

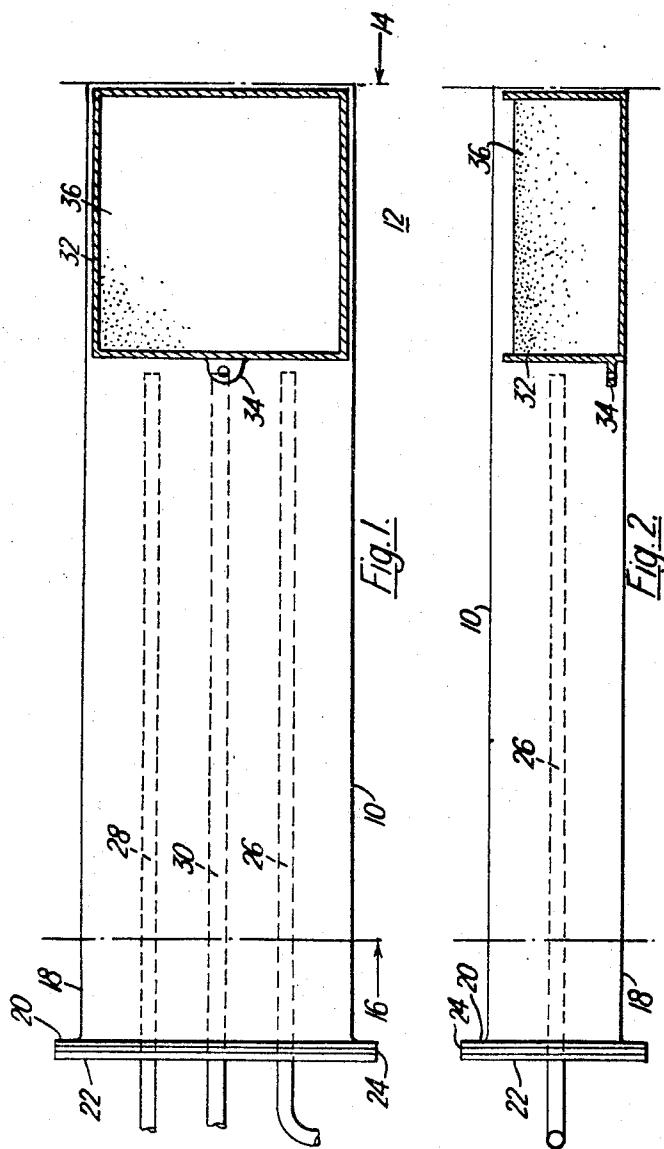
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G. LAMBERT ET AL

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ALUMINISING POWDER

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ALUMINISING POWDER

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4 Claims 10

ABSTRACT OF THE DISCLOSURE

The invention relates to a mixture for aluminising gas turbine blades, and to a method of aluminising using the mixture, the mixture comprising by weight:

	Percent
Powdered aluminum	0.05-5
Sodium fluoride or potassium fluoride	0.5-5
Potassium hydrogen difluoride	0.05-5
Ammonium chloride	0.05-5

the balance being calcined alumina and minor impurities.

This invention relates to a mixture for aluminising metals and to a process of aluminising.

According to the invention a mixture for aluminising metals has the following percentage composition by weight:

0.05 to 5% powdered aluminum,
0.5 to 5% of a fluoride selected from the group comprising sodium fluoride and potassium fluoride,
0.05 to 5% potassium hydrogen difluoride,
0.05 to 5% ammonium chloride,
The balance being calcined alumina and minor impurities.

Preferably the calcined alumina has the following percentage composition by weight:

	Percent
Alumina	98.50-99.50
Sodium oxide	0.35-0.70
Calcium oxide	0.01-0.10
Silica	0.02-0.05
Iron oxide	0.01-0.04
Calcium sulphite	0.01-0.05
Moisture content	Not above 0.03

The balance being minor impurities.

According to a preferred feature of the invention the mixture for aluminising metals has the following percentage composition by weight:

0.5 to 2.5% powdered aluminum,
0.5 to 2.5% of a fluoride selected from the group comprising sodium fluoride and potassium fluoride,
0.05 to 1% potassium hydrogen difluoride,
0.05 to 1% ammonium chloride,
The balance being calcined alumina and minor impurities.

Sodium fluoride is preferred to potassium fluoride.

From another aspect the invention comprises a method of aluminising metallic articles comprising burying the articles in a container of a powder in accordance with any

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of the above formulae, enclosing the container in a furnace, purging the container with an inert gas such as argon, bringing the container up to the desired aluminising temperature, and continuing the flow of the purging gas while aluminising at a temperature dependent on the material to be aluminised.

Where the method according to the invention is employed in aluminising materials such as nickel base alloys, for example nimonic 105 or nimonic 108 or nimonic 115, the aluminising treatment is carried out for a period of 5½ to 6½ hours at a temperature of 860 to 880° C. Where the material is a nickel base casting alloy such as Jessop alloy G64 or G67 or G94, the temperature range is the same but the time is increased to 6½ to 7 hours. With materials such as ferritic-type steels, for example a 12% chromium steel such as Rex 448, the temperature would be of the order of 950° C. or more.

The temperature is dependent not only upon the material but on the number of articles packed in the container and within the given ranges the best temperature can be found by trial and error.

To achieve the best results the powdered aluminum has to be both pure and finely powdered, and fine powder in accordance with British Standard 388 for aluminum has been found to give extremely good results.

The ammonium chloride in the formulae given above is included as a purging agent.

The sodium fluoride (or potassium fluoride) and the potassium hydrogen difluoride are cleaning agents.

