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(71) Applicant and
(72) Inventor: SCHUSTER, Jerry, L. [US/US]; 47 Deertrees Lane, Newfields, NH 03856 (US).

(74) Agent: RITCHIE, William, B.; The Law Offices of William B. Ritchie, 43 Jackson Street, Concord, NH 03301 (US).

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(54) Title: SILVER BRAZING FLUX AND METHOD OF MAKING

(57) Abstract: A non-corrosive, non-hygroscopic silver brazing flux compound. The compound includes in nature, and a method of making this flux. In the prefered embodiment, the flux compound consists of potassium fluoroborate approximately 26 % by weight, boric acid approximately 26 % by weight, potassium bifluoride approximately 24 % by weight, potassium tetraborate approximately 20 % by weight, and potassium tetraborate approximately 3.5 % by weight. The method of making the flux compound and its non-corrosive and non-hygroscopic properties enables the flux compound to be especially suitable for use as either as a flux paste or dried and milled into a powder to be dispensed within a sheath of silver based filler material to form a flux cored brazing wire.

SILVER BRAZING FLUX AND METHOD OF MAKING

FIELD OF THE INVENTION

The present invention relates to the field of silver brazing and, in particular, to a silver brazing flux that is non-corrosive and non-hygroscopic in nature.

BACKGROUND OF THE INVENTION

For many years, metal parts have been joined using silver-based brazing compounds. As is well known in the art, it is necessary to prepare the surfaces to be joined prior to applying the brazing compounds in order to provide adhesion of the brazing compound to the surfaces to be joined. This preparation is typically performed by a flux material, which is applied to the joint and activated by the application of heat to the joint. Once activated, the flux thoroughly cleans the surfaces to the joined and removes any oxides that will degrade the strength of the brazed joint.

As they must aggressively clean the surfaces to be joined, fluxes have typically been highly corrosive and hygroscopic in nature. Accordingly, it is necessary in many applications to remove any residual flux or flux residue from the joined parts in order to prevent corrosion of the parts. This removal increases the overall costs of the parts, due to the additional process steps and the cost of waste disposal from the cleaning process. In addition, the waste generated by this cleaning is hazardous to humans and harmful to the environment.

Finally, because of their corrosiveness and affinity for absorbing water, many typical fluxes have not been adapted for use in flux cored wires. As this is the case, the use of these fluxes has necessitated the additional step of applying the flux in a paste form prior to heating and joining the parts. As was the case with the cleaning

step described above, the need to perform this additional step increases the overall cost of the joined parts.

Accordingly, there is a need for a flux for use with silver brazing compositions that effectively prepares the surfaces to be joined, is non-corrosive and non-hygroscopic and, accordingly, does not need to be cleaned from joined surfaces after they are joined, and may be formed into a powder for disposal within a flux cored wire.

SUMMARY OF THE INVENTION

The present invention is a silver brazing flux that is non-corrosive and non-hygroscopic in nature, and a method of making this flux. In it most basic form, the flux includes the following compounds in the following percentages by weight:

Table 1: Composition of Basic Flux Compound

COMPOUND	PERCENTAGE BY WEIGHT
Potassium Fluoroborate	21% - 31%
Boric Acid	21% - 31%
Potassium Bifluoride	19% - 29%
Potassium Tetraborate	15% - 25%
Potassium Carbonate	2.5% - 4.5%

In some embodiments, the flux is combined with de-ionized water, or other suitable binder materials, to form a flux paste. In other embodiments, the flux is mixed and dried into a powder and dispensed within a sheath of silver based filler material, using the process described in U.S. Patent No. 5,781,846, which is incorporated herein by reference, to form a flux cored brazing composition.

The preferred flux includes the same compounds in the following percentages by weight:

Table 2: Composition of Preferred Flux Compound

COMPOUND	PERCENTAGE BY WEIGHT
Potassium Fluoroborate	26.3%
Boric Acid	26.3%
Potassium Bifluoride	23.8%
Potassium Tetraborate	20.2%
Potassium Carbonate	3.5%

The basic method of making the flux includes the following steps:

- Weighing all ingredients such that desired percentages are identified.
- Adding boric acid on top of potassium bifluoride.
- Mixing the boric acid and potassium bifluoride at medium-low speed until a completely smooth wet paste is formed.
- Adding potassium tetraborate and mixing at medium low speed.
- Adding potassium carbonate to the paste and mixing until it is completely dissolved
- Adding de-ionized water to each step of the mixture as it begins to stiffen in order to keep a loose, smooth consistency, similar to that of cake frosting, and scraping the sides and bottom of the mixing bowl as needed to keep the mix even
- Mixing the paste at medium speed.
- Stopping the mixer and pouring the mixture into a pan.

