Materials and Method

For the benefit of those people interested in constructing a TEA laser, details of separate components will be given.

1. Discharge electrodes

To obtain a uniform glow discharge suitable for arc free lasing, Rogowski[11] profile electrodes of 0.5 m in length and 0.037 m in width are used. The electrodes are machined out of an aluminium block using a specially fabricated milling cutting head. Normal electrode separation is ~ 0.035 m, two large screws on top electrode are provided for adjusting the electrode gap at an accuracy of 1 mm. per pitch. For successful operation without arcing or discharge instability problem, the electrodes must be kept clean and well polished, as dirt spo ts on aluminium surface will induce local heating and arc. Two side rows of 7 preionization electrodes are arranged inside the discharge chamber to provide direct UV radiation. These spark pins are made from short steel rods of diameter 0.15 cm and bent into 90 degree angle. Adjustment of pin gaps distances is by turning the rods. The distance from row of pins from the centre of the electrode is ~ 4.1 cm. Fig. 1 shows side view of spark pins connected to doorknob capacitors, commercial automobile spark plugs may also be used to provide UV radiation.

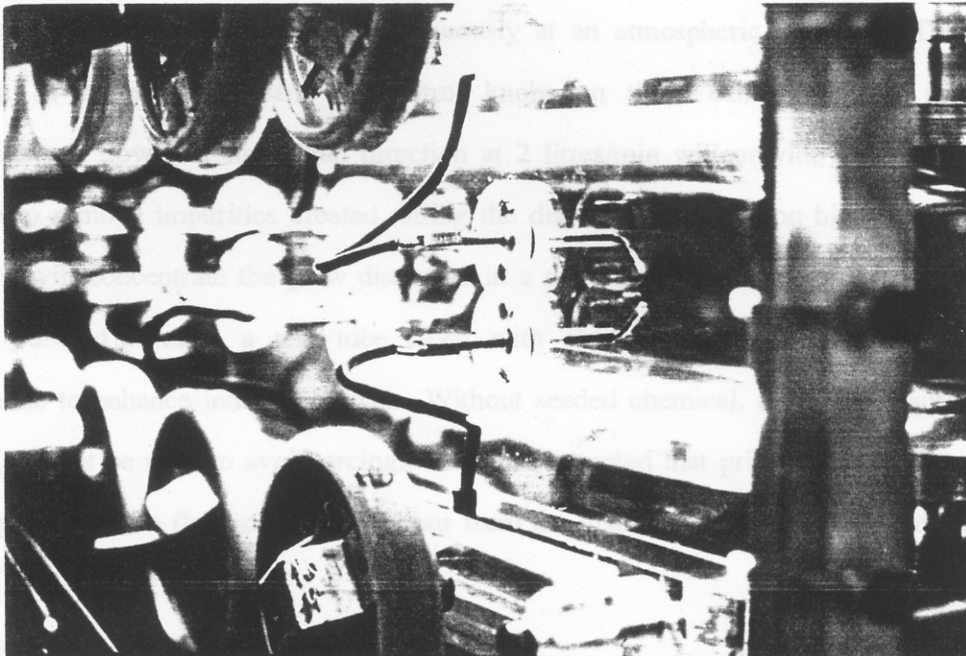

Fig.1 Side view of UV spark pins connected to door knob capacitors

2. Discharge chambers

A rigid perspex box of 16.5 x 11.5 x 56 cm^3 and 1.27 cm thickness houses the main electrodes and UV electrodes. The chamber needs not be vacuum tight, so it is sealed all round by rubber gasket. Bellow attachments hold the laser mirrors at the front and rear ends.

