

Development of Two Piece Type Contact Tip for Long Life

M.Kutsuna¹ and T. Murakami²

¹Advanced Laser Technology Research Center CO., Ltd. 40-7 Hiromi, Anjo-cho, Anjo-shi, Aichi-ken, Japan 446-0026

²Taiko Engineering Ltd, Hamamatsu, Shizuoka-ken, Japan

E-mail: altrec-kutsuna@nifty.com

Abstract

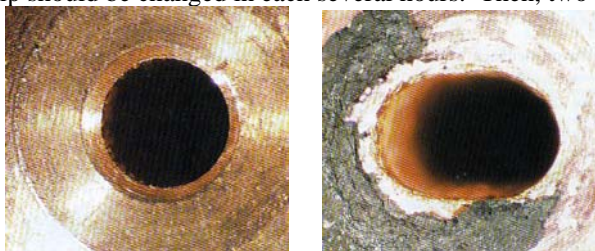
One piece type contact tip is now used as contact tip for gas shielded arc welding. The life time should be improved for automatic or robotic welding systems. In the present work, two piece type contact tip was developed to improve the life time and arc stability. The tip cover and contact tip unit are also developed for most of the arc welding torch in Japan. Comparing with the life time of a conventional contact tip, the life time of a developed one is 10 ~ 20 times longer than that of conventional one.

1. Introduction

In gas metal arc welding (GMAW), an electric arc is established between a continuously fed consumable electrode (welding wire) and the work piece. Welding current is supply from power source to the work piece through a contact tip and the electrode in the welding torch. So, the contact tip is a key component of a welding torch for stable GMAW process. The contact tip has two main functions. One of them is to feed the current to the work piece through the electrode which is fed through the tip. Another one is to introduce welding arc and electrode tip to the correct position during welding to get stable welding process, especially in robotic welding.

The life of contact tip is important in automatic welding, because the changing time of contact tip reduce the arc time and increases the welding cost. The contact tip should have long life time and lower price. Then, several research are reported on a conventional contact tip (one piece type).

For instance, contact tip wear was studied. If severe wear is occurred on the contact tip as shown in Figure 1, robotic welding operation can not continue. Conventional contact tip should be changed in each several hours. Then, two



(a) Unused contact tip (b) Tip wear after hours

Figure 1 The characteristics of contact tip wear [1]

piece type contact tip has been developed to solve the problems. One of the characteristics is long life time and another one is stable arc phenomena without any troubles.

2. Development of two piece type contact tip

To get a smooth/stable feeding of current from contact tip surface to electrode surface, low stress was applied to the one end (point C) of contact tip using a small spring in tip base as shown in Figure 2. Another end (point A) of contact tip can be rotated at point B as an axis. Then, the point A of contact tip is pushed to the electrode wire during welding. When a bended electrode wire is supplied, The gap of each contact tip can be expanded. The applied stress to the contact tip is not increased too much. The contact point of electrode is kept always at the point A. Then, Joule heating may be occurred from the point A. the temperature of end of tip is kept lower comparing with conventional one which has the contact point inside of tip Then, the wear of tip is not severe, comparing that of the conventional one.

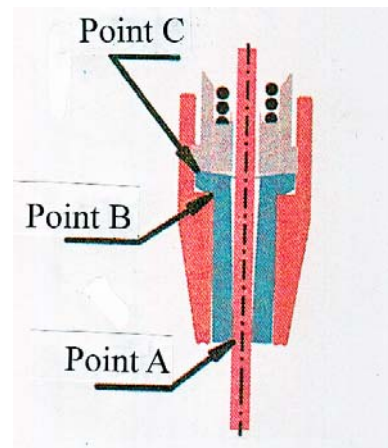


Figure 2 Cross section of two piece type contact tip

The weight of a developed contact tip is 3.2g. That of conventional one is 17g as shown in Figure 3. The material is copper or 3%Cr-Copper. The manufacturing process is different from that of conventional one. In the case of two

piece type contact tip, Roll forming, stamping and forge cutting are used for forming. High production rate can be obtained using these forming processes. Figure 4 shows a

type of developed contact tip and contact tip unit for MAG process using an electrode wire of 1.2mm in dia.

