NASA TT F-9285

PIONEERS OF ROCKET TECHNOLOGY

SELECTED WORKS

T. M. Mel'kumov, Editor in Chief

Translation of "Pionery raketnoy tekhniki - Kibal'chich, Tsiolkovskiy, Tsander, Kondratyuk - Izbrannyye trudy." Izdatel'stvo "Nauka," Moscow, 1964.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C.
NOVEMBER 1965

PIONEERS OF ROCKET TECHNOLOGY
SELECTED WORKS

Editor in Chief:
T. M. Mel'kumov

Editor-Compilers:
B. N. Vorob'yev and V. N. Sokol'skiy

Academy of Sciences of the USSR
Institute for the History of Natural Science and Technology

Translation of "Pionery raketnoy tekhniki - Kibal'chich, Tsiolkovskiy, Tsander, Kondratyuk - Izbrannyye trudy." Izdatel'stvo "Nauka," Moscow, 1964, pp. 1-20; 501-669.

ABSTRACT

The present collection contains selected representative writings of two of the earliest thinkers on rocketry in pre-revolutionary Russia and the Soviet Union, an editorial preface, a historical outline of pioneer rocket technology, relevant commentaries, and a complete bibliography, all extracted and translated from the larger work of the same title.

The two authors whose works have been selected, N. I. Kibal'chich ("Concept for an Aeronautical Machine") and Yu. V. Kondratyuk ("To Whomsoever will Read in Order to Build"; "Conquest of Interplanetary Space"), are distinct in that they are men essentially without formal education, least of all in rocketry. The former wrote his "concept" in the last days of his life before being executed, in 1881, for complicity in the assassination of Tsar Alexander II. The second author resided in the remote farming region of Novosibirsk, writing his work while employed in menial labor.

The editorial preface sets the stage by contrasting the concepts of the early pioneers of rocket technology with the most recent advances in this field, notably the impressive feats of the Soviet cosmonauts.

The historical outline completes the picture by presenting a grand sweep from the sheer fantasies of Cyrano de Bergerac in the seventeenth century to the beginning of the World War II, i.e., at which time rocket technology came into its own and gained universal recognition, rather than the attention of science fiction writers and a small handful of gifted visionaries.

It is stressed that the reader should bear in mind, in light of the present state-of-the-art, that the contents of this collection contain a few ideas that are now known to be erroneous, a manner of looking at phenomena that is archaic or even quaint, and a certain phraseology that comes through even in translation; however, the great bulk of the material should be recognized as basically sound and instructive. Again in light of modern-day knowledge, the works of the authors included herein admirably display their insight and foresight.

TO WHOMSOEVER WILL READ IN ORDER TO BUILD

/501

Yu. V. Kondratyuk

Above all, do not be frightened by the theme of this paper nor distracted from the realization, difficult as it might be to comprehend, that from the theoretical viewpoint rocket flight into outer space is nothing astonishing or improbable.

I will have frequent occasion to use phrases which are quite inadmissible in scientific writing, such as: "not too large," "sufficiently," etc., without indicating anything exactly. This is because I do not have on hand the materials for drawing the line between "sufficient" and "insufficient," in fact a good part of the materials needed for the construction of a rocket still have not been assembled.

On less frequent occasion, this is dictated simply by a disinclination to carry out the computations, which anyone can perform.

Allow me to say a word about terminology; in many instances, I have made up my own, in many others I have probably adulterated existing terminology, so that if such happens to be the case it should not be puzzled over, but probed for substance of meaning.

The realization of this undertaking will require tests, tests, and more tests on an ever-increasing scale. A gradual approach must be exercised particularly in flights with people. In such a new area, it is impossible to foresee everything, and in interplanetary space help is to be expected from nowhere.

General Theory

The first stipulation for flights from earth and back is that they do not risk the lives of the passengers.

The second stipulation is that they be maneuverable.

The first stipulation requires, first, that the mechanical accelerations imparted to a vehicle carrying passengers should not exceed a definite threshold, above which this acceleration could be harmful or fatal to humans; /502 second, that a vehicle with passengers on board must be hermetically sealed to prevent the escape of air, this air must be maintained fresh, and the temperature of the vehicle must be kept normal. All of the latter conditions are easily met, but the first requires some discussion; in order for the vehicle to be able to overcome the earth's gravitational pull, it must acquire a tremendous velocity (about 11 kilometers per second) (note 1, Commentary). In order to gain such a velocity without mortal consequences, acceleration must be imparted over a rather long period of time (in hours) and over a very long distance (hundreds) of kilometers). Any sort of cannon, in the conventional sense of the word,

solar radiation could be used to produce the active agent. On man-made satellite bases it would be necessary to store reserves of active agent, instruments, equipment, food supplies.

