembly 12 by way of shaft 31.

[0012] In an exemplary embodiment, the waterborne platinum coating composition for use on turbine engine components is formed from at least one polymeric binder, platinum powder, at least one surfactant, and water. The platinum powder used in the coating composition can be a precipitated platinum powder that has a globular or irregular shape, a gas atomized platinum powder having a substantially spherical shape, or platinum flakes. In the exemplary embodiment, the platinum powder is a precipitated platinum powder having a globular shape. In one embodiment, the platinum powder has an average particle size less than about 1 micrometer (μ), and in another embodiment, less than about 0.5 μ. The coating composition, in one embodiment, contains about 5 weight percent to about 40 weight percent, and in another embodiment from about 20 weight percent to about 35 weight percent, with the weight percent based on the total weight of the coating composition. It has been found that large platinum flakes do not disperse easily into the coating composition which can result in platinum agglomeration. To overcome this problem, platinum powders having an aspect ratio of about 1:1 to about 2:1 are preferred.

[0013] Any suitable polymeric binder can be used in the platinum coating composition. The binder provides platinum particle-to-particle bonding in the dry films formed from the coating composition, and bonds the dried film to the substrate. Examples of suitable polymeric binders include, but are not limited to polyethylene oxides, polypropylene oxides, polyvinyl alcohols, hydroxyethyl cellulose, polyvinyl pyrrolidone, and mixtures thereof. The coating composition, in one embodiment, contains about 0.5 weight percent to about 5 weight percent, and in another embodiment, from about 1 weight percent to about 2 weight percent of the polymeric binder, with the weight percent based on the total weight of the coating composition. In an exemplary embodiment, a polyethylene oxide resin is used. Polyethylene oxide resins are commercially available from Dow Chemical under the trade name POLYOX®. Polyethylene oxide resins are non-ionic which facilitates the dispersion of platinum powder in the coating composition. Also, polyethylene oxides include $-C_2H_4O-$ chains, which thermally decompose cleanly as CO_2 and H_2O, and therfore do not form an ash on the surface of the turbine component which facilitates the formation of a clean platinum diffusion coating.

[0014] The coating composition includes, in one embodiment, less than about 1 weight percent of a surfactant, and in another embodiment, less than about 0.5 weight percent of a surfactant. The surfactant lowers the surface tension of the water to permit wetting of the platinum powder and wetting of the surfaces to be coated by the coating composition. Suitable surfactants are non-ionic or anionic which facilitate particle dispersion in the ionic water-based coating composition. Examples of suitable surfactants include, but are not limited to polyethylene oxide/polypropylene oxide block copolymers, nonyl phenyl ethoxylate, alcohol ethoxylates, ethoxylated acetylenic diols, and mixtures thereof. In one exemplary embodiment, ethoxylated acetylenic diols, commercially available from Air Products and Chemicals, Inc., are used.

[0015] In one embodiment, the water used in the coating composition is clean, de-ionized water. About 55 weight percent to about 95 weight percent of water is present in the coating composition.

[0016] In one embodiment, the waterborne platinum coating composition is made by adding platinum powder, de-ionized water, surfactant, and the polymeric binder to a suitable container. The ingredients are milled to disperse the platinum powder particles in the polymeric binder. Any suitable milling method can be used to disperse the platinum powder, for example, a cowles blade, an attriter, a ball mill, a pebble mill, a sand mill, and the like. In one embodiment, a paste is first made from the platinum powder, the surfactant, and a portion of the water. The paste is milled to the desired dispersion and then reduced to the desired viscosity by adding the remainder of the water.

[0017] A platinum aluminide coating is formed on a gas turbine engine component, for example, an airfoil, by forming a platinum coating layer by depositing the waterborne platinum coating composition onto at least a portion of the turbine engine component by any suitable coating application method, for example, by dip coating, by dip/spin coating, by spray coating, by curtain coating, by knife coating, and the like. The deposited coating composition is cured and then heated to about 1700°F to about 2000°F to thermally decompose the organic portion of the deposited waterborne coating composition and to form a platinum diffusion coating on the surface of the turbine engine component. The platinum diffusion coating is then exposed to an aluminum-containing gas composition at about 1700°F to about 2000°F for about 4 to 6 hours to form the platinum aluminide diffusion coating on the turbine engine component.

