Introduction to Copper Thermite Welding Bond

1. INTRODUCTION

Recent years have seen upgrading in railway signaling systems aimed at safe and stabilized rail transportation. One of the core components of railway signaling systems is electric circuit called a track circuit using rails as electric conductor, which serves to detect existence of trains when the rails are short circuited by the axle shaft of a train.

An electric conductor directly jointed to the rail thereby constituting track circuits is called a bond. Although bonds are mainly jointed to the rail by soldering conventionally, it has been found that jointed bonds frequently fall off from their joint due to shock and vibration at the time of train passage, resulting in malfunction of the track circuit and thereby creating one of the major factors that prevent stabilized transportation. Copper thermite welding bond, with its superior mechanical strength and stabilized work performance, has been favorably reevaluated as a countermeasure against the falling-off of bonds, and has been employed by many domestic railroad companies achieving many successful results. Outline of the copper thermite welding bond will be presented here.

2. BOND FOR TRACK CIRCUITS

The type and use environment of track circuit bond will be briefly described as follows.

2.1 Type of Bond

Rail for railroads serves not only as a track on which trains travel, but also as a conductor like electric wire to guide different kinds of currents. Electric currents on the rail track include the return current from electric train motors, as well as the signal current used for train operation control such as location detection and speed control.

The bond for the former, i.e., for return current use is called a rail bond and for the latter, i.e., for signal current use is called a signal bond. More specifically, as shown in Figure 1, a rail bond is used to electrically connect between rails to effect smooth conduction of the return current. On the other hand, as shown in Figure 2, a signal bond is used to branch the signal current on the rail to lead the current to the lead wire of control equipment.

2.2 Use Environment

Since it is directly jointed to rails, the bond is exposed to intense vibration of the rail at the time of train passage. Although intermittently, the vibration lasts for a long time, sometimes exceeding 300 G in acceleration, which is unquestionably very severe for this kind of electric conductor equipment.

3. Copper Thermite Welding Bond

The outline of copper thermite welding bond of Furukawa Power Components will be presented here.

3.1 Product

1) Copper Thermite Welding Powder
   Copper oxide and aluminum powder are encapsulated

Figure 1 Rail bond installed on a rail.

Figure 2 Signal bond installed on a rail.

in a ceramic container. Figure 3 shows the appearance.

2) Bond
The bond comes in different conductor sizes and forms according to application and current capacity. Figure 4 shows the appearance.

3) Mold and Clamp
It consists of a crucible for combusting copper thermite welding powder and a clamp for fixing the crucible to the rail. Figure 5 shows the appearance.

3.2 Principle

The copper thermite welding is a welding method that takes advantage of a thermochemical reaction called a thermite reaction. In this reaction, the copper thermite powder comprising copper oxide and aluminum powder is ignited in the crucible and the generated heat is used to joint the bond to the rail. The welding process is shown in Figure 6.

Figure 3 Thermite welding powder.

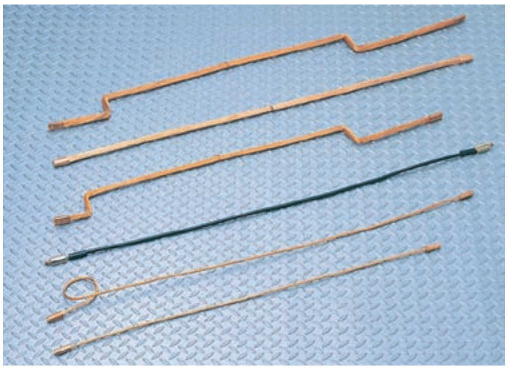

Figure 4 Typical rail bonds.

Figure 5 Mold and clamp.

3.3 Welding Procedure

Figure 7 shows the welding procedure.