- Placing the pan into a pre-heated oven at approximately 560 degrees Fahrenheit for a period of four hours such that substantially all de-ionized water is dried from the mixture.
- Removing the dried flux, milling to a powder and screening to a desired particle size.

The resulting flux powder is non-corrosive and non-hygroscopic, and is readily adapted for suspension within a paste or disposition within a sheath of brazing alloy to form a flux cored brazing composition.

Therefore, it is an aspect of the invention to provide a silver brazing flux that is non-corrosive.

It is a further aspect of the invention to provide a silver brazing flux that is non-hygroscopic.

It is a further aspect of the invention to provide a silver brazing flux that does not leave a residue that must be cleaned from surfaces after they are joined.

It is a further aspect of the invention to provide a silver brazing flux that effectively prepares surfaces for joining.

It is a further aspect of the invention to provide a silver brazing flux that may be formed into a powder.

It is a further aspect of the invention to provide a silver brazing flux that may be combined with a silver brazing alloy to form flux cored brazing composition.

It is a still further aspect of the invention to provide a silver brazing flux that may be combined with a binder material to form a flux paste.

These aspects of the invention are not meant to be exclusive and other features, aspects, and advantages of the present invention will be readily apparent to

those of ordinary skill in the art when read in conjunction with the following description, appended claims and accompanying drawings.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is a silver brazing flux that is non-corrosive and non-hygroscopic in nature and a method of making the flux. As set forth in the summary section above, the flux is a mixture of potassium fluoroborate, boric acid, potassium bifluoride, potassium tetraborate and potassium carbonate. When combined in the percentages set forth above, the resulting flux provides excellent surface preparation characteristics and is both non-corrosive and non-hygroscopic.

In some embodiments, the flux is combined with de-ionized water, or other suitable binder materials, to form a flux paste. In these embodiments, the flux paste is applied to the faying surfaces prior to the application of heat, and is subsequently heated until it flows and wicks across the faying surfaces, effectively preparing the surfaces for joining. Once the surfaces are prepared, a solid wire of a silver based brazing composition is brought into contact with the heated surfaces, causing the brazing composition to flow across the surfaces and, once cooled, to effectively join the surfaces together.

In other embodiments, the flux is mixed and dried into a powder and dispensed within a sheath of silver based filler material, to form a flux cored brazing composition. In these embodiments the faying surfaces are heated and the flux cored brazing composition is brought into contact with the heated surfaces, causing the flux to melt and flow and subsequently causing the brazing composition to melt and flow.

All embodiments of the flux may be utilized with all American Welding Society (AWS) standard industrial silver / copper / zinc alloys. Accordingly, the

preferred brazing alloy will vary depending upon the particular application in which it will be used.

As noted above, the preferred flux includes the following compounds in the associated percentages by weight:

COMPOUND	PERCENTAGE BY WEIGHT
Potassium Fluoroborate	26.3%
Boric Acid	26.3%
Potassium Bifluoride	23.8%
Potassium Tetraborate	20.2%
Potassium Carbonate	3.5%

The preferred method includes the following steps:

- Weighing each solid and liquid ingredient in separate clean, dry containers.
- Adding potassium bifluoride into a stainless steel mixing bowl and mashing any clumps with a rubber hammer until only granules remain.
- Adding boric acid on top of the potassium bifluoride.
- Mixing the boric acid and potassium bifluoride at medium-low speed until a completely smooth wet paste is formed.
- Adding de-ionized water to the paste as it begins to stiffen in order to keep a loose, smooth consistency, similar to that of cake frosting, and scraping the sides and bottom of the mixing bowl as needed to keep the mix even.
- Adding potassium tetraborate and mixing at medium low speed until the mixture becomes smooth and creamy, adding additional de-ionized water

to the mixture as it beings to stiffen, and scraping the sides and bottom of the mixing bowl as needed to keep the mix even.