[0018] While the invention has been described in terms

of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.

PARTS LIST

[0019]

gas turbine engine 10
fan assembly 12
core engine 13
high pressure compressor 14
combustor 16
high pressure turbine 18
low pressure turbine 20
booster 22
fan blades 24
intake side 28
exhaust side 30
first rotor shaft 31
second rotor shaft 32

Claims

1. A waterborne platinum coating composition comprising:

about 5 weight percent to about 40 weight percent of a platinum powder, weight percent based on the total weight of said coating composition;
about 0.5 weight percent to about 5.0 weight percent of a polymeric binder, weight percent based on the total weight of said coating composition;
less than about 1.0 weight percent of a surfactant, weight percent based on the total weight of said coating composition; and
about 55 weight percent to about 95 weight percent of water, weight percent based on the total weight of said coating composition.

2. A waterborne platinum coating composition in accordance with Claim 1 wherein said polymeric binder is selected from the group consisting of polyethylene oxides, polypropylene oxides, polyvinyl alcohols, hydroxyethyl cellulose, polyvinyl pyrrolidone, and mixtures thereof.

3. A waterborne platinum coating composition in accordance with Claim 1 or Claim 2 wherein said composition less than about 0.5 weight percent of a surfactant, weight percent based on the total weight of said coating composition.

4. A waterborne platinum coating composition in accordance with any preceding Claim wherein said surfactant is selected from the group consisting of polyethylene oxide/polypropylene oxide block copolymers, nonyl phenyl ethoxylate, alcohol ethoxylates, ethoxylated acetylenic diols, and mixtures thereof.

5. A waterborne platinum coating composition in accordance with any preceding Claim comprising about 1.0 weight percent to about 2.0 weight percent of a polymeric binder.

6. A waterborne platinum coating composition in accordance with any preceding Claim wherein said platinum powder comprises particles having an average particle size of less than about 1.0 p.

7. A waterborne platinum coating composition in accordance with any preceding Claim wherein said platinum powder comprises particles having an aspect ratio of about 1:1 to about 1:2.

8. A method of forming a platinum aluminide diffusion coating on a gas turbine engine component comprises the steps of:

coating at least a portion of an outer surface of the component with a waterborne platinum coating composition to form a platinum coating layer;
heating the component from about 1700°F to about 2000°F to thermally decompose the coating composition and form a platinum diffusion coating on the outer surface of the component; and
exposing the platinum diffusion coating to an aluminum-containing gas composition to form a platinum aluminide diffusion coating;
wherein the waterborne platinum coating composition comprises:
about 5 weight percent to about 40 weight percent of a platinum powder, weight percent based on the total weight of the coating composition;
about 0.5 weight percent to about 5.0 weight percent of a polymeric binder, weight percent based on the total weight of the coating composition;
less than about 1.0 weight percent of a surfactant, weight percent based on the total weight of the coating composition; and
about 55 weight percent to about 95 weight percent of water, weight percent based on the total weight of the coating composition.

9. A method in accordance with Claim 8 wherein the polymeric binder is selected from the group consisting of polyethylene oxides, polypropylene oxides, polyvinyl alcohols, hydroxyethyl cellulose, polyvinyl pyrrolidone, and mixtures thereof, and wherein the composition comprises less than about 0.5 weight percent of a surfactant, weight percent based on the total weight of the coating composition.

10. A method in accordance with Claim 8 or Claim 9

wherein the surfactant is selected from the group consisting of polyethylene oxide/polypropylene oxide block copolymers, nonyl phenyl ethoxylate, alcohol ethoxylates, ethoxylated acetylenic diols, and mixtures thereof, and the platinum powder comprises particles having an average particle size of less than about 1.0 μ, and having an aspect ratio of about 1:1 to about 1:2.

