Three Astronautical Pioneers — 2

K. E. Tsiolkovskii

an autobiography

Freely translated by A. N. Petroff

". . . In my life I have not only thought and computed, but, with my own hands, realized my ideas. But you cannot do without the idea. Thought goes before action, and imagination before exact computation."

—Konstantin E. Tsiolkovskii

Background

More than half a century ago, an impecunious Russian schoolteacher, who never had anything remotely resembling a laboratory as we understand it, and who throughout his entire life struggled to raise the few rubles he needed to go on with his experiments, established the basic principles of space flight.

Inconceivable though it may be, by 1903—the same year as the Wright brothers' first flight—Konstantin Eduardovich Tsiolkovskii, his mind filled with haunting visions which he attempted to turn into reality, had completed a full-scale study of a manned space vehicle powered by lox-hydrogen rockets, and had conceived many of the ideas in use in today's long-range ballistic missiles and space vehicles.

Almost unknown at the time of his death in 1935, Tsiolkovskii (of whom Theodore von Kármán once said, "He was perhaps the first man to base a project for space travel on sound principles") and his monumental work have in recent years been the subject of innumerable books and essays.

Some months ago, A. N. Petroff, director of research, Research Engineering Dept., Cessna Aircraft Co., and president of the ARS Wichita Section, was kind enough to supply Astronautics with a copy of this translation of Tsiolkovskii's autobiography, taken from "K. E. Tsiolkovskii, His Life Work and Rockets," by N. A. Rynin, published in Russia in 1931 and today extremely rare and almost unobtainable.

The brief but poignant document, presented here in English for the first time, presents a fascinating insight into the mind and life of the great Russian scientist in his own words.

This is the second in a series of autobiographical portraits of the three pioneers to whom present-day astronautical technology owes such a great debt. The Robert H. Goddard portrait appeared last month, while a new autobiography of Herman Oberth especially prepared for Astronautics *will run in the near future.*

I WAS born on the 5th of September, 1857, in Ijevski Village of Riazan Provence, Russia. My parents were poor, my father an impractical inventor and philosopher. Mother, as father used to say, had a spark of hidden talent; among her relatives were many gifted people. I was eight or nine years old when she showed me a small toy balloon made of collodium and filled with hydrogen which aroused my interest.

At the age of 10, my hearing was impaired by the aftereffects of scarlet fever. Being almost deaf made me a victim of ridicule to the rest of the boys in the neighborhood. This handicap estranged me from people and prompted me to read, concentrate, and dream to keep from boredom. Hurt pride sought satisfaction. There was a desire to do something big, heroic, to be rewarded, and at 11 I tried to express myself by composing silly verses. At 14, I gained from a physics textbook some theoretical understanding of aerostatics, and tried to fill a sack made of tissue paper with hydrogen. The experiment failed.

At that time, I was also interested in mechanical flight by means of flapping wings. Among other things, I made a small model of a carriage which moved in all directions, with and against the wind generated by bellows. There was another model of a carriage powered by a steam turbine. Later, I decided to build a larger carriage for myself, suitable for travel, spending lunch money on lumber, screws, nails, etc. The project failed due to lack of patience and money and the final realization that the thing was impractical.

At 15 or 16 my knowledge of elementary mathematics gave me a better understanding of physics. Above all, I was interested in static balloons and already had enough data to solve the following problem: To find the dimension of a balloon, constructed of metal of a certain thickness, that would lift a given number of people. It was clear to me that the thickness of the skin will increase indefinitely as the balloon grows in size. Since then, the idea of a metallic aerostat stuck in my mind. It tired me out, and then for months I

was occupied with something else, but I invariably came back to it.

Systematically, I studied very little and read only what could help me solve problems that interested me at the moment. For instance, the theory of centrifugal force interested me since I thought it could be used as a means toward the end of flight in cosmic space. There was a moment when it appeared to me that I had solved this problem (at 16). I was so excited that I could not sleep the whole night, and instead spent it wandering through the streets of Moscow and thinking about the great consequences of my discovery. Toward morning, I was convinced of the fallacy of my invention. I still remember that night, and even now, 50 years later, I sometimes dream about rising in my machine toward the stars and feeling the same exaltation.

My tribute to perpetual motion, thank God, was small. The confusion lasted only several hours due to an incorrect understanding of magnetism.