- Adding potassium fluoroborate and mixing at medium to medium low speed until smooth, adding additional de-ionized water to the mixture as it beings to stiffen, and scraping the sides and bottom of the mixing bowl as needed to keep the mix even.
- Adding potassium carbonate to the paste and mixing until it is completely dissolved.
- Stopping the mixer, scraping the sides and bottom of the bowl and the mixer blade, mixing again at medium speed.
- Stopping the mixer and pouring the mixture into a stainless steel pan.
- Placing the stainless steel pan into a pre-heated oven at approximately 560 degrees Fahrenheit for a period of four hours such that substantially all de-ionized water is dried from the mixture.
- Removing the dried flux, milling to a powder and screening to a desired particle size.

As noted above, the resulting flux powder is non-corrosive and non-hygroscopic, and is readily said potassium fluoroborate is approximately 26% by weight, boric acid is approximately 26% by weight, potassium bifluoride is approximately 24% by weight, potassium tetraborate is approximately 20% by weight, and potassium tetraborate is approximately 3.5% by weight.

Although the present invention has been described in considerable detail with reference to certain preferred versions thereof, other versions would be readily apparent to those of ordinary skill in the art. Therefore, the spirit and scope of the

appended claims should not be limited to the description of the preferred versions contained herein.

What is claimed is:

1. A brazing flux compound comprising: potassium fluoroborate ranging from approximately 21% to 31% by weight, boric acid ranging from approximately 21% to 31% by weight, potassium bifluoride ranging from approximately 19% to 29% by weight, potassium tetraborate ranging from approximately 15% to 25% by weight, and potassium tetraborate ranging from approximately 2.5% to 4.5% by weight.

2. The brazing flux compound of claim 1 further comprising a binder.

3. The brazing flux compound of claim 1 wherein said binder is de-ionized water.

4. The brazing flux compound of claim 2 wherein said flux compound is applied to a faying surface of at least two parts to be joined together, such that when heat is applied to said parts, said flux paste flows and wicks across the faying surfaces, effectively preparing the surfaces for joining.

5. The brazing flux compound of claim 2 wherein said brazing compound is a paste.

6. The brazing compound of claim 2 wherein said flux compound is dried into a powder and dispensed within a sheath of silver based filler material, to form a flux cored brazing composition.

7. The brazing compound of claim 1 wherein said potassium fluoroborate is approximately 26% by weight, boric acid is approximately 26% by weight, potassium bifluoride is approximately 24% by weight, potassium tetraborate is approximately 20% by weight, and potassium tetraborate is approximately 3.5% by weight.

8. The brazing compound of claim 2 wherein said flux compound is used to braze at least one metal selected from the group consisting of silver, copper, zinc.

9. A method of making a brazing flux compound comprising the steps of:

weighing each solid and liquid ingredient separately;

first adding potassium bifluoride;

second adding boric acid on top of the potassium bifluoride;

first mixing the boric acid and potassium bifluoride to form a substantially smooth wet first paste;

third adding potassium tetraborate to the first paste;

second mixing the potassium tetraborate with the first paste to form a substantially creamy second paste;

fourth adding potassium fluoroborate to the second paste;

third mixing potassium fluoroborate with the second paste to form a third paste;

fifth adding potassium carbonate to the third paste

third mixing until potassium carbonate is completely dissolved thus forming a fourth paste;

heating the fourth paste for a predetermined time at a predetermined temperature such that the fifth paste is substantially dried; and

milling the dried fifth paste to a powder.

9. The method of claim 8 further comprising the step of adding de-ionized water to at least one of said mixing steps as the paste in that corresponding mixing step begins to stiffen such that the amount of de-ionized water causes the paste to retain a loose, smooth consistency, similar to that of cake frosting.

10. The method of claim 9 wherein the predetermined temperature of said heating step is approximately 560 degrees Fahrenheit.

11. The method of claim wherein the predetermined time of said heating step is approximately 4 hours.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/17468

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B23K 35/365
US CL : 148/24, 26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 148/24, 26

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST TEXT SEARCH: (flux) and (potassium fluoroborate)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,490,888 A (ASSEL et al) 13 February 1996	1-11

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer DANIEL JENKINS Telephone No. (703) 306-4157

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