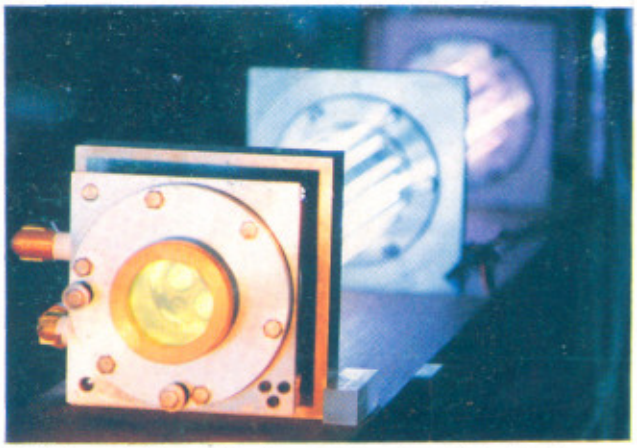

Multibeam CO_2 laser. Photograph shows the electrical discharge.

was provided on the sample to avoid oxidation of the melted zone. Laser power of 300 to 350 watts was used in this experiment.

The exposed samples were studied at IGCAR and it was found that surface melting was achieved, the melted zone being of the order of 900 μm wide and 150 μm deep. Surface melting of stainless steel improves the wear resistance of moving parts.

Pacemaker-welding laser machine

CAT has developed a PC controlled laser welding machine for welding of titanium shell of heart pacemaker assembly and a feed-through on it.

Heart pacemakers consist of an odd shaped titanium shell (0.4 mm thick) containing an electronic pulse generator circuit. Conventional welding techniques cannot be used for welding the pacemaker as it leads to heating of the job and the electronic circuit gets damaged. A pulsed laser, on the other hand, deposits a precise amount of energy on a small area in a short duration, causing only localised heating of the job.

The pacemaker welding laser machine consists of four sub systems, namely Nd:YAG pulse laser, its power supply, welding rig and a control system.

A pulsed Nd:YAG laser is used which delivers 5 Joules of energy in 8 msec long pulses at a rate of one pulse per two seconds. The flooded laser pumping cavity encompasses a Nd:YAG rod and two krypton filled flash lamps in a closely coupled, gold plated double elliptical chamber. The laser resonator consists of two dielectric coated mirrors, one having maximum reflectivity and other 70% reflectivity (at 1.06 micron). The chamber is cooled by a 500 W refrigeration capacity chiller unit. The cooling circuit incorporates a particle filter of 5 micron grade and deionizing cartridge.

The power supply consists of an ignition source, a simmer current source and main current pulse source for two flashlamps. The ignition source generates 20 KV, 5 μsec pulse for igniting flashlamps and simmer current source keeps the flashlamps in simmer mode by supplying 200 mA current. The main current pulse source is realized by a buck converter operating at 20 KHz and generates 120 A, 8 msec current pulses at the rate of one pulse in two seconds for each flash lamp.

A welding rig consisting of four degrees of freedom has been provided. It comprises of three mutually perpendicular translation stages having linear accuracy of movement within 10 μm and mutual perpendicularity within 30 μm over the entire length of travel, which is 50mm. These translation stages use crossed roller linear bearings and ball screws driven by stepper motor and timing belt pulley driver. The three prisms mounted on these stages move the laser beam in such a way so as to keep the beam focus exactly at the seam of the pacemaker assembly; which is rotating about its axis. The pacemaker to be welded is held in a fixture mounted on vertical shaft in a vacuum chamber, and the shaft is rotated by a stepper motor through 1:10 reduction gear pair. The backlash between the shaft and the fixture is avoided by a spiral spring. The welding of the pacemaker assembly is done in Argon and Helium atmosphere created in the vacuum chamber, previously evacuated to 50 mbar, using Nd:YAG laser. The welding is monitored by CCD camera, mounted on translation stage, which moves along with the focusing lens. The laser enters the vacuum chamber through an AR coated window.

