History of Rocketry and Astronautics

Proceedings of the Thirty-First History Symposium of the International Academy of Astronautics

Turin, Italy, 1997

Donald C. Elder and George S. James
Volume Editors

Donald C. Elder, Series Editor

AAS History Series, Volume 26

A Supplement to Advances in the Astronautical Sciences

IAA History Symposia, Volume 17

AAS Publications Office
P.O. Box 28130
San Diego, California 92198

Affiliated with the American Association for the Advancement of Science
Member of the International Astronautical Federation

First Printing 2005

ISSN 0730-3564

ISBN 0-87703-518-0 (Hard Cover)
ISBN 0-87703-519-9 (Soft Cover)

Published for the American Astronautical Society
by Univelt, Incorporated, P.O. Box 28130, San Diego, California 92198
Web Site: http://www.univelt.com

Printed and Bound in the U.S.A.

Chapter 1

Tsiolkovsky's "Album of Space Voyages:" Visions of a Space Theorist Turned Film Consultant*

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Introduction

In the summer of 1933 a retired schoolteacher living in the city of Kaluga received a letter from Moscow's famed Mosfilm Studios. In it, the film director V. N. Zhuravlev asked the retiree to consult on the making of 'Cosmic Voyage' (*Kosmicheskij Reis*), a science-fiction film about a rocket flight to the Moon. Although a seventy-five year old pensioner who had spent most of his life teaching basic mathematics and science in provincial schools might seem an unlikely person to provide technical advice on such a futuristic film, Zhuravlev knew what he was doing. The recipient of the letter, Konstantin Eduardovitch Tsiolkovsky, was uniquely qualified for the job.

Before Robert Goddard, Hermann Oberth, or anyone else Tsiolkovsky had mathematically worked out the theory of spaceflight and specified that liquid-fueled rockets would get us into space. This innovative thinker had been dream-

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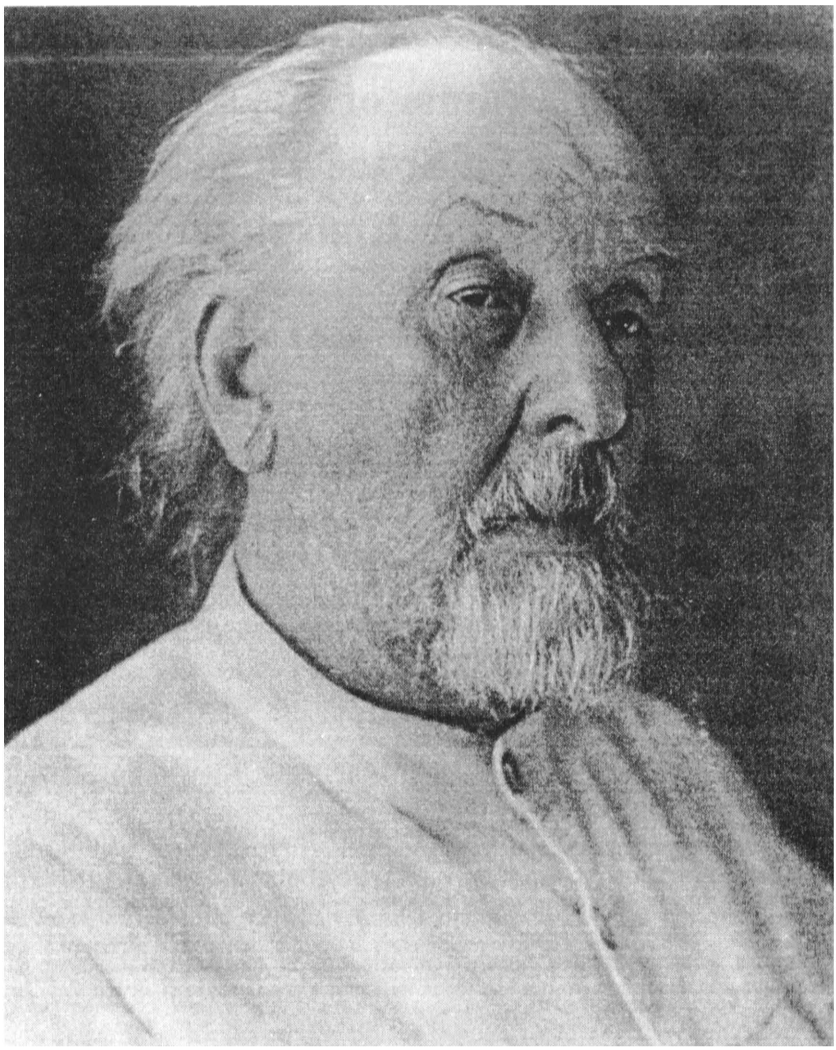
ing about humankind expanding into space since he was a teen-ager haunting the libraries of Moscow, reading all the books he could to educate himself. During his early twenties Tsiolkovsky prepared a manuscript about the prospect of humans living in the weightless environment of "Free Space" and moving about by means of the reactive principle, and he even constructed a crude centrifuge in which he conducted experiments on the effects of acceleration on insects and chickens. In 1897, exactly one century ago, he derived the formula for rocket movement, now known by aerospace students as the "Tsiolkovsky Equation." Then in 1903 his landmark paper, "The Investigation of Space by Means of Reactive Devices," was published in Science Review (*Nauchnoye Obozrenie*).[1]



