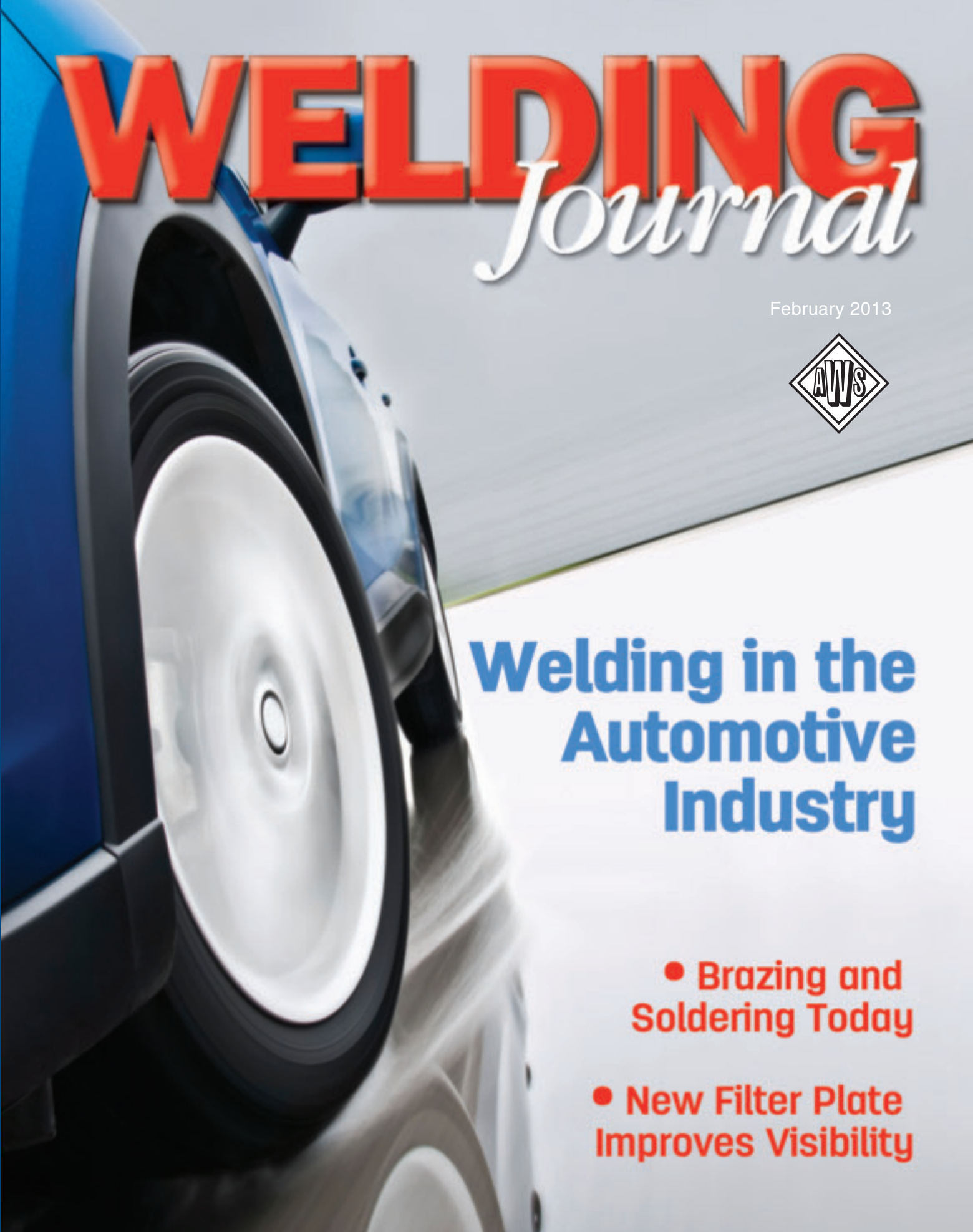

WELDING Journal

February 2013

Welding in the Automotive Industry

- Brazing and Soldering Today
- New Filter Plate Improves Visibility

PUBLISHED BY THE AMERICAN WELDING SOCIETY TO ADVANCE THE SCIENCE, TECHNOLOGY, AND APPLICATION OF WELDING AND ALLIED JOINING AND CUTTING PROCESSES WORLDWIDE, INCLUDING BRAZING, SOLDERING, AND THERMAL SPRAYING

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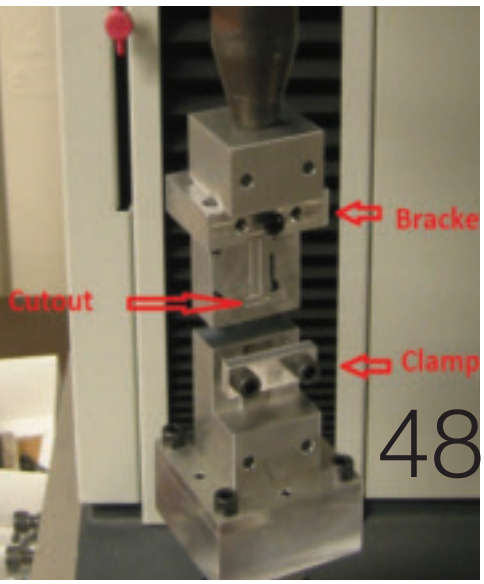

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What Is WEMCO and Why Should I Join?

