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(ENGLAND) DEPT.. F B CARLETON ET AL. 31 JUL 87
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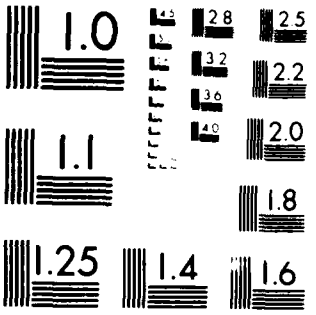
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RD-5462-AN-01-12

DEPARTMENT OF CHEMICAL ENGINEERING AND CHEMICAL TECHNOLOGY

IMPERIAL COLLEGE

Laser Initiated Ignition of Liquid Propellant.

US ARMY CONTRACT NO. DAJA 45-87-C-0010

FIRST INTERIM REPORT

1st June - 31st July 1987

F.B. Carleton

F.J. Weinberg

Introduction

The contract was finally approved to commence on June 1st and this report covers the first two months of its tenure. Several aspects of the work have been set back by the much delayed starting date, making this very much a preliminary report.

Staffing

Fortunately, Dr. F.B. Carleton was able to start immediately and put in the time required by the contract, but the beginning of June, being examination time, is a pretty hopeless period for recruiting a graduate student. The vacancy has now been advertised and, at the time of writing, two applications have been received. It is hoped that an appointment will be made as from October 1st 1987, the research project being offered as part of a PhD programme so that it will eventually give rise to a London University PhD thesis.

Laser

Central to the study of laser induced ignition of propellants is the provision of the igniting pulsed laser. Single pulses delivering in excess of 10 J energy were considered desirable. Because of the delay, the required laser which was to be obtained through BRL was not immediately available and some doubt has been expressed as to whether it would become available in the current financial year. Accordingly, an emergency plan based on attempting to revive our defunct 211A pulsed ruby laser was put into operation. This laser became non-operational some time ago, due to the leakage of cooling water through a small pin hole into the pumping flash lamp. Contrary to the manufacturers' specifications, replacement of the failed component did not cure the problem but caused the output to drop by 2 orders of magnitude to around 200 mJ. The measures taken since then are summarised below:

Power Supply

1. Major repair carried out on main trigger system to improve reliability of firing.
2. Potential on capacitors checked independently of meter readings on front of apparatus.
3. RC characteristics of power circuit established and found to be compatible with manufacturers' specification.
4. Duration of current flow during discharge sequence checked against manufacturers' specification - good agreement: 1.25 ms.
5. Duration of emission of light from flash tube checked against manufacturers' specifications - good agreement: 2.25 ms.

Laser Head

1. Optical components aligned using 1 mW HeNe laser

   components (a) Front window
   (b) Front ruby
   (c) Rear ruby
   (d) Rear window
   (e) Roof top prism

   Component '(d)' deliberately misaligned to increase pre-lasing threshold.

   All components, further finely adjusted for maximum power output.
2. Flash tube replaced and procedure 1 above repeated.
3. Prism and windows cleaned. Procedure 1 repeated.
4. Alignment of polarisation plane in ruby rod checked using polarising filters.
5. Windows on cavity checked - found to have no polarising effect on the light.
6. Internal reflector of cavity cleaned.

None of these measures succeeded in reinstating laser pulses to their formal power; pulses were of the order of 100 mJ, none exceeding 0.5 J. Unfortunately the device is so old that the manufacturers are no longer in business and we shall therefore have to 'buy advice' from other manufacturers, unless BRL can provide us with an alternative laser, as originally planned. The disadvantage of 'buying advice' in this manner is that, not only is it very expensive, but our consultants will not accept any responsibility for it leading to a successful outcome.

Optical Systems

No major changes in the diagnostic optical system used under the previous contract (DAJA 45-83-C-0040) are anticipated in the immediate future. The title refers to the 'igniting' system. The work of Professor Richard Chang of Yale University which was presented at the Liquid Propellant Mini Symposium, 30th April-1st May 1987, highlighted the great complexity of the interaction between a parallel laser beam and a droplet. As the result of this, we decided to endeavour to design an experimental system in which the droplet is exposed to a laser beam converging upon it from as large a solid angle as possible. It is also desirable that the laser beam should be wide enough where it interacts with optical components so as not to damage them due to energy absorption by surface impurities, etc.

