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(54) Title: METHOD OF MANUFACTURING A COMPONENT AND USE OF SAID METHOD

(57) Abstract: A component comprising a load-carrying member and a corrosion resistant member is manufactured by means of Magnetic Pulse Welding in order to avoid deteriorated properties of the component.

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METHOD OF MANUFACTURING A COMPONENT AND USE OF SAID METHOD

The present invention relates to a method of manufacturing a component according to the preamble of claim 1 and the use of said method.

Metal dusting is a form of catastrophic carburization, where the metal disintegrates rapidly into coke and pure metal or other types of metal rich reaction products. Metal dusting typically occurs in gases that are initially supersaturated with respect to carbon, i.e. having a carbon activity greater than unity.

WO2005/021255 discloses a composite tube for use in environments where the risk of metal dusting is high. The tube comprises a metal dusting resistant member of a copper-aluminum alloy and a load-carrying member of an alloy based on Fe, Ni or Co. The tube may be produced by methods such as co-extrusion, overlay welding, explosion welding, dipping, co-drawing or shrinkage of one tube on another tube. According to this document, overlay welding is preferable.

By utilizing overlay welding, a relatively high production rate can be accomplished at a low cost compared to other methods. However, this method may cause intermixture of the materials of the load-carrying member and the metal dusting resistant member. This in turn will lead to a premature decrease in corrosion resistance over time of use in the intended application. Moreover, overlay welding can in some cases cause cracking and/or penetration of melted metal from the welded material into the load-carrying member which in turn may lead to deteriorated mechanical properties of the load-carrying member. These problems are not necessarily severe if the component shall be processed further as in the case of WO2005/021255 but could be detrimental when producing component into the final shape directly.

Furthermore, US 6 737 175 discloses methods, such as CVD and sputtering, for production of this type of components. These two methods can only be used for deposition of relatively thin coatings, such as typically up to 100 µm. Consequently, there is a risk of a too low resistance to metal dusting, especially at high temperatures, since thin coatings will loose their corrosion resistance over time in the intended use.

The methods given above all have at least one disadvantage when used as manufacturing method for components to be used in environments where there is a risk of metal dusting occurring, i.e. environments with high carbon activity, especially at high temperatures. Hence, there is a need of an alternative method for manufacturing these types of components.

Consequently, the object of the invention is to provide a method of producing components with long service life, especially at high temperatures, to be used in environments with high carbon activity.

Summary of the invention

The stated object in achieved by a method as initially defined and having the features of the characterizing portion of claim 1.

In this disclosure metal dusting is taken to mean the process whereby a metal or an alloy is attacked by a carbon rich gas and corroded into a mixture of coke/carbon and metallic or metal rich particles.

Manufacturing of a component comprising a load-carrying member and a material with high resistance to metal dusting is accomplished by utilizing Magnetic Pulse Welding (MPW). The metal dusting resistant member is

preferably only applied to the surfaces of said component, which are exposed to the environment where the risk of said corrosion type is high.

Brief description of the drawings

Figure 1 illustrates the principle of the MPW process wherein an outer tube is welded to an inner tube.

Figure 2 illustrates the principle of the MPW process wherein an inner tube is welded to an outer tube.

Figure 3 illustrates the principle of the MPW process when joining two corrosion resistant members to a load-carrying member.

Detailed description of the invention

Magnetic Pulse Welding (MPW) is a cold welding process that is accomplished by a magnetic pulse causing a high-velocity impact between two materials resulting in a true metallurgical bond. The technology of Magnetic Pulse Welding was developed more than 40 years ago, but new development of inductors and switchers raise the commercial implementations of the process. The term welding in Magnetic Pulse Welding is some misleading as the method can be used for crimping, forming, cutting and perforating, and the process should therefore be addressed as Magnetic Pulse Technology.

To ensure a good weld the following parameters are of importance: magnetic pressure, mass of the accelerated part, material properties, gap between the two parts to be welded and the impact angle of the moving object.