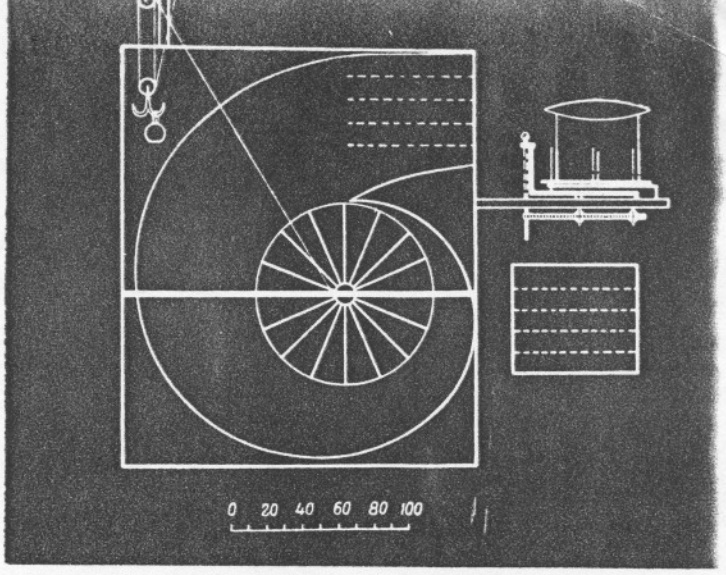
The thought of communicating with cosmic space never left me. It prompted me to study higher mathematics. Later, in 1895, I cautiously expressed my conjectures in "Dreams about Earth and Skies" and, still later (1898), in "Investigation of Cosmic Space by Reactive Machines," published in *Scientific Survey*, 1903.

Astronomy attracted me because I always thought that not only the earth, but the whole universe is the heritage of mankind. The articles "On the Moon," "Gravitation as a Source of Cosmic Energy," and others prove my constant interest in astronomy.

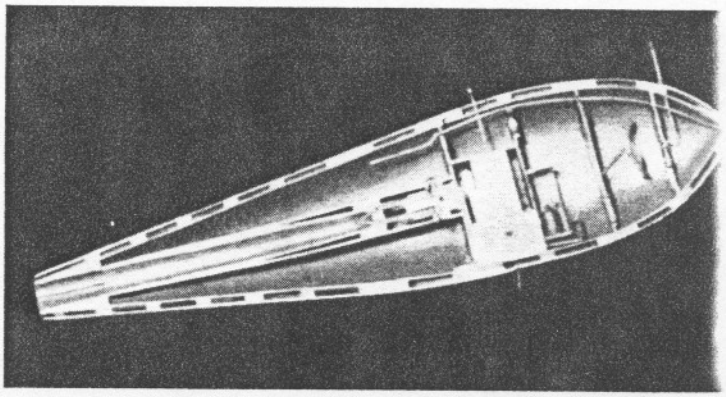
Books Were Nonexistent

Books on the subject of flight were practically nonexistent. Therefore it was necessary for me to think independently, and often, in the wrong direction. Quite often I invented and discovered things that were already known. I learned by creating, however—quite often without success and too late. For instance, in 1881 I worked out a theory of gases without knowing that it was 24 years too late. Nevertheless, by doing so, I acquired a habit of thinking independently and being critical of everything. It could be that self-reliance was in my nature. However, deafness and the compulsory withdrawal from society strengthened my initiative.

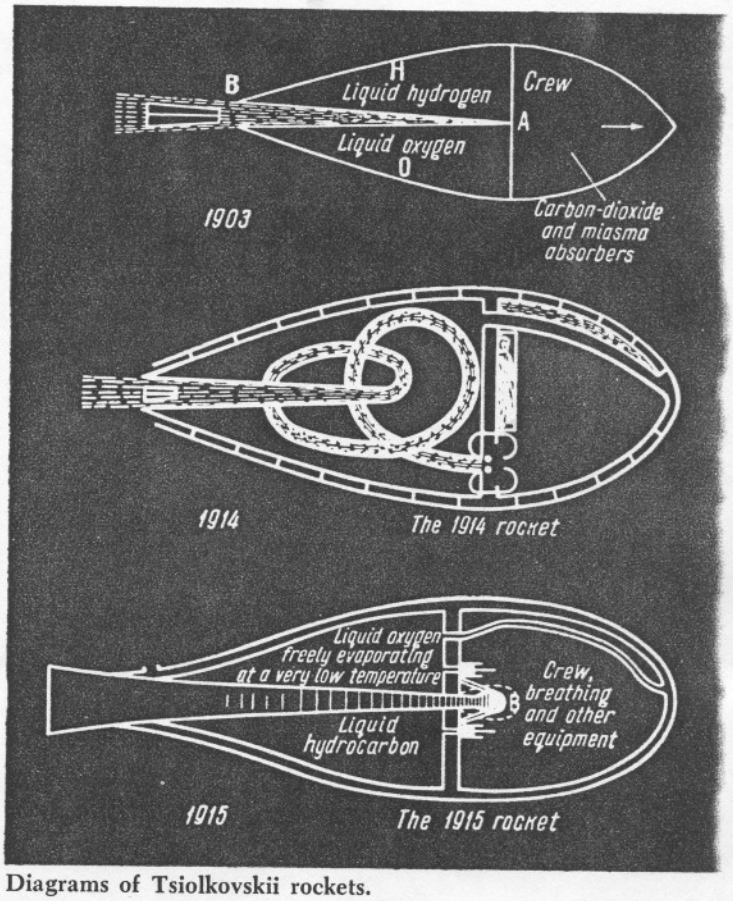
In spite of lack of formal education, I passed the required examinations and was granted a certificate for teaching in high school where I taught mathematics and physics for nearly 40 years. Although I read the textbooks, I found it easier to prove a theorem without the book since I was used to working independently. At 25, I was interested in the improvement of steam engines and made several models of blowers and (CONTINUED ON PAGE 63)