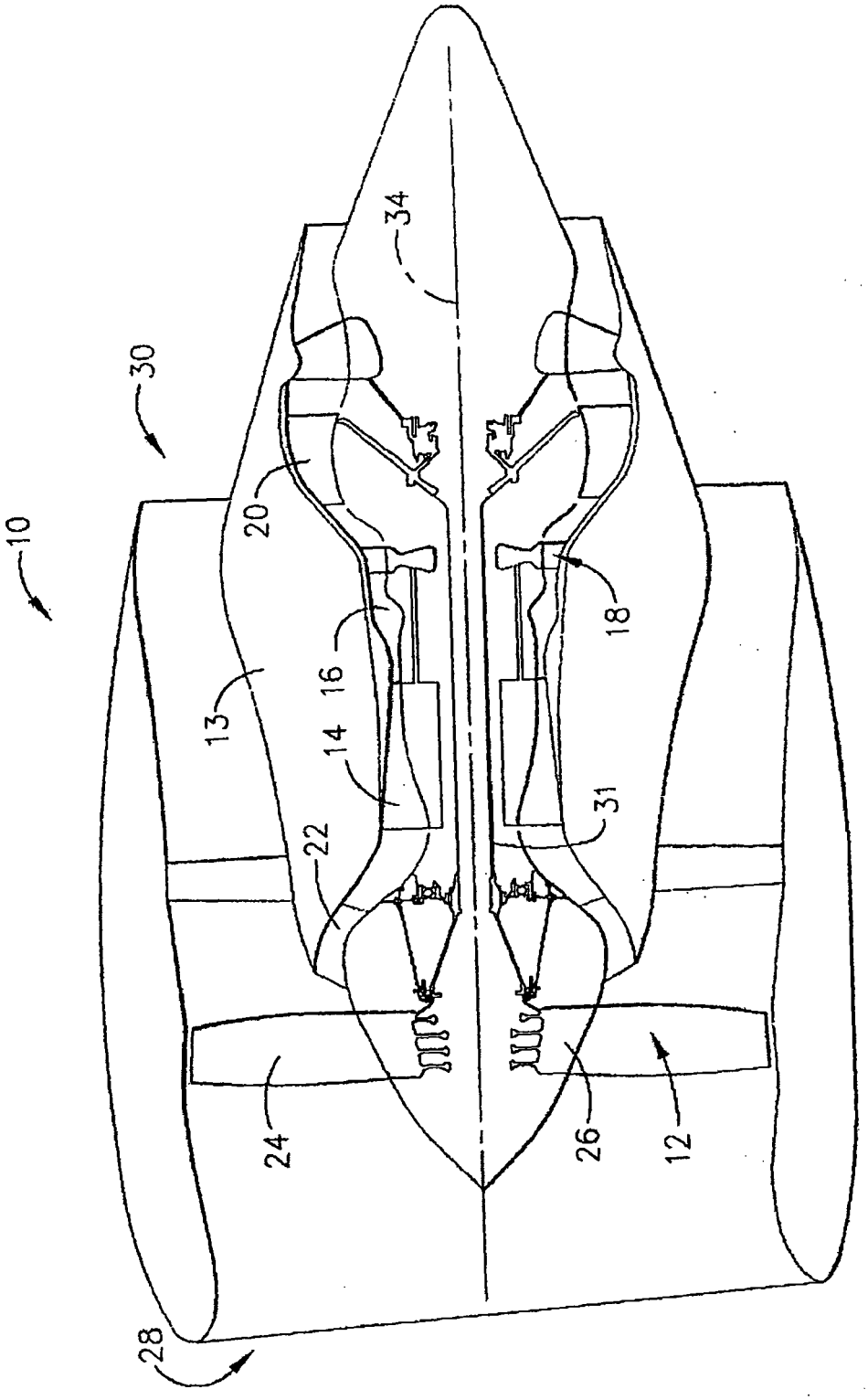


FIG. 1