

ON THE DEVELOPMENT OF A RAMJET IMPLEMENTING A CYCLE CLOSE TO THE CYCLE WITH DETONATIVE COMBUSTION

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Abstract: The paper presents the results of work on creating a detonation ramjet based on the simplest form of a jet engine — a valveless pulsejet. The seductive simplicity of the design of such engines conceals the complexity of its operation process. The authors achieve cyclic combustion modes close to detonation in the pulsejet. The possible mechanism of initiating the detonative combustion is discussed.

Keywords: pulsejet; Glukharev engine; longitudinal detonation; spherical detonation; vortex zone precession

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Figure Captions

Figure 1 Schematic of the inlet section of the engine and the stages of the operation cycle: 1 — inlet tube; 2 — diffuser chamber; 3 — trunk or tube package; 4 — main combustor; 5 — fuel injectors of the prechamber; 6 — fuel injectors of the main combustor; 7 — spark plugs; (a) first stage; (b) second stage; (c) third stage; and (d) fourth stage

Figure 2 Fragment of the oscillogram of thrust pulsations in a pulsejet; sweep time 20 ms/div; frequency of thrust pulsations is 25 Hz. The upper curve is the signal of the load cell and the lower curve is the signal of the fuel flow meter

Figure 3 Photograph of the plume of the operating pulsejet

Figure 4 Schematic diagram of an experimental pulsejet. Dimensions are in millimeters

Figure 5 Schematic diagram of a dual-circuit ejector pulsejet operating on gasoline. Dimensions are in millimeters

Figure 6 Numerical calculation: visualization of the flow in the engine duct

Figure 7 Influence of duct length on the pulsation frequency and thrust

Figure 8 Engine operating in the mode close to the mode with detonative combustion

Figure 9 Velocity characteristics of two types of ejector pulsejets with single-tube reactors and plates in the second mixer: 1 — engine with axial aerodynamic valve; and 2 — engine without axial aerodynamic valve

Figure 10 Specific thrust of engines of different types: 1 — turbojet; 2 — ramjet; 3 and 4 — dual-circuit ejector pulsejets with deflagrative and detonative combustion, respectively

Figure 11 Calculated temperature fields in the engine duct at the approaching air velocity of 120 m/s and a pulsation frequency of 100 Hz: (a) first phase — development of the flow separation zone; (b) second phase — detachment of the recirculation zone into the duct; (c) third phase — outflow of gas from the flow separation zone into the confusor part of the duct; and (d) fourth phase — formation of a new flow separation zone

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