ISSN 1041-9489

SAFETY BRIEF

September, 2004 Volume 26, No. 4

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Limited Movement Machinery Rollers

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ABSTRACT

Ancient Egyptians allegedly moved large stone blocks by placing cylindrical rollers beneath them and manually urging them along. This rolling procedure required that the rollers emerging from the rear of the stone be manually lifted and replaced in front. This roller replacement protocol has been automated in commercially available roller units that allow continuous movement of heavy machinery under the action of pry bars, come-a-longs, winches, or manual push efforts. Unfortunately, when slopes or asperities are encountered these heavy loads may accelerate uncontrollably or steer themselves in unsafe directions when the roller units become reoriented. This paper describes two inventions that cause the locomotion of the machinery to proceed in inchmeal fashion by intermittently braking the system while the roller units are manually reset.

INTRODUCTION

A typical roller unit is illustrated in Fig. 1 where cylindrical rollers are mounted along a roller chain that circulates around a load bearing platform that supports a superstructure which in turn upholds a heavy machine. These roller units are often referred to as roller skids or skates. The rollers transfer compression loads between the ground and the

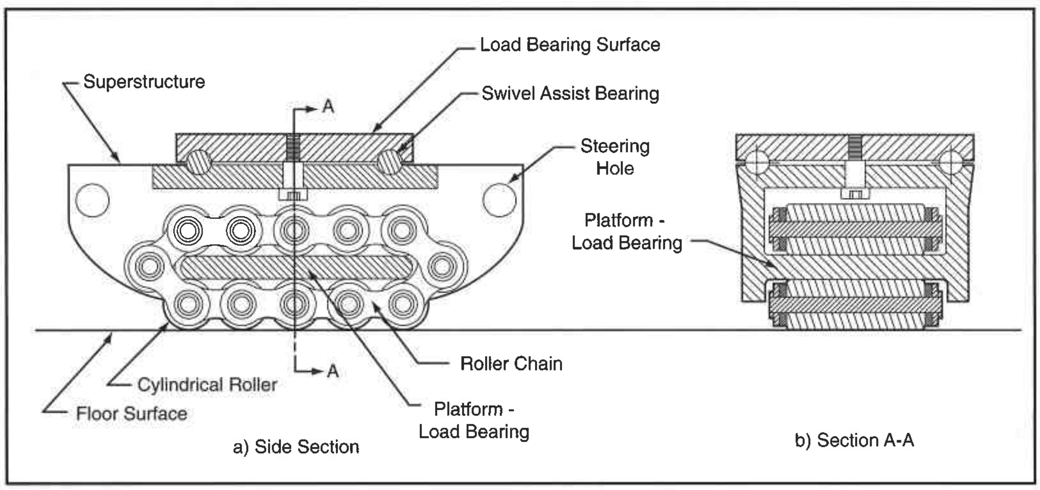

Figure 1 - Typical Roller Unit

This paper will be published in the Proceedings of the American Society of Mechanical Engineers' International Mechanical Engineering Congress and Exposition in November of 2004.

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bottom of the load bearing platform. Off-the-shelf units are available in capacities from 4-tons to 100-tons. Roller units are symmetrical longitudinally and transversely.

A roller system typically uses four roller units which are inserted beneath a load, such as a boiler, by jacking up its corners or other hard points. The roller units are seldom attached to the load which may be propelled by horizontal forces generated by shoving, winching, or prying. The load is steered by rotating the individual roller units about an imaginary vertical axis. This is accomplished manually using a three to five foot long lever with a T-bar handle. The steering lever is temporarily affixed to either end of the roller unit. A swivel bearing is sometimes added to the top of the roller unit to minimize rotational resistance and improve its steering capability.

Moving large masses across horizontal homogenous surfaces free of asperities may be safely accomplished by any horizontal force system that can be instantaneously interrupted, e.g., manual pushing or pry bars. As ideal conditions degenerate, the following may be experienced:

- Sloped surfaces, ramps, and inclines
- Textured and anisotropic surfaces (broom finished concrete)
- Nonhomogeneous floors composed of multiple materials (brick, wood, steel, etc.)
- Weak floor spots, expansion joints and drains
- Uneven surfaces
- Dirty and debris laden floors

When significant slopes are encountered, heavy loads may accelerate uncontrollably and this action may be exacerbated by spring-like propelling devices such as come-a-longs or winches. Roller manufacturers recommend that holdback devices be used on inclined surfaces; however, these manufacturers offer no specific suggestions for doing this. Surface imperfections generally contribute to the propensity of roller units to realign themselves and steer the moving machinery in unsafe directions. To help maintain control of the loads, roller manufacturers advocate the following precautions:

