Applying Jet-propulsion to Gliders

by ZBIGNIEW ZRZYWOBLOCKI* **

REACTION-propulsion depends on the principle, to every action there is an equal contrary reaction. The recent application of this principle in aviation called jet propulsion uses a flow of gases. If the exhaust gases flow from the nozzle directly into space, the reactive force is equal to the product of the mass of gases in 1 sec. times the velocity of the flowing gases. Jet-propulsion may be divided into 2 types, depending on the fuel used:

(a) Rocket-propulsion in which the fuel carries its own supply of oxygen or air, for example black powder.

(b) Jet-propulsion in which the fuel needs an external supply of oxygen or air, for example gasoline, heavy oils, petrol, etc.

The main advantages of powder-rockets are their simplicity of design and operation. The charge may be ignited by a small battery. There are 3 great disadvantages;

(a) Serious difficulties in the manufacture of big powder rockets with the attendant danger of explosion during manufacture.

(b) The possibility of explosion of the rocket in flight.

(c) Lack of control of charge after it is ignited.

Though jet-propulsion has none of the disadvantages of powder rockets, its disadvantages are as follows:—

(a) Necessity of designing special jet-motor.

(b) Additional weight of this motor.

In both types of reaction-propulsion, two coefficients of efficiency are of importance:

(a) Coefficient of internal efficiency which depends on the losses inside the combustion chamber and inside the nozzle.

(b) Coefficient of external efficiency which depends on the ratio of velocity of flight to the velocity of exhaust gases.

The value of the internal coefficient is better than the coefficient of internal efficiency of combustion engines, since the construction in the first case is much simpler. The tests of Oberth, Goddard, Sanger and others, proved that this coefficient for reaction-propulsion may reach the value of 0.7 or better. The coefficient of external efficiency reaches its optimum value when the velocity of flight is close to the velocity of exhaust gases. Consequently, in the case of gliders, one must be prepared beforehand for a low value of this coefficient and for a low over-all efficiency of reaction propulsion when applied to gliders. Nevertheless, the simplicity of reaction propulsion as compared with a propeller engine unit is so great, that already 16 years ago, there were tests of the application of this type of propulsion to gliders. It is enough to mention that the first flight in history of an airplane with reaction-propulsion was performed by a gliding society. Namely, the first rocket flight was performed by the Rhon-Rossitten Gesellschaft on June 11, 1928. The test was performed with models. Very soon after these tests, the first successful powder rocket flight was performed with a glider designed by Dr. Lippisch. During one of the succeeding flights, there was an explosion of the powder rocket in the air, causing serious damage to the glider. After that, the Rhon-Rossitten stopped the tests. In 1929, the Gliding Society in Breslau built a model of five feet span, driven by powder-rockets, which performed some successful flights. In 1931, the Italian Company, Cattane, Pierro, Magni, built a powder rocket glider of eighty-eight feet long span. The results of any of the tests of this glider are unknown. In 1935, the idea of applying reaction propulsion to gliders was again undertaken by the Gliding Institute attached to the Lwow Institute of Technology. There were published for the first time in the world the calculations for take-off with powder-rockets by the author. Some tests were performed with models but lack of money did not permit the author to run comprehensive tests.

It might be of interest to discuss what advantages gliding can gain from rocket or jet-propulsion. The tests of the Rhon-Rossitten Gesselschaft were performed with the aim of the elimination of shock cord launching. In general, reaction-propulsion might be applied to the following conditions of flight:

(a) Take-off from a level hilltop. No gain in altitude required.

(b) Take-off from flat ground with a requirement that altitude must be gained.

(c) Horizontal flight.

The purpose of applying reaction propulsion in the cases (a) and (b) will be the elimination of external take-off devices, and to gain whatever altitude is needed.

Case (c) may occur in a thermal flight when the pilot wants to pass from thermal to thermal. The location of rockets inside the glider will depend upon the construction. Powder-rockets may be easily located in the rear part of the fuselage, behind a fire wall in a special chamber. Also, the wing may be a good location for them.

*Follow in Aeronautical Engineering and Instructor at the Polytechnic Institute of Brooklyn.

**Presented at the Motorless Flight Conference of the Soaring Society of America, at the Polytechnic Institute of Brooklyn, on Aug. 5 and 6, 1944.