INVESTIGATION OF THE INFLUENCE OF THE GEOMETRIC PARAMETER AND THE MIXING CHAMBER LENGTH OF AN EJECTOR ON THE ORIGINATION OF THE CRITICAL MODE

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Results are presented of experimental investigations to determine the dependence of the pressure drop at which the critical mode sets in in an ejector, on the geometric parameter and the mixing chamber length.

It is known, [1-3], say, that a gas ejector goes over to the critical operation mode for a definite value of the pressure drop when the gas velocity reaches the speed of sound in a certain section of the low-pressure jet within the mixing chamber. The ejection factor is independent of the magnitude of the counter-pressure in the critical mode. Later, G. M. Ryabinkov established experimentally still another flow scheme in the mixing chamber of an ejector operating in the critical mode when the gas mixture in the neighborhood of the mixing chamber exit section reaches the speed of sound.

The present paper is devoted to an experimental investigation of the influence of a geometric parameter and the chamber mixing length on the magnitude of the pressure drop at which the critical mode sets in in the ejector. Pressure drop ranges are determined in which the flow diagram is realized with closing of the mixing chamber. Let us note that it is not possible to obtain such data by computational means at this time.

The experiments were performed on an ejector installation with an annular nozzle of high-pressure gas (Fig. 1). The high-pressure gas (air) went from the gas holder through a pipeline with the slide gate 1 into the forechamber 2 and then through the sound nozzle 3 into the mixing chamber 4. The low-pressure gas was sucked through the measuring collector 5 from the atmosphere into the low-pressure channel 6 and later into the mixing chamber. The mixing chamber was assembled from cylindrical compartments. The relative mixing chamber length $\bar{\ell}''$ varied between 3.8 and 19.3 during execution of the experiments. The ejector geometric parameter a varied between the limits 0.54-13.4 by utilization of nozzles with different exit diameters. A choke 8, which could be used to regulate the mixture pressure, was placed to the side of the exit from the subsonic diffusor 7 with aperture angle 3°.

The static p_1 and total p_{01} pressures of the low-pressure gas in the measuring collector, the total high-pressure gas pressure p_0' and the total mixture pressure p_0'' at the exit from the subsonic diffusor were measured during the investigations. The reduced velocity of the low-pressure gas λ_1 in the mixing chamber input section, the pressure drop σ, and the degree of compression ε were determined from the parameters measured. All the measurements

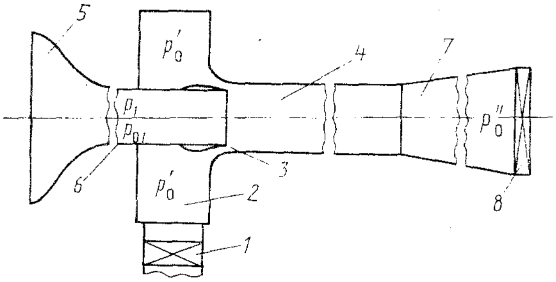

Fig 1. Diagram of the experimental installation.

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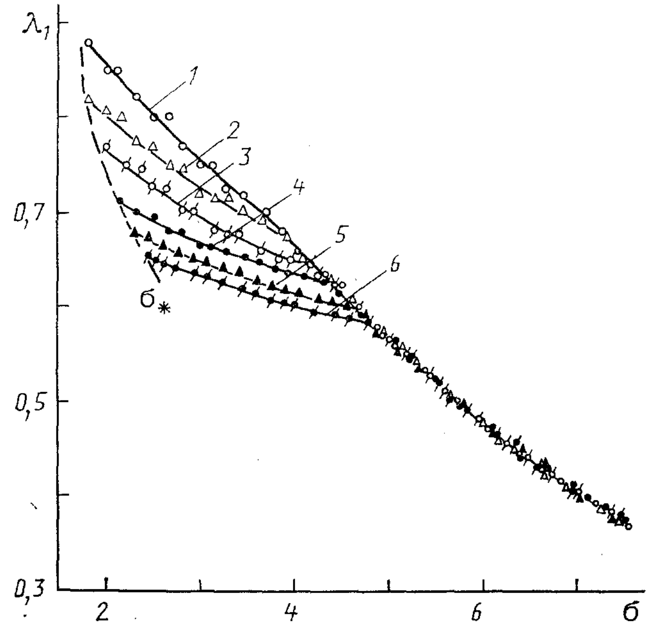

Fig. 2. Dependence of the reduced low-pressure gas velocity on the pressure drop for an ejector with $a = 3.80$: 1) $\bar{\ell}'' = 3.8$; 2) 7.3; 3) 10.0; 4) 12.7; 5) 15.5; 6) 19.3.

and calculations were performed by using an automatic information collection and processing system.

Let us examine the results of the experimental investigations. The characteristic dependences $\lambda_1(\sigma)$ are presented in Fig. 2 for ejectors with identical geometric parameters operating in the critical modes. The ejector emergence into the critical mode was determined by means of the changes in the counterpressure by using the choke 8: The quantity λ_1 is independent of the degree of compression ε in the critical mode. The dashed line is drawn through points corresponding to minimal values of the pressure drop σ_* at which the critical mode sets in in all the ejectors. For $\sigma < \sigma_*$ the critical mode in the ejector is not realized. For $\sigma \geq \sigma_*$ the critical mode sets in with closing of the mixing chamber, which is replaced by a critical mode with closing of the low-pressure flow within the mixing chamber as the pressure drop increases for $\sigma \geq \sigma_{**}$ when the quantity λ_1 is independent of $\bar{\ell}''$ and all the points lie on one curve. An increase in the ejector chamber mixing length in the range of pressure drops between σ_* and σ_{**} results in significant degradation of the gasdynamic characteristics (diminution of the ejection factor).