3. Gas System

N_2, He, CO_2 gases at 1 : 1 : 10 ratio are mixed in the two litres mixing flask and then passed through the system continuously at an atmospheric pressure. The gas ratio can be altered by means of control knobs on three calibrated flow meters. Continuous gas flow in longitudinal direction at 2 litres/min will provide sufficient turn over rate to remove impurities created during the discharge cycle. Too high or too low flow rates will concentrate the glow discharge in a particular area of electrodes. N_2 gas may be bubbled through a test tube filled with chemical additives such as Tri-n-Propylamine to enhance ionization level. Without seeded chemical, a greater quantity of helium gas must be used to avoid arcing. It should be noted that prior to laser operation, dry N_2 gas is used to flush out water vapour from the discharge chamber for 20 minutes.

4. Optical System

Rosonant cavity of hemiconfocal resonator type is formed by using a spherical reflecting gold coated mirror (R=1 m) at the rear end and a Ge flat mirror at the front end. Both mirrors have diameters of 5 cm and are housed in metal bellows by adjustable screws. The size of mirrors and crossectional area of the main electrodes gives a discharge volume of 0.7 litre.

Alignment of laser mirrors is easily and accurately accomplished by using a simple interferometry technique. In this setup, the Ge mirror is first removed, a small modulated He-Ne laser is aligned with longitudinal axis along the main electrodes, and the laser beam is reflected from the gold mirror. The Ge mirror is then put back. If both mirrors are parallel to the vertical axis, a slight mirror vibration will create a good interference fringes pattern signal which can be detected by a XP1117 photomultiplier, amplified by a cathode follower and displayed on an oscilloscope. Note that, if the laser is to be operated at subatmospheric pressure, fine alignment should be done at the operating pressure.

5. Discharge circuit

A Simple self-Synchronisation for both UV and main discharges is used. Fig. 2 shows the discharge circuit. A Sorensen of Brandenburg Power Supply is used to charge five cylindrical type capacitors (rating at 0.03 μF 60 kV) connected in parallel via charging Vitoreen resistor of 10 MΩ. Seven stacks of doorknob capacitors (1000 pF 25 kV) C_t couple the spark pins to main discharge along the side of the discharge chamber. A small spherical air trigatron sparkgap is used to switch stored capacitive energy into the discharge. When the gap is triggered externally, the small side spark pins will breakdown, giving intense UV flashes and simultaneously pale pink colour glow discharge occures between the main electrodes.

The discharge current is monitored by using a Pearson pulse transformer (Model 110, calibration 0.1 V/A), while the high voltage is measured by tektronix P 6015 probe. Note that all metal frames supporting the laser must be properly connected to ground, otherwise corona discharges will be observed.

