FIRING RESULTS OF LASER MULTI-POINT IGNITION & FLAMESPREADING IN A SMALL CALIBER GUN*

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Laser ignition technology is a well-distributed ignition & flamespreading technology, and it plays an important role in improving gun launching safety. At first, multi-point laser ignition simulation experiment is conducted in a ignition simulator. The pressure history at four different ports is recorded by piezoelectric transducers and the flamespreading process is recorded by high speed photography. The high speed photography and pressure vs time at different ports of multi-point laser are recorded separately. And it is compared with the common electric igniter. Then Firing experiments of laser multi-point ignition & flamespreading in a small caliber gun is conducted. The pressure wave curves of multi-point laser ignition and base electric ignition are obtained. The pressure wave was reduced from -52.9MPa to -6.2MPa. The experiments show that the multi-point laser ignition system is successful and it is very effective to restrain dangerous pressure waves.

INTRODUCTION

In order to improve gun performances, there are many high-energy propellants used in charge structure and propellants are highly loaded. But ignition non-uniformity is obvious. In the past years, there are many new type igniters arisen. Laser ignition technology is a well-distributed ignition & flamespreading technology, and it plays an important role in improving gun launching safety. Laser ignition is one of the most prosperous ignition technology, because it has so many advantages which have been

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discussed widely in other references. Laser ignition may hold solutions to the difficulty of achieving effective ignition of a two-piece cartridge for the tank cannon gun system or the modular artillery charge system for artillery.

Although the concept of using laser pulses to ignite propellants is not new, the technology must be advanced before the concept becomes practical. The major difficulty is to ignite a propelling charge with an ignition delay acceptable to gun users. To meet these requirements, various laser beam parameters are used, such as power, energy, wavelength and so on. In this paper, a multi-point laser ignition simulation experiment is conducted in an ignition simulator. The pressure history at four different ports is recorded by piezoelectric transducers and the flamespreading process is recorded by high speed photography. The high speed photography and pressure vs time at different ports of multi-point laser are recorded separately. And it is compared with the common electric igniter. Then firing experiments of laser multi-point ignition & flamespreading in a small caliber gun is conducted. The pressure wave curves of multi-point laser ignition and base electric ignition are obtained.

EXPERIMENTS OF LASER MULTI-POINT IGNITION IN AN IGNITION SIMULATOR

In order to study the ignition & flamespreading phenomenon of multi-point laser ignition, a laser ignition simulator is designed, shown in Figure 1. There are four ports for recording the pressure. The pressure history at four different ports is recorded by piezoelectric transducers and the flamespreading process is recorded by high speed photography. The high speed photography and pressure vs time at different ports of multi-point laser are recorded separately. The experiments at different conditions are conducted, for example, three, five and seven point laser ignition at different laser parameters level. The typical experimental results of laser ignition are shown in Figure 2 and Figure 3. In order to compare with the ignition of common electric primer, the experiments of common electric primer are also conducted, typical results shown in Figure 4 and Figure 5. From the photography and the recorded pressure vs. time curve, we find that the pressure curve of laser ignition is smooth and ignition is uniform.

Figure 1. The experimental setup of an ignition simulator

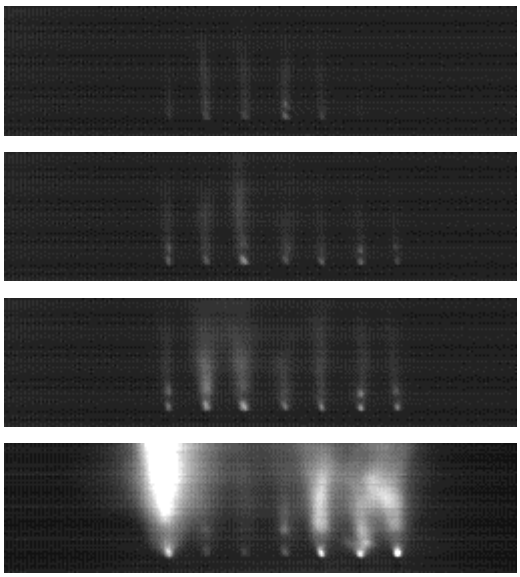

Figure 2. High speed photography of multi-point laser ignition in a ignition simulator

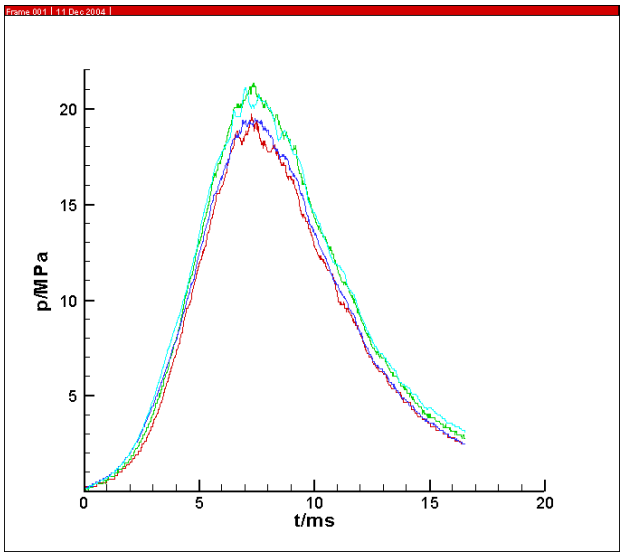

Figure 3. Pressure vs time at four ports of multi-point laser ignition in a ignition simulator