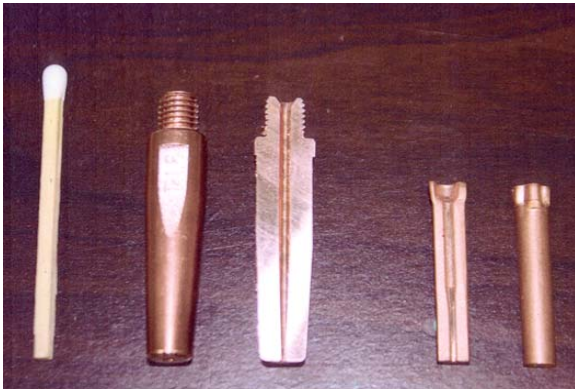


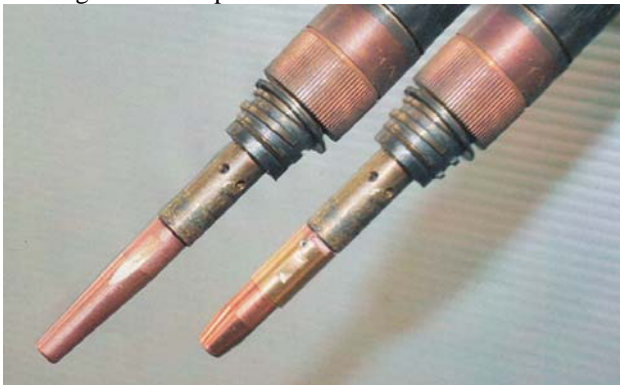
Figure 3: Contact tips (Left: conventional, Right; new one)



(a) Tip cover (b) Contact tip (c) Tip base

Figure 4 Developed contact tip and tip units for MAG

Several types of tip unit which includes tip cover and tip base has been developed to attach to several type of welding torch. in Japan.



.Figure 5 Contact tip unit with a ceramic guide

The size of screw of conventional contact tip is the same as a developed tip unit. So, It is easy to change the contact tip from a conventional tip to the developed tip unit as shown in Figure 5..

3. Advantages of two piece type contact tip

The two piece type contact tip has the following features;

- 1) Excellent current transferability:
The wire contact point is kept at Point A in Figure 2 due to the spring mechanism during welding.
- 2) Long life of contact tip: The life time of contact tip is

10 ~20 times longer than that of conventional tip. It is Due to the no Joule heating before contact of tip at the Point A.

- 3) Higher arc stability without feeding hesitation :
Resulting in less spatter and good arc starts
- 4) Good linear adjustment of filler wire to arc location
- 5) Low price of contact tip :
Due to the high production process (forging/stamping)
- 6) Small size and low weight of copper tip:
The weight of 25mm length tip is 3. 2g
and that of 30mm length tip is 4.2g .

4. Evaluation of two piece type contact tip

4.1 Tip wear test in CO2 and MAG welding

Mild steel SS400 plates were welded under the following Welding conditions using a MG-50 (1.2mm in dia) filler wire for a long time as shown in Figure 6.

Welding current : 280A ~ 307A.

Arc voltage : 32.7V ~32.9V

Welding speed : 600mm/min

Shielding gas : 100%CO2 20L/min

or 80%Ar +20%CO2 20L/min

Wire extension : 17mm-19mm

Figure 6 Welding test for contact tip using a robot

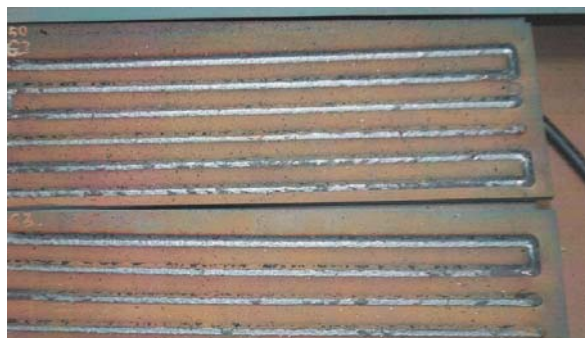


Figure 7 Bead appearance of welded plates

Arc time of each test piece was 6 minutes and weld length was 3.6m each. 120 test pieces were welded in 24 hours. The arc time was 12 hours. Tip wear was measured by a laser microscope as shown in figure 8.

