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METHOD OF PRODUCING FILLETS

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The invention relates to alloys for producing fillets and producing fillets therewith.

Desiderata in fillets produced in structures, such as hollow steel propeller blades, are: A smooth or good meniscus on the fillet and one which will form slightly above the quench temperature of the propeller blade to prevent warpage during the filleting operation; a tenacious or efficient bond between the fillet material and the blade which will not rupture or loosen when the blade is subjected to working stresses; avoidance of an interface action between the fillet material and the steel after aging; avoidance of any appreciable affect upon the fillet material during subsequent heat treating operations or processing of the blade, and the avoidance of brittleness in the fillet which, so far as is known to me, have not been completely achieved with filleting materials heretofore used.

One object of the invention is to provide an alloy for use in producing fillets which results in a smooth or good meniscus on the fillet; which produces a tenacious bond with the steel which will not rupture or become loose when the blade is subjected to working stresses; which will not produce interface reaction with the steel when the fillet material is aged; and which has a melting temperature sufficiently higher than that used in heat treating or quenching the blade after it has been filleted so that the fillet will not be appreciably affected by heating and quenching the blade.

A filleting alloy of substantially 85% copper and 15% manganese has been found to achieve the desired results in a steel propeller and the fillet has been found to achieve unexpected results, after the blade has been heat treated or quenched and cooled, by maintaining its bond with the steel without rupture in destructive tests in which the steel was subjected to rupture.

Another object of the invention is to provide an improved method of producing fillets with the alloy.

Other objects of the invention will appear from the detailed description.

The invention consists in the several novel features which are hereinafter set forth and more particularly defined by claims at the conclusion hereof.

The preferred filleting material of the invention consists of an alloy of substantially 85% copper and 15% manganese. In producing fillets in a structure, for example, the inside corners of the leading and trailing edges of a hollow steel propeller blade of airfoil contour, with this alloy,

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the surfaces to be filleted are treated with a flux composed of sodium borate and silicon dioxide. The alloy in powder form or in the form of a wire is placed in the corners to be filleted in any suitable manner as well understood in the art. This copper manganese alloy has a melting point ranging from 1760° to 1780° F. The blade is then heated to a temperature sufficient to melt the fillet material and form the fillet in the corners where the alloy has been placed. During the melting of the fillet material, the chamber in the blade which contains the alloy is subjected to a reducing atmosphere, such as a gas composed of approximately 10% H₂, 10% CO, and 80% N₂. This reducing atmosphere is maintained in the chamber in the blade during the formation of the fillet, usually by means of a tube or conduit which extends through the open shank and terminates adjacent the tip of the blade. A constant flow of this gas is maintained in said chamber so that a very slight increased pressure of the reducing gas is maintained. A gas pilot flame is maintained adjacent the end of the tube, to burn the reducing gas escaping from the chamber in the blade and prevent the entrance of oxygen into the inside of the blade while the fillet is being formed.

In producing the fillet, it is highly desirable that a good reducing atmosphere should be maintained to prevent contamination of the alloy by oxidation. The extreme activity of the manganese in the alloy makes it necessary to prevent any oxygen from coming in contact with the material, which would result in oxidation and deterioration of the effectiveness of the material. This alloy does not develop any brittleness in the fillet.

In processing hollow steel propeller blades after the blade has been filleted, the blades are heat treated and quenched and drawn to harden the steel to increase its resistance to fatigue and abrasion. The quenching is done while the blade is approximately at 1550° F. and the blades are drawn at approximately 1000° F., and as a result the temperatures to which the blade is subjected after filleting do not melt or unfavorably affect the previously formed fillet. For that purpose, the melting point of the alloy should be from 100° to 150° F. above the quenching temperature.