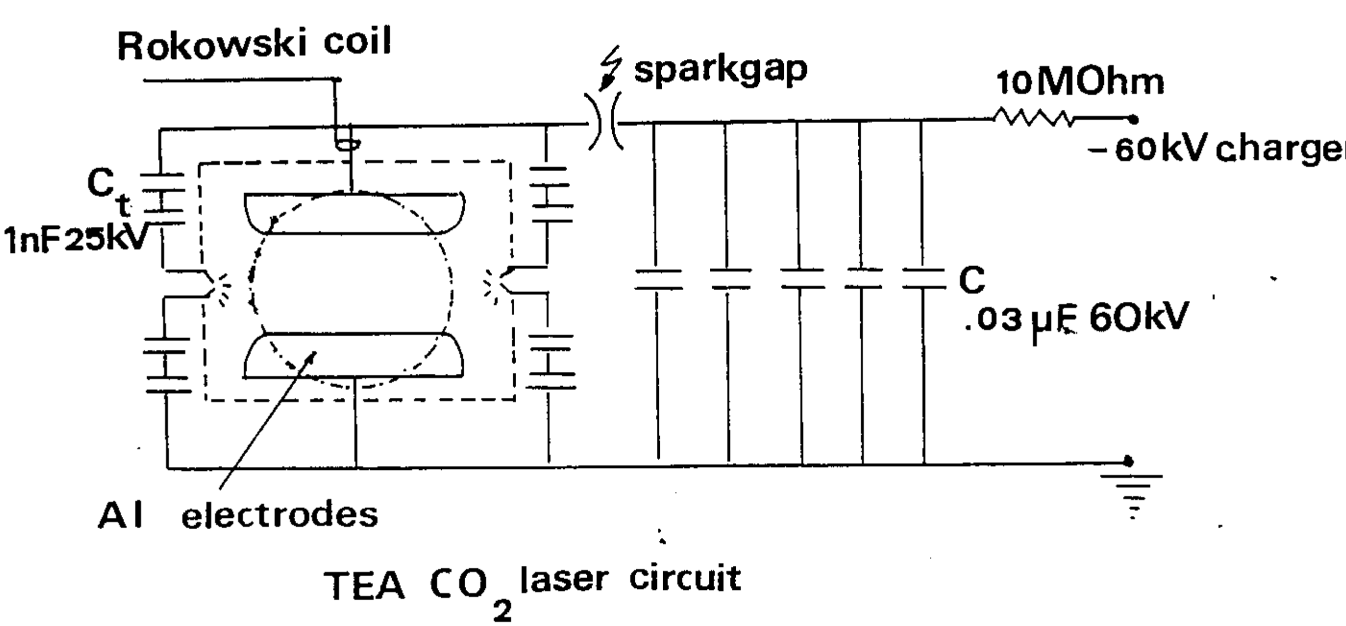

Fig.2 TEA CO_2 laser discharge circuit

6. Laser detectors

Burn pattern is observed by focussing invisible laser beam onto Aquadag(R) coated paper or Polaroid paper. Laser energy is measured by TRG 108 thermopile connected to Keithley millivoltmeter (sensitivity 62 μV/J). Photon drag detector (sensitivity 0.18 mV/kW) is used to detect laser pulse, its signal is recorded by Tektronix 7633 oscilloscope. Fig. 3 shows the photograph of TEA CO_2 laser