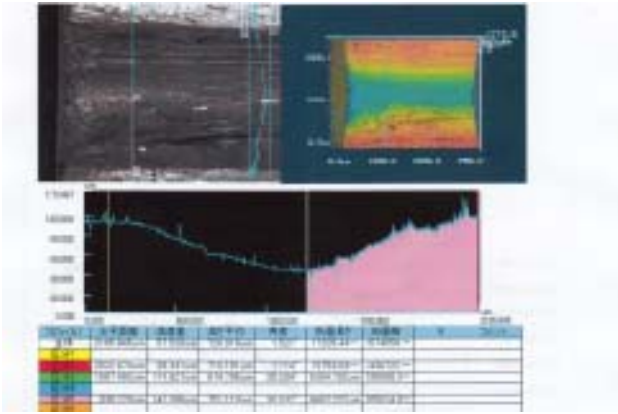


Figure 8 Measurement of tip wear using a laser

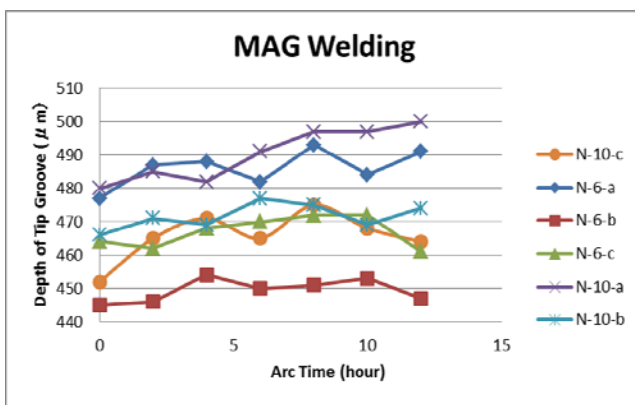


Figure 9 Measured groove depth of contact tip in MAG process using a two piece type of contact tip (tip No.6 and No.10 a) Tip of contact tip b) middle point, c) Root of contact tip

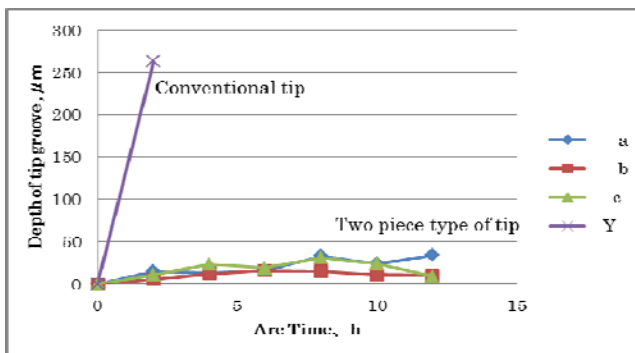


Figure 10 Comparison of new tip wear to conventional tip

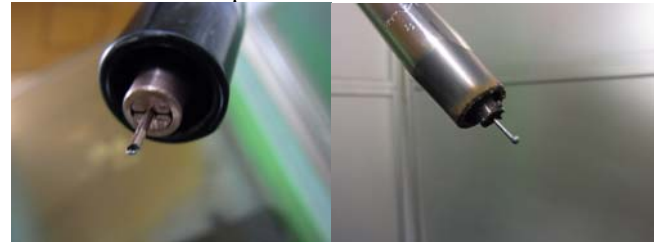
Figure 9 shows the results of groove depth measurement after each two hours of arc time in MAG Process. Measurement error is about $\pm 15 \mu m$. Wear occurs mainly tip of the contact tip (line a). Total (Tip No.6 and No.10)

groove wear was $37 \mu m$ after 12 hours of arc time. In the case of conventional tip, the groove wear was $263 \mu m$ after

2 hours as shown in Figure 10. It was 39 times higher than

that of two piece type contact tip. In case of CO2 arc welding, Total groove wear was $57 \mu m$ after 12 hours of arc time. Amount of Spatter on nozzle and contact tip was measured each 36 minutes of operation. it was .0187g/min. Figure 11 shows the photos of welding nozzles. Spatter on the nozzle and tip are a small amount. Color changing of

welding wire occurred from the tip of contact tip as shown in Figure 12. This means Joule heating of wire starts from the tip of contact tip. The temperature of wire is not high at the end of contact tip.



