REM SOLOUKHIN FIRST SHOCK TUBE AND DEVELOPMENT OF 3-D SHOCK WAVES INTERACTIONS INVESTIGATIONS IN ENIN AND IHED

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Rem Soloukhin first steps in science

1. Pioneering experiments in shock tubes - calibration of the pressure gauge - were done in the Krzhizhanovsky Power Research Institute (1953**).**

2. Rem Soloukhin proposed the construction of a smooth shock tube of rectangular cross-section **-** the copper wave-guide 7 meters long**,** which was reinforsed with thick metal plates outside.

3**.** First Soloukhin international paper (VII Symp. (Int.) on Combustion, 1958) was devoted to development of the detonation in gas mixtures behind the incident and reflected shock waves in channels with constant and contracted cross sections [1]. The flash photographs of the reactions centers and detonation formation behind the incident and reflected shock waves in hydrogen-oxygen mixtures were compared with the moving image of the reactions centers and pressure histories. Detonation formation delays were obtained.

Shock waves interactions investigations [2]

The Soloukhin shock tubes are used in our laboratory till now. Some old and new results will be presented.
1. Three shock configurations (Mach reflection) in the gas with endothermic reactions were investigated. It was demonstrated, that if the specific capacities ratio is low, the reflected shock wave angle is higher, than that of the attached oblique shock wave at the wedge, the smooth conjunction is impossible and the double Mach reflection occurs.

2. Shock wave diffraction in selfsimilar case was investigated. The wall pressure, separation angle and last line of the rarefaction fane angle in wide range of incident shock wave Mach numbers and wall angels were measured.

Development of 3-D shock waves interactions investigations [3]

The time and space distribution of the intensity of the shock wave, diffracted from the tube of square cross-section near the wall at 90° were obtained. It was found, that behind the diffracted shock wave along the 90 edge the maximum wall pressure in the axisymmetrical case is less, than in the selfsimilar case and than that in the square side direction in 3-d case. In the diagonal directions the relatively low pressure zones are formed.

3-D diffracted shock wave interaction with the flat plate [4]

It was found that the stagnation wave (6) position (Fig. 1) is closer to the obstacle in the case of square cross-section. The flow Mach number in front of the stagnation wave and total pressure losses behind the stagnation wave were found to be more considerable in the of square cross-section case. The action of the shock wave on the obstacle in the case of square cross-section is less than in the round one.

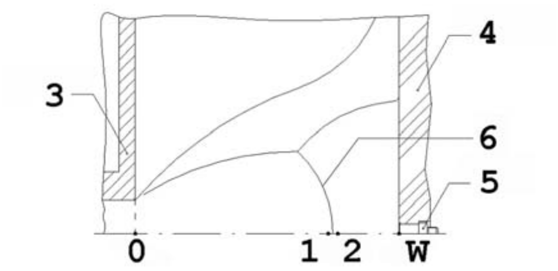

Fig. 1. Diffracted shock wave interaction with the wall (4). 3 – shock tube exit, 6 - Mach disk

Reduction of total pressure losses of non-stationary flow can be obtained by destruction of Mach disk varying the initial and boundary conditions of the flow. Total pressure losses reduction was obtained by introduction of concave angles into the cross-section geometry of channel, the channel of X-shaped cross-section. On the schlieren pictures of the flow from the channel of X-shaped cross-section Mach disk disappeared when the pressure gauge on the obstacle shows the pressure rise several times higher, than in the case of square cross-section and in the round one (Fig. 2). In the case of weak shock wave emerging from the channel of X- shape cross-section the summary force at the obstacle is lower because of the vortex formation on the edges, seen on the schlieren pictures.

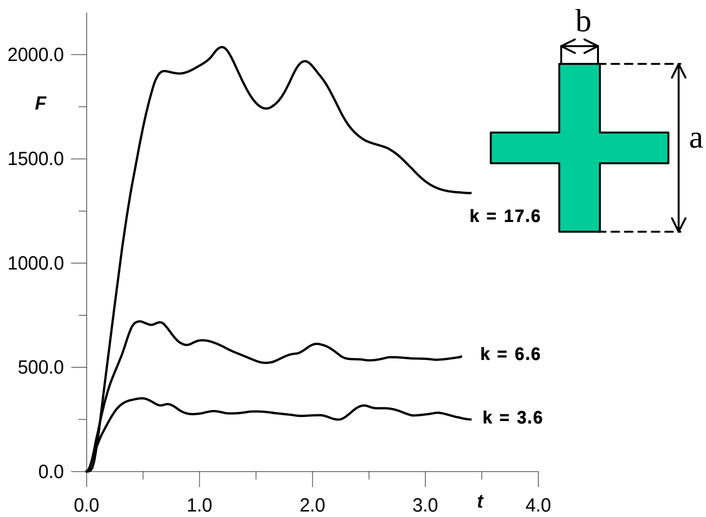

Fig. 2. Action ***F*** on the obstacle of the shock wave diffracted from the channel of X-shaped cross-section. k = a / b. Incident shock wave Mach number $M_0 = 3.05$. In the case of the round cross-section ***F*** = 80

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References

[1] Bazhenova T., Soloukhin R. (1957) Sevens Symposium (International) on Combustion, p. 487.
[2] Bazhenova T., Gvozdeva L., Nettleton M. (1984) Prog. in Aerosp. Sci., V 21, p. 249.
[3] Bazhenova T., Bazarov S., Bulat O., Golub V., Shulmeister A. (1993) Fluid Dynamics, V. 28, p. 153.
[4] Bazhenova T, Golub V, Kotel'nikov A, Chizhikov A, Bragin M, Shcherbak S, (2004) High Temperature. V. 42. N 6. p. 900.