Research and development of innovative stud welding technology

1. **Merchandise Name**：Research and development of innovative stud welding technology

2. **Developing Staff Members**

單位（系 / 所）	姓名	職稱
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3. **Development Idea**

According to a conventional stud welding method, a welding portion of a fastener is positioned into contact with a welding zone of a metal workpiece. When an electric current flows through the fastener to the metal workpiece, and then the fastener is lifted from the metal workpiece, thus drawing an electric arc between the fastener and the metal workpiece. Consequently, the welding portion of the fastener and the welding zone of the metal workpiece are melted by the heat of said electric arc. Finally, a mechanical force is applied to the fastener, plunging the welding portion of the fastener into the welding zone of the metal workpiece, resulting in a welded joint.

In practice, the stud welding process is usually carried out with a stud welding machine. The stud welding machine includes a welding gun for holding the fastener. When such a machine is switched on, a voltage is applied to the fastener to form a current flowing from the fastener to the metal workpiece, such that the electric current flows through the fastener to the metal workpiece. A push-pull mechanism will then lift off the fastener from the metal workpiece to draw an electric arc, consequently melting the welding portion of the fastener and the welding zone of the metal workpiece. After a predetermined arcing time, the push-pull mechanism will apply the mechanical force to plunge the fastener into a molten pool formed on the metal workpiece, forming a soundness joint connecting the fastener and the metal workpiece after the molten pool cools down.

Particularly, when a fastener with a large diameter is used, it is usually required to dig a small hole at the center of its welding portion and to insert an ignition tip into said hole before drawing the electric arc for welding. Without the ignition tip, the electric arc cannot be easily created and smoothly formed, thus the fastener and the metal workpiece cannot sufficiently melt to tightly connect with each other. However, the insertion process of the ignition tip is complicated with high cost, significantly reducing welding efficiency and increasing the cost of production.

The objective of this project to provide an ignition flux for stud welding. By coating the ignition flux on the surface of a metal workpiece, a fastener can be tightly connected with the metal workpiece, without the need of inserting an ignition tip into the welding portion of a fastener. The project further provides a stud welding method which utilizes the ignition flux to tightly connect the fastener with the metal workpiece, without the need of inserting an ignition tip into the welding portion of a fastener.

4. Technological Competition and Industrial Application

This innovative stud welding method, including preparing a fastener having a welding portion; preparing a metal workpiece having a welding zone; coating an ignition flux onto the welding zone of the metal workpiece, positioning the welding portion of the fastener in firm contact with the welding zone of the metal workpiece, and then providing an electric current to the fastener; separating the fastener and the metal workpiece to draw an electric arc between the fastener and the metal workpiece until the welding portion of the fastener, said ignition flux, and the welding zone of the metal workpiece are melted; and applying a mechanical force to plunge the welding portion of the fastener into the welding zone of the metal workpiece. As such, the fastener can be directly connected with the metal workpiece without the need of inserting an ignition tip into the welding portion of a fastener. The complicated steps and high cost for inserting the ignition tip can be avoided, improving the welding efficiency, and reducing the cost of production.

This innovative stud welding process has high efficiency, and is widely used for shipbuilding, building, bridge constructions, automotive bodies, mechanical equipments, chemical equipments, and electricity equipments.

5. Merchandise Statement of Achievement

This innovative stud welding method utilizing the ignition flux to connect the fastener to the metal workpiece. The fastener can be a stud; and the metal workpiece is usually a metal sheet or a metal tube.

According to needs, the fastener and the metal workpiece can be cleaned initially before welding. For instance, dirt and oil adhered to their surfaces can be washed off using a volatile solvent, and rusty spots thereon can be removed by sandblasting or polishing steps. Next, as shown in Fig. 1, the ignition flux **1** is coated onto the welding zone of the metal workpiece **2**.

The coated area of said ignition flux is preferably larger than the size of the welding portion of the fastener **3**. When the fastener is a stud, the welding portion is usually a conical end thereof. Accordingly, the welding zone of the metal workpiece can be a plat surface or a curved surface. The ignition flux can be premixed with a solvent to form a paint-like consistency and then coated onto the welding zone of the metal workpiece using a brush. Alternatively, the ignition flux in the powder form can be directly sprinkled on the welding zone of the metal workpiece.

After coating the ignition flux onto the welding zone of the metal workpiece, the welding portion of the fastener is positioned into firm contact with the welding zone of the metal workpiece, and then a voltage is applied to the fastener to form a current flowing from the fastener to the metal workpiece, such that the electric current flows through the fastener to the metal workpiece. During welding, the metal workpiece can be placed on ground or held by a rack. The fastener can be hold by a welding gun, and the electric current can be provided to the fastener through said welding gun. With the electric current provided, the fastener is moved away from the metal workpiece, such as moving or lifting the welding gun holding the fastener to adjust the distance between the fastener and the metal workpiece, thus the electric arc can be readily drawn between the welding portion of the fastener and the welding zone of the metal workpiece. Under the high temperature provided by the electric arc, the welding portion of the fastener melts into a molten pool, and the welding zone of the metal workpiece melts into another molten pool. When both the welding portion of the fastener and the welding zone of the metal workpiece are melted, these two molten pools are positioned into contact with each other. A mechanical force is applied to plunge the fastener to the metal workpiece, such that the two molten pools fuse together. After the molten pool cools down, the welding portion of the fastener is tightly connected to the welding zone of the metal workpiece.