3.4 Features

1) As illustrated in the welding procedure above described, the jointing work on the rail is simple and skill-less.
2) The molten copper generated by the thermite reaction reaches a temperature as high as approximately 2,000℃. Due to this high temperature, the bond terminal and the rail matrix partially melt to make a reliable joint, so that the bond joint has a high mechanical strength leading to superior durability against shock and vibration at the time of train passage. On the other hand, unless treated by suitable means, the rail matrix at the bond joint is subjected to rapid heating and cooling, so that a residual tensile stress is generated on this spot resulting in disadvantageously a

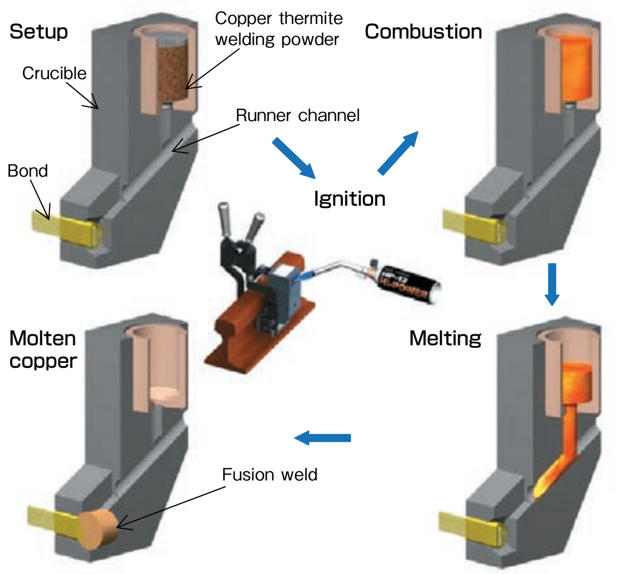

Figure 6 Thermite welding process.

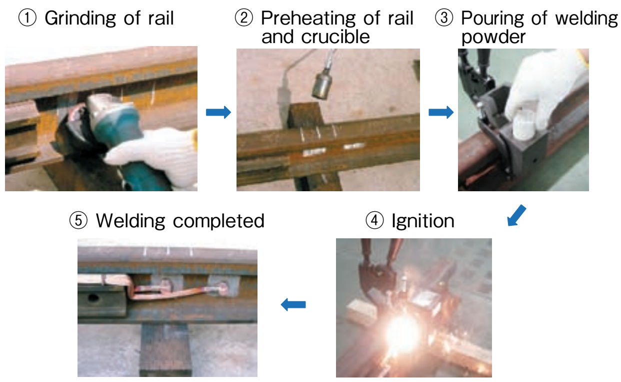

Figure 7 Welding procedure.

decreased fatigue resistance.

3.5 Remedial Measures Proprietary to Furukawa Power Components for Improvement of Rail Fatigue Strength

To summarize and repeat the description above, the high-temperature copper thermite welding has, in spite of its strong welding strength, thermal effects on the rail to lower the fatigue strength. It is said that this is the reason why copper thermite welding failed to be widely used in rail track applications. Furukawa Power Components has developed a new method to suppress the decrease in the fatigue strength of welded rails, thereby succeeding in expanding the application area of copper thermite welding for rail tracks. In this method, depressed areas are formed around the bond that is welded on a rail, thus removing the residual tensile stress on the welded portion of the rail so as to improve the fatigue strength. The depressed areas are formed by impact blowing and compression. The method is called “peening”, and is standardized as shown in Figure 8. The peening method has expanded the application of copper thermite welding bonds, resulting in the widespread use of today.

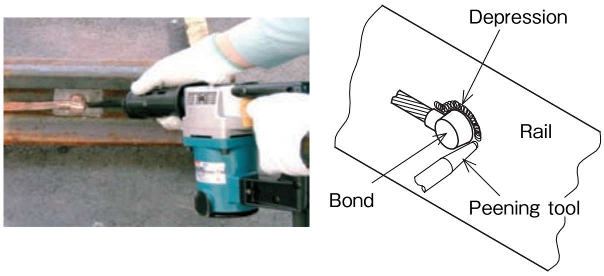

Figure 8 Peening method.

4. CONCLUSION

Although, as mentioned at the beginning, the copper thermite welding bond has received a certain extent of recognition as a countermeasure for reinforcing track circuits, it is still a developing product. Installation works on the rail are usually done at night, so that the working tools are required to be low in noise, non-power driven and lightweight. However, it is true that the welding tools of Furukawa Power Components have to be improved still to meet these requirements. We intend to focus on the improvement of the welding tools, thus responding to the customers’ requirements.

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