Konstantin Eduardovitch Tsiolkovsky (1857-1935), Russian Astronautical Pioneer. Photo by M. Larova, From *Ogonek*, 15 September 1957, p. 12.

Publishing his mathematically elaborated theory of spaceflight did not, however, bring Tsiolkovsky instant fame—or even notoriety and ridicule, as happened sixteen years later when Robert Goddard published his own paper on using rockets to reach extreme altitudes. Tsiolkovsky had the misfortune of submitting his article to a journal edited by a chemist specializing in explosives; most of the copies of the issue in which his paper appeared were confiscated when suspicious police, ever vigilant for bomb plots against the Czar, raided the editor's laboratory. Nonetheless, Tsiolkovsky kept plugging away, developing his ideas further and publishing when and where he could, even if it meant paying for the printing out of his own pocket.

By the early 1930s, after all his struggles and setbacks, the thinker had the satisfaction of knowing that his ideas about spaceflight had finally gained wide recognition in the Soviet Union and were known abroad among the small but growing ranks of enthusiasts who were experimenting with rockets. He was particularly delighted that in his own country young engineers were developing liquid-fueled rocket engines and using them to power their first generation of experimental rockets, the descendants of which he hoped would one day enable humankind to reach space. After years of disappointment at the slow progress of rocketry, late in his life Tsiolkovsky had actually become openly optimistic about the prospects of achieving spaceflight in the foreseeable future. In July of 1935, just two months before his death, he wrote the following words in the youth newspaper, *Komsomolskaya Pravda*.[2]

> Until recently, I supposed that hundreds of years would be necessary to effect flight at astronomical velocity (8-17 km/sec). This was confirmed by poor results achieved both here and abroad. But the uninterrupted work carried out in recent times has shaken my pessimistic views: methods have been found which will produce amazing results in a few dozen years from now.

Zhuravlev was not, therefore, appealing to a bitter old man, but rather one who was enjoying the great pleasure of finally seeing progress in a cause that had obsessed him since he was a teen-ager. Furthermore, Tsiolkovsky was most receptive to the idea of consulting on a science-fiction film about spaceflight. He himself had long sought to popularize his own ideas through publishing science-fiction stories such as *Dreams of Earth and Sky* and *Outside the Earth*.[3] As the thinker expressed it in his *Komsomolskaya Pravda* article, "science-fiction stories on interplanetary travel carry new ideas to the masses," arousing interest among those "who will work in this field in the future." In the same article he also noted that "cinema has a wider appeal than books," and that "they are more graphic and closer to nature than pure description."[4] Years earlier a colleague had persuaded him to go see Georges Méliès' 1902 film, 'Voyage dans le Lune,' which is generally considered to have been the first film to feature spaceflight. Although Tsiolkovsky reportedly found Méliès' brief film to be an "awfully stupid thing," seeing it did start him thinking about cine-

matography's potential for showing spaceflight long before people could ever fly in the cosmos.[5] Later, in the mid-1920s he was approached by filmmakers to adapt his novella *Outside the Earth* for the screen, but this proved to be too complicated and the project was unfortunately dropped.[6] Zhuravlev's request that he consult on the making of *Cosmic Voyage* therefore represented a marvelous opportunity for the thinker to use this new medium to expose his ideas about spaceflight to the general public.