In the project, M6 stud is used as the fastener, and stainless steel sheet with a thickness of 2 mm is used as the metal workpiece. After welding, the specimens are cut at a section passing through the axis of the welded joint. All samples are then mounted, ground, polished and etched. The weld profiles are photographed using a stereo microscope, and the results are shown in Figs. 2~4, respectively. Fig. 2 which uses no ignition flux, shows low penetration depth of the weld, indicating the welded joint with insufficient strength. Fig. 3 which uses A composition ignition flux, significantly increases the penetration depth of the weld, and can be readily used in practice. Fig. 4 which uses B composition ignition flux, shows a further increased the penetration depth of the weld, dramatically increasing the strength of the welded joint.

The experimental results show that by using the ignition flux, the fastener can be directly connected with the metal workpiece without the need of inserting an ignition tip into the welding portion of a fastener. Thus, welding efficiency can be improved, and the cost of production can be reduced. Besides, in the stud welding method, by using the ignition flux, the electric arc can be easily created and smoothly formed with high temperature, significantly improving the penetration depth of the weld and the strength of the welded joint.

This innovative stud welding, comprising : preparing a fastener having a welding portion ; preparing a metal workpiece having a welding zone ; coating an ignition flux onto the welding zone of the metal workpiece ; positioning the welding portion of the fastener in firm contact with the welding zone of the metal workpiece, and then a voltage is applied to the fastener to form a current flowing from the fastener to the metal workpiece ; separating the fastener and the metal workpiece to draw an electric arc between the fastener and the metal workpiece until the welding portion of the fastener, said ignition flux, and the welding zone of the metal workpiece are melted; and applying a mechanical force to plunge the welding portion of the fastener into the welding zone of the metal workpiece.

This innovative stud welding method, further comprising placing the fastener and the metal workpiece into a protective atmosphere after coating the ignition flux onto the welding zone of the metal workpiece and before providing the electric current to the fastener.

This innovative stud welding method, further comprising enclosing the welding portion of the fastener and the welding zone of the metal workpiece with a ceramic ferrule after coating the ignition flux onto the welding zone of the metal workpiece and before providing the electric current to the fastener.

This innovative stud welding method coats the welding zone of the metal workpiece with the ignition flux, the fastener can be tightly connected with the metal workpiece without the need of inserting an ignition tip into the welding portion of a fastener. Hence, the complicated steps and cost of ignition tip insertion can be avoided, improving the welding efficiency, and reducing the cost of production.

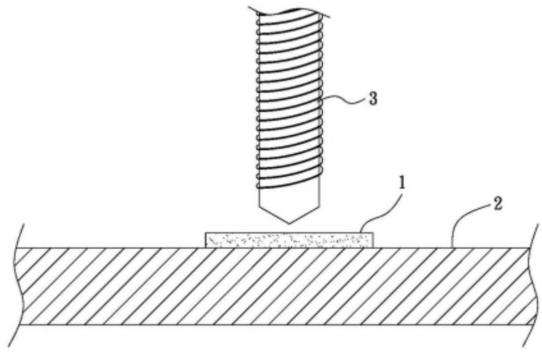

Fig 1 : Schematic diagram of coating an ignition flux.

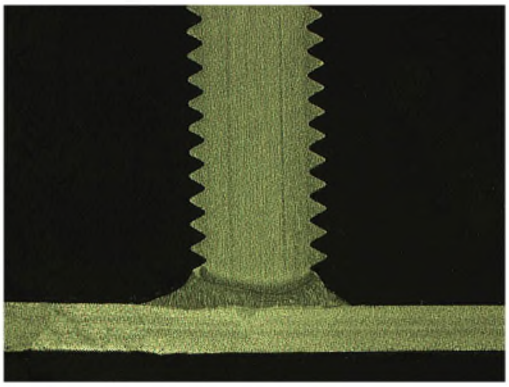
Fig 2 : Weld profile of without ignition flux.

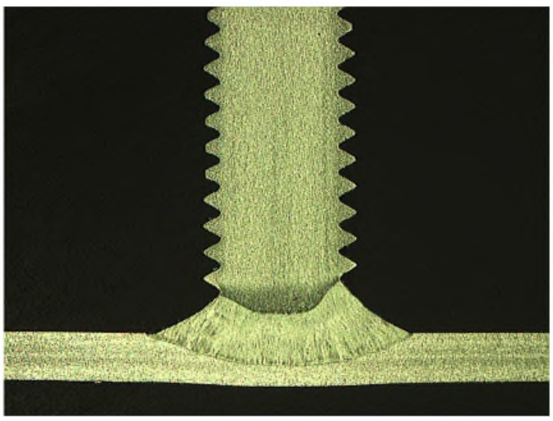
Fig 3 : Weld profile of with A composition ignition flux.

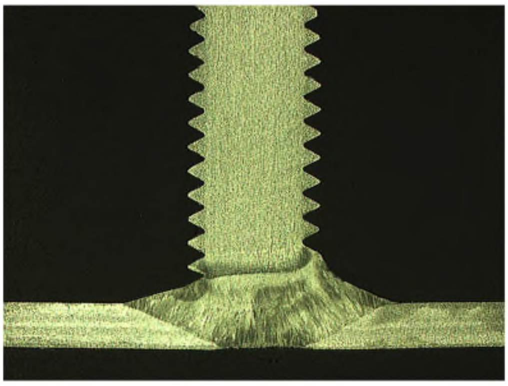

Fig 4：Weld profile of with B composition ignition flux.