Tsiolkovskii's drawing of his wind tunnel.



Model of Tsiolkovskii's 1903 rocket.



Diagrams of Tsiolkovskii rockets.

Tsiolkovskii Autobiography

(CONTINUED FROM PAGE 49)

pumps in order to acquire experience in shop work.

Finally in 1885, at 28, I dropped this hardware and firmly decided to devote my efforts to aeronautics and the theoretical development of a dirigible, a project I worked on for two years. I was a conscientious teacher and came home from school very tired. Only toward evening could I resume my calculations and experiments. What to do? There was not enough time and energy for both. I tried getting up at daybreak, working on my project and then going to school to teach. After a second two-year period of mental strain, there was a constant heavy feeling in my head. Nevertheless, in the spring of 1887, I made the first public presentation on metal dirigibles at the Society of Natural Sciences in Moscow. Reception was sufficiently encouraging. The manuscript "The Theory of Dirigibles," consisting of 480 pages and 800 formulas, was given to Prof. Joukovski for comments. I did not think that his work was sufficiently complete, but asked, for the good of the project to be transferred to Moscow. This was promised, but for some reason the transfer was not approved.

Then I became ill, temporarily lost my voice, and fire destroyed my little library, shop, and models. In a year, I recovered and resumed my work. In the autumn of 1890, through Prof. Mendeleev, I sent to the Imperial Russian Technical Society my new work: "On the Possibility of Construction of a Metal Dirigible," along with a model. Shortly, through the newspapers, I learned that the Society had found my calculations and ideas to be completely correct. Later, I received a copy of the comments, which encouraged me considerably.

Investigation of flight on wings showed me that this method required a greater amount of energy than was anticipated from incomplete experiments, a fact which subsequently was corroborated in practice. This conclusion again caused me to lean toward dirigibles. Another effort resulted in a new work, "Maneuverable Metal Dirigibles." My brother and friends helped to publish it in 1892. I was never so happy as I was looking over the printer's proofs of this work. In 1894, I paid my last tribute to the airplane by publishing in *Science and Life* a theoretical investigation showing the advantages of gas-filled metal dirigibles.

The controversy between the dirigible and the airplane pushed me to

make experimental studies of air resistance. Theoreticians found the air resistance of dirigibles to be enormous. My experiments showed that it was not so significant and that the drag coefficient reduces with speed. Experiments were conducted inside and sometimes on the roof of the house in a strong wind. I remember how excited I was to find that, when a strong wind was blowing, the coefficient of drag was found to be smaller. I nearly rolled off the roof and hit the ground without feeling it.

Little Funds

Sympathetic reviews by the press brought several donations to help the cause of aeronautics. Altogether, I received 55 rubles which were used for new experiments on air resistance. I received the money with much gnashing of teeth since several donors, through a misunderstanding, were giving for the sake of charity. I suffered greatly, but endured, hoping for the possibility of carrying out future work. In spite of considerable publicity, the total amount was negligible. For instance the city of St. Petersburg sent 4 rubles toward the cause of aeronautics. Results of the experiments and a description of the setup were published in *Messenger of Experimental Physics* in 1899 in an article entitled "Air Pressure Upon a Surface in an Artificial Flow of Air." This work, submitted to the Imperial Academy of Science, was received favorably and brought 470 rubles toward continuation of the experiments.

These experiments, along with calculations, gradually clarified my understanding of the true nature of air resistance. The accuracy increased with each succeeding step, but it was still a far cry from the absolute truth.