One advantage of the process is the ability to join dissimilar materials. It may also be used for joining of difficult-to-weld materials, such as materials which may loose their mechanical or corrosion properties when welded. Since it is a cold welding process, a very narrow heat affected zone is accomplished due to a very

low heat input. The utilization of said welding process results in high strength joints, high welding speed, high repeatability, and good process tolerances. Furthermore, there is no need for filler metal or shielding gases.

The present invention may suitably be used for joining tubular elements and the principle of the process for such elements is illustrated in Figure 1. An outer tube 2 is welded to an inner tube 1 by usage of a coil 3 generating a magnetic force 4. The load-carrying member can be either the inner or outer tube. Figure 2 illustrates the same process for an inner tube 1 welded to an outer tube 2.

Figure 3 illustrates the utilization of the method according to the present invention for joining an inner metal dusting resistant member 5 and an outer metal dusting resistant member 6 to a tubular load-carrying member 7. An inner coil 8 is used to provide an inner magnetic force 9 and an outer coil 10 is used to provide an outer magnetic force 11. The inner and outer magnetic forces can be generated simultaneously, or could be generated one at a time and thereby joining the two metal dusting resistant members with the load-carrying member in two separate steps. The advantage of utilizing this embodiment with two steps, in comparison with first using the embodiment of Figure 1 followed by the embodiment of Figure 2, is that the component to be produced need not be moved from one manufacturing apparatus to another for joining the different members. Thereby, the manufacturing lead time is substantially reduced, and consequently, the manufacturing process is more cost effective.

According to one embodiment the surface of the load-carrying member and/or metal dusting resistant member is cleaned in a proper way before welding. Suitable methods for cleaning are for example machining, pickling and shot peeing.

The metal dusting member suitably consists of a copper based alloy containing 2-20 % by weight of Al. The alloy may also contain additions of up to 6 % Si, up

to 1 % Fe, Ni and/or Co, and up to 1 % of rare earth metals (REM). According to a preferred embodiment, the composition of the alloy is (in percent by weight):

4-10 % Al
>0-3 % Si
0-1 % REM
balance Cu and normally occurring impurities.

The effect of the different elements of the alloy above is comprehensively described in WO2005/021255 and will therefore not be described further in the present disclosure. The effect of the different alloying elements as described in WO2005/021255 is hereby incorporated in its entirety.

The component comprising the two different members may also comprise further members. Examples of such members are diffusion barriers located between two other members, and surface coatings for enhanced heat transfer and/or electrical conductivity to and/or from the tube.

Suitable thickness of the metal dusting resistant member to be used in applications where the risk of metal dusting is high is usually 0,25-1 mm. The lower limit is determined *inter alia* by the risk for reaction between the materials of the corrosion resistant member and the load-carrying member and/or the risk of evaporation of elements such as Cu when in service. Normally, the thickness of the metal dusting resistant member does not need to be more 2 mm.

Suitable materials for the load-carrying member are alloys based on Fe, Ni or Co which have good mechanical properties especially at high temperatures, such as austenitic alloys. Examples of load-carrying materials are:

- 18-25% Cr, 25-40% Ni, balance Fe and normally occurring additions like Al, C, N, Ti, Nb, Mo etc.
- 16-35% Cr, 50-75% Ni, , balance Fe and normally occurring additions like Al, C, N, Ti, Nb, Mo etc.

- 7-13% Cr, 0-0.2% C, 0-0.2 % N (min 0.05% C+N) balance Fe and additions of Nb, Ti, V, Mo and/or W etc.
- 16-22% Cr, 8-20% Ni, balance Fe and additions of for example Mn, Nb, C

The thickness of the load-carrying member is suitably adjusted to the conditions in which the product will operate and to the selected composition. Suitable thicknesses are ranging from 1 mm to 15 mm. However, tubes with even thicker walls can be used if so required. Preferably the wall thickness of the tube is within the range 1-10 mm, most preferably 2.5-5 mm. The load-carrying member can be in any geometrical form, such as in the form of seamless or welded tube, sheet, plate or even complex geometrical forms.

