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NEW DEVELOPMENTS IN AERODYNAMICS

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In Competition for the Lenin Prize

NEW DEVELOPMENTS IN AERODYNAMICS

One of the basic characteristic features in the development of aeronautical and rocket engineering in the last 15 years is a sharp increase in speeds of planes and rockets. At this moment, many types of planes are flying at supersonic speeds, and it is possible to say definitely that the basic types of aircraft in the immediate future will also be destined for supersonic speeds. The speeds of flight, which are two to three times greater than the speed of sound, are already common(note that the speed of sound exceeds 1,000 kilometers per hour). At the present time it is possible to consider on valid grounds the flights of guided craft in the atmosphere at speeds exceeding the speed of sound by five to seven times and even more. During the flight of modern rockets into the atmosphere, their speeds change over a wide range and can reach quantities exceeding the speed of sound by more than twenty times.

During the treatment of these problems the scientists and engineers encountered new phenomena, essentially different from the phenomena experienced at moderate supersonic speeds. An understanding of these phenomena required the development of new fields of aerodynamics, and namely, supersonic aerodynamics. The need arose for new theories and methods of investigating and creating essentially new aerodynamic testing plants with high-speed measuring systems.

As the flight speeds increase, the creation of new planes and rockets is becoming a problem of ever increasing difficulty. A great difficulty

arises in solving technical problems of designing and building new flying craft. Vast preliminary comprehensive scientific researches are necessary to overcome these difficulties. Their role is increasing more and more. Large groups of people are involved in theoretical, experimental and testing work in the field of aeronautical and rocket engineering; complex and expensive plants and reliable measuring instruments are required for carrying out this work. In light of this fact, it is especially important to develop a theory providing a profound understanding of the physical laws of penomena, which with we have to deal here.

In a series of works by Professor G. G. Chernyy on aerodynamics of flows having powerful shock waves(presented in 1961 in contest for the Lenin Prize), the most important problems of gas dynamics were theoretically investigated, in addition to problems of turbulent air motion around elongated arrow-shaped bodies at great supersonic speeds(this is precisely the most advantageous shape of flying craft at these speeds), the motion of air or gases on powerful explosions, pulsed electrical discharges, etc.

A new method of investigating and calculating such motions, proposed and developed by G. G. Chernyy, is based on a profound internal realationship between seemingly different phenomena of propagation of shock waves in the air and the air motion during the flight of a missle or other body in the air at very high speed. It turns out that the motion of a body in the air at very high speed can be considered a continuous sequence of explosions from charges, distributed in places where the body is flying through. Precisely this circumstance served as the basis for Professor Chernyy's fruitful unification of the already existing theory of air motion or powerful(atomic) explosions and high supersonic aerodynamics.

G. G. Chernyy's success consists not only in the utilization of the theory of shocks in aerodynamics, but chiefly in the development of unique theories of computation methods in both classes of phenomena. He created effective calculation methods, which make it possible to find simply and convieniently, the pressure in various points of a flying craft's surface, and determine quantities of resistance during the flight of a body in the air.

G. G. Chernyy devised a method which proved to be very effective. This method permits a calculation of air motion even at a high temperature, which is highly important, since the air temperature near the center of the explosion or near the nose of the body is very high on explosions and in flights of bodies at high speed. It is necessary to bear in mind, that at high temperature, a chemical decomposition of the air oxygen and nitrogen molecules takes place into atoms, and, because of this, the mechanical properties of air as a gas become complicated.

An analysis of the method developed by Professor Chernyy proved that good results can be obtained with its aid, agreeing with the few available calculations on high-speed computers and with experimental data obtained in hypersonic wind tunnels.

In G. G. Chernyy's works and in the works of other Soviet and Foreign authors, developing this method, many theoretically interesting and practically important problems were solved, and the nature of the effect of diversity of geometric forms of moving bodies on their resistance was revealed. In particular, it brought to light an unexpected and highly essential effect of a slight blunting of the nose of thin flying craft shells and leading edges of wings at high supersonic speeds on pressure distri-

bution over their surfaces and on total resistance. For example, if a wing is one meter wide and eight centimeters thick in the center, and its leading edge is blunted by 0.5 millimeters, then the resistance of such a wing will be twice as great as the resistance of a wing with a sharp leading edge. The effect has very important technical significance, because a slight blunting is virtually always present, an a sharp nose unavoidably melts and blunts, even with an initially pointed body, during its motion in the air.

On the basis of the results of his investigations, Chernyy found an essentially new law of similarity for ambiant flow at high supersonic speed around elongated bodies with a slight blunting of the nose. This law, which perfectly agrees with experimental data, permits to reduce significantly the number of difficult and expensive experiments, and utilize by recalculation experimental data for other bodies at different motions. The practical importance of these recalculations is evident.

The theory, created by Chernyy, leads to simple formulas, suited for utilization in preliminary aerodynamic and ballistic calculations, which must be conducted in a large quantity in the designing and selection of flying craft. His theory can serve as a useful initial base in the composition of calculation schemes on electric computors, because these calculations require a large preliminary analysis and labor-consuming preparation of computation programs. No ready programs are available so far for solving many problems of aerodynamics on computors.

Chernyy's theoretical works are devoted to the most important problems of modern high-speed aerodynamics. They have already received recognition in world-wide literature and have served as the basis for numerous investi-

gations by other Soviet and foreign scientists.

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