Discussions of this film-consulting episode in Tsiolkovsky's long career are to be found in the following publications:

1. Reminiscences of the filmmakers of how the thinker interacted with them, excerpts of Tsiolkovsky's letters to Zhuravlev and his comments on the film's scenario, which are contained in a series of three articles that appeared in the journal 'Film Art' (*Iskusstvo Kino*) in 1957 and 1959, right after the launch of the first Sputnik.[7]

2. The 1966 compilation edited by B. N. Vorobeva and B. V. Levshin, of Tsiolkovsky's manuscript materials held in the archives of the Academy of Sciences of the U.S.S.R., in which is included the only version of the *Album of Space Voyages* to appear in print.[8]

3. A. S. Fedorov's brief account of Tsiolkovsky's consultancy, based heavily on the *Iskusstvo Kino* articles cited above, which he presented at the 1969 Tsiolkovsky Readings, and published the following year in the popular science journal *Nature* (*Priroda*).[9]

4. T. Zhelnina's detailed discussion, presented at the 1987 Tsiolkovsky Readings, of the genesis of the *Album*, how it related to a new science fiction novella that he was planning (but never finished), and the exact status of the various drafts and drawings that went into the making of the *Album*.[10]

Although the authors of these publications of course mention how prophetic were the illustrations Tsiolkovsky included in his *Album*, none of them focus specifically on these drawings. This paper therefore seeks to build upon these works by analyzing the *Album's* visual images of spaceflight and comparing them with what has actually occurred in space during the sixty-four years since he made his sketches.[11]

The version of the *Album* published by the Academy of Sciences is composed of two sections, one (pp. 129-140) dated 21 June 1933, and the other (pp. 141-169) evidently prepared some months later. At first glance the two sections might seem to form a unified whole, with the first section, which is composed only of text, providing the primer on spaceflight for the filmmakers, and the second section, composed primarily of drawings with associated legends and comments, illustrating that primer. However, Zhelnina argues that the sections are in fact separate drafts, the first one representing a verbal approach to ex-

plaining spaceflight and the second a pictorial approach to the same task. The fact that each drawing in the second section are not explicitly connected with the divisions and paragraphs of the first section supports Zhelnina's contention.

This paper analyses only the second, pictorial draft of the *Album*, which was originally divided into 57 numbered topics. Topics 1 and 2, which apparently dealt with details of a space rocket, seem to have been lost as they are not included in the Academy of Sciences version. Topics 3 through 18, 25 through 29, 36 through 48, and 51 through 57 each consist of one drawing, or sometimes two or more related drawings, with legends and explanatory material accompanying the drawings. Topics number 19 through 24, 30 through 35 and 49 through 50 consist only of legends without drawings.

Considered together, the topics appear to have been organized around two main themes: (1) (topics 3-49) the launch of a spacecraft into orbit around Earth, with details surrounding the launch and then the behavior of objects and people in space, and then the return of the spacecraft to Earth; (2) (topics 50-57) the design of orbital stations, focusing particularly on "plant nurseries" for producing food and oxygen for permanent habitation.

We have selected a sampling of the illustrated topics for analysis. Each drawing shown below is accompanied by a few lines of text which summarize the legends and accompanying comments, and in some cases include additional explanatory material not in Tsiolkovsky's text. (The slides projected during the presentation of this paper to show contemporary analogs of Tsiolkovsky's drawings are not reproduced or discussed below.)

Discussion

Those visions of Tsiolkovsky that have so far proved most prescient involve living and working in the weightlessness of space. The parallels between what the thinker was able to imagine sixty-four years ago and what has come to pass in space—from joyously performing acrobatics to making tethered space walks—is apparent in photographs and films we have seen from Voskhod, Gemini, Salyut, Skylab, Mir, the Space Shuttle and other spacecraft. That Tsiolkovsky was able to visualize in his mind's eye how people would one day live and work in space should not be surprising. He had spent a lifetime thinking about the prospects for humans living in what he called "free space," liberated from the tyranny of gravity and bathed in perpetual sunlight.