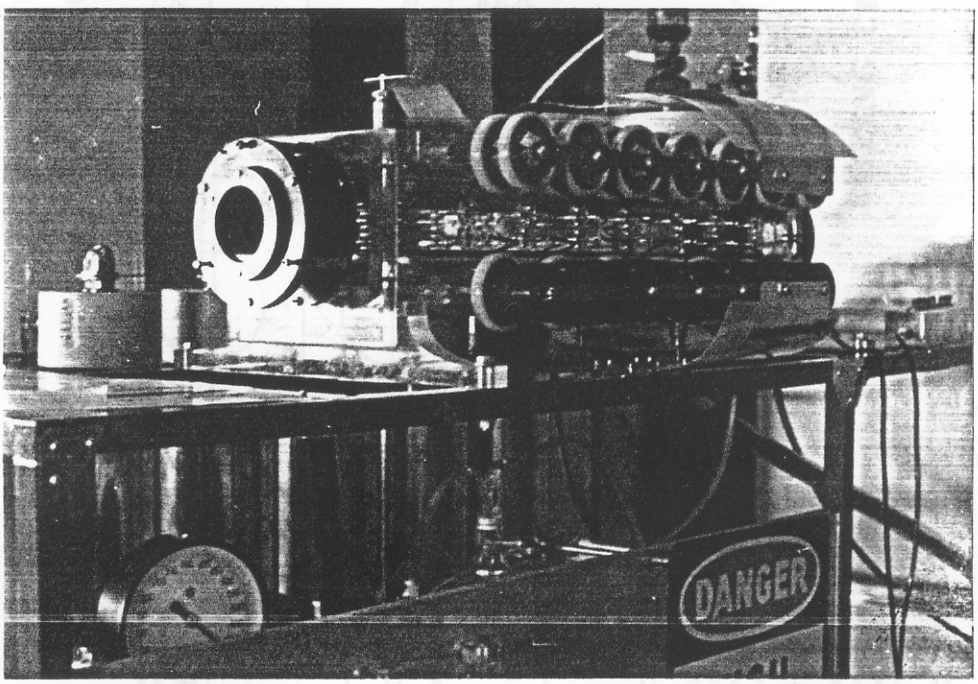

Fig.3 The photograph of TEA CO_2 laser

Its schematic diagram is shown in Fig. 4

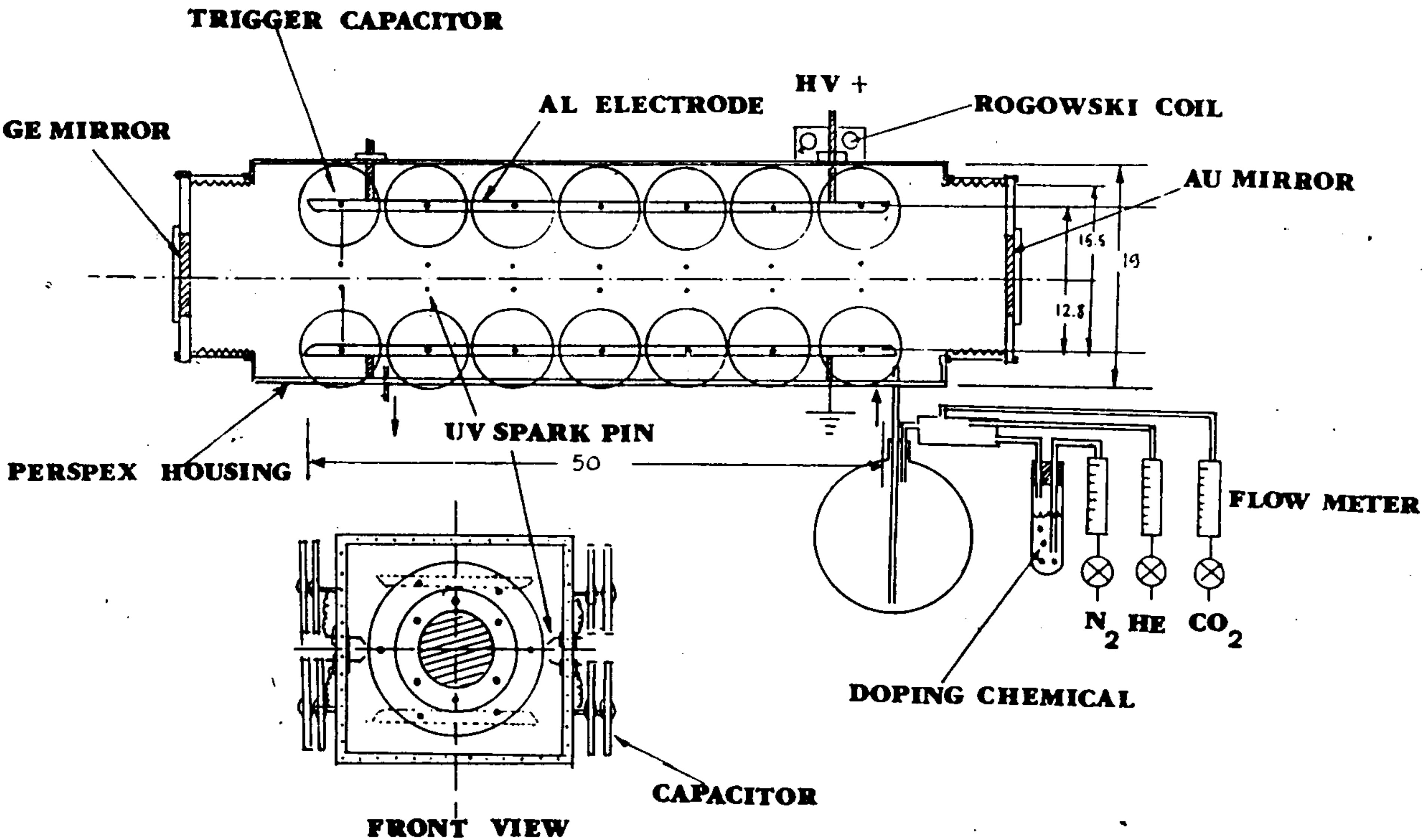

Fig. 4 Schematic diagram of TEA CO_2 laser