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-USSR-

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[Following is the translation of an article by Ye. A. Feoktistova in Doklady Akademii Nauk SSSR (Proceedings of the Academy of Sciences of the USSR), Vol 136, No 6, 1961, p 1325-1327.]

These experiments were inspired by the work of G. M. Gangel'man (which will be described later) dealing with the solution of the problem of a skew collision of detonation waves. The solution obtained by him was not accurate enough because the equation of state of the detonation products was not accurate, and the solution of the problem was not confined to the narrow region of the particular collison angles, the analytical solution of which can be two-digital. The critical value of angle α_{cr} which separates the regular and Mach reflection, was determined only in the region 40-44° (Fig. 1).

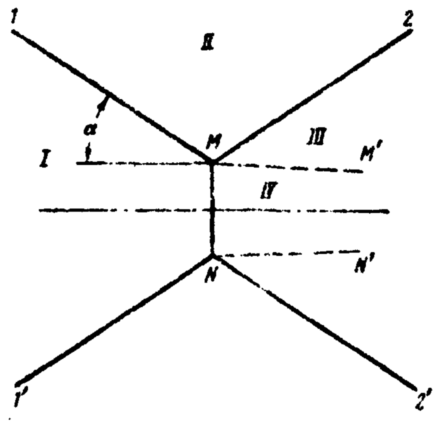

Fig. 1. Mach reflection of the detonation waves. The fronts; 1,1' are of incident waves; 2,2' of reflected waves; and MN, of Mach waves. The regions: I, is of undetonated material; II, III, and IV, of the detonation products just behind the front lines of the incident, reflected, and Mach waves; MN' and NN' are lines of tangential burst lines.

It was of interest, therefore, to find out experimentally "the third" Mach wave, to measure its propagation velocity, and to determine the value of α_{cr}. Two kinds of experiments were conducted.

Trihedral prisms of various sizes were used in the first series of experiments. The prisms were made of solid explosive material. Two plane detonation waves were applied simultaneously to the side facets OB and OC of the prism (Fig. 2). Thus the prism angle 2α is also the collision angle of the detonation waves at the same time.

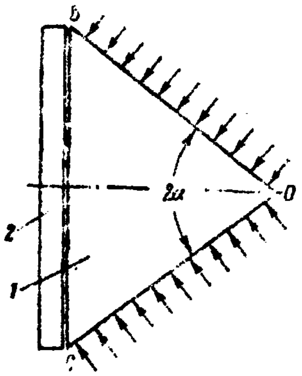

Fig. 2. Recording the collision of the detonation waves occuring at 2α angle. 1) is solid explosive material; 2) is the organic glass [orgglass ?]. The detonation plane waves are marked arbitrarily by arrows.

A photochronograph was used for recording of the process. The propagation of detonation on the plane for prism base BC was recorded. The prism top edge was parallel to the direction of the detonation process. The optical system of the chronograph had a number of slits perpendicular to the direction of the detonation process.

The prism base BC was covered over with a thin plate of organic glass which reduced the duration of the recorded glow in each point of the object due to the organic glass turbidity caused by the impact wave. This reduction of the duration of glow made it possible to record the process on a large portion of the prism base without overlapping of the glow coming through the slits.

The photochronogram in Fig. 3 was obtained by the above method and it shows the irregular reflection of detonation waves. The front of the third detonation wave is seen clearly on this photochronogram. The value of α_{cr} found in these experiments was 49°.

It was noticed that the third wave cannot be observed in the case of small prisms regardless of the value of α. Consequently, this wave originates in the depth of the prism and not at its top. This, probably, is due to the initiation method (ignition), or to the limited zone of chemical reaction.

Since the point of origin of the third wave in prism is not known, the velocity of its propagation, D_T, could not be measured in these experiments.

Fig. 3. Photochronogram of the irregular reflection of detonation waves

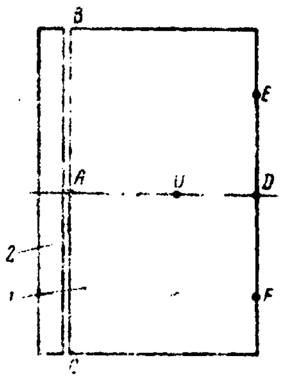

Fig. 4. Recording the skew collision of the propagated detonation waves. 1) is the solid explosive material; 2) is the organic glass.

In order to measure D_T a series of another experiments were undertaken using a parallelepiped made of explosive material (Fig. 4). The detonation processes in these experiments were initiated at points E and F. The propagation of the detonation waves on plane BC was recorded (similarly to the first series of experiments).

The line AD is the crossection of the Fig. 4 plane with the plane of collision of two propagated detonation waves. The collision angle 2 α, which increases with the spreading of the detonation process from right to left, reaches its critical value at a certain point O, the point of origin of the third wave. On the basis of the chronogram it is possible to measure the time interval between the meeting of line BC of the third wave with point A and the meeting of the crossection of the fronts of incidence waves with the same geometric point.

Comparing the two photochronograms obtained with parallelepipeds of various thicknesses (AD), the propagation velocity of the third wave can be determined on its path which is equal to the difference in thickness of the compared parallelepipeds. Velocities D_T for several collision angles were obtained by this method.

The experimental results are given in Table 1. The velocity D_T is expressed in units of the detonation of normal velocity. The calculated values of D_T, which were obtained by G. M. Gandel'man, are given for reasons of comparison. Their calculation was based on the critical angle value (found experimentally), which was equal to 49°.

Table 1

	Intervals of , in degrees					
	49—53	53—57	57—62,5	62,5—67,5	67,5—70	70—[illegible]
D_T exp.	1,3019	1,2241	1,1722	1,1138	1,0824	1,052
D_T calc.	1,4219	1,3006	1,2187	1,1455	1.0901	1,0404

A skew collision of the impact waves in aluminum was investigated in addition to the study of the skew collision of the detonation waves. These experiments were carried out with trihedral prisms of aluminum, the height of which was 100 mm. Two plane detonation waves of the explosive material were applied to the side facets of the prism. It was established that the $_{cr}$ for aluminum under the given conditions was $\alpha_{cr} \approx 38^{\circ}$.

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REFERENCES

K. P. Stanyukovich. Transient Motion of the Continuous Medium. Moscow, 1955.