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THE CAPTURE OF LUNAR MATERIALS EJECTED INTO DEEP SPACE; Dr. Mamdouh Abo-El-Ata, San Francisco State University, San Francisco, California.

This abstract describes the concepts of two devices that can be used to capture payloads of materials ejected from the moon into space. The first device is a passive catcher which stays almost stationary in space and captures only payloads targeted to its cross-section. The second device is an active catcher that could track and move to intercept payloads over a considerably larger area than the passive catcher.

The analyses and designs have been made assuming payloads which are solid spheres 0.20 m in diameter, made of compacted and sintered lunar soil. Each payload has a mass of 10 kg and arrives at the catcher with a speed of 200 m/s. The frequency of arrival is one payload per second.

A. Passive Catcher

A passive catcher could be a bag with a one way door to prevent rebound, a bag filled with low density glass wool, or a rigid foam disc. Only the last passive catcher, the rigid cellular foam disc, is analyzed herein.

As the payload impacts rigid cellular foam, it has to shear the foam, crush it and carry the crushed foam in front of it. The payload will come to a stop when the work done against the three resistances mentioned above equals its initial kinetic energy. A theoretical analysis of the dynamics of the payload as it penetrates the foam is given in reference (1). As an example, the analysis showed that a typical payload would penetrate FR type polystyrene foam (density = 28.4 Kg/m^3) a distance equal to 1.3 m. For a circular disc 10^4 m^2 in area, the mass of the catcher is approximately 500 tons.

The foam catcher could be foamed in place. After collecting for a period of time (a lunar day, for example), it could be melted down with solar furnaces, the desired material extracted and the catcher refoamed in space. It also has the advantage of being very simple in conception with essentially no moving parts. Its 500 tons mass for a catch area of 10^4 m^2 is a disadvantage. Like other passive catchers, the foam catcher requires very high precision in launching payloads from the moon surface.

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B. Active Catcher

If an extremely high precision of launching payloads from the lunar surface could not be attained, catch areas of the order of 10^6 m^2 or higher would be required. In this case, passive catchers become too massive to be practical and an active catcher becomes a necessity.

The catcher is in the form of a thin light net, $10m^2$ in area, which is manipulated by three strings to position the net anywhere within an equilateral triangle abc as shown in the Figure. The strings are wound on motorized reels which move on three closed loop tracks. The equilateral triangle is 1000 m on the side, providing 0.43 X 10^6 m^2 catch area.

By using a perimeter acquisition radar system, the catcher could track and move the net to intercept payloads. Having captured the payload, the net and reels assembly (rig) act to decelerate it from its incoming velocity of 200 m/s to 20 m/s. The payload is then released into a storage depot and the rig returns to its initial position by means of the closed loop tracks. The estimated circulation time is 60 sec/rig and therefore 60 such rigs are required.

A detailed kinematic, force and stress analysis is given in Reference 1. The length of the active part of the track is about 1000 m The forces involved are less than 1000 N. For a catcher frame made of 2024 Aluminum alloy, the weight of the entire catcher is a little over 200 tons. Contrasting the weight of catcher per unit catch area gives the active catcher a 100:1 advantage over the passive catcher described in A above. On the other hand, the active catcher requires many moving parts, synchronized motions and thus considerable developmental work is need before this concept is realized.

Acknowledgement

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Reference

1. NASA-Ames Research Center, Final Report of 1975 Systems Design Summer Study, "The Colonization of Space." To be published in Spring of 1976.

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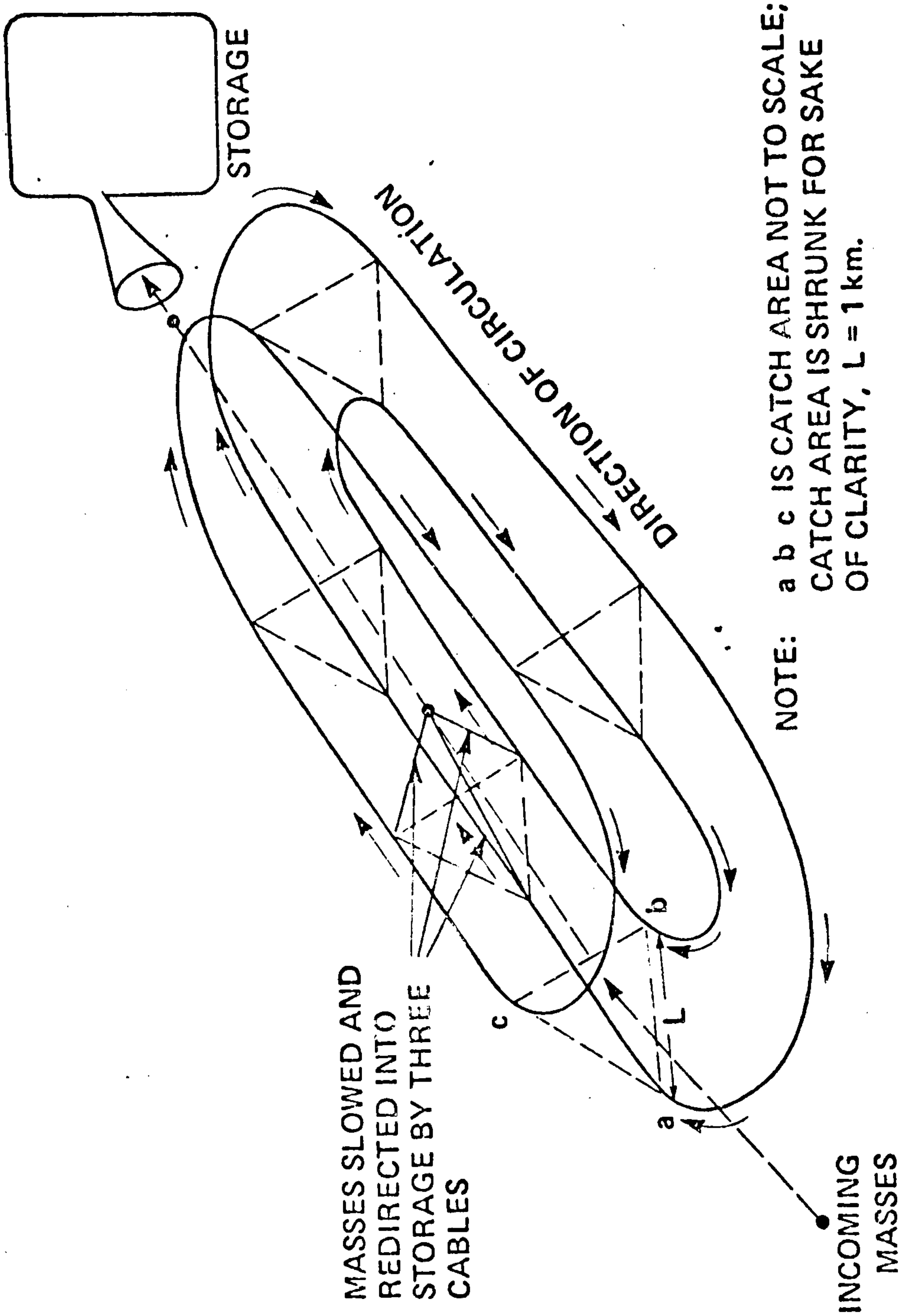

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