Bases, in general, could provide incomparably greater freedom of operation (note 26). Emergence from the chamber of the vehicle, of course (except on planets whose atmosphere can be breathed), can be made in outfits more or less resembling diver's suits, with a stored air supply. All bases will have to be made in the form of a chamber if we wish to take off the diver's suits (note 27).

Flights Inside and Outside the Solar System

The potential energy of the sun's gravity on earth corresponds to approximately 40 km/sec (note 28). But we already have 27 km/sec in the earth's velocity in its orbit; we only need an additional 13 km/sec to acquire the velocity needed for the flight and return to earth (35 km/sec), in order to be able not only to fly away from earth and back again, but also to move freely /533 inside the solar system and even to fly away from it altogether. The ratio M/m for this only needs to be raised to the power (13 + 35)/35, which is about 4/3. This is not too frightening. In order to move about in the solar system from one place to another, two methods of flight are also possible, by complete analogy with the arguments relative to flight from the earth (straight or spiral trajectories). The second method has the advantage here that, after flying away from earth, we are already in the second phase; we are no longer confronted with its shortcoming, namely the considerable difficulty in maintaining control in the flight from earth, when it is necessary to operate quickly and with precision; on the other hand, the second method requires much more time (note 29). Consequently, I believe that if the vehicle is to function solely on the active agent, the first method will be more suitable, but if reflectors are used and they cannot provide considerable acceleration in comparison with the sun, it will be necessary to fly by the second method.

But there is a happy combination of both: to wait until the earth moves around the sun to a point nearest the prospective destination, then to head there.

In all flights, of course, the method and direction of flight will have to be such that the motion of the vehicle relative to the sun will be in the same direction as the motion of the earth (or base), just as the flight from earth was made in the direction of its rotation about its own axis. This means that solar gravitation will only have to be slightly reckoned with.

Utilization of the Relative Motion of Celestial Bodies

Use of a satellite for flight in the solar system when it is required to gather velocity, and the return from this flight when it is required to absorb velocity.- Figure 22 shows a line of flight equally suitable for flight from a planet and for return (under the conditions specified in the heading). Consid- /534 ering the relative size of the satellite and its distance, this method can provide or take away velocity in an amount equal to as much as twice its velocity.

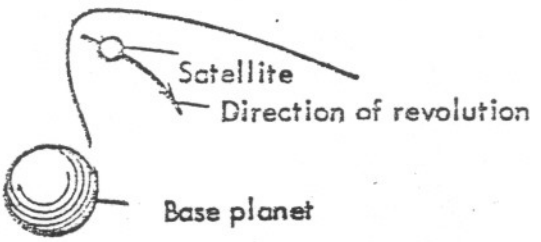

Figure 22

Utilization of Bodies Moving Toward or Away from One Another. - It is readily perceived that if we describe a curve about two bodies approaching one another (fig. 23), the velocity of the vehicle will be increased until we are able to force it to break away into outer space, even flying near their surface. If the two heavenly bodies are moving apart, on the other hand, the velocity will be decreased.

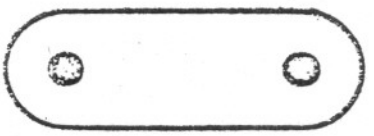

Figure 23

The Electric Gun

If, for some reason, the convenience afforded by motion in interplanetary space can justify the very large cost, it will be necessary to build an electric gun, the only device that will provide the necessary velocity, and if not all that is needed for escape, at least part of it. Here is its construction (fig. 24).

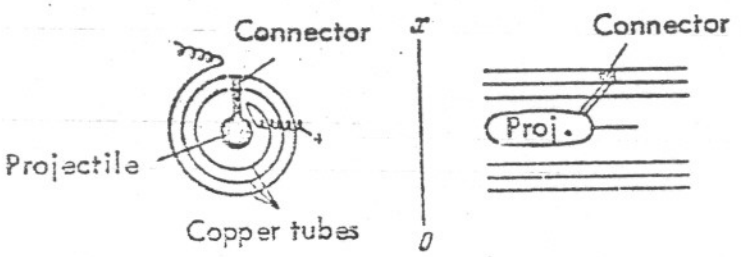

Figure 24