Space Journal

Volume 1 | Number 2 Article 7

4-1-1958

Rocket Mail to the Moon

Harold W. Richey

Recommended Citation

Richey, Harold W. (1958) "Rocket Mail to the Moon," *Space Journal*: Vol. 1: No. 2, Article 7.
Available at: https://louis.uah.edu/space-journal/vol1/iss2/7

rocket mail to the moon

What should the stamp cost, based on current propulsion technology?

By Dr. H. W. Ritchey

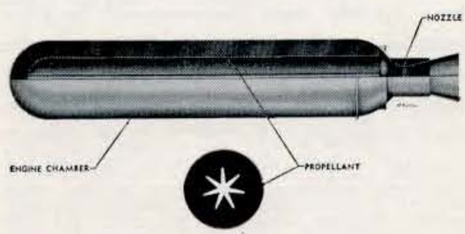
technical director
thiokol chemical corporation
redstone division

MOST ASPECTS of space travel have been covered extensively in a great volume of literature that has appeared on this subject over the last few years. The problems of propulsion and control have received a tremendous amount of attention. Other problems relating to the survival of the human being in space and his psychological and physical reactions to wide variations in gravitational fields have also received considerable attention.

Perhaps the one greatest problem now impeding progress is that of the subconscious inhibitions buried in the minds of those technologists now capable of effecting space travel. This problem may be solved for future generations by the publicity now being released in the semi-technical publications and on television. The younger generation, now in the formative stage, have seen animated cartoons and other demonstrations of the feasibility of space travel to the extent that they now look upon it as an accomplished fact. On the other hand, our present generation of scientists, even those who are able to prove logically by engineering calculations that space travel can be accomplished, have been so subjectively inhibited by their early conditioning that most of them still regard it as impossible in some segment of their mind buried deeply in subconscious. Only within the last few years has it been respectable in scientific circles to discuss seriously the feasibility of space travel.

The actual fact exists that we are now capable of sending an object outside the influence of the earth's gravitational field and, therefore, with an adequate system of guidance could send this object almost anywhere in the solar system. The design characteristics of a rocket system capable of propelling an object outside the earth's gravitational field are so well understood that it is possible to make reasonably accurate calculations of the cost of such a propulsion system. Such a propulsion system could carry rocket-mail letters to the moon or to a planet, and we are then able to estimate to a fair degree of accuracy the cost of a rocket-mail stamp needed to send a rocket-mail letter to outer space.

The problems inherent in the necessary propulsion system have already been solved by progress in the field of solid-propellant rocketry. In the solid-propellant rocket engine, the propellant is properly mixed and "injected" into the combustion cham-



ber at the manufacturing plant. A composite type of solid propellant can be processed as a slurry in the manufacturing plant and cast directly into the pressure vessel. A typical engine of this type is shown above.

The charge burns on all the exposed inside surface of a specially-shaped propellant cavity. Since burning occurs from the inside outward, the flame does not contact the walls of the pressure vessel until near the end of the burning period. If a proper fuel binder is used, the charge can be bonded to the walls of the pressure vessel and penalties in weight are paid for support of the propellant. Although the performance characteristics of present rockets cannot be disclosed, calculations utilizing obvious assumptions concerning propellant densities and densities of the high-strength structural materials can be used to show that it should be relatively easy to make a solid-propellant rocket engine in which 86% of the gross weight would be propellant. Since both this ratio and the propellant specific impulse are related to combustion chamber pressure, it is assumed that this ratio can be attained with a propellant exhibiting a sea-level impulse with an optimum nozzle of 195 lb-sec/lb. If such a rocket is designed to operate somewhere near optimum in the very low-pressure conditions existing at high altitude, this specific impulse figure will rise to a value of about 230.

Many multistage, solid-propellant rocket vehicles have been fired and the capabilities of staging and of high-altitude ignition have already been demonstrated in such missiles as the Lockheed X17 and the multistage, solid-propellant test vehicles fired by NACA. For the purpose of estimating the take-off weight in an "escape velocity" missile, the stage load ratio of 1:4 has been assumed; in other words, each rocket engine weighs four times all the load that it carries. These performance values and design criteria are then used in the following equation for rocket motion:

$$V = I_{sp} \times g \times 2.303 \log \frac{W_1}{W_2}$$

V = velocity, ft/sec
I_{sp} = propellant specific impulse, lb-sec/lb
g = gravitational acceleration, 32.2 ft/sec^2
W_1 = initial weight of system
W_2 = final weight of system

The calculated velocity, uncorrected for drag and gravitational effect, is shown in Table I. This velocity is then corrected for drag and gravitational effect by subtracting an overall gross "loss" figure, converted to equivalent velocity loss.

It has been assumed that each rocket stage is a faithful linear scale reproduction, in which case the following scale relationships obtain:

Burning time of Rocket B = scale factor times burning time of Rocket A

Thrust of Rocket B = scale factor squared times thrust of Rocket A

Gross weight of Rocket B = scale factor cubed times gross weight of Rocket A

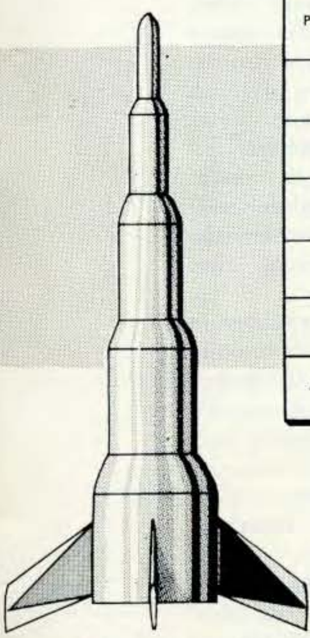
Using these relationships it is easy to estimate the time of burning and obtain a correction for the so-called "g" losses of velocity. This correction is also shown in Table I. It is more difficult to arrive at an accurate correction for atmospheric drag, especially since design of the specific aerodynamic configuration is beyond the scope of this article. Based on experience, however, it would seem reasonable and adequate to incorporate a correction of 2,000 ft/sec as the loss to be incurred by atmospheric drag for the smaller, "high-g" rocket, and 1,400 ft/sec for the larger rocket. Thus, as Table I illustrates, it is possible to attain escape velocities with a one-pound payload using a missile having a total take-off weight of less than 3,200 pounds.

