The powder particle velocity and temperature are the key factors determining the quality of coatings applied by spray-deposition techniques. In the detonation spraying process particles obtain kinetic energy and heat up through interaction with detonation products. In this connection, information concerning the temperature and velocity of the gas stream forming as a result of the detonation of an explosive gas mixture in a barrel is of great interest.

In [1] data are given on the character of the variation of these parameters along the axis of the stream. However, the relations derived in that work describe the state of detonation products only up to the instant when the front of the detonation wave reaches the mouth of the barrel. So far nothing appears to have been published in the literature on the temperature and velocity attained by detonation products during their passage through the mouth, and it is therefore impossible fully to determine the character of the interaction between the gas stream and particles of the material being sprayed.

The laws governing the variation of the temperature and velocity of detonation products during this period of time can be determined experimentally. In our experiments temperature measurements were made with the aid of "resistance thermometers" [2] — thin tungsten wires of different cross sections connected to inputs of a multichannel oscillograph and (through active resistances) a constant voltage source. Several thermometers were necessary because the "readings" of each of them corresponded to the true temperature of detonation products only once during a whole measurement — at the instant when the voltage drop along the wire was a maximum (Fig. 1). The discrepancy between the temperature of the gas stream and the wire during the remaining time was due to the inertia of the wire heating and cooling processes. Of course, as the wires differed in diameter and hence heat capacity, the instant of equality of the two temperatures was reached at a different time for each of them, and it was therefore possible to plot a curve of temperature (t) variation as a function of time (Fig. 2, curve 1). The temperature of combustion products at any given time was determined from the maximum voltage drop (U) in a wire, using the formula

\[ t = \frac{1}{a} \left( \frac{R_h}{R_x} - \frac{l}{l_x} \right), \]

where \( R_h = \frac{U}{I} \) is the resistance of the wire when heated; \( I \), current in the circuit; \( R_x \), the room-temperature resistance of the part of the wire being heated; \( a \), temperature coefficient of the resistance; \( l \) length of the wire; and \( l_x \), length of the part being heated.

The time dependence of the velocity of detonation products at the mouth of the barrel was determined experimentally using electrical conductivity pickups. The experiment differed in some respects from that described in [2]: The shaping unit had been excluded from the signal recording circuit, the active resistance incorporated into the pickup circuit had been substantially reduced, and the design of the pickup itself had been slightly modified. This made it possible to reveal nonuniformities of the gas stream issuing from the barrel of the detonation apparatus, which caused characteristic changes in the shape of the signal. The recording of such characteristic signals from stream nonuniformities enabled the difference in time to be established between the instants of their action on two pickups placed at a certain distance from each other along the path of travel of the stream. With data obtained in this manner, the velocity of detonation products could be determined during the whole time of their flow from the barrel (Fig. 2, curve 2).
Measurements of the velocity of a powder introduced into the barrel of the detonation apparatus confirmed that after prolonged acceleration by the gas stream the powder particles reached the velocity of the stream itself (Fig. 2), the acceleration being due to the gas stream under consideration.

Let us examine the origin of the gas whose temperature and velocity have now been measured. In [5, 6] it is assumed that the acceleration of powder particles in detonation spraying is effected by the stream of gases moving behind the front of the detonation wave. However, an elementary algebraic calculation shows that this stream can only exist (at a detonation velocity D of 3000 m/sec and a barrel length L of 1.2 m) for a time \( \tau = L/D \) not exceeding 0.4 msec. Yet from the data of Fig. 2 it can be seen that in our experiments, under real conditions, the gas stream existed for a much longer time, 3–5 msec. Values of this order have been obtained in [7] by experiment for the powder discharge time (and hence the discharge time of the gas stream accelerating the powder).

An alumina powder was introduced into the barrel at a distance of \( \approx 20 \) mm from the mouth. The velocity of the powder was measured with photosensors.