IIW-DOC-IV-506-89

A Study of Behavior of High Frequency Pulsed Plasma Welding Arc

For welding of precision ultra thin components Microplasma arc welding is one of the important methods. However, its use is limited because microplasma arc is not stable. Authors suggest use of high frequency pulsed current as a way to improve the stability of microplasma arc. They find that by using pulsing frequencies in the range of 10-70 KHz it is possible to obtain higher energy concentration, better stability at low weld current and high heat transfer efficiency. They have used infrared microcomputer image sampling and processing technique to study the arc. They have welded different materials such as Nickel, Zinc, Titanium, Stainless Steel etc. in the thickness range of 0.1-0.5 mm using HF pulsed plasma arc and obtained very good results and recommend this welding method as especially fit for welding thin and ultra thin plates.

IIW-DOC-IV-538-90

The control of High power YAG Laser Plume in narrow space welding

The authors have developed a Laser Welding Process for repair of damaged heat exchange tubes of in service steam generators used in PWR Nuclear Power Plants. In this process a sleeve is inserted in damaged heat exchange tube to cover damaged area and it is welded from inside at both the ends to repair the damage. Welding is carried out using a 2 KW YAG Laser transmitted to laser welding and effector through a quartz optical fiber. The end effector is a special device to take the laser beam in very narrow space inside diameter of the sleeve is 18.8 mm and consists of focussing lenses, mirror to change the beam direction from axial to redial to carry out circumferential welding, an assisting gas nozzle to protect optical components from plumes generated from the weld and driving mechanism which rotates the assembly of lenses, mirrors and nozzle around the axis of the device.

Correct selection of assist gas is very important to ensure sound weld and gas flow rate is important to ensure that the plume generated during welding and weld spatter does made of nickel base alloy (ASME SB 163, Ni-Cr-Fe alloy). For this it was found both Ar and He lead to porosity while N_2 as shielding gas gives good weld. By adding up to 2% O_2 to N_2 penetration depth can be maximised. Using 575 W of laser power and 0.8% m/min welding speed operating in pulsed mode (Modulation factor 100%, duty ratio 50%, pulse rate 42 pps) 1.7 mm penetration could be obtained compared to 0.5 mm when operated in cw mode. The authors have used the equipment developed for in site welding of sleeves and more than 100 joints were effectively welded without significant deterioration of the optical components

IIW DOC IV-539-90

CO_2 Laser Beam Welding of Aluminium Alloys for Transport Systems

Substantial benefits can be achieved by adopting LBW process for welding of aluminium alloys used in sheet metal processing industry for casing & plant construction, for car body construction as well as for aircraft industry. However, LBW of aluminium and its alloys is difficult because of high reflection losses and porosity and hot cracks formed during solidification.

Investigations have been carried out using a 5 KW CO_2 laser to establish process variables and conditions to obtain defect free deep penetration welds in three aluminium alloys, namely 6005 A, 7020 and 5083 and using filler metal 5183 + Zr.

Some of the important conclusions arrived at by authors are as follows :

1. It is necessary to work at high intensities of at least 4 to10 W/cm^2 to obtain deep penetration in Aluminium because of high reflectivity.
2. Clean oxide free surface is necessary to avoid porosity requiring expensive seam preparation.
3. Hot cracks can be avoided by right filler metal even while welding at high speeds.
4. High quality welds can be produced only by using gas shielding preferably helium as working gas and argon as protective gas.
5. Good top bead without under cut and good root can be obtained by properly shaped and located nozzle for working gas, right gas flow quantity and most gas filled back up bar.

IIW DOC IV-540-90

Characteristics of 500 KV Ultra-High Voltage Electron Beam Heat Source

The authors have developed an ultra high voltage EB Heat source rated at 500 KV, 100 KW for thermal processing of materials. Main reason for choosing such high voltage was to obtain very high beam power densities which are not possible with conventional sources rated up to 175 KV. They report achieving of average beam power density of 14000 KW/cm^2 at beam power of 10 KW. They describe the schemes used for EB Gun and Accelerating power supplies which enable stable operation of the system without arcing.

Using this system they could weld 200 mm thick stainless steel in flat position and obtain narrow deep penetration, sound weld at welding speed of 100 mm/min and 60 KW beam power. Moreover it was found that using 500 KV beam 130 mm thick steel could be welded at 50 KW power compared to 100 KW power required with 100 KV beam under same conditions.