Of course, not all of Tsiolkovsky's visions have been realized. Some of his ideas, such as launching spacecraft from long ramps or immersing space travelers in water during the launch, have not been attempted. Others have been the subject of much experimentation, but remain to be fully developed in the future. For example, although there have been interesting experiments undertaken on closed ecological life support systems at the Institute of Biophysics in

Krasnoyarsk, various NASA centers and Biosphere II, and wheat has been grown in space, the oxygen and food requirements of spacefarers have yet to be supported by the "plant nurseries" envisioned by Tsiolkovsky. Nonetheless, the idea of using such "plant nurseries" to recycle human wastes into oxygen and food remains in the minds of serious thinkers. In this crucial field, Tsiolkovsky—whose 140th birthday was celebrated just a few weeks ago in Kaluga at the conference held there each year in his honor—still remains well ahead of what is actually being done.

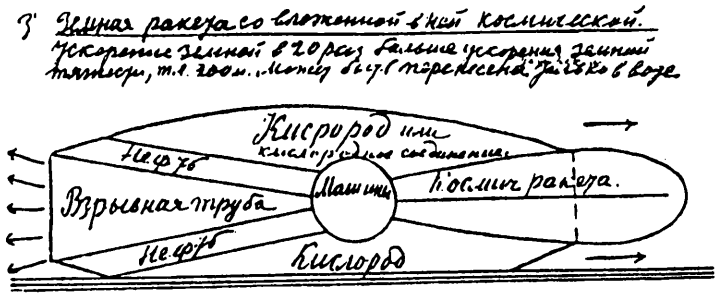
The lighthearted scenario of *Cosmic Voyage* features the adventures of a flamboyant, white-bearded academician, his young female assistant and a boy, who in the summer of 1946 make the first flight to the Moon. The launch of the spacecraft from a ramp dramatically extending above the skyline of Moscow, the immersion of the space travelers in water during the launch, and then their delight at being able to joyously perform acrobatics in weightlessness more or less follow the sketches in the *Album*. But much of the story takes place on the surface of the Moon, and the *Album* does not include any lunar scenes. However, since the film portrays, though with some exaggeration, how people would move over the Moon's surface by hopping rather than walking, it appears that once again Tsiolkovsky "got it right," and advised the filmmakers accordingly.

The plot of *Cosmic Voyage* could hardly be called sophisticated. A flamboyant academician disregards his director's opposition to make the first flight to the Moon, and, after flashing letters C.C.C.P. back to Earth and rescuing a cat that had been sent to the Moon in an unpiloted probe, he and his unlikely assistants triumphantly return to Earth. Furthermore, the lack of a sound track and the exaggerated silent acting make the film seem more like a product of the late 1920s than the mid-1930s. Nonetheless, *Cosmic Voyage* deserves a place in the history of space cinema for its attempt to accurately show human movement in weightlessness and the reduced gravity of the Moon.[12]

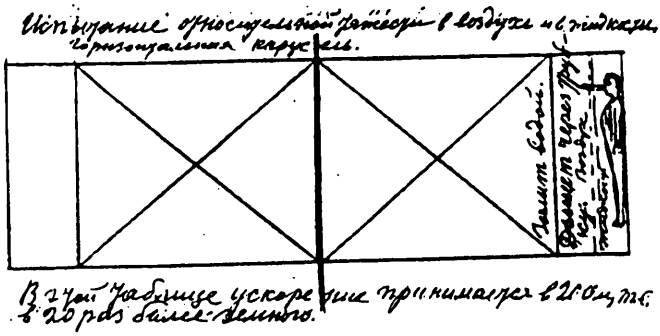
However, the lasting legacy of this film remains those wonderfully prescient drawings of the retired schoolteacher from Kaluga turned film consultant.