I wanted to continue this journey along the path of science. But how could I gather enough energy, means, and support? In these experiments, I arrived at many new conclusions toward which scientists felt rather skeptical. These conclusions can be corroborated by succeeding experimenters. But where are they?

It is difficult to work alone for many years, under unfavorable conditions, without encouragement and support. It is true that sometimes, on rare occasions, there were expressions of sympathy and understanding. For instance, a group of students at Kaluga Technical College found my concept of a metal dirigible entirely practical.

In the 1920's, I resigned from my teaching post due to poor health. I always liked to teach even though it took almost all my strength, leaving very little for my own studies and work. I wrote, calculated, and worked with my hands mostly during holidays and vacations.

Space Flight Theories

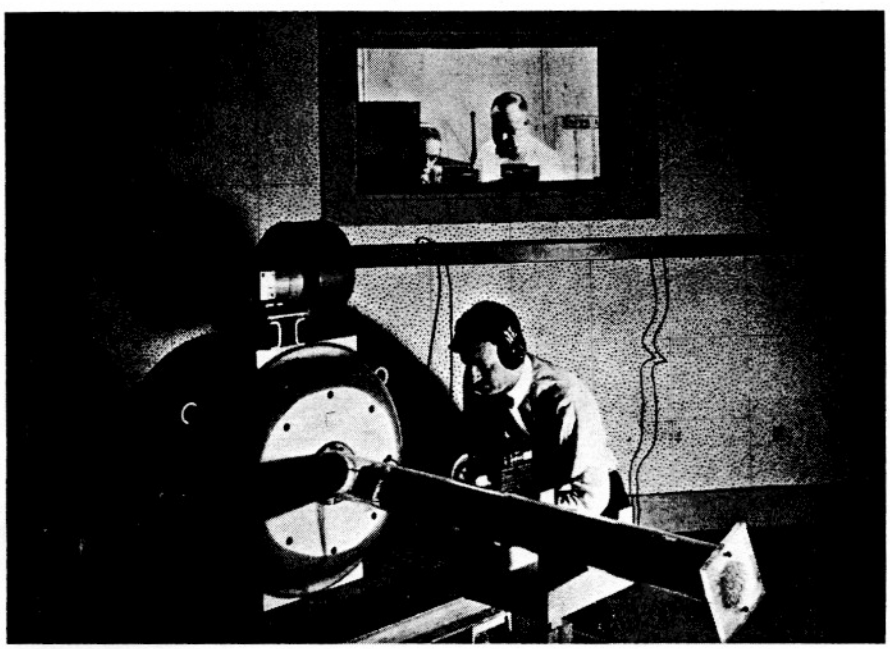
In the course of my work, I developed theories concerning certain phases of flight into space by means of a reactive device similar to a rocket. Mathematical deductions, based on available data already verified, indicated the possibility of human ascent into space, perhaps to populate areas beyond the earth's atmosphere. Perhaps, a hundred years will pass before my idea will find application and people will travel not only upon the surface of our globe but also upon the face of the universe. Almost all the energy of the sun is uselessly wasted as far as humanity is concerned, earth receiving only two-billionths of what the sun emits.

What is so strange about the idea of utilizing this energy? What is so strange in the thought of penetrating the endless space surrounding our earth? At any rate, is it a sin to express such ideas, since they are the fruit of serious labor?

Since childhood, partial deafness resulted in a total ignorance of the ways of everyday life, and therefore a lack of "connections." Perhaps, this is the reason that even at 68 I did not progress and had no real success. All my life consisted of meditation, calculations, and experimental work. The shop in the basement of my home always followed me. When destroyed by fire or flood, it was shortly restored.

It is boring to talk about myself and the small events of life while there are so many unsolved problems, unfinished or unpublished papers. The main things are still ahead. Will there be enough strength and ability to transform these thoughts into reality?

Noise Tests Missile Components



Avco acoustic noise generator subjects a nose cone component to as much as 170 db in progressive wave tube.

Missile components that pass mechanical vibration tests can still fail in high random-amplitude noise produced by the rocket engine and by re-entry. As laboratory testing with an actual rocket engine to determine the resistance of a component to noise is neither practical nor economical, it has become the practice to build powerful loudspeakers to generate high levels of random noise for such testing.

Avco Research and Development Div. has designed, for example, the acoustic noise generator shown here for testing critical components for Titan and Minuteman re-entry bodies. An electromechanical unit with a 12-in. moving coil, the generator produces noise of random amplitude at discrete frequencies up to 170 db. Components are tested in a progressive wave tube, operating systems in a reverberant chamber.

Avco has tested an operating system of relays, transducers, oscillators, transmitters, power supplies for Titan re-entry body with this generator.