(a) Before welding (b) After 18 minutes
Figure 11 Photos of Welding nozzles

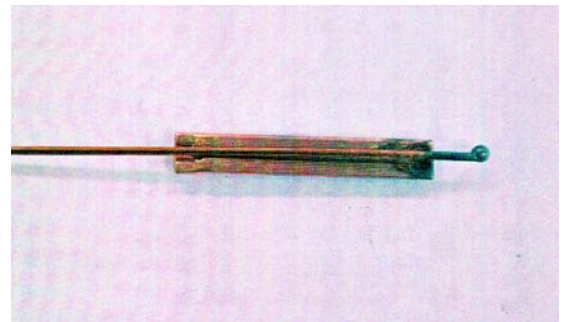


Figure 12 Appearance of welding wire and contact tip after 4 hours welding operation

4.2 Arc stability test in CO2 and MAG welding

For evaluation of arc stability using a two piece type contact tip, CO2 arc welding and pulsed MAG welding were conducted using a conventional and a developed contact tip. DS1A filler wire of 1.2 mm in dia. was used under the following welding condition;

welding current : 208 A for pulsed MAG
230A for CO2 arc W.

arc voltage : 27V ~ 30 V

travel speed : 50 cm/min

Figure 13 and 14 show the bead appearance in pulsed MAG Welding using a conventional and a developed contact tip. The arc starting was excellent. Spatter is more less on the plate in the case of a developed .contact tip.

Figure 15 shows the spatter on the torch nozzle. Spatter on The nozzle using a developed contact tip is more less than that by a conventional one. In addition, the characteristics of arc starts was checked. The developed contact tip showed good arc starts. Next, the welding current and arc voltage are recorded during pulsed MAG welding using a memory recorder. The results are shown in Figures 15 and -16.



Figure 13 Bead appearance in pulsed MAG Welding using a developed contact tip.



Figure 14 Bead appearance in pulsed MAG Welding using a conventional contact tip.

Arc stability in MAG process using a developed contact tip is better than that using a conventional one.

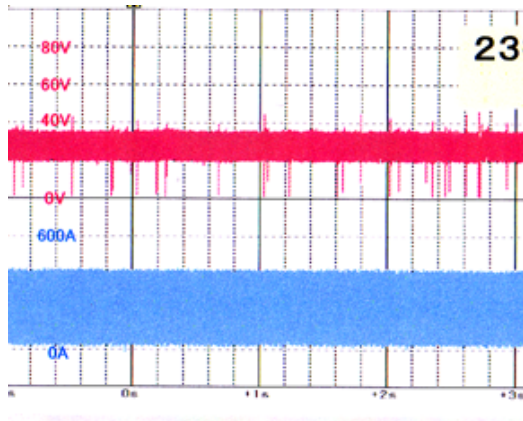


Figure 15 Welding current and arc voltage during welding using a developed contact tip in pulsed MAG

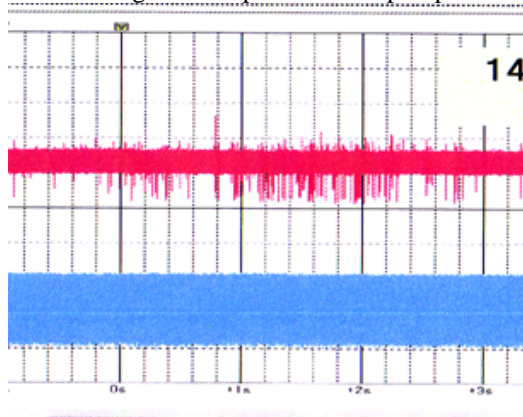


Figure 16 Welding current and arc voltage during welding using a conventional contact tip in pulsed MAG

Figure 17 shows the changing range of welding current during CO₂ arc welding and pulsed MAG welding. The

welding conditions are following;

Filler wire : DS1A 1.2mm in dia.