In a particular application of the invention some nickel alloy turbine blades were aluminised using the apparatus shown in the attached figures, in which:

FIGURE 1 is a plan view, partly in section, of an apparatus for aluminising metals, and

FIGURE 2 is an elevation, partly in section, of the apparatus shown in FIGURE 1.

In FIGURE 1 there is shown an elongated retort 10 mounted in an electrically heated furnace, generally indicated at 12, the boundaries of the furnace 12 being defined by lines 14, 16. The retort 10 has an open end 18 which protrudes from the furnace 12 by a small amount and which is provided with a flange 20. A lid 22 is bolted onto the flange 20, leakage between them being prevented by a sealing ring 24 of rubber or asbestos.

Argon is led into and withdrawn from the retort 10 through inlet and outlet ducts 26, 28, respectively, both ducts passing through the lid 22. The temperature inside the retort 10 is measured by a thermocouple (not shown), the leads of which are led through a tube 30 which also passes through the lid 22.

At the end of the retort 10 remote from the lid 22 is an open-topped box 32 (FIGURE 2) made of nimonic 75 material with argon arc welded seams. Metallic articles to be aluminised are packed in aluminising powder in the box 32 as will be described below. The box 32 is provided with a lug 34 which is used when withdrawing the box from the retort 10.

The nickel alloy turbine blades were aluminised using the following method:

The blades were cleaned and degreased in trichloroethylene vapour and allowed to cool. The root and shroud ends of the blades were stopped off using nickel caps or

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other suitable stopping-off agents. The blades were then packed in the box 32 in a powder consisting of:

	Percent
Pure aluminium powder in accordance with British Standard 388	1.5
Sodium fluoride	1
Potassium hydrogen difluoride	0.1
Ammonium chloride	0.1

the balance being calcined alumina having the following composition by weight:

	Percent
Alumina	98.50-99.50
Sodium oxide	0.35-0.70
Calcium oxide	0.01-0.10
Silica	0.02-0.05
Iron oxide	0.01-0.04
Calcium sulphite	0.01-0.05
Moisture content	Not above 0.3

The balance being minor impurities.

The blades were packed in layers separated by an aluminising powder and after the last layer of blades a further half-inch of powder was added and pieces of silica bricks were placed on top of the final layer of powder so as to cover about 60% of the surface of the box 32. The packed box 32 was loaded into the far end of the retort 10 and the lid 22 of the retort bolted on using a rubber or asbestos sealing ring 24 between the lid and the retort. The retort 10 is of elongated form and is so designed that about 8 inches of it protrudes when loaded into the furnace. Argon is supplied to the retort 10 so that a controlled flow passes through the retort for 30 to 60 minutes at 15 to 18 cu. ft. per hour to purge all the air from the retort.

The purged retort with the argon still flowing was then loaded into the electrically heated furnace 12 and the argon flow reduced to a steady 10 cu. ft. per hour. The furnace 12 was controlled so that the temperature of the box was maintained at 870° C., but if the temperature varied the furnace was controlled so that variation was not greater than 10° either way. At the end of the heat treatment period the retort 10 was withdrawn from the furnace 12 and allowed to cool to approximately 50° C. during a period of about 6 hours with the argon still flowing.

When cooled the blades were removed from the powder and blown with a clean dry air blast to remove surplus powder. The nickel caps were removed from the ends of the blades and any remaining powder removed by hand brushing and, finally, with a fine stainless-steel wire rotary brush.

In another application of the invention the blades which were aluminised were gas turbine engine stator blades made of a 12% chromium martensitic stainless steel. The process was exactly the same except that the temperature was maintained at 900° C.±10° C. and the time for the heat treatment was 6 hours.

In a further application the blades were of 18% chromium, 8% nickel austenitic stainless steel, and the process was repeated at a temperature of 900° C.±10° C. for a period of 6 hours.

We claim:

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1. A mixture for aluminising metals, the mixture having the following percentage composition by weight:

	Percent
Powdered aluminium	0.05-5
Flouride selected from the group consisting of sodium fluoride and potassium fluoride	0.5-5
Potassium hydrogen difluoride	0.05-5
Ammonium chloride	0.05-5

the balance being calcined alumina and minor impurities.

2. A mixture for aluminising metals as claimed in claim 1 and in which the calcined alumina has the following percentage composition by weight:

	Percent
Alumina	98.50-99.50
Sodium oxide	0.35-0.70
Calcium oxide	0.01-0.10
Silica	0.02-0.05
Iron oxide	0.01-0.04
Calcium sulphite	0.01-0.05
Moisture content	Not above 0.03

the balance being minor impurities.

3. A mixture for aluminising metals as claimed in claim 1, the mixture having the following percentage composition by weight:

	Percent
Powdered aluminium	0.5-2.5
Flouride selected from the group consisting of sodium fluoride and potassium fluoride	0.5-2.5
Potassium hydrogen difluoride	0.05-1
Ammonium chloride	0.05-1

the balance being calcined alumina and minor impurities.

4. A method of aluminising metallic articles which are subject to high temperatures in use comprising burying the articles in a container containing a mixture for aluminising metals, the mixture having the following percentage composition by weight:

	Percent
Powdered aluminium	0.05-5
Flouride selected from the group consisting of sodium fluoride and potassium fluoride	0.5-5
Potassium hydrogen difluoride	0.05-5
Ammonium chloride	0.05-5

the balance being calcined alumina and minor impurities, enclosing the container in a furnace, purging the container with an inert gas such as argon, bringing the container up to a desired aluminising temperature, and continuing the flowing of the purging gas while aluminising at said temperature.

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