It is also beyond the scope of this article to estimate the production costs of such a missile; however, experience with relatively small numbers of rockets made in research-

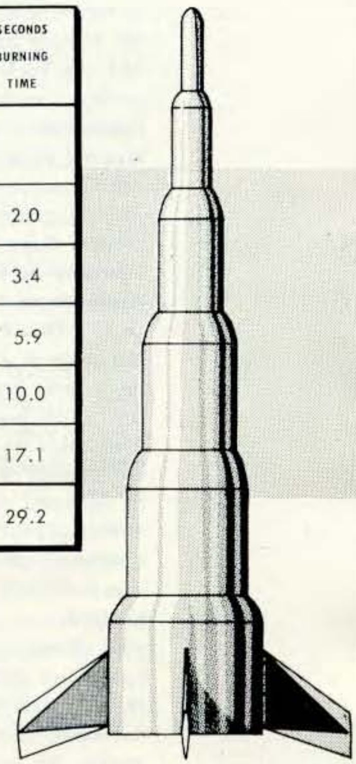
TABLE I

MAIL ROCKET TO THE MOON—SPECIFICATIONS

STAGE	STAGE WEIGHT	ENGINE WEIGHT	PROPELLANT MASS RATIO	PROPELLANT SPECIFIC IMPULSE	THEORETICAL VELOCITY INCREMENT "RETRO-ROCKET" WITHOUT	WITH	SECONDS BURNING TIME
PAYLOAD	1	0					
5	5	4	0.85	230	8400	(—8400)	2.0
4	25	20	0.85	230	8400	8400	3.4
3	125	100	0.85	230	8400	8400	5.9
2	625	500	0.85	230	8400	8400	10.0
1	3125	2500	0.86	230 195	7200	8400	17.1
ADDED	15,625	12,500	0.86	195		7200	29.2
				TOTAL	40,800	40,800	
				"g" LOSS	1,400	2,000	
				DRAG LOSS	2,000	1,400	
				NET	37,400	37,400	



without "retro-rocket"



with "retro-rocket"

and-development quantities would indicate that 20 such systems could be assembled at a total cost not exceeding $10.00 per pound of missile weight, amounting to $32,000 per vehicle.

Certain other problems would naturally exist if such a project were to be attempted. For example, there is hardly need to send a rocket-mail letter to the moon unless someone were there to receive it. This problem is normally not related to the cost of the stamp, and, therefore, the cost of placing a recipient in the right location has not been included.

There is also the problem of either hitting the target object with a free-flight ballistic missile or providing some type of terminal guidance. Since the moon subtends a visual angle of about 10 mils, it should not be too difficult a task to launch a rocket in the right direction and with sufficient velocity to hit the moon on a free-flight ballistic trajectory.

The recipient post office on the moon, of course, must bear the cost of finding the rocket at the impact point and recovering it. Here we get into a nebulous area where it might very well be argued that the cost of finding and recovering a rocket would far exceed the cost of the vehicle itself. In fact, the expense of renting one of the conventional launching sites for launching the vehicle might very well fall into the same category. Let's assume, however, that it requires investment of two man-days time and $2,000 in amortization of equipment in order to launch the rocket. So far as recovery is concerned at the other end of the line, it hardly seems reasonable to permit the rocket to impact on the moon's surface with the incremental velocity equivalent to free-fall in the moon's gravitational field plus what velocity is left at the "turn-over" point. In other words, in order to prevent the rocket from being completely destroyed on impact, it would be necessary to cancel out about 8,500 ft/sec accumulated velocity shortly before impact. This would be done by using the last stage as a "retro-rocket" and by adding on a new first stage weighing four times the 3,125 pounds appearing in Table I. This adds an additional 12,500 pounds to our take-off weight and additional $125,000 to the cost.

The payload will be a one-pound object consisting of a steel shell, a properly constituted dye marker, and the mail will be micro-filmed on 16mm film. Each stamp will allow the sender two pages of correspondence which would be transmitted in the form of two micro-film frames. Since volatility of the dye marker would be a matter of extreme importance, the dye marker will consist of carbon black and a small explosive charge, the total of which weighs four ounces and which will be arranged to explode on impact so that the impact point will be marked by the black powder.

Dye marker rocket impacting on surface of the moon.

The steel shell containing this load will weigh two ounces. The burned-out "retro-rocket" itself will act as a buffer against impact damage, and it is expected that the steel shell containing ten ounces of 16mm micro-filmed correspondence would survive an impact at several hundred feet per second. The cost of recovery and delivery at the receiving end will, in accordance with U. S. Postal policy, be subsidized by the U. S. Government, and, therefore, these costs are not included.

The ten ounces of micro-film will contain 12,800 16mm frames, and will require 6,400 postage stamps to send 6,400 letters. A summary tabulation of the cost of mail service is as follows:

$125,000.00		Added stage
32,000.00		Other rockets
2,000.00		Amortization launching equipment
250.00		Two man-days (consultant rate)
$159,250.00	÷	6,400 = $25.00 per stamp

Dividing by the number of letters that may be transmitted, this leaves us a cost of $25.00 for rocket-mail stamps to the moon.