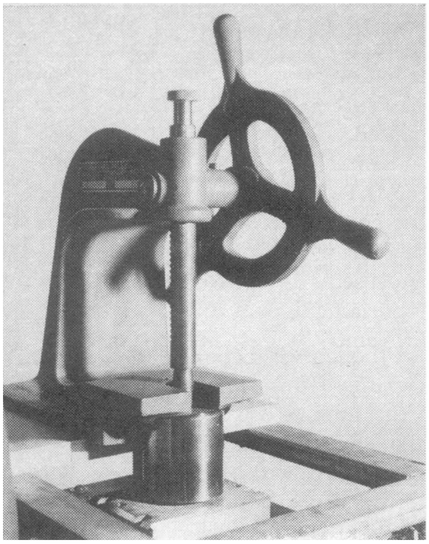

Fig. 1. The piston extractor.

has small capacity (20 ml or less) and normally requires thawing before the piston can be removed. The extractor described in this note (Fig. 1) allows the piston to be readily withdrawn from the frozen cylinder. Thus the press may be used repeatedly to handle large volumes of cells or many different samples in a minimum time.

A hole was drilled in the top of the piston and a thread cut (*3*). The extractor was made by modifying a mechanical Arbor press. A hole was drilled through the vertical shaft of the Arbor press to pass a steel rod, which had a knurled knob at the top and was threaded at the bottom to engage the piston. The bottom of the Arbor press was machined to present a horizontal surface to the cylinder block. The piston is quickly and easily drawn from the frozen cylinder by raising the vertical shaft of the Arbor press. The total cost of the extractor was under $70.

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References and Notes

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2. L. Edebo, *Acta Pathol. Microbiol. Scand.* **52**, 300 (1961); N. R. Eaton, *J. Bacteriol.* **83**, 1359 (1962).
3. The press used is one supplied by W. A. Schaerr, 356 Gold Street, Brooklyn, N.Y.
4. Supported by PHS research training grant GM 397 and NSF grants G-11228 and GB 2176.

28 February 1966

Sky-Hook

In "Satellite elongation into a true 'sky-hook'" [*Science* **151**, 683 (1966)], Isaacs, Vine, Bradner, and Backus begin by saying that "a satellite is in balance between centrifugal and gravitational forces. There is (for all practical purposes) only one force being exerted on a satellite, and that is the centripetal force of gravity. Obviously, if there were two equal and opposite forces acting, the body would merely continue to move in a straightline path according to Newton's first law of motion.

Secondly, a radial cable extending from the surface to whatever altitude is incapable of exerting any tangential force on a mass "climbing" up the cable, if the dynamics of the synchronous system are not to be upset. Further, the system is mechanically incapable of transferring any portion of the earth's energy of rotation into energy of revolution of a satellite. Any energy of revolution will have to be put in by rocket motor, which is precisely the way it is done at present. Consequently, the system is inefficient as well as mechanically unsound and theoretically impossible.

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9 March 1966

Shea is correct that in a nonrotating (inertial) reference frame the only force on the satellite is gravitational and accelerates the satellite. We chose to work in a reference frame rotating with the earth. In such a reference frame the satellite or cable is stationary when unperturbed but is acted on by a D'Alembert force, usually called the centrifugal force, as well as by gravity.

Shea's second argument stems from an aspect of the mechanism that appears to be difficult for many to recognize. It is true that no normal force can be sustained by a rotating cable that is flexible through the length from outer terminus *to the center of rotation*. However, the system that we presented possesses a finite *rigid* rotating portion. This rigid segment is the planet. Thus, crucial to our proposal is an approximately equatorial attachment of the inner terminus. By their inclusion and consideration of this segment of the system, Shea and others who have raised the same question, should recognize how a normal accelerating force can act upon a body that is moved up the cable. We further clarify this in Fig. 1. It is seen there that a tangential force component arises from the deflection of the cable at the rigid periphery at a finite radius, and that a normal force component from a related deflection also acts on the body to accelerate it.

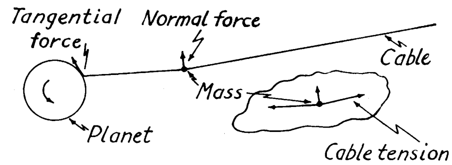

Fig. 1. Configuration of cable with mass moved radially.

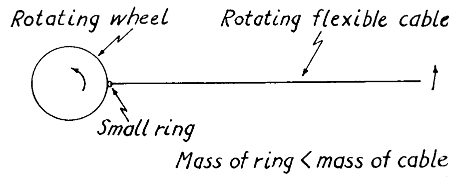

Fig. 2. An experiment demonstrating tangential force on a mass moving radially along the cable.

The experiment diagrammed in Fig. 2, a variation of David's sling, demonstrates that a flexible cable, attached by one end to the periphery of a rotating wheel, and free at the other, is capable of imposing a tangential force on a mass that is moved radially out the cable. When the ring is released it moves radially and achieves an appropriately high tangential velocity which is in marked excess to the peripheral velocity of the wheel. Yet this higher velocity is derived from the motion of the wheel. Although in this case the region of gravitational attraction is miniscule, the experiment nevertheless demonstrates that a singly attached flexible cable is capable of conveying tangential velocity to a body moved radially along it.

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26 March 1966

Science

Sky-Hook

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