



Tsiolkovsky speaks at the meeting in honour of his seventy-fifth birthday (Kaluga)

with the technical ideas presented clearly and Tsiolkovsky's writings present to the attention remarkable simplicity of reasoning and wisdom, translating into the laws of Nature which are of classical works.

In some of his articles Tsiolkovsky draws of the flight of the space rocket and descriptions of the passengers in a space ship.

"In setting off upon our journey we shall very strange and utterly unexpected sensations be presented forthwith.

"The signal is given; explosions have started a deafening din. The rocket quivers and becomes weighty. We feel an excessive heaviness—I feel 40 kg weight become 400 kg. I fall on the floor and my bones, perhaps I die. No time for observation there is a way of bearing such enormous pressure: you are packed up, or immersed in a liquid anon.

"I don't think, however, that if we were in a liquid we should feel more inclined to motions. Be it as it may, gravity in the rocket increases ten-fold. We could see this by a special dynamometer, by the accelerated swing of a pendulum (more than three times as quick as by the quicker falling of bodies, by the size of diameter has diminished 10-fold, by all the heavier, and by many other signs.

"The phenomenon of the increase of weight served only within the powered trajectory the rocket has reached the second cosmic velocity (km/sec) the motor can be switched off and motion the momentum acquired can be utilized at altitudes (over 100 km) the rocket with a will be subject to gravity alone.

"We shall experience this awful heaviness the deafening explosions go on. No soon

The orbital velocity is sometimes called the first cosmic velocity and the parabolic velocity, the second cosmic velocity. The era of cosmic flight will begin after the first cosmic velocity has been obtained, and of interplanetary flight—with the attainment of the second cosmic velocity.

What possibilities are there for obtaining the first and second cosmic velocities? The Tsiolkovsky formula furnishes an answer to this question. As has been noted above, the formula provides for two ways of getting high speeds of rocket flight: 1. by increasing the exhaust velocity, and 2. by increasing the mass-ratio of the rocket.

Tsiolkovsky thoroughly investigated the methods of obtaining high exhaust velocities. In a rationally constructed motor the exhaust velocity can be increased by proper selection of fuel components. Tsiolkovsky carried out a careful study of fuels for rocket motors and formulated the chief requirements the fuels must conform to. These are used by scientists and engineers to this day. Here are the results of his researches formulated towards the end of his life:

"The components of the explosives for rocket motors must possess the following properties: 1. they must give maximum performance per mass unit in combustion; 2. in mixing they must produce gases or volatile liquids which vaporize when heated; 3. they must burn at as low a temperature as possible, so as not to scorch or melt the combustion-chamber; 4. they must occupy minimum volume, i.e., possess high density; 5. they must be liquid and easy to mix, for the use of powders involves difficulties; 6. they may be gaseous but must possess a high critical temperature and low critical pressure, so as to be easy to use in the liquid state. Liquefied gases, as a general rule, are undesirable as they have low temperatures and absorb much warmth in heating. Besides, there are evaporation losses and an ever-present danger of explosion. Expensive

unstable chemicals or substances hard to obtainable."

Tsiolkovsky investigated a great number of fuels and oxidizers and selected the best. He recommended the fuel-oxidizer couples he recommended for rocket motors:

liquid hydrogen and liquid oxygen;
kerosene and liquid oxygen;
alcohol and liquid oxygen;
methane and liquid oxygen.

In his latest works Tsiolkovsky spoke still greater exhaust velocities by using alcohol. The third pair of components, alcohol-oxidizer, was widely used in Germany for rockets. Knowing the heat value of one kilogram of motor, one can find the exhaust velocity and taking into account losses peculiar to the motor, calculate the thrust.

Tsiolkovsky was the first to scientifically establish the possibility of obtaining cosmic velocities, the practicability of interplanetary travel, and technical experience of the 20 years that since his death has proved the correctness of his ideas.

Here are some of these ideas: "At first be used for circling the Earth, then a journey in some other relation to the Sun, say to send a rocket can come more or less close to the Sun or escape from it into space and become a flying for thousands of years among the stars reaches one of them, which may become a traveller and their descendants. Mankind a series of space bases around the Sun using pose asteroids (small planets which are the Solar System). Reaction devices will conquer infinite space and to receive 2,000

of very short duration (fractions of a second, or a second at the most), and therefore the study of the influence of long accelerations and retardations on humans and animals is highly important for the further development of reaction propulsion.

It is clear from the above that, like any other progressive scientific and technical problem, reaction propulsion involves a wide range of problems, demanding attention of research workers of most varied specialities.

Tsiolkovsky's successful work in Soviet times, his observations of scientific and technical progress in the Soviet Union brought him a conviction of the feasibility of his ideas.

Here are some of Tsiolkovsky's ideas as expressed in his short address to the Soviet people on May Day 1933 when, during a broadcast from Red Square, his Kaluga residence was switched in.

"My greetings to you!

"With my mind's eye I can see Red Square with hundreds of steel birds circling over the marching columns. And there, sailing very low overhead, are dirigibles, the dream of my young days, the realization of my cherished aspirations, I may even say, a certain result of my early work. The air is filled with steel birds, but this has become possible in our country only now, at a time when our Party and Government, all our working people, every single worker have devoted themselves to the realization of humanity's daring dream—conquering space beyond the clouds.

"Now, Comrades, I am fully convinced that another dream of mine—space flight—for which I have sought and found a theoretical foundation, will also come true.

"For forty years I have been working on the rocket motor, but I thought that a journey to Mars could take place hundreds of years later. Time, however, moves quicker, and now I am sure many of you will be witnesses of the first transatmospheric flight.