According to an embodiment of the invention, the Magnetic Pulse Welding process is used for manufacturing components directly into their final dimension. It can also suitably be used for butt welding of the previously described component. Furthermore, it can be used for production of the different members before the actual joining of the members, for example for producing the load-carrying member and/or metal dusting resistant member in the form of a seam welded tubes. Moreover, it is possible to produce the component by means of MPW and thereafter use MPW to weld the component to the desired final geometrical shape, such as a seam welded tube.

According to another embodiment of the invention, the Magnetic Pulse Welding process is used for manufacturing a blank or billet which should be processed further, for example by means of extrusion or rolling.

According to a further embodiment of the invention, the Magnetic Pulse Welding process is used for forming, such as bending or the like, of the previously described component.

The utilization of Magnetic Pulse Welding for joining the load-carrying member and the second member in accordance with the present invention is especially beneficial since the copper based alloy providing the resistance to metal dusting does not penetrate the load-carrying member. Consequently, the problems of deteriorated mechanical properties of the load-carrying member or deteriorated corrosion resistance of the component with the previously used methods are overcome. Furthermore, a cost effective method is accomplished as a result of the high welding speed.

CLAIMS

1. Method of manufacturing a component with high resistance to metal dusting wherein said component comprises a load-carrying member of a first material and a second member of a metal dusting resistant material characterized in that the metal dusting resistant material is applied to the load-carrying member by means of Magnetic Pulse Welding.

2. Method according to claim 1 characterized in that the load-carrying member is provided with a third member by means of magnetic welding wherein said third member preferably consists of a metal dusting resistant material.

3. Method according to claims 1 or 2 characterized in that the metal dusting resistant material is a copper based alloy comprising 2-20 % by weight of aluminum.

4. Method according to claim 3 characterized in that the metal dusting resistant material has the following composition in percent by weight:

   4-10 % Al
   >0-3 % Si
   0-1 % REM
   balance Cu and normally occurring impurities.

5. Use of the method according to any of the preceding claims for manufacturing of components to be exposed to environments wherein there is risk of metal dusting occurring.

6. Use according to claim 5 wherein the component is in the form of a tube, sheet, strip or bar.

7. Use according to claim 5 wherein the load carrying member has at least one weld other than the weld accomplished when joining of the load-carrying member and the other member of a material resistant to metal dusting.

8. Use according to claim 7 wherein the one weld other than the weld accomplished when joining of the load-carrying member and the other member of a material resistant to metal dusting is a butt weld.

9. Use according to claim 7 wherein the one weld other than the weld accomplished when joining of the load-carrying member and the other member of a material resistant to metal dusting is a seam weld produced when manufacturing the load-carrying member, the member of a material resistant to metal dusting or the final component of claim 1.