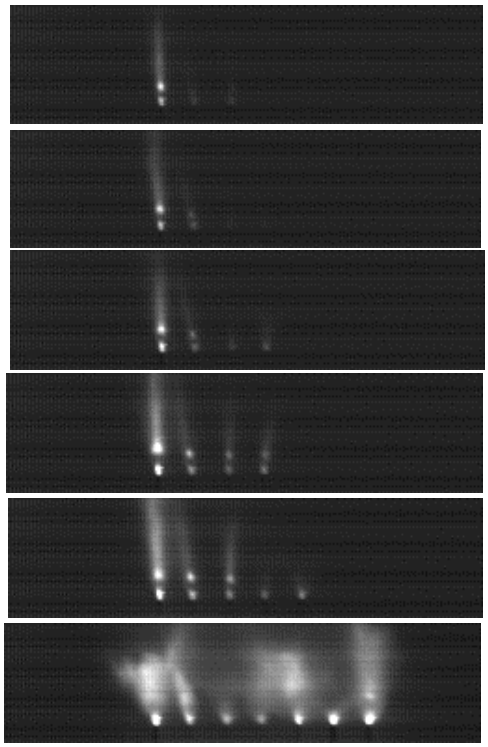

Figure 4. High speed photography of common electric ignition in a ignition simulator

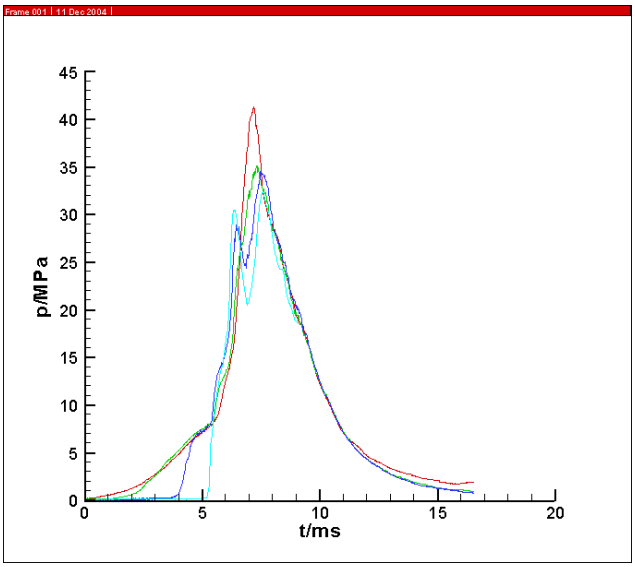

Figure 5. Pressure vs time at four ports of common electric ignition in a ignition simulator

FIRING RESULTS OF LASER MULTI-POINT IGNITION IN A SMALL CALIBER GUN

The laser multi-point ignition experiments are conducted in a small caliber short-barrel gun. A three-point fiber igniter are used and the loading density is 0.79g/cm^3 .Figure 6 is the pressure vs. time curve of three-point laser ignition and Figure 7 is the pressure vs. time curve of base electric ignition. Their pressure waves are -5.6MPa and -52.9MPa respectively. Their maximum pressure is about 290MPa and the pressure curve of laser multi-point ignition is smoother than the common base electric ignition. From the firing results, we find that: (1) Laser ignition is effective to restrain dangerous pressure waves; (2) The designed device can seal propellant gas in high pressure.

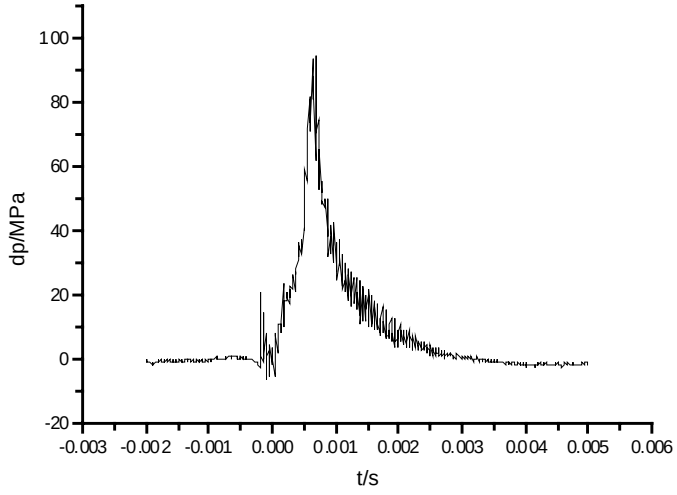

Figure 6. Pressure wave vs time of multi-point laser ignition in a small caliber gun

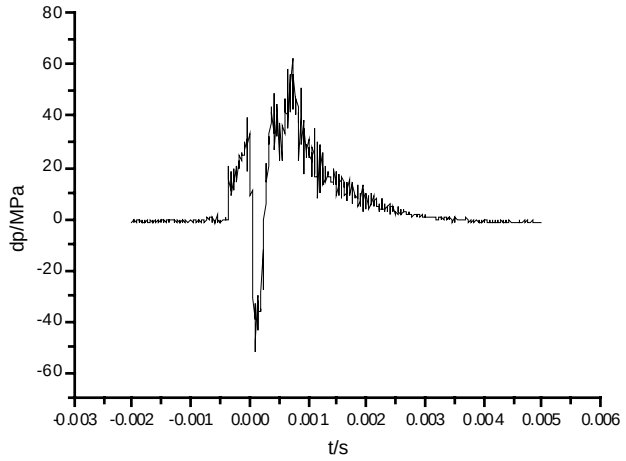

Figure 7. Pressure wave vs time of base electric ignition in a small caliber gun

CONCLUSIONS

On the basis of the fundamental experiments of laser ignition in a simulator, the

multi-point laser igniter is designed and it is used in a small caliber gun. From the firing results, we find that: (1) Laser ignition is effective to restrain dangerous pressure waves, reducing from -52.9MPa of base electric ignition to -5.6MPa of multi-point laser ignition; (2) The designed device can seal propellant gas in high pressure.

REFERENCES

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