History of Rocketry and Astronautics

Proceedings of the Fifteenth and Sixteenth
History Symposia of the International Academy of Astronautics

Rome, Italy, 1981
Paris, France, 1982

Roger D. Launius, Volume Editor

R. Cargill Hall, Series Editor

AAS History Series, Volume 11

A Supplement to Advances in the Astronautical Sciences

IAA History Symposia, Volume 6

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 1994

ISSN 0730-3564

ISBN 0-87703-382-X (Hard Cover)
ISBN 0-87703-383-8 (Soft Cover)

Published for the American Astronautical Society
by Univelt, Incorporated, P.O. Box 28130, San Diego, California 92198

Printed and Bound in the U.S.A.

Chapter 1

On the Design of N. I. Kibal'chich's Flying Machine (on the 100th Year of its Development)[1]

A. M. Vinitsky[2]

In Russia in the middle of the nineteenth century a large number of military rockets with solid-propellant motors were produced and successfully employed. At that time, Russian scientists and inventors suggested the idea of flying machines that used jet propulsion. To them are attributed two designs—one, a lighter-than-air flying machine using the jet reaction of gas or steam as a motive force (Treteskii, Sokovnin); and the other, a heavier-than-air flying machine propelled by the jet action of a burning liquid fuel carried onboard and using the outside air as an oxidizer (Teleshova).

Nikolai Ivanovich Kibal'chich (1853-1881) introduced an entirely new method, unprecedented in other domestic designs, for making a heavier-than-air flying machine that did not require the atmosphere as a support medium or a source of energy. His device was powered by one or two solid-propellant rocket engines with an automatic feed system (using a timing mechanism), which consumed solid-propellant cells that had different sized surface-burning areas to provide variable thrust. During engine operation, the changing area of the solid-propellant's burning surface provided for controlled, variable thrust, from launch through flight, hovering, and a safe, soft landing.

Flight control was to be provided by the rocket engine's inclination in the vertical plane and its cone-shaped rotation around a joint. As an alternative, Kibal'chich suggested using a second solid-propellant engine in the horizontal plane to improve flight-control attitude—an engine that had to be able to rotate around the vertical axis.

---

[1] Presented at the Fifteenth History Symposium of the International Academy of Astronautics, Rome, Italy, 1981.

[2] National Committee for the History of Science and Technology, U.S.S.R. Academy of Sciences, U.S.S.R.

Stability for the flying machine was to be achieved by applying thrust above the center of gravity and along a single axis. In order to insure that burning proceeded from the end face of the solid propellant, the idea arose to place the propellant in reinforced, cylindrical casings. For propellant, Kibal'chich thought to use compressed gunpowder (a mixture of sulfur, saltpeter, and coal) and other slow-burning explosive materials.

When considering Kibal'chich's nineteenth century project on the whole, one must take note of his originality. His flying machine incorporated, among other features: (1) rocket propulsion for a flying machine; (2) control of vehicle attitude through pitch, roll, and yaw; (3) provision of flight stability by the reciprocal location of the vehicle's center of gravity and the rocket motor; (4) varying speed through a change of rocket thrust (altering of the solid-propellant element); and (5) flight return to a soft landing.