PRODUCTION OF A BLAST WITH A HIGH ENERGY CONCENTRATION

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UDC 534.222.2

The results of experiments on countercollision of clusters of tungsten particles with a density of about 1 g/cm^3 moving with velocity 24 kg/sec are described.

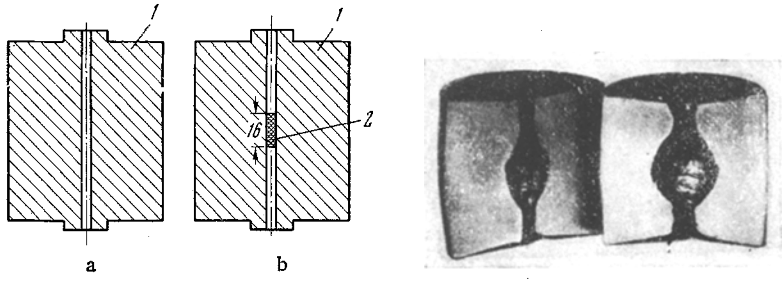
As a result of collision an explosion occurs with an energy concentration exceeding the energy concentration in high explosives by more than 50 times.

Before collision each of the clusters of tungsten particles with mass 0.18 g, density about 1 g/cm^3, moving with velocity 24 kg/sec had a diameter of 5 mm and length of 10 mm. The clusters moved counter to each other along a 5-mm-diameter channel. The instant of collision of the clusters and the propagation of the shock wave formed were recorded by an SFR-2M photochronograph and SFR-3M slow-motion camera. Experiments on collision of the clusters in blocks of organic glass and steel and in air were carried out.

The form of the shock wave and its velocity were recorded upon collision of the clusters in the organic glass block. Photography was carried out in transmitted light created by the illumination of the blast. A photograph obtained by means of the slow-motion camera is shown in Fig. 1. The photographic frequency was $5 \cdot 10^5$ frames/sec. The initial velocity of the shock wave in organic glass was 10.5 km/sec [the velocity was about 5.8 km/sec in the case of detonating trinitrotoluene (TNT)]. We see on the photograph that the shock wave has a spherical form.

Experiments on the collision of clusters in steel cylinders were carried out without recording the development of the explosion and served for determining the size and shape of the cavity formed upon collision. In these experiments direct collision of the clusters and collision through a paraffin plug occurred. The setup of the experiments and the appearance of the cavities that formed after the explosion in the steel cylinders are shown in Fig. 2. In the figure a is direct collision, b is collision through paraffin, 1 is the steel cylinder, and 2 is paraffin. The cavity formed in the case of the direct collision of the clusters has a noticeably elongated shape and volume of 10.5 cm^3. Such a shape indicates partial preservation of the direct

Fig. 1



a b

Fig. 2

Chelyabinsk. Translated from Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki, No. 1, pp. 168-170, January-February, 1973. Original article submitted June 17, 1971.

action of the substance of the clusters after their collision. The cavity formed upon collision of clusters through paraffin has a shape closer to spherical. Its volume is 22 cm^3. We note the large difference in the volumes of the cavities, which is apparently explained by the formation of an additional quantity of "explosion products" and change of their properties.

On the basis of the size of the cavities, using Hopkin's theory [1] for cavities formed in the case of a spherically symmetric explosion and having used 8600 kg/cm^2 as the dynamic yield point for steel St.3 [2], we determined the magnitude of the energy extracted by the medium, which proved to be equivalent to 8.5 kg TNT in the case of direct collision and 18 g TNT in the case of collision through paraffin. The energy determined thereby is less than the total energy of the blast, since a part of the energy remains in the explosion products and part passes into the thermal energy of the medium. The kinetic energy of one cluster is equivalent to about 12 g TNT and exceeds the evaporation energy of tungsten by 60 times.

To determine the blast energy we conducted experiments on the collision of clusters in air, which were carried out in an organic glass tube with a wall thickness of 0.3 mm. The blast wave formed in this case was bounded by two steel shields located perpendicular to the movement of the clusters with a distance of 20 mm between them. This created conditions for cylindrical symmetry of the blast.

The energy given off during the blast occurring upon collision of the clusters was determined on the basis of the experimentally determined law of damping of the shock wave with the use of Sedov's solution of the problem of a strong explosion for cylindrical symmetry [3]. The blast energy was equivalent to 24.6 g TNT. The initial velocity of the shock wave in air was 23 km/sec (upon detonation of TNT the initial velocity of the shock wave in air is about 7.5 km/sec). In the case of the energy released in the form of an explosion on the surface of the barrier upon collision of the cluster on the paraffin and tungsten barriers, the magnitude of the energy was only 2.3 and 3.5 g TNT, respectively [4].

Thus, by using countercollision of masses of substances moving with velocity 24 kg/cm^2 we produced under laboratory conditions an explosion with a volume energy concentration exceeding the energy concentration of a TNT-type explosive by a factor of 75.

The authors thank A. M. Kalugin for help in conducting the experiments.

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