PC based system controller for pacemaker laser welding system consist of stepper motor controller (SMC), analog input card and digital I/O add-on card. The SMC controls four stepper motors required for four degrees of freedom, the analog card checks laser energy, the I/O card enables the PC to control the system. The PC issues the position command to the motor controller, according to the required position, and at the same time it also checks for fault conditions. Software facilitates two modes of operations, namely semiautomatic and manual mode. In semiautomatic mode, all the position commands are generated by the PC according to the profile stored in the memory. This adjusts focussing of the laser spot and positions the job in the vacuum chamber. Before firing a laser shot it checks the temperature of the cavity and coolant flow. If the parameters are within the set limits, the laser fires else alarm is sounded. In manual mode all the above operation involved in welding are done manually.

Besides controlling the position, PC gives online display of the system status. It displays the laser energy, the current position of the job, graphically as well as by co-or-

Cover: *Laser based pacemaker welding machine with computer controls.*

dinates, gas flow ON/OFF status and also the shutter position. This unit also controls the laser power supply. In case of emergency, the laser supply can be switched off from the control panel. The pulse repetition rate of laser is controlled both by hardware as well as software.

One such machine has been commissioned at Shree Pacetronics Ltd., Pithampur, and is working satisfactorily. This company was earlier getting pacemakers welded abroad, and has now started using our machine in its production line.

CW Nd:YAG laser

An intra cavity frequency doubled CW Nd:YAG laser system has been developed. The laser is also acousto-optically Q-switched for high repetition rate pulsed operation. $LiIO_3$ and KTP crystals were used for frequency doubling experiments. With $LiIO_3$ crystal operating in type I phase matching condition, 2 W average power, 5 KHz repetition rate laser pulses at 532nm are obtained. In the same resonator configuration and operating conditions, with a KTP crystal operating at type II phase matching condition, 5 W average power laser pulses at 532 nm are obtained.

Development of laser workstation

The application of high power lasers in laser material processing requires a fast work handling equipment. CNC based co-ordinate tables, with specific design features to meet such applications, have therefore been developed.

A small workstation of 800 x 600 mm traverse has been designed. This system works on stationary beam, moving workpiece principle and has two axes contouring control. This machine has been designed for R&D work on laser material processing using CO_2 lasers and all aspects for such an application have been considered during the design and fabrication.

This machine has been fabricated at CAT and has an overall accuracy of 20 microns in movement along either axis. The drive components, motors etc. have been procured indigenously, while ball screws and linear motion guides have been procured from M/s THK Ltd., Japan. The system has two axes CNC traverse as specified above and speed range available in either axis is upto 10 m/min. The third axis movement is manually adjustable upto 250 mm traverse for mounting the beam handling system.

Laser workstation fabricated at CAT.

A laser workstation with two axes CNC control, on composite movement of beam in one axis and workpiece in second axis, has been procured from M/s HMT Ltd., Bangalore. It has a traverse of 3 metres and of 1.2 metres along the two axis respectivly. Design work for 5 axis laser workstation has also been undertaken with 3 co-ordinate axes x, y & z and rotation and revolution of the work pieces.

Alignment jig for range finder

Alignment jigs for axes alignment to within 10 secs of arc in laser range finder transmitter, receiver and collimator were designed and got fabricated. This jig was commissioned at 509 Army Base Workshop, Agra Cantt.

INFRASTRUCTURAL DEVELOPMENT

Computer facility

One mini computer system based on the latest microprocessor chip 'Pentium' has been installed in the computer centre. This machine will be used for scientific computations and also as a server for the e-mail.

One parallel computer system "ANUPAM" has been bought and commissioned at CAT. This machine developed at BARC, is based on i860, and has four nodes. "ANUPAM" is the fastest parallel machine available in India.

Two electronic telephone exchanges (one in the lab area and one in the residential area), with interconnectivity, have been commissioned. These exchanges have the latest technical features and the facility of 'DID' (Direct Inward Dialing), enabling every extension to have a separate number for access from outside CAT. This will obviate the need for telephone operators. These exchanges are also capable of handling voice and data simultaneously on the same pair of wires.