withstanding a tension of 1.5 to 2 tons would meet the requirements of a cosmic lift. The minimum diameter of the cable at the earth's surface would be about 1 mm, and the total mass up to a height of 50,000 km would be about 900 tons. Building materials with the required characteristics have been obtained in laboratories, although only in microscopic amounts.

Naturally, to make the cosmic lift work, a source of energy is required. However, this energy would have to be expended only on the lower section of the path—from the earth's surface to the stationary satellite. Above this level, the centrifugal force would exceed the force of gravity, and the load would ascend by centrifugal force. Any moving mass has energy, and, in its upper path, the cosmic lift, far from consuming energy, would itself become a source of energy.

This energy liberated by the lift can be used in different ways. First of all, it can be used for space flights. The energy developed over the upper section—above 36,000 km could be fed to a power station supplying the lower section of the lift. This would result in an interesting situation. The expenditure of energy for ascending the "cableway" to outer space could be reduced to a minimum. According to Artsutanov's calculations, a height of 144,000 km can be reached without wasting any energy at all. The amount of work obtained along the upper part of the path would equal that spent along the lower part. At heights greater than 144,000 km, operation of the cosmic lift would turn into pure profit. The lift would become a sort of power station.

The capacity of the heavenly funicular would evidently be limited by the strength and dimensions of the structure and also by the speed of the loaded car. The strength of the suspension could be increased a thousandfold by strengthening the initial cable. The speed should be about 1000 km/hr. Then it could handle about 500 tons an hour or 12,000 tons a day. A lift with a capacity of 500 tons an hour could convey 360,000 tons to the upper platform in a month. This would make it possible to assemble and equip 20 space liners of 30,000 tons each. These spaceships could start off from a height of 47,000 km with their engines idle, solely through the action of the centrifugal force caused by the earth's rotation. Such lifts could conceivably be built on the moon, Mars, the asteroids, and other planets.

Exactly when it will be technically feasible to build space lifts, it is hard to say. Such a project may possibly get underway by the end of this century.

We in the Soviet Union have read the paper of Isaacs *et al.* with great interest. It testifies to the fact that ideas are "in the air." Analyzing the investigations of Isaacs *et al.*, we do not find any new elements, as compared to Artsutanov's published 6 years earlier. I also assert that the "sky-hook" problem has been dealt with in greater detail in Artsutanov's paper. This inclines us to stress his priority in this field. Our attitude toward priority is devoid of chauvinism or nationalism. We welcome international ties in science and believe that the "sky-hook" project affords a good opportunity for the cross-pollination of ideas in science.

VLADIMIR LVOV
*Novosti Press Agency, Moscow, U.S.S.R.*

**References**

1. D. Isaccs, A. C. Vine, H. Bradner, G. E. Backus, *Science* **151**, 682 (1966).
2. K. E. Tsiolkovski, *Grezi o zemle i nebe* (in Russian) (Academy of Sciences, U.S.S.R., Moscow, 1959), p. 35.
3. Yu. Artsutanov, "V kosmos na elektrovoze" (in Russian), *Komsomolskaya Pravda*, 31 July 1960.

17 August 1967

We have read Lvov's discussion of Tsiolkovski's work and Artsutanov's ideas with interest. We have also inspected a copy of Artsutanov's newspaper article to which Lvov refers (Sunday–Special Supplement of the Komsomolskaya Pravda, 31 July 1960). The article clearly demonstrates that Artsutanov proposed the "sky-hook" development some 6 years before our paper appeared in *Science*.

Artsutanov's article presents none of the calculations or results on cable diameters, strength, energetics, traffic capacity, and a number of other factors to which Lvov alludes. Presumably Lvov has also had access to studies of a scholarly nature that Artsutanov has prepared, although no reference is made to these.

In his article, Artsutanov is far bolder than we, as he foresees an immense development of routine and scheduled space commerce on "heavenly funicula" (a term we applaud). Our proposal is modest and is concerned with the immense engineering challenge of the possibility. Nevertheless, we also believe that developments based on the principles of "sky-hook" may indeed become important realities.

We hope that Artsutanov derived as much excitement and enjoyment working on the idea as we did.

JOHN D. ISSACS
HUGH BRADNER
GEORGE E. BACKUS
*Scripps Institution of Oceanography, University of California, La Jolla 92037*
ALLYN C. VINE
*Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543*

## Continental Drift and Spreading of Ocean Floors

Shapiro's footnote (*1*) on the use of radar interferometry to measure present-day continental drifts deserves several comments. Although negative results with such an interferometric system would not preclude relative continental movements at some time in the past, positive results would irrevocably settle the dispute regarding the feasibility of such movements—something that more conventional approaches have yet to do. Positive results that were geographically extensive might greatly enhance our understanding of the development of continents and ocean basins. With regard to ocean basins, positive interferometric measurements from oceanic island–based receivers could resolve at least one major controversy (*2*) in the hypothesis of spreading of the sea floors: Is spreading taking place today? Furthermore, data from base lines having both continent- and oceanic island–based arms might give us rates of movement between ocean floors and continents. Such data could greatly clarify any relation between spreading of the sea floors and relative continental movements.

It is time for us to begin active pursuit of the enormous potential of these techniques in some well-coordinated fashion. It would be more than appropriate if such coordination were thoroughly international in spirit and practice.

EDWIN KARP
*Department of Geology, New York University, New York 10003*

**References**

1. I. I. Shapiro, *Science* **157**, 806 (1967).
2. T. Saito, L. D. Burckle, M. Ewing, *ibid.* **154**, 1176 (1966); J. D. Phillips, *ibid.* **157**, 920 (1967).

3 October 1967