CHAPTER - I : INTRODUCTION
Basically, laser is a device designed to produce a coherent beam of electromagnetic radiation. The word 'LASER' is the acronym of Light Amplification by Stimulated Emission of Radiation. The amplification of radiation is realised directly through the stimulation of radiative transition between two energy levels of an atom or a molecule. Laser has become an indispensable tool for various investigations in the field of quantum electronics.

It was Albert Einstein who first introduced the idea of stimulated emission /1/ in 1917, in order to be able to reproduce Planck's radiation law, which deals with emission and absorption of energy by an atom in an electromagnetic field. As far back as 1923, Tolman /2/ was aware that in the presence of population inversion, stimulated emission will exceed the absorption and an electromagnetic signal will be amplified but he had his own doubts about the feasibility of this process. The first experimental demonstration of population inversion came in 1951, when Purcell and Pound showed the existence of negative absorption under conditions of switching of a R.F. field /3/.

Stimulated emission of radiation as a way to obtain oscillations and amplification at microwave frequencies had been proposed independently by Townes /4/.

Schawlow and Townes/10/ in 1958 theoretically showed that at optical frequencies maser oscillators could be built by using a Fabry Perot type cavity to sustain the cavity modes that amplify the radiation.

The major break through was in 1960 when Maiman/11/ obtained amplification of radiation in Ruby at 693.4 n.m. using a Fabry Perot type cavity. In early literature this device is referred to as 'Optical maser', but at present it is an accepted practice to use the word 'Laser' for stimulated amplification at all frequencies of the electromagnetic spectrum. This discovery triggered an avalanche of laser activity everywhere. In course of time laser action in other systems i.e. solids, gases, semiconductors and liquids was obtained.

On the way to progress in lasers, a new class of lasers called the 'Super radiant lasers' was discovered. These lasers do not require a cavity to sustain the
oscillations as the gain in the medium is so high as to provide enough amplification in a single pass of the incident radiation. The lasers that belong to this class are H₂, N₂, Ne, Cu vapour, Pb vapour and excimers etc.

We have chosen the molecular nitrogen laser (the N₂ laser) for study because of its potentialities and wide range of applications.

H.G. Heard/12/ obtained lasing action in nitrogen for the first time at 337.1 n.m. in the year 1963, by passing a very high voltage discharge through nitrogen gas. Although lasing can take place in a capillary discharge tube, the need of reducing the circuit inductance to a very low value favours transverse discharge configuration for an efficient high power laser.

The molecular nitrogen laser (second positive) utilises the inversion in the \( ^3\Pi_u \rightarrow ^3\Pi_g \) transition and lasing occurs on some thirty rotational lines of the (0,0) band/13/. The principal laser output is an envelope of spectral lines, less than 0.1 nm wide, centered at 337.1 nm with pulse widths ranging roughly from 3 to 10 nanoseconds.
$N_2$ laser has proven to be a useful device for pumping many chemically stable dyes, to obtain lasers with large spectral bandwidths in the visible region. The advantage being that, using a suitable tuning element, laser radiation can be selectively chosen at any desired wavelength, right from infrared through visible up to ultraviolet. Nitrogen laser pumped dye lasers have been used in lifetime determination of atomic and molecular energy levels and selective excitation of isotopes of some elements. These lasers are also used in Raman, Brillouin and other scattering experiments.

In the present work, the techniques and equipment required for producing lasing, namely, the pulse forming line (PFL), Marx generator and high voltage power supply; and also the associated measuring and noise suppression techniques have been emphasized and studied in detail. This is essential as this forms the core of the development of lasers and in particular, the pulsed molecular lasers. It is the performance of these building blocks that ultimately defines and determines the actual performance of the laser.

For pumping of nitrogen laser discharge, after careful consideration of various possible techniques, a water dielectric pulse forming line is developed. This
design is flexible in the sense that it can be used as a simple parallel plate pulse forming line (PFL) or as a Blumlein line. Two laser heads are designed and constructed. The laser performance is studied by changing various parameters, operating it in simple PFL mode with and without a series transfer gap, and in Blumlein line mode and the results are discussed.

A two stage Marx generator is designed and constructed to drive the PFL. Marx generator charging of PFL is adopted because of the requirement of short time loading of the water PFL. Water behaves as a good dielectric for short pulse loading of the order of a microsecond/14/. The design of two stage marx generator, the components used and the performance are discussed.

Measurement of high voltage wave forms across the laser head and the detection of laser pulse becomes very difficult in the noisy environment, full of electromagnetic interference, and the results no more stand true. Various factors introducing interference in measurements and the techniques adopted for reducing this effect are discussed. A double shielded room is designed and constructed for this purpose and the details discussed.

For measuring high voltage pulse waveforms in the system, a remote sensing method based on quadratic electro-
optic Kerr effect/15/ is developed and adopted. The theory and performance of the same are discussed in detail and the results are compared with those obtained by a calibrated high voltage probe.
REFERENCES

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