10. Use according to claim 5 wherein the component has a complex geometry.

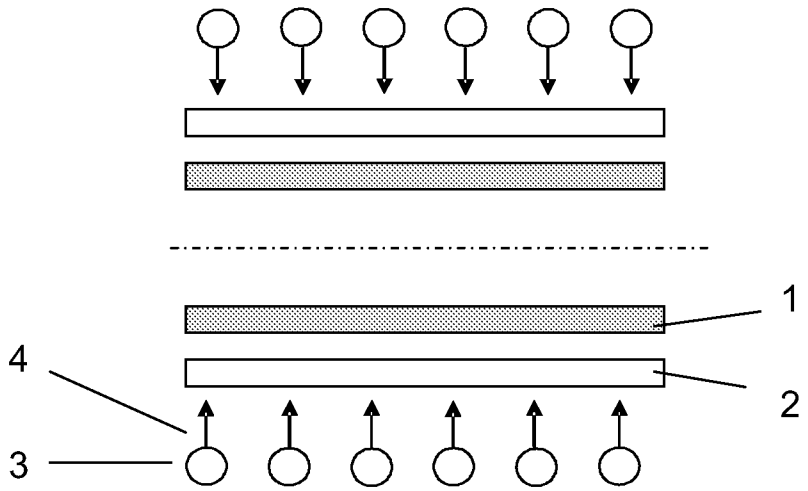

Fig. 1

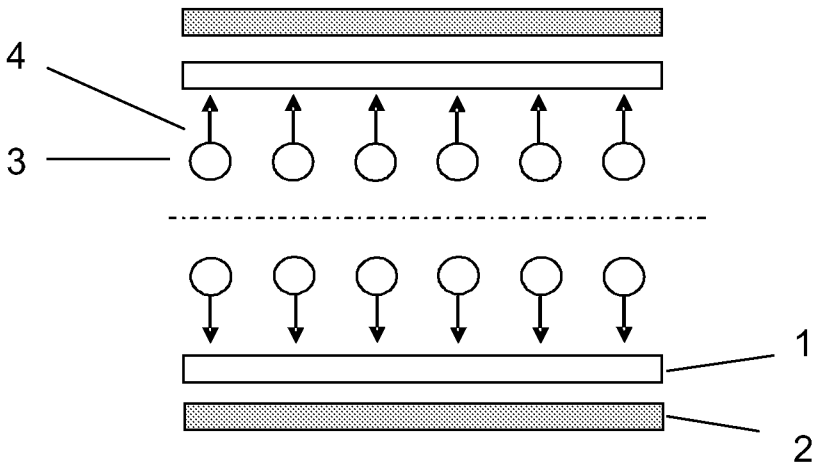

Fig. 2

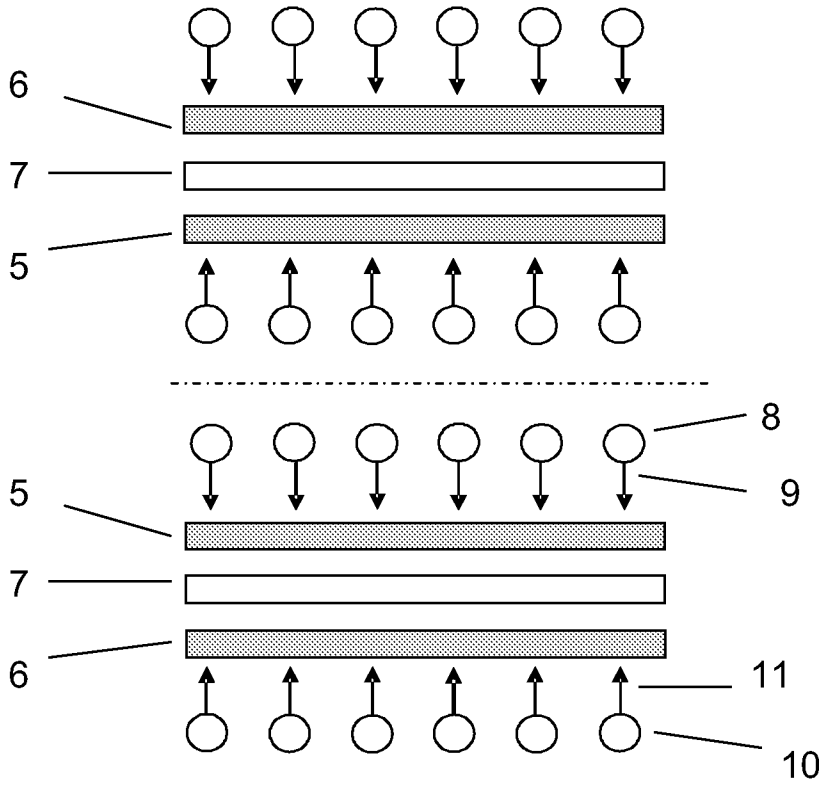

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2008/050183

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
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)

IPC: B23K

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4150274 A1 (MININ, V E ET AL), 17 April 1979 (17.04.1979), whole document ---	1-10
A	US 6234375 B1 (DURAND, R D), 22 May 2001 (22.05.2001), whole document ---	1-10
A	US 20030127453 A1 (KICHLINE, JR), 10 July 2003 (10.07.2003), whole document ---	1-10
A	GB 1387721 A1 (MIKHAILOVICH ANDRIANOV, A), 19 March 1975 (19.03.1975), whole document --- --------	1-10

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 June 2008	17 -06- 2008
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Ulrika Nilsson/PR Telephone No. +46 8 782 25 00

International patent classification (IPC)
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Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

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