The data represented in Fig. 3 confirm the passage from one flow diagram to another as the pressure drop rises. The magnitude of the relative static pressure $\bar{p}_1$ was measured in

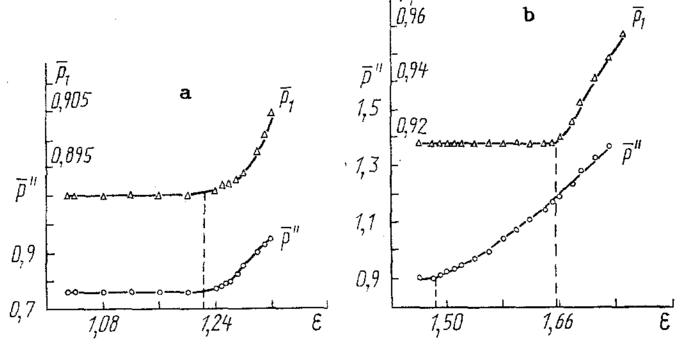

Fig. 3. Dependence of the static pressure at the end of the mixing chamber and in the low-pressure gas channel on the degree of compression for an ejector with $a = 3.8$ and $\bar{\ell}'' = 19.3$: a) $\sigma = 3.98$ ($\sigma_* < \sigma < \sigma_{**}$); b) $\sigma = 5.97$ ($\sigma > \sigma_{**}$).

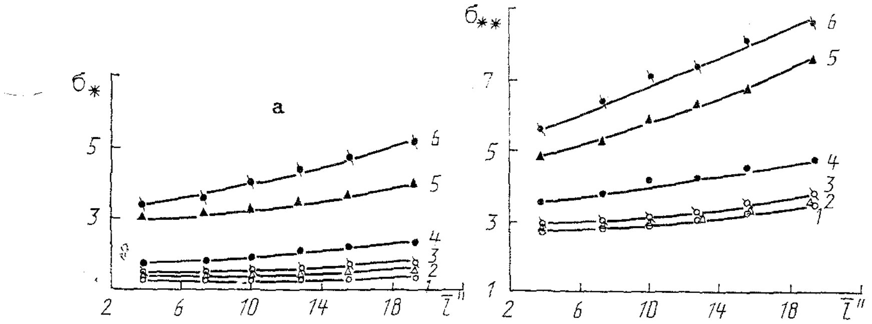

Fig. 4. Dependence of the critical pressure drops on the relative mixing chamber length: 1) $a = 0.77$; 2) 1.38; 3) 2.24; 4) 3.80; 5) 8.40; 6) 13.10.

the appropriate section of the low-pressure gas channel while the quantity $\bar{p}''$ was measured in the mixing chamber exit section. When the pressure drop lies in the interval between σ_* and σ_{**} the growth of $\bar{p}_1$ and $\bar{p}''$ occurs for the identical value of ε, which indicates the achievement of sound speed by the flow at the end of the mixing chamber. For $\sigma > \sigma_{**}$ the growth of $\bar{p}_1$ occurs at a higher value of the degree of compression than the growth of $\bar{p}''$. In this case, the closing occurs within the mixing chamber and an additional increase in the degree of compression is necessary to displace the compression shock to the closing section of the low-pressure jet.

The dependence of the boundary magnitudes of the pressure drop σ_* and σ_{**} on the relative mixing chamber length is presented in Fig. 4 for different values of the geometric parameter. An increase in $\bar{\ell}''$ and a results in an increase in the corresponding pressure drops.

In conclusion, let us note that the results obtained are of practical interest since they permit determination, for given values of $\bar{\ell}''$, a, σ, in what mode a given ejector will operate, and a selection of appropriate methods of improving its gasdynamic characteristics.

NOTATION

$\bar{\ell}'' = \ell''/d''$, relative mixing chamber length; d'', mixing chamber diameter; $a = F_1/F'$, ejector geometric parameter; F_1, transverse section area of the low-pressure jet at the mixing chamber entrance; F', transverse section area of the high-voltage jet at the mixing chamber entrance; $\sigma = p_0'/p_{01}$, pressure drop; p_0', total pressure of the high-pressure gas; p_{01}, total pressure of the low-pressure gas; $\varepsilon = p_0''/p_{01}$, degree of compression; p_0'', total gas mixture pressure in the subsonic diffusor exit section; λ_1, reduced velocity of the low-pressure gas in the mixing chamber entrance section; σ_*, σ_{**}, minimal pressure drops at which the critical mode sets in with closing of the mixing chamber and closing of the low-pressure jet within the mixing chamber, respectively; $\bar{p}_1 = p_1/p_{01}$, relative static pressure in the low-pressure gas channel, and $\bar{p}'' = p''/p_{01}$, relative static pressure of the gas mixture in the mixing chamber exit section.

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