- Constant monitoring of the rollers
- Moving slowly at all times
- Absolute cleanliness of moving surfaces

It is not unusual for movers to rig a machine with various winch-like devices to control its movement. Under general conditions, such as an elephant on an icy slope, holdback rigging is not elementary. Our agenda does not allow a full discussion of holdback technology, however, a few examples may illustrate some of the difficulties. When simultaneously pulling and holding back with two come-a-longs, the cables must be collinear, otherwise a moment is introduced that will tend to rotate the elephant. If three nonparallel cables are used to restrain the beast, their lines of action must all intersect at a point, otherwise they will again rotate the elephant. The four cables shown in Fig. 2 completely fix the position of the elephant against rotation and translation. On the other hand, loosening and tightening the cables to cause the creature to move along a desired path in a specific orientation is a daunting exercise. It should be noted that some four-line rigging systems will not fully restrain a load. In addition, the location and structural integrity of available tie off points cannot be taken for granted.

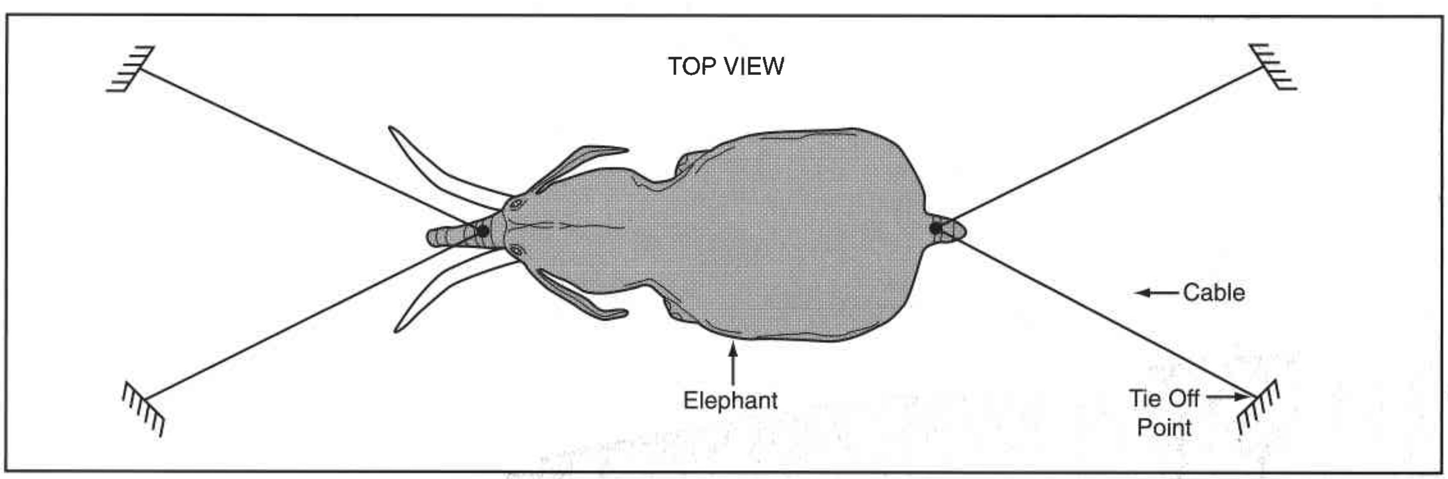

Figure 2 - Four-Cable Rigging System

STOP BLOCK SYSTEM

To maintain control of a roller system affecting the movement of a large load, we can proceed incrementally in inchmeal fashion. Every few inches a roller unit can be forced into a braking mode which must be manually reset to resume another few inches of movement. Fig. 3a illustrates a standard roller unit which has been modified by removing one or more rollers from the top of the load-bearing platform and replacing it by a stop block fixed to the platform. This feature is the subject of a U.S. Provisional Patent application by Ralph Barnett (Ref 1). The roller unit has been advanced to the right in Fig. 3b where we observe that Roller 1 has moved away from the stop block and Roller 9 has moved closer to the stop block. Further motion of the roller unit causes Roller 9 to contact the stop block which terminates all revolving of the roller cylinders as shown in Fig. 3c. The roller units experience full friction braking. Further locomotion of the roller units requires that the units be rotated approximately 180 degrees using standard steering levers. After the unit has been turned around, Roller 9 takes the original position of Roller 1 and locomotion continues.