A Sampling of Drawings From the *Album*

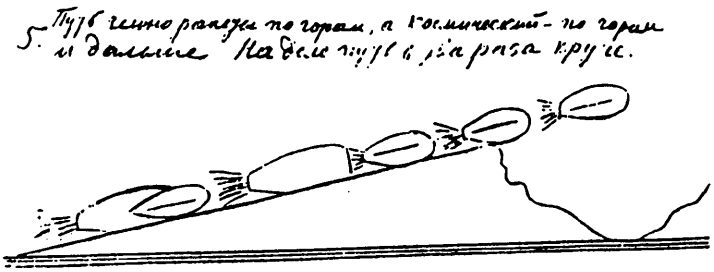
I. Rocket flight into Earth orbit and then return to Earth.



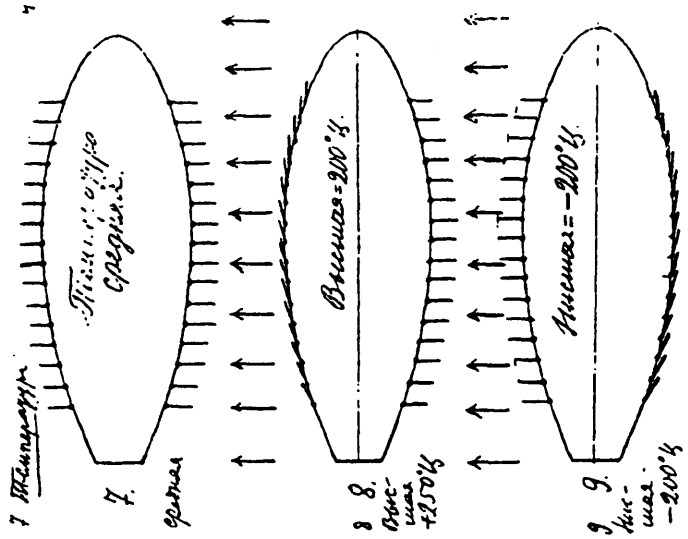
3. Diagram of a two-stage vehicle composed of an "Earth Rocket," powered by oxygen and oil rocket motors, and a "Cosmic Rocket."



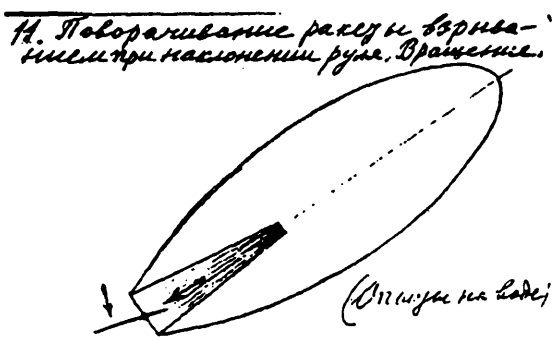
4. A centrifuge in which a human subject is immersed (note breathing tube) in water and rotated to subject him to multiple G forces. (In topic 3 above, Tsiolkovsky noted that the acceleration of the Earth Rocket would subject occupants to more than 20 Gs, a force which he thought humans could survive only if they were in water.)



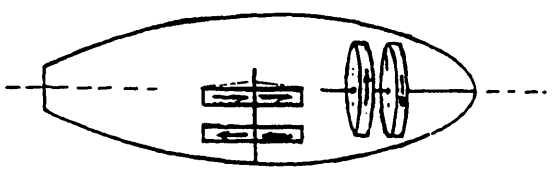
5. A two-stage vehicle, composed of an "Earth Rocket" and attached "Cosmic Rocket" being launched along a ramp extending up a mountainside.



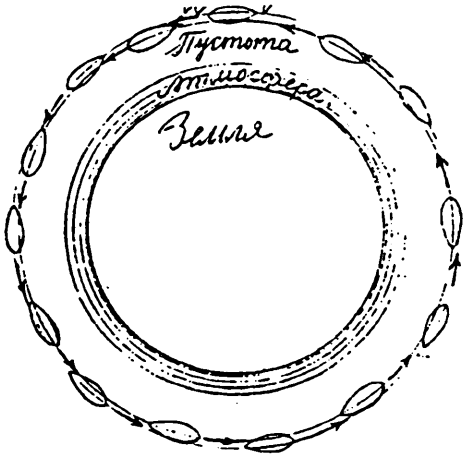
7, 8 & 9. Temperature control by means of opening and closing shutters to sunlight.