Since the two questions above are always the first ones manufacturers ask when we approach them about joining our association, I thought I'd give you the answers.

The Welding Equipment Manufacturers Committee (WEMCO), a standing committee of the American Welding Society (AWS), is a group of more than 80 welding equipment manufacturers that was formed 15 years ago so manufacturers could promote, discuss, and improve the industry. Members meet annually in February for great networking and to hear first-rate speakers address pertinent topics affecting our industry. The intrinsic value is in meeting with top executives of various-sized manufacturers involved in the welding industry. Each member is given the opportunity to hear new ideas, share best practices, and network with some of the best minds in our industry. The highlight of the annual meeting is the economic forecast by renowned economist Alan Beaulieu of Industry Trends Research.

The value of membership cannot be overstated. Long-time WEMCO member Dave Marquard, CEO/owner of SuperFlash Compressed Gas Equipment, recently wrote, "My time and expenses have always been critical. Especially time. Time is really the only product and service that all of us have. If you are to be successful, or even just survive, you have to optimize every minute of it. WEMCO has helped me optimize it."

Here's what WEMCO members rely on:

- Exposure to the best networking in the welding industry.
- WEMCO's annual meeting. Compelling topics, top-level presenters, and invaluable information to your company. This year's meeting will be held in conjunction with the Resistance Welding Manufacturers Alliance (RWMA) at Saddlebrook Golf & Tennis Resort in Wesley Chapel, Fla. For more information, visit *www.wemco.org.*
- Participation in business forums and roundtables that provide workable options and better leveraging.
- Receiving quarterly newsletters, forecasting reports, and research from WEMCO's leading economist.

WEMCO membership benefits extend the bounds of the annual meeting. WEMCO, along with the American Welding Society, continues to lead the way in promoting welding as a career. AWS via its new Careers in Welding Committee has made a huge investment in promoting the welding industry to high schools, Boy Scouts, and technical colleges. Its "Careers in Welding" mobile trailer tours the country to provide students an opportunity to learn about welding with virtual welding machines. WEMCO is proud to sponsor the Image of Welding Awards given annually to outstanding contributors and leaders in the fields of education, promotion, and individual excellence in welding at the FABTECH show.

John Stropki, chairman of Lincoln Electric, recently said, "If we, as welding equipment manufacturers, don't promote our industry, who will? And, if we don't, who will we sell our products to?"

For more information about WEMCO, contact Keila DeMoraes at AWS at *kdemoraes@aws.org* or (800/305) 443-9353, ext. 444. Isn't it time you join the leaders from such companies as 3M Speedglas, Abicor Binzel, ESAB, Harris Products, Hypertherm, Jackson Safety/Kimberly Clark, Lincoln Electric, Miller Electric, Victor Technologies, to name only a few, and enjoy the benefits of being a member of WEMCO?

Robert E. Ranc Sr.
Past Chair, WEMCO

BY ALEXANDER E. SHAPIRO

Q: We are very interested in brazing titanium products. My question concerns brazing titanium with steel. Basically, we would like to join titanium Grade 5 plate with stainless steel 304 round bars (1 or ⅞ in. in diameter) and require a strength of 40 ksi at the joint. Please suggest a suitable filler metal and a brazing process for us to try.

A: Technically, vacuum brazing of titanium Grade 5 (Ti-6Al-4V alloy) to stainless steel is not a problem. The process of joining titanium to nickel-plated stainless steel using a silver-copper eutectic (AWS BAg-8) as a brazing filler metal has a long history of industrial application, and has been studied rather thoroughly (Ref. 1).

The brazing is carried out over a wide temperature range from 820° to 920°C depending on design of joined parts and the required joint strength.

BAg-8a — the lithium-modified BAg-8 filler metal — can also be used in the same range of brazing temperatures. The brazed parts are shown in Fig. 1. BAg-8a is not suitable for vacuum brazing, unless the heating rate is so high that it takes only 1 to 2 min. to reach the brazing temperature. So, this braze is ideal for induction brazing or brazing by energy beam (electron or laser).

Within the last two decades, new processes and material options have been studied and tested. The application of new titanium flux RL3 A16 opened the opportunity to join titanium to titanium and titanium to steel in air using torch brazing or, preferably, induction brazing. Standard silver-based filler metals such as BAg-24 or BAg-34 are successfully used for brazing in air. A key point of this process is rapid and uniform heating of the joint area, because titanium oxidizes very fast and the protection ability of flux is limited in time. Therefore, brazing in air is successful mostly for small-size parts.

