LASER PROGRAM

L.1 Miniature laser module with integrated HV power supply

A compact sealed-off nitrogen laser module measuring only 145mm x 75mm x 50mm has been developed. The module contains a sealed-off metal-ceramic N_2 laser tube, developed in-house, with pre-aligned cavity mirror and output coupler. The laser module is self-contained with all the high voltage circuitry and spark gap, also developed in-house, and integrated in the module. This laser module requires a 12V dc power supply for its operation. The photograph (fig. L.1.1) shows the laser operating from a 12Volt nickel-metal hydride rechargeable battery pack.

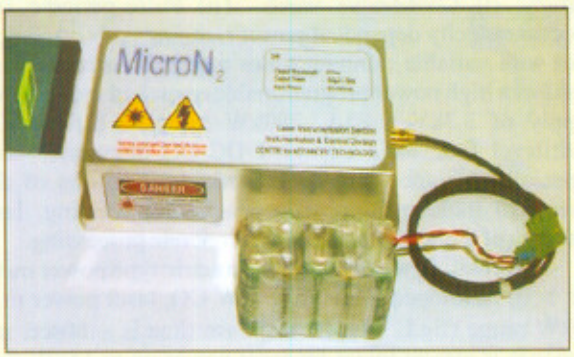

Fig. L.1.1 Micro N_2 Laser

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L.2 Laser aided land-leveling system

A laser beam due to its high directionality and low divergence serves as a ready reference for a straight line. If this beam is scanned in 360°, a laser plane is generated, which can be used as a reference for various leveling applications. In most leveling applications this reference plane would have to be orthogonal to the local plumb line. This is achieved by suspending the laser, so that it is plumb and a plane is swept out by a rotating penta-prism. This set-up ensures that the generated laser plane is always orthogonal to the local plumb and serves as a reference for leveling land for agriculture, civil construction, road and rail laying etc. This can also be used for leveling poured concrete in building construction. If the suspended laser is tilted from the plumb by a small angle θ, the generated plane is also tilted by an angle θ from the horizontal and can serve as a reference plane to level land to various grades.

The system consists of a laser plane generator or the scanner unit, a scale mounted sensor unit for initial surveying and a tractor mounted sensor and controller unit for controlling the scrapper bucket to automatically level land. The control unit can be modified, appropriately to control earth movers and road and rail laying machines.

Scanner unit : The scanner unit is shown in fig. L.2.1 (a), which is mounted on a tripod. The unit is coarsely leveled using the leveling screws, a bulls-eye spirit level mounted on the tripod aids leveling. The unit consists of a flexure suspended diode laser module with a large pendulum mass. When the unit is coarsely leveled to ±5° the laser is under free suspension and is plumb. A penta-prism mounted on a precision rotating platform with the axis co-axial to the laser beam scans out a laser plane. Since the laser is plumb and the penta-prism reflects the laser by 90°, the generated plane is exactly horizontal.

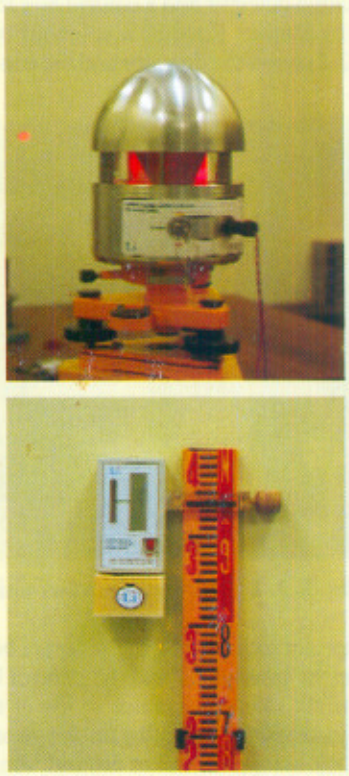

Fig. L.2.1 Scanner and Scale unit

The central part of the unit is the window through which the scanned laser beam emerges. The bottom portion contains the precision rotating platform with the motor drive, the ON/OFF key and the battery socket. The portion above the window contains the pendulum suspended laser module. The laser used is a semiconductor diode laser, which is compact and consumes very little power. The scanner unit as a whole consumes 2watt and runs on a rechargeable battery pack capable of powering the unit for 10hrs of continuous operation.