Wire feeding speed: 767cm/min (for CO₂ arc welding)
800cm/min(for Pulsed MAG)

Travel speed : 50cm/min

Base metal : Mild steel (thickness : 9mm)

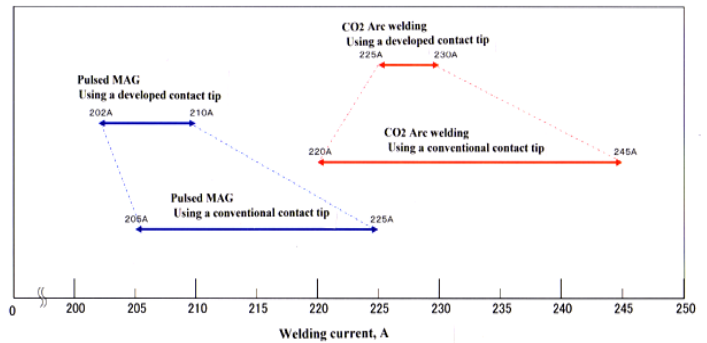


Figure 17 Changing range of welding current in CO₂ and pulsed MAG

Welding current changes using contact tip in both welding process are small comparing with that using a conventional one. This means that arc stability using a developed contact tip is higher than that using a conventional one.



Figure 18 Tip appearance of two piece type contact tip after 50 hours in 8 days in the work shop. (welding current: 120A ~ 160A)

Figure 18 shows the tip appearance of the developed contact tip after 50hours operation in 8days. However, the tip wear is not severe.

5. Application of two piece type contact tip

The applications of two piece type contact tip is the same as a conventional one. It is also the same as application field of MAG welding process. One of the application fields is automotive industry. Figure 19 shows example of parts to be welded using a two piece type contact tip in CO₂ arc welding. Motorcycle parts were welded for 50hours in 8days.

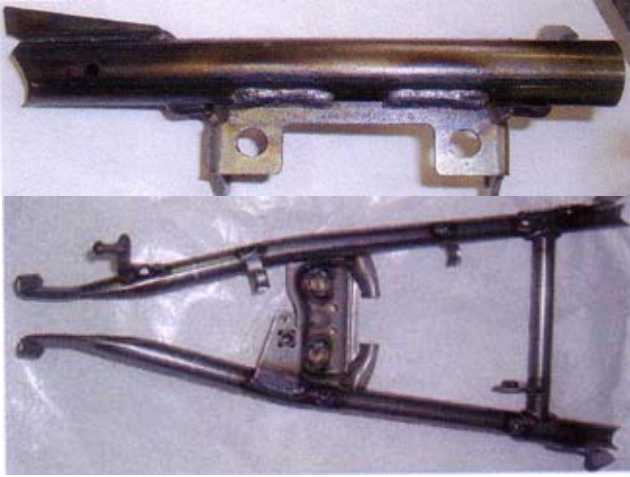


Figure 19 Motorcycle Parts welded by CO₂ arc welding using a two piece type contact tip. (Diameter of filler wire : 1.0mm)

Conclusion

The two piece type contact tip has been developed for GMAW process. It has the following features;

- 1) Excellent current transferability
- 2) Long life of contact tip
- 3) Higher arc stability without feeding hesitation
- 4) Good linear adjustment of filler wire to arc location
- 5) Small size and low weight of copper tip

These characteristics are shown in the welding tests comparing with a conventional contact tip.

The contact tip unit is also developed for most of the arc welding torch in Japan. Comparing with the life time of a conventional contact tip, the life time of a developed one is 10 ~20 times longer than that of conventional one.

References

- [1] J. Villafuerte, "Understanding Contact Tip Longevity for Gas Metal Arc Welding," *Welding Journal*, vol.78, pp. 29-35, Dec. 1999.