This alloy and the temperature to which it is subjected during filleting result in a smooth and good meniscus on the fillet. This alloy, with its suitable melting point, produces high tensile strength in the fillet with a minimum of distortion of the blade. This alloy also results in a

tenacious bond between the fillet and the steel. The use of a flux containing sodium borate and silicon dioxide has been found to be important in achieving these desired results with the copper-manganese alloy. The use of common sodium borate and boric acid flux has been found to yield porous and inferior melts. The alloy has a good capillary action and does not become brittle during the formation of the fillet or the processing of the blade. There is no harmful interface action between the fillet metal and the steel after aging. Unexpected results from destructive tests have indicated that the fillet retains its bond to the steel and will not rupture when the steel is subjected to rupture.

The alloy composed of 15% manganese and 85% copper has been found to achieve the aforesaid desired characteristics. The alloy, if the manganese content is increased substantially above 15%, has a binary or two-phase characteristic which it is believed should be avoided. A substantial increase of the copper content over 85% raises the melting temperature and lowers the tensile strength of the fillet. The alloy of 85% copper and 15% manganese has been found to be the optimum and to produce the most efficient and desirable results. These results can, to some degree, be attained by an alloy consisting of 82 to 90% copper and 18 to 10% manganese. It has also been found that the addition of 5% nickel to the copper-manganese alloy may be beneficial in some instances, but on account of being a critical metal, it is not deemed preferable.

The invention exemplifies an alloy: for producing fillets with a flux composed of sodium borate and silicon oxide; and which has a suitable melting range and capillary action; which has no appreciable per cent of silicon which results in brittleness; which produces good menisci; which forms a tenacious bond with the steel; which has a high tensile strength, and has no interface reaction with the steel from aging or produced by subsequent heating operations on the blade at a temperature lower than the melting point of the alloy. These characteristics are particularly advantageous in filleting hollow steel propeller blades. While the alloy is adapted for filleting in propeller blades, it is to be understood that it may also be used for fillets used for joining parts together on account of its great tensile strength and its tenacious bonding properties.

The invention is not to be understood as restricted to the details set forth, since these may be modified within the scope of the appended claims without departing from the spirit and scope of the invention.

Having thus described the invention, what I

claim as new and desire to secure by Letters Patent is:

1. That improvement in forming a fillet in an element of ferrous metal, which comprises: applying a suitable flux and an alloy containing from 82 to 90% copper, 10 to 18% manganese and having a melting point substantially over 1550° F. to the surface to be filleted, and melting the alloy on said surface in a constantly maintained reducing atmosphere to prevent oxidation and in such manner that said alloy will become alloyed with the ferrous metal and form the fillet.

2. That improvement in forming a fillet in an element of ferrous metal, which comprises: applying a flux containing sodium borate and silicon dioxide and an alloy containing from 82 to 90% copper and 10 to 18% manganese and having a melting point substantially over 1550° F. to the surface to be filleted, and melting the alloy on said surfaces in a constantly maintained reducing atmosphere to prevent oxidation and in such manner that said alloy will become alloyed with the ferrous metal and form the fillet.

3. That improvement in forming a fillet in an element of ferrous metal, which comprises: applying a flux containing sodium borate and silicon dioxide and an alloy containing substantially 85% copper and 15% manganese and having a melting point substantially over 1550° F. to the surface to be filleted, and melting the alloy on said surface in a constantly maintained reducing atmosphere to prevent oxidation and in such manner that said alloy will become alloyed with the ferrous metal and form the fillet.

4. That improvement in forming a fillet in an element of ferrous metal, which comprises: applying a flux and an alloy containing from 82 to 90% copper and 10 to 18% manganese and having a melting point substantially over 1550° F. to the surface to be filleted, melting the alloy on said surface in a constantly maintained reducing atmosphere to prevent oxidation and in such manner that said alloy will become alloyed with the ferrous metal and form the fillet, and quenching the filleted element without melting the fillet.

5. That improvement in forming a fillet in an element of ferrous metal, which comprises: applying a suitable flux and an alloy containing from 82 to 90% copper, 10 to 18% manganese, and not over 5% of nickel, and having a melting point substantially over 1550° F. to the surface to be filleted, and melting the alloy on said surface in a constantly maintained reducing atmosphere to prevent oxidation and in such manner that said alloy will become alloyed with the ferrous metal and form the fillet.

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