IIW DOC IV-541-90

Study of Laser Surface Melting & Carbon Steels in Controlled Atmospheres

The authors have used a 2 KW CO_2 laser introduced in to a vacuum chamber through KCI windows to study laser surface melting of carbon steels in vacuum as well as helium, nitrogen argon atmospheres as well as in air a oxygen. The report following results :

1. Cross sectional area of fusion zone in smaller when melted in vacuum.
2. Carbon content of fusion zone in graphite coated specimen without scale increases when method in vacuum and also in helium, nitrogen or argon atmosphere. Because of this carbon alloying hardness of the fusion zone method in vacuum is about 200 to 300 HV higher than that in air

In conclusion they state that the laser-surface melting graphite coated steel open-up possibility of surface hardening by carbon alloying.

IIW-DOC-IV-542-90
EB Welding-Residual Magnetism Problems, Proposed solutions

Electron Beam Welding of thick sections (100 mm - 300 mm thick) of high strength low alloy steels used in heavy manufacturing poses new problems such as large gun to work distances, complex tools and jigs etc. One of the most important problem is unwanted beam deflection because of residual magnetic fields. The author has carried out exhaustive study of this problem and worked out certain demagnetising procedures which will ensure round welds. Important observations made by the author is as follow :

1. Residual magnetizam depends on thermo-mechanical history of the component
2. Beam deflection is more at beginning and end of longitudinal point (edge effect).
3. Residual magnetic values can alter during storage.
4. While welding thick sections even small values of residual magnetic field can be damaging viz. while welding 300 mm thick 2 CrMo plates with values of magnetic fields less than 36, the weld bead had shifted by 37 mm from the seam at a depth of 250 mm

IIW-DOC-1V-545-90
Laser Beam Welding with filler wire

Using high power co_2 Lasers it is possible to weld in single pass thicknesses in the range of 0.1 mm - 35 mm Because of small beam diameters in Laser Beam Welding required tolerances on edge preparation and beam to weld seam alignment are very close frequently requiring costly seam preparation and clamping techniques, restricting its application in industrial production. These tolerance can

be relazed to some extent by using filler material. Authors have used a wire feed system for LBW developed by 1 SF. This wire feed unit can handle wire diameters of 0.6-1.0 mm with feed rates up to 13 m/min. Using this technique it was possible to produce good quality welds in low alloy steel when joint gaps were in the range of 0.2 mm for plate thickness of 1.0 mm to 1.0 mm for thickness of 10 mm.

IIW/IIS DOC. X-1205-90 :
Investigations on Microstructure, Toughness and Defect Tolerance of Gas Metal Arc Weld Metal

In this document, results on the investigations into the toughness of weld metal produced by CO_2 gas shielded mechanised metal arc welding using MnSi electrode with various nickel contents, are reported. Multilayer welds were deposited with both unalloyed and alloyed wires, containing Mn, Si and to some extent Mo.

The fracture properties were investigated by charpy-V notch specimens. To evaluate the microstructural influence, the test specimens were prepared in two ways; one where the fracture plane is primarily in the coarse grain structure and another in the fine grain structure.

It was observed that the charpy impact strength was generally higher in ecimens with their crack plane mainly in the secondary fine grained ..ea, which has been influenced by the subsequent weld metal passes. Suitably constructed Failure Analysis Diagrams (FAD) were used for an analysis of fracture criterian. Using force-displacement curves of pre-cracked charpy specimens, it was observed, that at an approximately equal impact strength level, differing fracture safety margins exist.

IIW/IIS DOC-X-1207-90 :
"FRACTURE ANALYSIS OF JAPANESE WIDE PLATE MODEL TESTS-COMPARISON OF JWES APPROACH AND R6 APPROACH''

In this document, the JWES approach and the CEGB R6 approach for the brittle fracture situation where it occurs from a defect at a structural stress concentration. In JWES approach, the CTOD concept is adopted to describe failure, where the condition of fracture is expressed as. In the CEGB R6 approach, the envelope of Kr and Lr is plotted as a Failure Analysis Diagram (FAD) and if the assessment point is inside the FAD, then the component is regarded safe.

Three types of wide plate model tests simulating stress concentration were carried out; Type-A wide plate test with longitudinal stiffness, Type-B wide plate test with transverse stiffener, and Type-C wide plate test with cracks at a hole. The validity and accuracy of the failure assessment methods of JWES ad CEGB R6 approach were carefully examined using the above 3 types of wide plate tests.

Conservation of each approach is examined by calculating a safety factor S, which is defined as the ratio of this measured fracture stress to the estimated fracture stress. It is found that, in general the R6 approach gives more conservative results of assessment than JWES approaches becomes very clear, if JWES approach is also plotted in the form of Fracture Assessment Diagram.