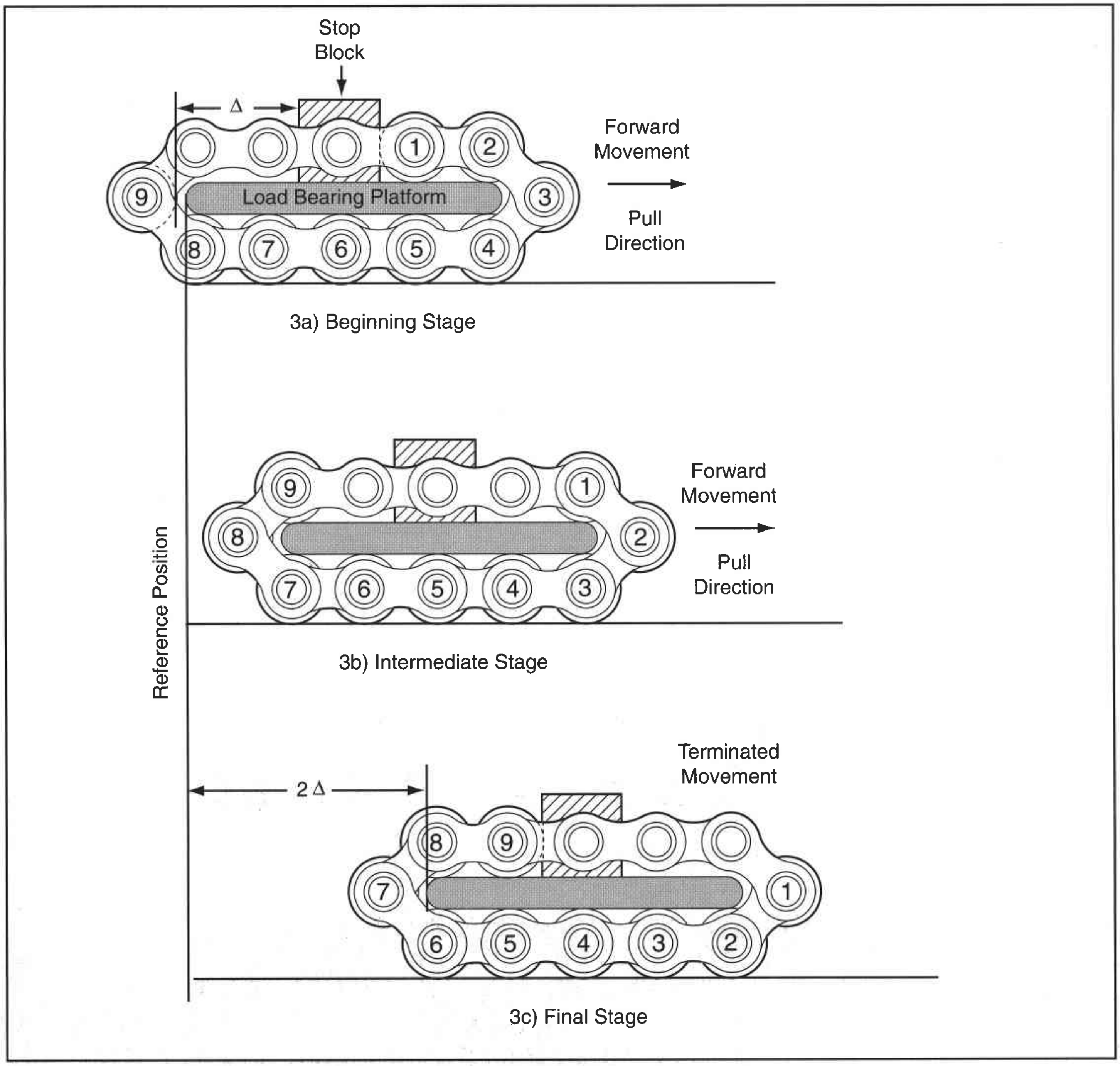

Figure 3 - Stop Block System

DOUBLE WHEEL CHOCK FRAME

Another device that will enforce intermittent motion is shown in Fig. 4. This double wheel chock frame surrounds a standard roller unit with a preset rattle space fore and aft as shown in Fig. 5. This concept has been submitted as a U.S. Provisional Patent application by Ralph Barnett (Ref. 2). The roller unit may move forward or rearward until the leading cylindrical roller rolls into contact with the vertical face of the chock as depicted in Fig. 6. Observe in Fig. 6 that Roller 8 will push the wheel chock frame to the left while the roller chain lowers Roller 9 on top of the wheel chock as illustrated in Fig. 7. This action locks up all of the rollers and produces a braking action.