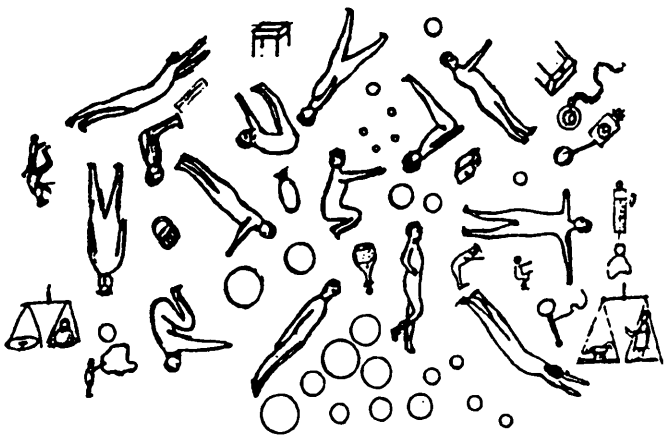
11. Turning a rocket by means of a rudder vane in the exhaust stream.



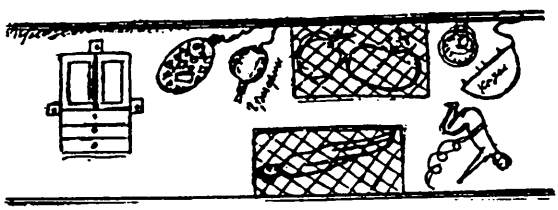
13. Stabilizing the rocket by means of counter-rotating disks



16. Rocket in orbit around Earth.



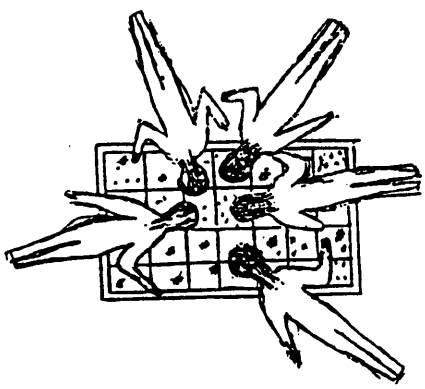
17. The behavior of people and objects in weightlessness.



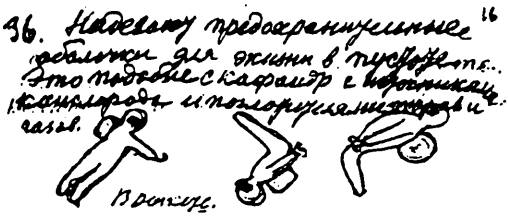
25. "Keeping things in order," by enclosing them in containers, drawers, nets or on tethers. Note the net restraining sleepers.

27. Drinking water from a central reservoir through tubes which can be opened and closed by means of a tap.

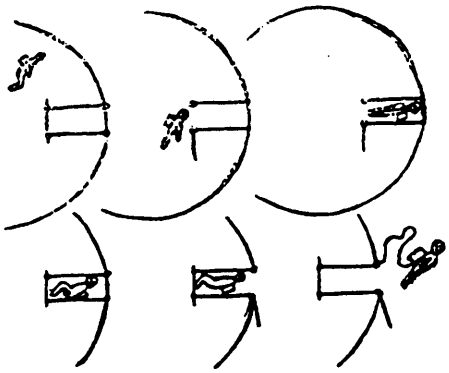
28. Flight within the gaseous atmosphere (presumably of a large spacecraft) by means of wings attached to the arms.