IIW/IIS DOC-X-1208-90 :
Probabilistic Aspects of HAZ CTOD Value Of Multipass Welded Joint OF STEEL For Off-shore structure

In earlier experiments with CTOD testing of welded joints in steel used for off-shore structures, occasionally very low levels of fracture toughness were observed, because of the influence of small local brittle zones that actually existed in the conventional C-Mn steels. In this document, the experimental HAZ CTOD data in terms of the size and number of local brittle zones hit by the fatigue pre-crack was generated. A probabilistic model is also proposed, assuring that the IIAZ, viz, the weakest link concept. Numerical simulations based on this model compared well with the experimental results. The plate thickness effect is also discussed.

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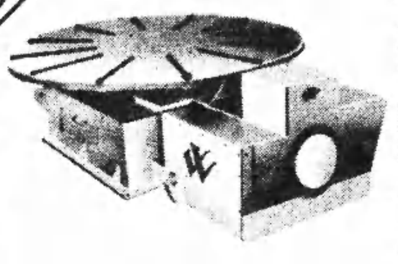
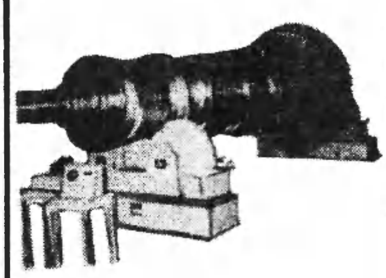
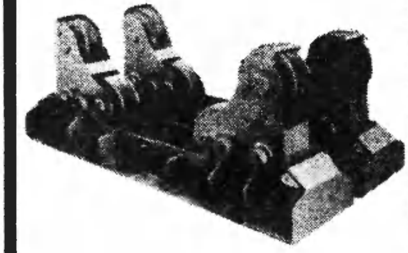


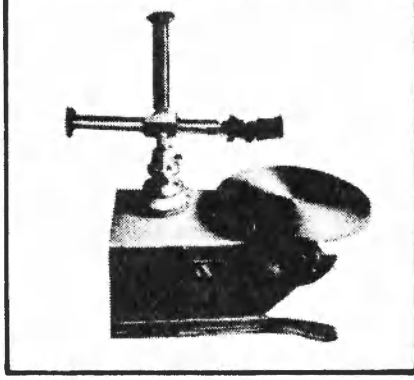
FLOOR TURN TABLES 9 Models
Capacity 500 kg. to 50,000 kg

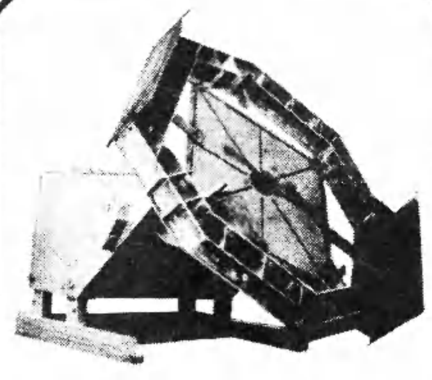


TURBINE ROTORS 10 Models
Capacity 5 tonnes to 100 tones.

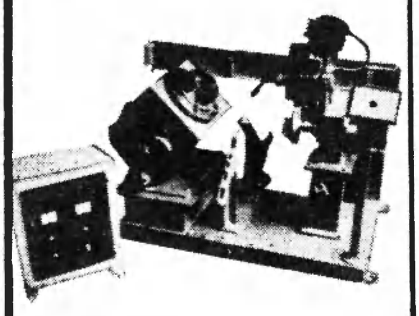


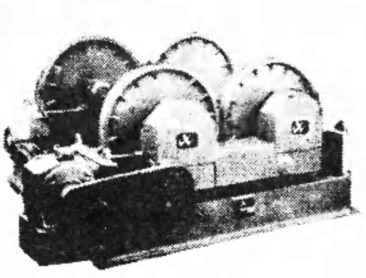
SELF-ALIGNING ROTATORS 14 Models
Capacity 1 tonnes to 120 tonnes.



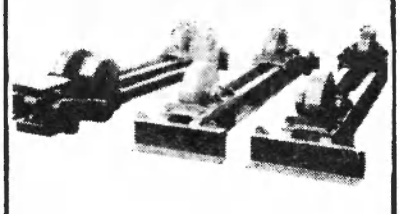


HEAVY DUTY 6 Models
Capacity 6500 kg. to 28000 kg.

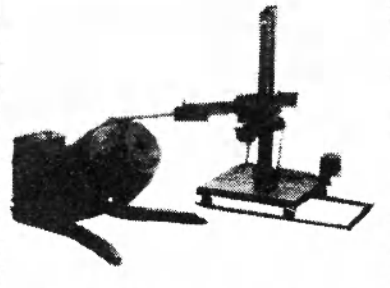




HEAVY DUTY 6 Models
Capacity 50 tonnes to 180 tonnes.



MEDIUM DUTY 6 Models
Capacity 10 tonnes to 40 tonnes.



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