NOTATION

h is the layer thickness; μ is the dynamic liquid viscosity; σ is the surface tension of the liquid; ρ is the liquid density; g is the gravity acceleration; u_0 is the linear speed of body extraction; φ is the angle between the horizontal axis of the drum end and the radius-vector of the point under consideration; φ_0 is the angle between the horizontal axis of the drum end and the radius-vector of the boundary at which the drum is immersed into the liquid.

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THE SPECIFICS OF THE SHOCK COMPRESSION OF MATTER IN CYLINDRICAL BOMBS

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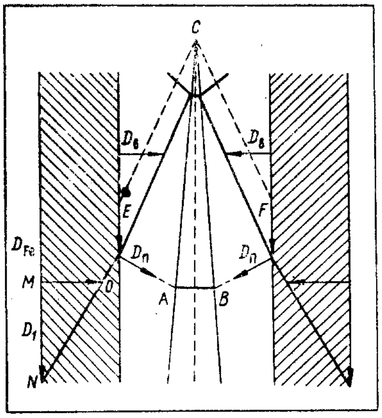
The dynamic pattern of the shock compression of a substance in cylindrical bombs is examined. It is demonstrated theoretically and experimentally that conditions are established in the center of the bomb for nonregular Mach repulsion.

In studying the shock compression of powders in cylindrical bombs, we noted that a narrow region ("filament") is established along the axis, this region noticeably different from the remaining mass of the substance in form and properties [1]. Thus, in compressing carbonates [2] in this region we find predominant decomposition of the substance, while with NaCl, CsBr, and the nitrates [3], we find the formation of defects. Within the "filament" we frequently encounter voids in the form of channels or vacuoles whose walls are fused. The "filament" usually appears in the case of a small bulk density for the material being compressed. As the bulk density is increased these effects are reduced.

It is interesting to examine the reasons for the appearance of the "filament" within the substance. The most important moment in the explosive compression of a steel bomb contained within a cylindrical explosive charge is the formation of the oblique shock-wave front within the substance (figure). This configuration arises as a result of the fact that the bomb is not simultaneously compressed over the entire surface, but successively.

As a matter of fact, at a certain instant in time the detonation front reaches the point M. From the point M the perturbation is propagated in the walls of the bomb at a velocity D_{Fe} and reaches the point O within a unit of time. Within this same period of time the



Shock wave configuration in a cylindrical ampul: ABC $= 2\beta$, opening angle of a head wave; ECF $= 2\alpha$, angle of impact of oblique shock waves; NO, shock wave front in ampul; EC, shock wave front in a substance.

detonation front will reach the point N, i. e., an oblique shock front NO arises within the material of the bomb. Assuming similar considerations, we obtain an oblique shock front in the substance.

As mentioned in [1], in this case Mach repulsion becomes possible when shock waves meet in the substance. From simple geometric constructions we find that the impact velocity of the bow wave (when $\alpha \gg \beta$) is equal to the detonation velocity D_1, which in our experiments is equal to 6.2 km/sec. The pressure in the bow wave

$$P_{\text{bow}} = \rho \frac{D_1(D_1 - c)}{g}. \qquad (1)$$

The parameters c and g are determined from the equation

$$D = c + gu. \qquad (2)$$

From the data of [4] we find: for NaCl with $\rho = 2.165$ g/cm^3, $P_{\text{bow}} = 274$ kilobars, while with $\rho = 1.44$ g/cm^3, $P_{\text{bow}} = 275$ kilobars. For CsBr with $\rho = 4.45$ g/cm^3, $P_{\text{bow}} = 800$ kilobars, while with $\rho = 2.95$ g/cm^3, $P_{\text{bow}} = 700$ kilobars.

This result is approximate, since the reflection and refraction of the shock waves at the boundaries between the explosive and the steel and between the steel and the substance have not been taken into consideration, nor have the conditions for the convergence of a cylindrical shock wave. The pressure behind the bow-wave front is of one order of magnitude in the case of either a dense or a weak charge, but for a weak charge (great porosity), the thermal component of the pressure is considerably greater. As a result the substance in the region of the bow wave exhibits a higher temperature, which is one of the factors leading to the formation of the "filament."

We carried out experiments to verify the assumption of the appearance of a bow wave on compression of cylindrical bombs. Thus with the placement of thin metallic plates within the substance, perpendicular to the axis of the bomb [6], we noticed that all of the plates in the case of a weak charge were punctured from top to bottom at the center and were fused. The area of the puncture in the upper plate was smaller than in the lower plates. Having measured these areas and knowing the distance between the plates, we found that the angle $\beta = 1$–$2°$. This quantity is in good agreement with the characteristics of the bow wave from reference [5]. Moreover, a depression 2–2.5 mm in diameter is noted in the lower plug of the bomb, which is apparently a result of the bow-wave action. The latter, impinging on and being reflected from the plug, takes with it a part of the iron. Indeed, spectral analysis has demonstrated that the content of iron is at its maximum at the lower plug and diminishes sharply toward the top of the bomb. Assuming the cross section of the depression to be equal to the area of the bow-wave base, we find that $\beta = 1.5°$, i. e., a value coincident with the data on the plates.

The bow wave generated by the converging oblique shock waves is continually supplied with energy by the latter. If this pumping process were to be curtailed, i. e., if the external action on the bomb were to be removed, the bow wave would continue to pass through the substance for some additional distance on account of reserve energy. To check this we conducted an experiment in which only half a bomb was compressed, and it developed that the "filament" actually passes beyond the boundary of the compressed part by 5–10 mm.

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