N91-71220

LIGHTWEIGHT MOBILITY SYSTEMS FOR LUNAR OPERATIONS UTILIZING ELASTIC LOOP SUSPENSIONS; Wolfgang Trautwein, Lockheed Missiles and Space Company, P. O. Box 1103, Huntsville, Ala. 35807 and Nicholas C. Costes, National Aeronautics and Space Administration, Marshall Space Flight Center, Alabama.

Effective utilization of lunar resources has been identified as the key to reduce the cost of constructing large scale solar power satellites. All phases of erecting and operating a lunar base including site surveying, shelter construction, exploratory and production mining, hauling, processing and launch of lunar materials will require highly reliable surface transportation equipment.

The enormous cost to transport equipment from the earth to the moon places a high incentive on lightweight and low power consumption.

The four-wheeled lunar roving vehicle (LRV) used very successfully by the Apollo 15, 16 and 17 astronauts and the eight-wheeled remotely controlled Lunokhod I and II vehicles demonstrated that wire mesh wheels can perform light to moderate lunar logistics functions.

Additional traction as required in more adverse terrain and for digging, loading and hauling of ore and overburden would call for much larger and heavier wheels.

An alternate mobility concept has been under development at Lockheed Missiles and Space Company's Huntsville Research and Engineering Center for the last five years. The loopwheel or elastic loop, is a one-piece continuous band providing a large track-like footprint and spring suspension in a simple and lightweight design.

NASA's Marshall Space Flight Center recognized the attractive features of the loopwheel, such as high performance in marginal terrain, lightweight and low part count, and has supported the exploratory development for low-gravity extraterrestrial applications through several prototype and test programs. Tests of a second generation loopwheel conducted for NASA-MSFC by the U. S. Army Engineers Waterway's Experiment Station (WES)have shown that the loopwheel provides an 85 to 100% improvement in soft soil mobility over the Lunar Roving Vehicle at a lower power requirement (refs. 2, 3, and 4). An early test model is shown in Fig. 1.

The loopwheel's low weight and potential for high reliability has prompted the U. S. Marine Corps to support a loopwheel development program at Lockheed-Huntsville (Ref. 5) which is now being joined by the Army Tank Automotive Command. Weight savings of over 40% and an 80% reduction in the number of major moving parts over track suspensions in high-performance off-road vehicles appear feasible.

Early lunar operations call for a multi-purpose vehicle with maximum mobility to minimize the risk of getting immobilized in adverse terrain. An articulated three-loop vehicle with yaw steering between the dual-loop and the single-loop module was found to provide the best pay-off in mobility per unit cost.

A front-loader version is shown in Fig. 2. The front bucket could be removed for personnel transportation or replaced by a drilling or scientific unit for surveying sorties.

The spring suspension inherent in each elastic loop enhances ride qualities and reduces shocks and vibration levels for onboard instruments, antennas and imagery in both manned or remote control operation. Shocks and vibration levels could be limiting factors in efforts to adapt conventional unsprung earth-moving equipment to lunar operations which must relay on heavy instrumentation, a factor not addressed in earlier vehicle surveys for lunar mining operations (Refs. 6 and 7).

References

1. Costes, N. C., and W. Trautwein, 1973, J. of Terramechanics, Vol. 10, No. I, pp. 89-104.

2. Costes, N. C., K. -J. Melzer and W. Trautwein, 1973, AIAA-Paper No. 73-407.

3. Green, A. J., and K. -J. Melzer, 1971, Performance of Boeing LRV Wheels in a Lunar Soil Stimulant, U. S. Army Engineer W. E. S., Tech. Rep. M-71-10.

4. Melzer, K. -J., and G. D. Swanson, 1974, Performance Evaluation of a Second Generation Elastic Loop Mobility System, Tech. Rep. M-74-7, U. S. Army Engineer W. E. S.

5. Trauwein, W., G. W. Fust, and J. A. Mayhall, 1974, Exploratory Development of Loopwheel Suspensions for Off-Road Military Vehicles, Part 1, Contract N61331-74-0064, Material Selection and Structural Test Loop Design, Huntsville, Ala., 1974; Part 2, Contract N-61339-75-C-0090, Loop Core Fabrication and Testing, Huntsville, Ala., 1975; Contract DAAE07-76-C-3246, Operational Loopwheel Suspension Development.

6. Cox, R. M., R. Q. Shotts, S. A. Fields, and H. H. Weathers, 1967, Proc. Fifth Annual Meeting of the Working Group on Extraterrestrial Resources, pp. 161-180.

7. Shotts, R. Q., 1969, Proc. of the 7th Annual Working Group on Extraterrestrial Resources, NASA SP-229, pp. 119-129.

FIG. 1: Sub-scale functional test vehicle with titanium loops, electric drive and remote control demonstrated high degree of rough-terrain mobility and maneuverability under NASA-MSFC sponsored test program (Refs. 1 & 2).

FIG. 2: Multi-purpose articulated three-loop vehicle concept for lunar operations.

Figure 1

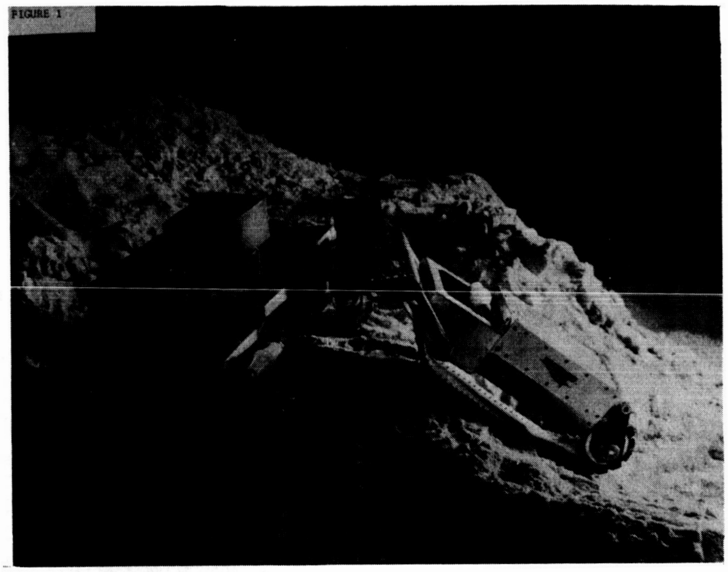

Figure 2