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(72) Inventor: VIKTOR SENDEROVICH LIFSHITS

(54) IMPROVEMENTS IN OR RELATING TO FLASH BUTT WELDING

(71) We, VSESOJUZNY NAUCHNO-ISSLEDOVATELSKY INSTITUT po STROITELSTVU MAGISTRALNYKH TRUBOPROVODOV a Corporation organised and existing under the laws of U.S.S.R., of Okruzhnoi proezd 19, Moscow, Union of Soviet Socialist Republics, do hereby declare the invention, for which we pray that a patent may be granted us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The present invention relates to a straight flash welding process.

Flash welding processes have two main phases, these being a flashing phase in which the ends of the articles to be welded are heated to their melting points by electric arcs flashing between the articles, and an upsetting phase in which the articles are upset and undergo plastic deformation.

According to one aspect of the present invention, there is provided a flash butt welding process in which electrical energisation is from a source of alternating current of square waveform, the frequency of said alternating current being increased during the flashing phase of the welding process.

According to another aspect of the present invention there is provided a flash butt welding process, comprising clamping articles to be welded in the jaws of a flash welding machine, connecting to said articles current leads from a secondary winding of a flash welding transformer of the machine, connecting a primary winding of said welding transformer to a source of alternating current of square waveform, and moving said articles towards each other at a speed which varies during said movement, so that said articles are first heated during a flashing phase of welding and then plastically deformed during an upsetting phase of welding, the frequency of the alternating current supplied to the welding transformer being varied during said flashing phase.

The method of varying the current frequency is preferably set to suit the manner in which the other parameters of the welding process are controlled.

For maximum efficiency, the frequency of current supplied to the flash welding transformer should be continuously increased as the flashing phase progresses, the maximum value of the current frequency occurring at the initial moment of upsetting.

A flash butt welding process in accordance with the invention will now be particularly described, by way of example.

First, the articles to be welded (for example, pipes) are clamped in the jaws of a flash welding machine so that there is provided but a minimum clearance between the butt ends of the articles. The jaws form part of a clamping arrangement operated by an hydraulic system. Another hydaulic system serves to operate drive means for moving the articles towards each other during the welding process.

Next, current leads from the secondary winding of a flash welding transformer of the machine are connected to the articles to be welded. The flash welding machine is then set up to give particular welding conditions by the setting of the following parameters:

- the secondary open-circuit voltage of the flash welding transformer;
- the speed-time characteristic for the mutual approach of the articles during the welding process (this characteristic being set by a programme cam or speed variation algorithm);
- the frequency-time characteristic of the current supplied to the flash welding transformer during the welding process; and
- the distance through which the articles are moved towards each other during the phases

of the welding process, or an algorithm determining this distance.

In addition, a predetermined pressure is established in the hydraulic system of the clamping arrangement and of the drive means for moving the articles towards each other.

Thereafter, the primary winding of the flash welding transformer is connected by means of a relay system to a source of alternating current of square waveform. The drive means for moving the articles towards each other is also set in operation. The actual welding operation has now begun.

In the course of the flashing phase of the welding process, the frequency of current supplied to the flash welding transformer is automatically varied. The instantaneous speed of approach of the articles can be varied in dependence on the elapsed time t or on the distane ℓo the articles have moved towards each other. The current frequency f can be increased in dependence on the elapsed time t or on the distance ℓo. For example, it is possible to vary the current frequency f in accordance with the following formulae:

$$f = a_I + k_I l^n_o \quad (1)$$

$$f = a_2 + k_2 t^n \quad (2)$$

where a_I, a_2, k_1, k_2 and n are the coefficients which depend upon performance characteristics of the welding machine (e.g. short-circuit impedance of the welding circuit), upon the material of the articles being welded, (e.g.heat conductivity and specific resistance), and the section to be welded.

It is also possible to regulate the welding process in accordance with the thermal condition of the articles being welded and in this case the current frequency can be increased with the temperature T_k of the butt ends of said articles according to the following formula:

$$f = a_3 + k_3 T_k^n$$

where a_3, k_3, and n are coefficients which depend upon the performance characteristics of the welding machine, upon the material of the articles being welded, and the section to be welded.

The flashing phase of the welding process is terminated either upon the articles having been moved towards each other through a predetermined distance ℓo, or upon the butt ends of the articles reaching a prescribed temperature T_k (in cases where the welding process is regulated in accordance with thermal conditions). Therefore, a device is actuated to initiate upset action. The upsetting of the articles being welded is carried out under a stress of forces acting perpendicularly to the welding plane. After a given period of time, 0.1 to 0.2 sec prior to completion of the upsetting phase of the welding process, the supply of current is discontinued.

The upsetting phase of the welding process is terminated upon the distance through which the articles are moved together during the upsetting phase becoming equal either to a predetermined value or to a value corresponding to the distance between the sections with a prescribed temperature T_g at the butt joint boundary in cases where the welding process is regulated in accordance with thermal conditions. At this end of the upsetting phase the welding process is complete and the welded articles are released from the jaws of the welding machine and are then disconnected from the current leads of the welding transformer secondary winding. Finally, the driving means for moving articles being welded closer together is returned to its initial position.

The described flash butt welding process is characterised by the shape of current supplied to the flash welding transformer and by the change of current frequency effected during flashing. The described process permits the welding time to be reduced by 20 to 30 per cent and also enables the distance through which the articles are moved together during flashing to be decreased 10 to 20 per cent. Furthermore, by using the described process, a substantial reduction is possible in the rated power of a mobile power-plant such as may be used during pipe welding in the field.

The described welding process can be advantageously used in the welding of pipes, rails, sheet and other articles of large cross section.

WHAT WE CLAIM IS:

1. A flash butt welding process, comprising clamping articles to be welded in the jaws of a flash welding machine, connecting to said articles current leads from a secondary winding of a flash welding transformer of the machine, connecting a primary winding of said welding transformer to a source of alternating current of square waveform, and moving said articles towards each other at a speed which varies during said movement, so that said articles are first heated during a flashing phase of welding and then plastically deformed during an

upsetting phase of welding, the frequency of the alternating current supplied to the welding transformer being varied during said flashing phase.

2. A flash butt welding process according to claim 1, wherein the frequency of the alternating current supplied to the welding transformer is varied in dependence on the distance through which the articles have been moved towards each other.

3. A flash butt welding process according to claim 1, wherein the frequency of the alternating current supplied to the welding tranformer is varied in dependence on the elapsed time from the start of the flashing phase.

4. A flash butt welding process according to claim 1, wherein the frequency of the alternating current supplied to the welding transformer is varied in dependence on the temperature of the adjacent butt ends of the articles being welded.

5. A flash butt welding process according to any one of claims 1 to 4, wherein the frequency of the alternating current is continuously increased as the flashing phase progresses, the maximum value of the current frequency occurring at the initial moment of upsetting.

6. A flash butt welding process in which electrical energisation is from a source of alternating current of square waveform, the frequency of said alternating current being increased during the flashing phase of the welding process.

7. A straight flash welding process, as claimed in any one of the preceding claims and substantially as hereinbefore described.

MATHISEN, MACARA & CO.,
Chartered Patent Agents,
Lyon House,
Lyon Road,
Harrow,
Middlesex. HA1 2ET.
Agents for the Applicants.

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