The proposed system consists of two large, short focal length, Fresnel lenses, one backed by a plane mirror, in a confocal arrangement. The droplet is to be suspended in a wire loop at the common focus - see Fig. 1.

Experiments with this system will have to await the availability of a sufficiently energetic laser pulse.

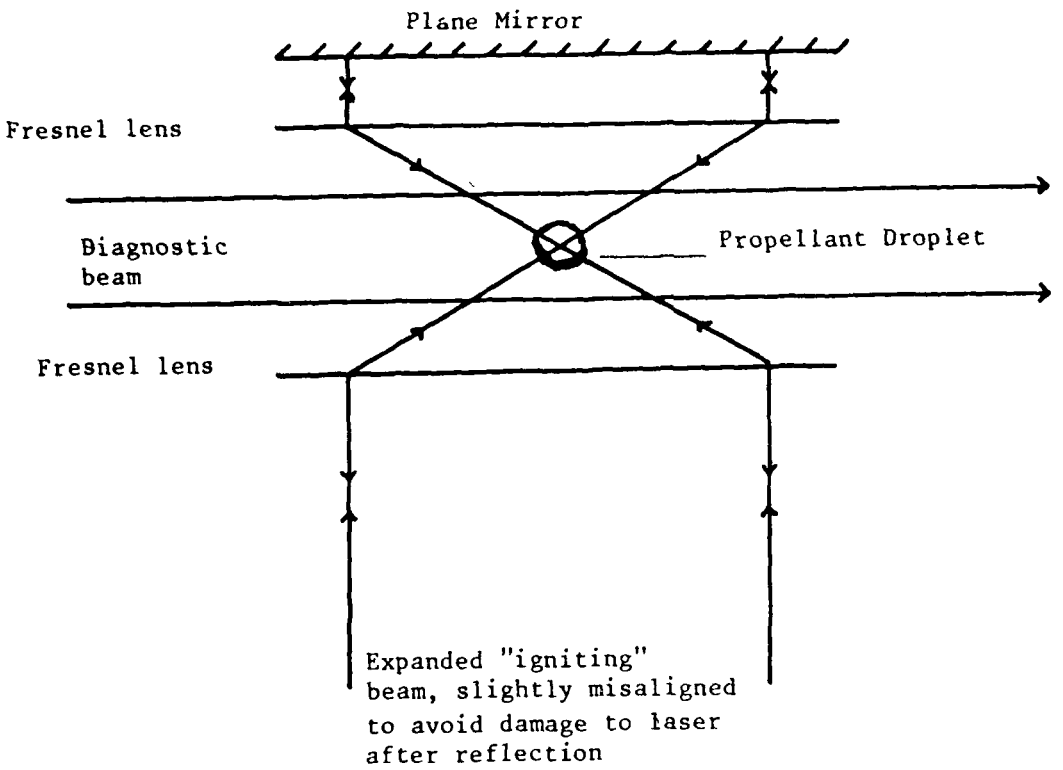
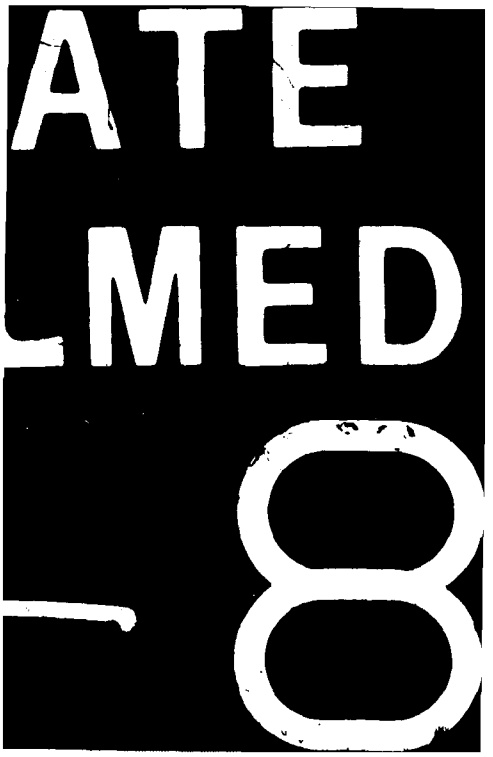

Plane Mirror
Fresnel lens
Diagnostic beam
Propellant Droplet
Fresnel lens
Expanded "igniting" beam, slightly misaligned to avoid damage to laser after reflection

Fig. 1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