Scale unit : The scale mounted detector unit is a laser sensor, which indicates the position of the scanned laser beam from the scanner unit by buzzer as well as on a LCD display. The unit is mounted on a measuring shaft, which indicates the local height at that place. The unit is shown mounted on a measuring shaft in fig.L.2.1 (b). This unit is used for surveying the land before leveling. This method of surveying requires only one person to carry the measuring shaft around and measure the height at various places, unlike surveying with a theodolite system where two persons are required, one for holding the measuring shaft and another to read the elevation from the theodolite. The scale unit measures 60mm x 110mm x 25mm and runs on a 9V alkaline battery.

Scrapper controller: This unit consists of a scrapper-mounted detector and a control box for controlling the scrapper hydraulics through a solenoid operated flow valve. Fig. L.2.2 shows the detector and the control box.

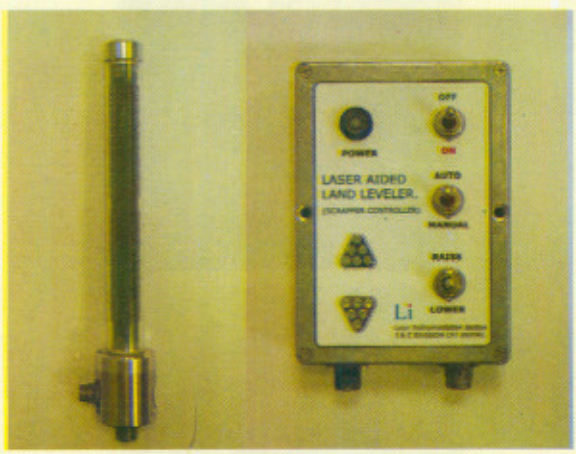

Fig. L.2. 2 Scrapper controller unit

The detector mounted on the scrapper bucket detects the position of the laser plane and the control box switches on the appropriate solenoid to raise or lower the bucket to maintain the laser plane centrally on the detector. As the tractor drags the scrapper bucket around, the control box maintains the scrapper height level with reference to the laser plane, this ensures that the scrapper cuts soil at high points and dumps at low points thus automatically leveling the field. The control unit runs on the 12V battery of the tractor. The control box provides indication of the laser plane position on the detector and also the direction of the scrapper movement. The control box also has a provision for manual override and for manually raising and lowering the scrapper bucket, which is required for sensor set-up, while traveling on the road.

A proof of principle system was developed and demonstrated at CIMMYT New Delhi in Feb 2003. This is a pre-production prototype that has been demonstrated at PUSA farms and CIMMYT New Delhi on 30th June 2003.

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L.3 20kW CO_2 laser

High power CW CO_2 laser has been developed. More than 15kW of output power was obtained with about 15% electro-optic efficiency from two of its four discharge sections. This is the maximum cw laser power reported so far in an industrial CO_2 laser in the country. Work is on to extract laser power from all four-discharge sections in the oscillator-amplifier configuration. The unique feature of this laser is that this can be operated in four different modes, namely, (i) Continuous wave (ii) Pulse-periodic (iii) Process velocity dependent power ramping and (iv) Single-shot with variable ramping times mode. To achieve these features a high power programmable-switched mode power supply of 3.3kV, 9-85A, 280kW rating, which uses a multilevel four stage cascaded DC-DC converter, was especially designed and developed. Applications of this laser will include laser deep penetration welding, laser cladding of large area surfaces and concrete processing.

A rotating water cone calorimetric type power meter has been developed to measure CW CO_2 laser power in 1-20kW range (fig.L.3.1). Its response time is ~ 60sec. and response is almost linear for laser power up to 15kW with 7lpm water flow rate.

Several laser material processing experiments were done with the CW and pulsed CO_2 lasers and the full system is shown in fig. L.3.2. Cold rolled grain non-oriented (CRNGO) sheets of 0.5mm thickness were laser cut to develop scanning magnets of food irradiating electron beam system. Dimensional accuracy of the dross-free profiled cuts was within ±50microns limited by the CNC workstation accuracy. Near the laser cut edge there was no change of microstructure in terms of any phase transformation or grain growth, an important favorable factor for the magnet.

Fig. L.3.1 Rotating Water Cone Power Meter