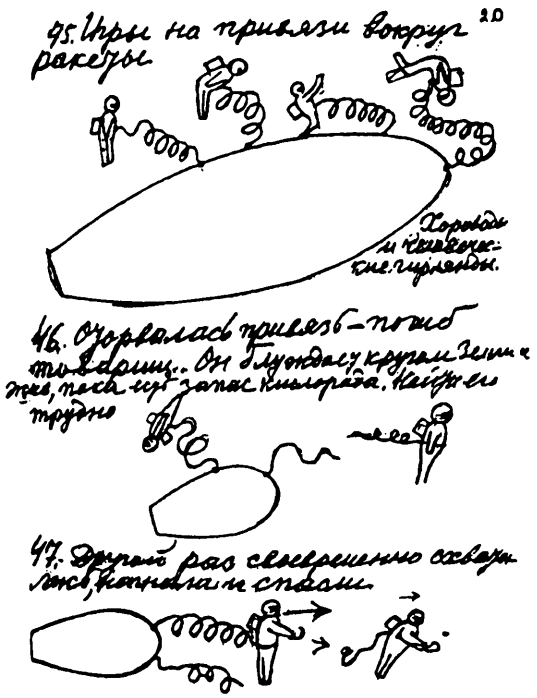
29. The fascination of "looking outside through a glass window" at (listed as separate topics): the black sky dotted with stars; the Moon; the "bluish dazzling Sun," the Earth; its phases; and an eclipse.



36. A spacesuit, modeled on a ocean diving suit, for protection in the vacuum of space, and containing a supply of oxygen and other gases and a vapor absorber.



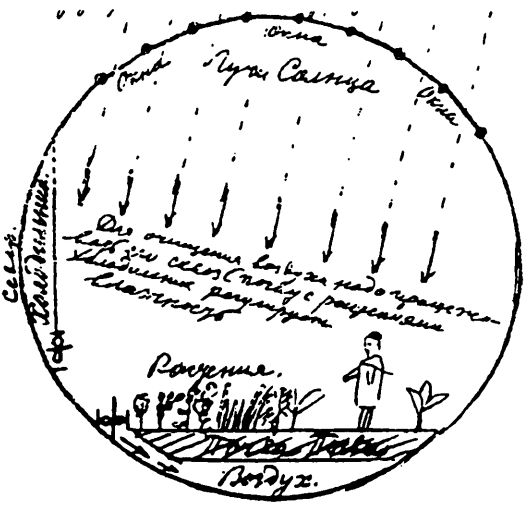
37. Using an airlock to exit the spacecraft without losing internal atmosphere.



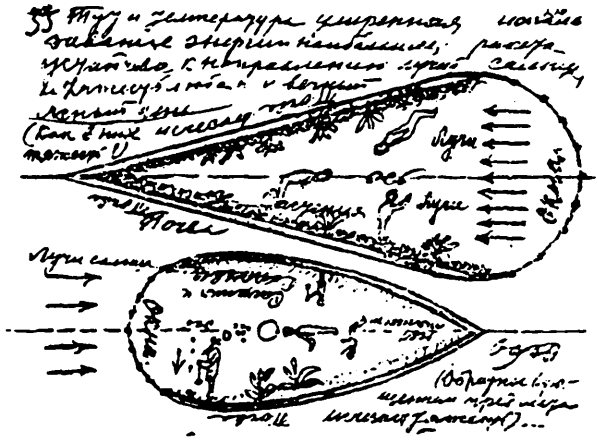
45, 46 & 47. Cavorting around the spaceship while attached by tether; the perils of breaking the tether; and the possibility of rescue.

48. Return to Earth after "the supply of food and oxygen has been exhausted," by a combination of first retro-firing and then atmospheric braking.

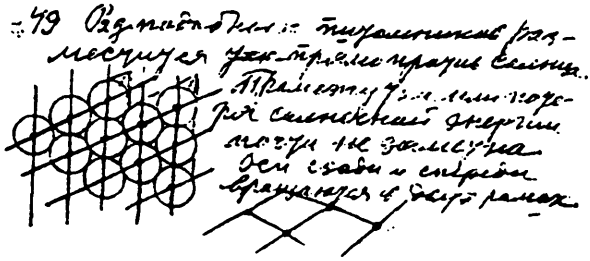
II. Orbiting space stations and greenhouses.



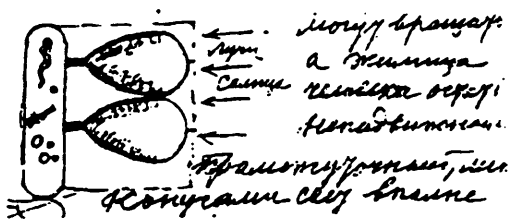
51. Experimenting with an artificial biosphere on Earth in which "one square meter of some plant's leaves produces enough oxygen for one person's needs," and the humidity and cleanliness of the air are regulated by the plants and by pumping air through the soil.



