BRIEF COMMUNICATIONS

DIAPHRAGM-BURSTING SYSTEM FOR THE CHEMICAL SHOCK TUBE

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Inzhenerno-Fizicheskii Zhurnal, Vol. 12, No. 3, pp. 398–400, 1967

UDC 621.07

The "chemical" shock tube method, first used in 1955 [1], occupies an important place among the various methods of investigating chemical reaction kinetics. The principle has now been quite thoroughly developed. In chemical shock tubes the necessary reaction time is determined by the delay in bursting diaphragms Nos. 1 and 2, which respectively separate

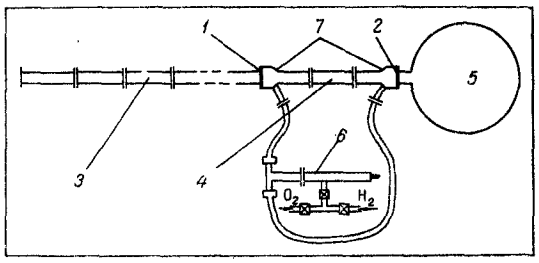

Fig. 1. Diagram of chemical shock tube: 1) diaphragm No. 1, 2) diaphragm No. 2, 3) reaction chamber, 4) high-pressure chamber, 5) evacuated vessel, 6) detonation chamber, 7) plunger sections.

the high- and low-pressure chambers and the high-pressure chamber and evacuated vessel (Fig. 1). This delay determines the difference in the times of arrival at the observation point of the incident or reflected shock and the rarefaction wave associated with the bursting of diaphragm No. 2.

A common method of bursting diaphragms is to use plungers driven by the pressure created in a detonation wave. For this purpose it is customary to employ a detonation chamber filled with mixtures of hydrogen and oxygen. In this case the delay in triggering plunger No. 2 as compared with plunger No. 1 is determined by the difference in the lengths of the tubes connecting the plunger sections of the shock tube and the detonation chamber.

At the All-Union Scientific Research Institute of Natural Gas we have developed a new system of bursting diaphragms which makes it possible to vary the delay over a broad interval without using a detonation chamber.

This system consists of two identical devices with plungers which are actuated by powerful springs with a force of about 750 N. Each of these devices is equipped with an electromagnetic lock which makes it possible to hold the plungers in the cocked state with the springs compressed. A section through the plunger is shown in Fig. 2. In the compressed state a powerful spring tries to push out the plunger. The plunger is cocked manually by means of a special rod which is screwed into the body of the plunger by turning a knob. After the power supply to the electromagnet has been turned on, this rod is unscrewed. In order to ensure that the high-pressure chamber is airtight during evacuation, the rod is sealed with a teflon gland. Thanks to the use of a powerful spring and a small plunger mass the scatter of the triggering times could be kept small.

The delay in the operation of the two plungers is provided by a simple delay circuit (Fig. 3), which by means of intermediate relays switches off the voltage in the coils of the electromagnetic locks. The delay intervals range from 0.5 to 30 msec. The electromagnets are supplied from a 40-V dc source. The current

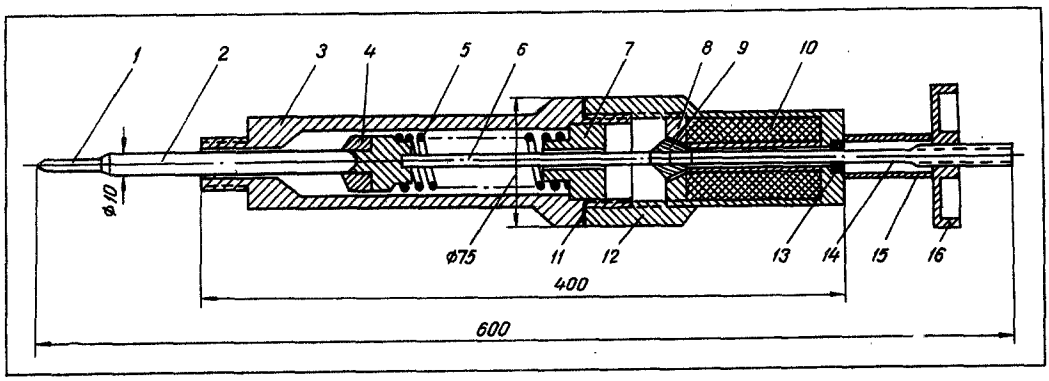

Fig. 2. Electromagnetic device for bursting diaphragms: 1) plunger needle, 2) plunger, 3) case, 4) rubber shock absorber, 5) spring, 6) armature rod, 7) regulating nut, 8) nut, 9) armature, 10) solenoid coil, 11) rubber gasket, 12) case of solenoid, 13) teflon gland, 14) rod, 15) sleeve, 16) knob.

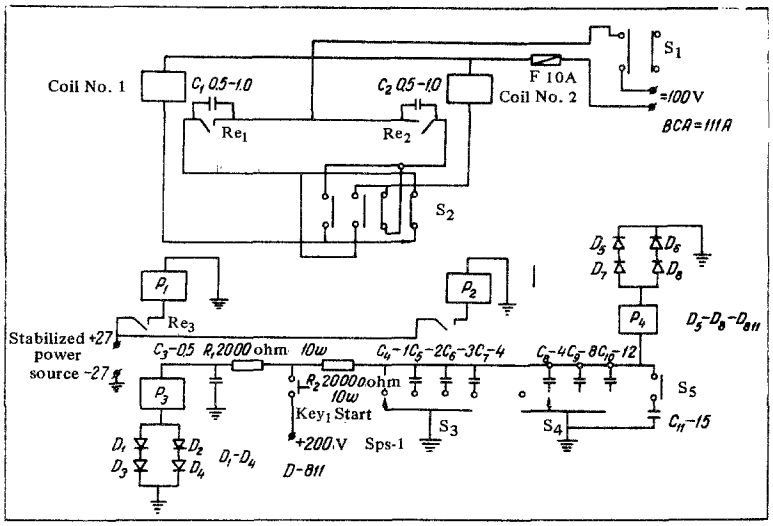

Fig. 3. Delay circuit.

required to retain the plungers in the cocked state is 3 A.

The entire system was tested on a special test bench using piezoelectric transducers reacting to vibration and under working conditions; it was found that for the given parameters the scatter of the delay times does not exceed tenths of a millisecond, which fully ensures the necessary experimental accuracy in a chemical shock tube. As established experimentally, using a detonation chamber gives no greater accuracy, particularly at low detonating-mixture pressures.

A great advantage of the system tested consists in the possibility of continuous variation of the delay, not to mention its simplicity and reliability. It takes 2–3 min to get the system ready for operation as compared with 20–30 min for the old system, and in addition it is possible to save on the gases used in the detonating mixture.

The electromagnetic plunger can be used for bursting diaphragms not only in chemical shock tubes but in shock tubes of any other type.

REFERENCES

1. H. S. Glick, W. Squire, and V. Herzberg, Fifth Symp. on Combustion, 39, 1955.

6 July 1966 Moscow Institute of Natural Gas