United States Patent Office 3,536,879 Patented Oct. 27, 1970

3,536,879

WELDING SYSTEM

Ernest W. Hartsell, Jr., Hightstown, and Benoit J. Sirois, East Brunswick, N.J., assignors to Phelps Dodge Copper Products Corporation, New York, N.Y., a corporation of Delaware

Filed Sept. 12, 1967, Ser. No. 667,172
Int. Cl. B23k 9/02, 11/02
U.S. Cl. 219—60 9 Claims

ABSTRACT OF THE DISCLOSURE

A butt welding and grinding system employs axially aligned orbiting welding and grinding units for joining contiguous metallic tube sections. Long lengths of tubing may advantageously be automatically fabricated by interconnecting such sections with strong nonporous weld joints characterized by a relatively small internal bead, and little or no external bead.

DISCLOSURE OF INVENTION

This invention relates to welding systems and, more specifically, to a system for butt welding lengths of metallic tubes.

Many applications of present day interest require long, continuous lengths of metallic tubes. For example, multistage flash heat exchangers for large desalination plants employ many parallel runs of such tubes in continuous lengths up to approximately three hundred feet. Since tubes of this length cannot be transported economically, a job site system for welding abutting component tube sections to fabricate the necessary long lengths is required. Such butt welds must be nonporous, and of substantial mechanical strength.

As a further prerequisite for many applications of commercial interest, the inside and outside diameters of the welded joint must not vary appreciably from the dimensions of the tube itself. For example, a pronounced welding bead inside the joint will produce turbulence in the liquid flow therein. When a corrosive fluid is conveyed, this irregular liquid flow wears away the tube about the joint area.

Variations in the outside diameter of the weld from the nominal tube dimension often interfere with the mechanical mounting of the long tube lengths. Typically, such tubing must fit through a plurality of aligned apertures contained in corresponding positions in parallel, chamber-defining baffle plates of a heat exchanger or the like. Such apertures are normally just larger in size than the outer tubing diameter. If the welded joint is too large, the joined tube will not fit through the baffle apertures. If a joint is undersize its mechanical strength will be reduced.

However, a composite welding system for fabricating strong, nonporous butt welds with close diameter tolerances has heretofore not been available.

It is therefore an object of the present invention to provide an improved butt welding system.

More specifically, it is an object of the present invention to provide an automated butt welding system which effects at low cost strong, nonporous joints on tubes with thin walls while maintaining close diameter tolerances. Moreover, such welds may be accomplished under job site conditions.

These and other objects of the present invention are realized in a specific illustrative automated welding system employing axially aligned, orbiting welding and grinding arrangements. Abutting ends of two metallic tube sections to be fastened are urged together beneath a

tungsten electrode in an inert gas environment by a cam-spring biased chucking apparatus.

The welding arrangement includes the tungsten electrode with a concentric inert gas containing jacket thereabout, a motor driven cold filler wire feeding organization, and a tube positioning indexing arm. All of the foregoing structure is affixed to a rotating support plate for orbiting about the stationary tube ends in a reciprocating manner. During such rotation, welding current of a characteristic wave shape and a filler wire are supplied to the joint area.

After the weld has been completed, the newly formed joint is axially traversed to lie beneath the grinding arrangement which includes a pneumatically driven grinding wheel. The grinder orbits about the stationary tube joint, and removes the superfluous weld flashing head subject to the limiting action of a mechanical guide which maintains contact with the tube.

A complete understanding of the present invention and of the above and other objects, features, and advantages thereof may be gained from a consideration of the following detailed description of an illustrative embodiment thereof presented hereinbelow in conjunction with the accompanying drawing in which:

FIG. 1 is a block diagram of a composite butt welding and grinding system embodying the principles of the present invention;

FIG. 2 illustrates a welding unit **20** included in the arrangement of FIG. 1;

FIG. 3 illustrates in detail welding torch apparatus shown in FIG. 2;

FIG. 4 depicts in detail a cold filler wire feeding arrangement shown in FIG. 2;

FIG. 5 illustrates a grinding unit **60** shown in block form in FIG. 1;

FIGS. 6A and 6B respectively comprise the top and bottom portions of a schematic diagram of a circuit arrangement for automatically effecting system functioning for the FIG. 1 organization; and

FIGS. 7A through 7I are timing diagrams depicting illustrative system sequencing for the arrangement of FIG. 1.

SYSTEM ORGANIZATION

Referring now to FIG. 1, there is illustrated in block form a composite welding system which includes axially aligned welding and grinding units **20** and **60** respectively secured to a main housing **11** via frames **21** and **22**, and **61**, **62** and **63**. Two metallic tubes **5** and **6** to be joined translate through the units **20** and **60** along a common tubing axis, with abutting ends of the elements **5** and **6** meeting within the welder **20**.

The metallic tubes may comprise, for example, copper-metal compositions such as copper-nickel alloys, but is not limited thereto. Metallic tubes of many other compositions such as the steels, stainless steels, titanium and aluminum alloys may be joined by this process.

A control circuit **100** is employed to actuate automatically the welder **20**, and the grinder **60**, and to regulate the flow of water coolant, inert gas, welding current, compressed air, and motor actuating potential thereto. A direct potential source **19** selectively supplies the welding current **16** to the torch **34** in the unit **20** and power for bidirectionally rotating the orbiting structures included in the welding unit **20** and grinding unit **60**.

Source of high velocity and low velocity inert gas **15** and **13** are selectively operable by the control circuit **100** for supplying an inert gas such as argon or helium to the remote end of the metallic tube **6**, and also to the tungsten torch **34** included in the welding unit **20**. Similarly a water source **18** operable under the control circuit **100** supplies coolant to the torch **34**. A compressed air source