55. "Plant nurseries" in space, rotated around their longitudinal axes to keep soil along the sides of the structure, with windows at large end to let in sunlight.



56. Grouping plant nurseries together in a linked structure.



57. "Plant nurseries" rotate while the connected dwellings stay immobile, allow occupants to enjoy weightlessness.

Reference Notes

[1]Kosmodemyansky, Arkady A., *Konstantin Eduardovitch Tsiolkovsky* (in Russian). (2nd ed. with additions; executive ed. A. S. Fedorov). Moscow: Nauka. Rynin, N. A., 1971. *K. E. Tsiolkovskii: Life, Writings and Rockets*. Vol. 3, No. 7 of *Interplanetary Flight and Communication*. (Originally published in Russian, Leningrad, 1931.) Jerusalem: Israel Program for Scientific Translations. Gazenko, O. G., 1996. "K. E. Tsiolkovsky and his Contributions in the Space Life Sciences." in *History of Rocketry and Astronautics*, Vol. 25, *AAS History Series*, H. Moulin and D. C. Elder, eds., 2003, 45-49 (Paper originally presented as Preprint IAA-96-IAA.2.1.07, Beijing: 47th International Astronautical Congress).

[2]Tsiolkovsky, Konstantin E., 1979. Is this Mere Fantasy? (from *Komsomolskaya Pravda*, 23 July 1935) *In The Science Fiction of Konstantin Tsiolkovsky*. (Ed. and trans. Adam Starchild). Seattle, Washington: University Press of the Pacific, 453-455.

[3]Tsiolkovsky, Konstantin E., 1979., 52-154; 161-332.

[4]Tsiolkovsky, Konstantin E., 1979., 453-455.

[5]Federov, A. S., 1970. "Tsiolkovsky Consults on a Film" (in Russian), *Priroda* Vol. 5, No. 8: 117-120.

[6]Tsiolkovsky, Konstantin E., 1979., 453-455.

[7]Zhuravlev, B. N., 1957. "Assault on the Cosmos" (in Russian). *Iskussivo Kino* No. 2; Tsiolkovsky, Konstantin E., 1957. "Nine Letters of K. E. Tsiolkovsky" (in Russian). *Iskussivo Kino* No. 2; N. a. 1959. "K. E. Tsiolkovsky Reads a Scenario" (in Russian). *Iskussivo Kino* No. 3.

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[9]Federov, A. S., 1969. "Work of K. E. Tsiolkovsky on the Film 'Cosmic Voyage'" (in Russian). *Trudy Chetvertyx Chtenij K. E. Tsilkovskogo, Sektsiya "Issledovanie Nauchnogo Tvorchestva K. E. Tsiolkovskogo."* Kaluga: Government Museum of the History of Cosmonautics Named for K. E. Tsiolkovsky, 67-72; Federov, A. S., 1970.

[10]Zhalnina, T. N., 1987. "Creative Materials for K. E. Tsiolkovsky's Science-fiction Novella 'Cosmic Journeys'" (in Russian). In *Trudy Dvadsat Vtoryx Chtenij K. E. Tsiolkovskogo, Saktsiya "Issledovanie Nauchnogo Tvorchestva K. E. Tsiolkovskogo, Istoriya Aviatsii I Kosmonavtiki."* Kaluga: Government Museum of the History of Cosmonautics Named for K. E. Tsiolkovsky, 118-143.

[11]A number of publications have reproduced a few of Tsiolkovsky's drawings from the Album, without, however, providing a full analysis of the collection. Among the more recent publications to do so is: Kosmolinsky, F. p., and E. I. Kuznets, 1990. *Problems of Space Medicine in the Works of K. E. Tsiolkovsky* (in Russian). Tula, Priokskoye Knizhnoye Izdatelstvo.

[12]Ordway, Frederick I., III. 1982. "Space Fiction in Film, Part A: Eight Decades from Méliès to Lucas." In *Science Fiction and Space Futures, Past and Present*. Eugene M. Emme (ed.), *AAS History Series*, Vol. 5, San Diego, California: American Astronautical Society, 27-46.