Precoating the titanium part before brazing is recommended. This means that you should use a three-step process: 1) deposition of the silver braze alloy onto the titanium surface by heating and melting with the flux, 2) removing flux residues from the surface using hot water and a metal brush, and 3) assembling with the steel part and brazing them together with new additions of flux and braze filler metal.

The joint clearance between the parts to be brazed should be as small as possible due to difference of coefficients of thermal expansion. With your design, this means that you should slightly compress the parts during brazing and cooling.

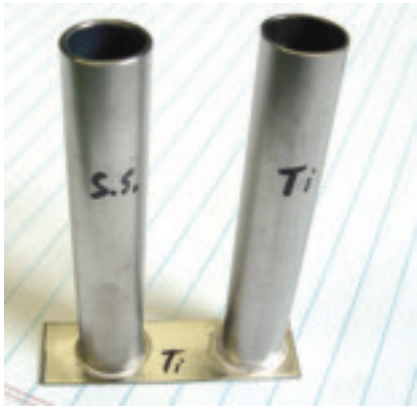

Fig. 1 — Stainless steel and titanium tubes brazed to titanium plate in vacuum using BAg-8a filler metal in the form of 1/16-in. wire ring placed inside the tubes. (Photo courtesy of Dr. Yury Flom, NASA Goddard Space Flight Center.)

Brazing titanium to steel can also be done in air with the same flux and aluminum-based filler metal TiBrazeAl-635 (the Al-Cu-Mg system) or TiBrazeAl-655 (the Al-Cu system) at a temperature below 700°C — Fig. 2. The aluminum filler metals can be used, when a low brazing temperature is needed, while the strength of joints is not a critical issue.

However, vacuum brazing with BAg-8 is still the most often used process for joining titanium to stainless steel. In order to reach the maximum strength of the brazed joint, the brazing should be done in compliance with the recommendations below.

First, the stainless steel should be plated with nickel 0.0004 to 0.0006 in. (10 to 15 microns) thick. Nickel plating significantly improves the spreading of liquid filler metal along the steel surface. Sometimes, electroless nickel plating does not provide a stable quality of coating. Then, silver plating 0.0006 ± 0.0001 in. (12 to 15 microns) thick is used instead of a nickel coating. The nickel or silver layer serves as an effective barrier to prevent the formation of brittle Ti-Fe intermetallics that are replaced by NiTi, AgTi, and CuNiTi phases.

Second, the brazing temperature in the range of 830° to 850°C and dwell time from 3 to 6 min are optimal process parameters to produce 25 to 30 ksi (170 to 210 MPa) joint shear strength. Higher brazing temperature and longer holding time result in uncontrolled growth of the brittle $TiCu_2$ intermetallic layer at the interface of the joint metal with titanium, and the strength of the joints goes down to 20 ksi (140 MPa) or even lower values.

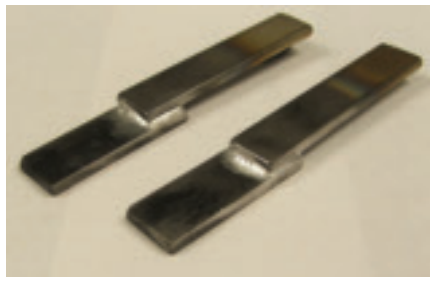

Fig. 2 — Titanium Grade 5 brazed in air to stainless steel 304 using TiBrazeAl-655 filler metal. The shear strength of these brazed joints is 17 to 19 ksi (118 to 130 MPa).

If you want to increase the strength of the joints to 40 ksi (275 MPa) and higher, you will have to change the joint design. For example, use a tube-in-tube design instead of a simple overlapping, or provide so-called mechanical securing of brazed joints, such as brazing of a threaded connection.◆

Acknowledgment

My thanks to Dr. Yury A. Flom of NASA Goddard Space Flight Center for his advice on this subject.

Reference

1. Shiue, R. K., Wu, S. K., Chan, C. H., and Huang, C. S. 2006. Infrared brazing of Ti-6Al-4V and 17-4 PH stainless steel with a nickel barrier layer. *Metallurgical and Materials Transactions A*, Vol. 37, No. 7: 2207–2217.

This column is written sequentially by TIM P. HIRTHE, ALEXANDER E. SHAPIRO, and DAN KAY. Hirthe and Shapiro are members of and Kay is an advisor to the C3 Committee on Brazing and Soldering. All three have contributed to the 5th edition of AWS Brazing Handbook.

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Readers are requested to post their questions for use in this column on the Brazing Forum section of the BSMC Web site www.brazingandsoldering.com.

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