When the double wheel chock frame just begins to move to the left, the operator may kick the frame forward the full preset distance. The locomotion of the roller system may then continue until the rattle space has once again been consumed. Any time the orientation of the roller unit needs adjustment, the

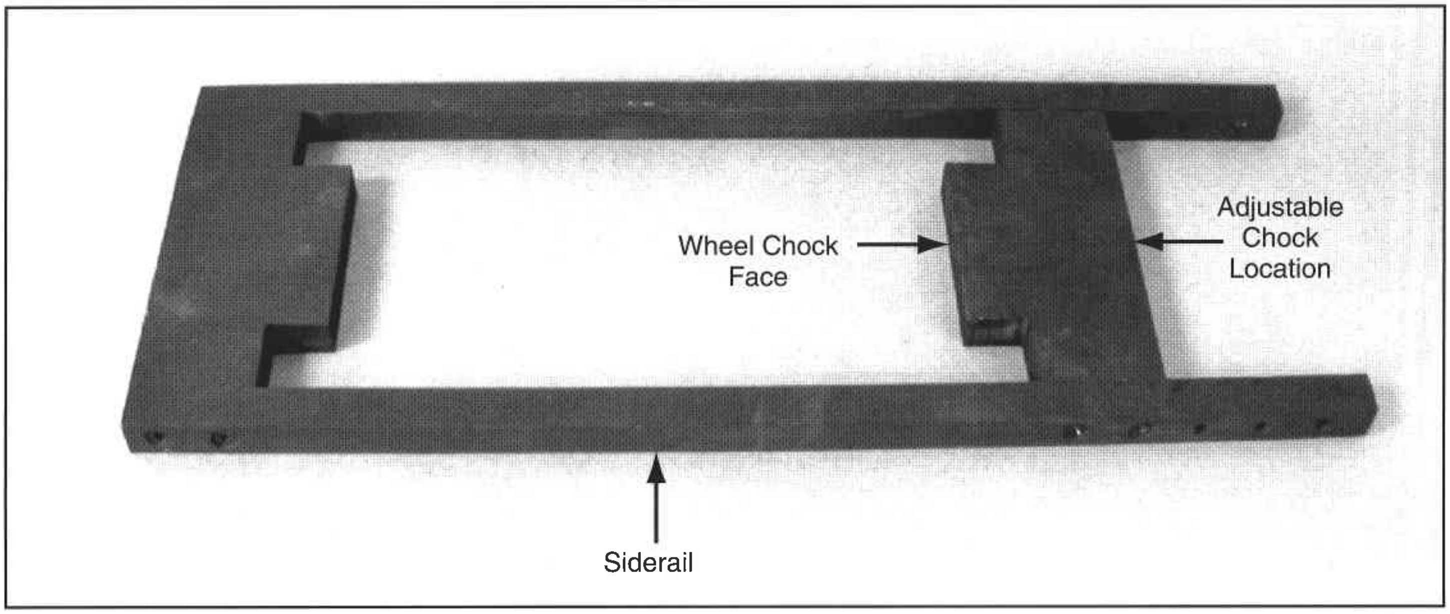

Figure 4 - Double Wheel Chock Frame With Adjustable Aperture

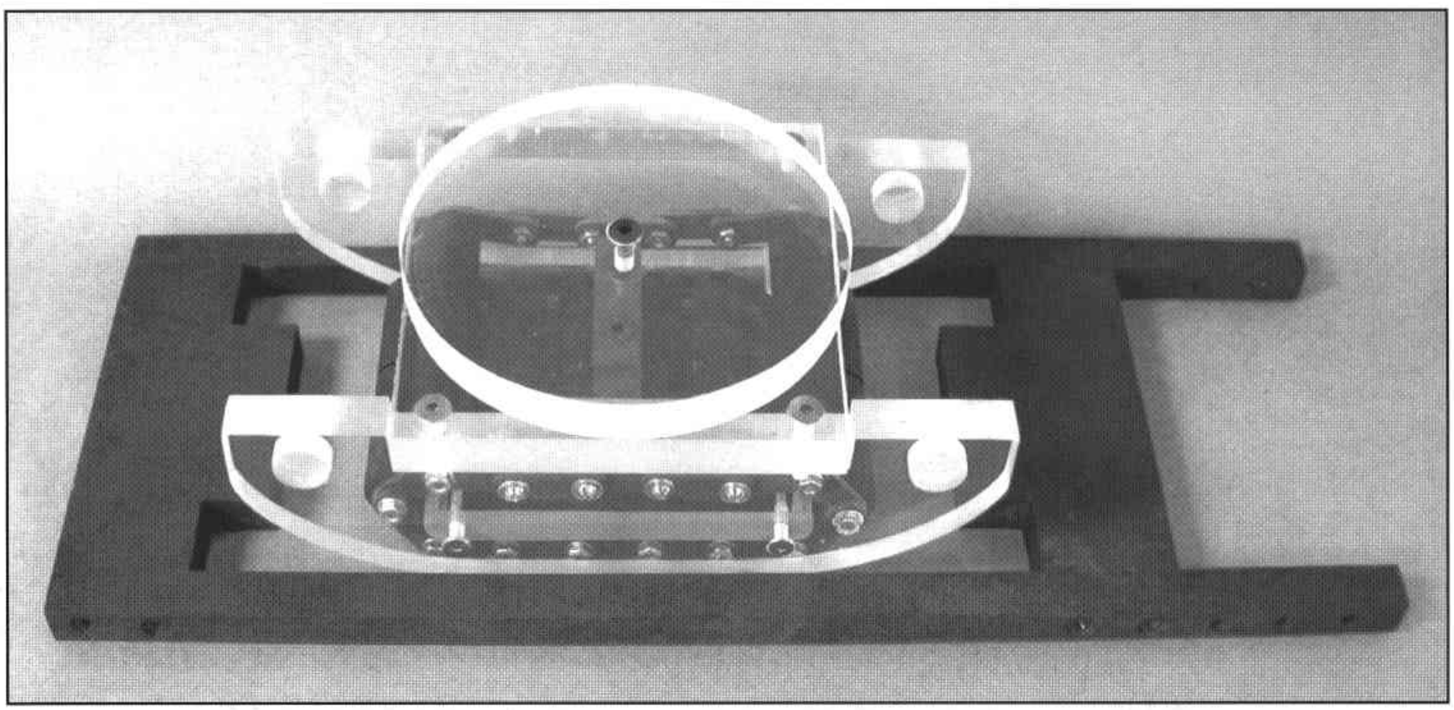

Figure 5 - Standard Roller Unit with A Double Wheel Chock Frame

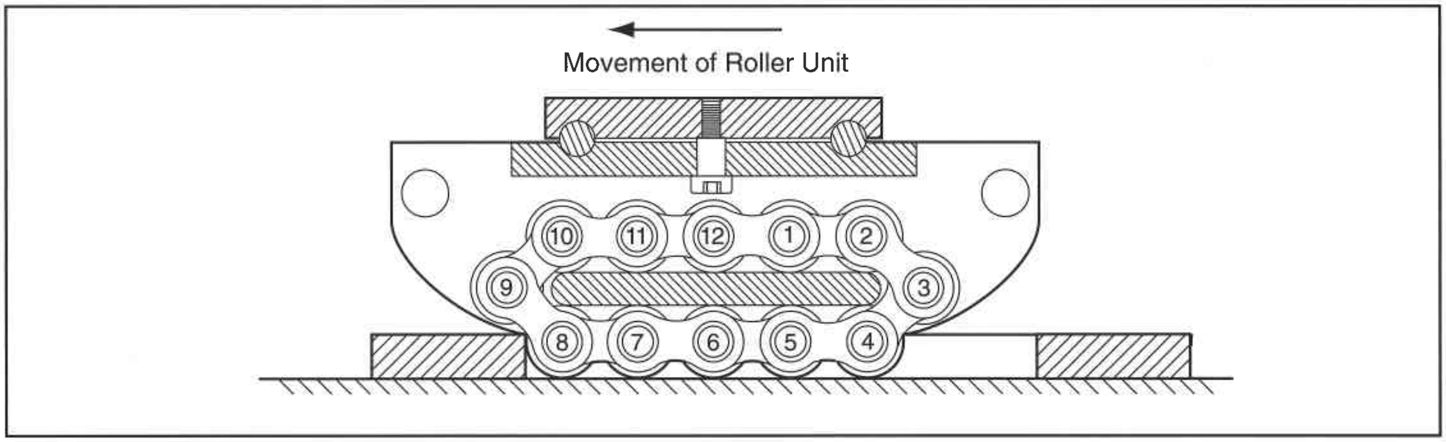

Figure 6 - First Contact of Cylindrical Roller With Wheel Chock Face

standard T-handled lever may be applied to the roller unit. As the roller unit is rotated, the side rails of the wheel chock frame will cause the frame to rotate and adopt the roller unit's new orientation. By shuffling the double wheel chock frame along, a continuous movement of the load may be achieved while insuring that any runaway excursion will be interrupted within a few inches. If the frame is not shuffled forward in a timely fashion and a cylindrical roller is allowed to climb on top of it, kicking the frame forward will not be possible. The trapped frame may be released by moving the roller system slightly rearward. If this is not practical, the entire roller unit and wheel chock frame may be rotated 180 degrees using the standard T-handled lever. After rotation, locomotion may be resumed.

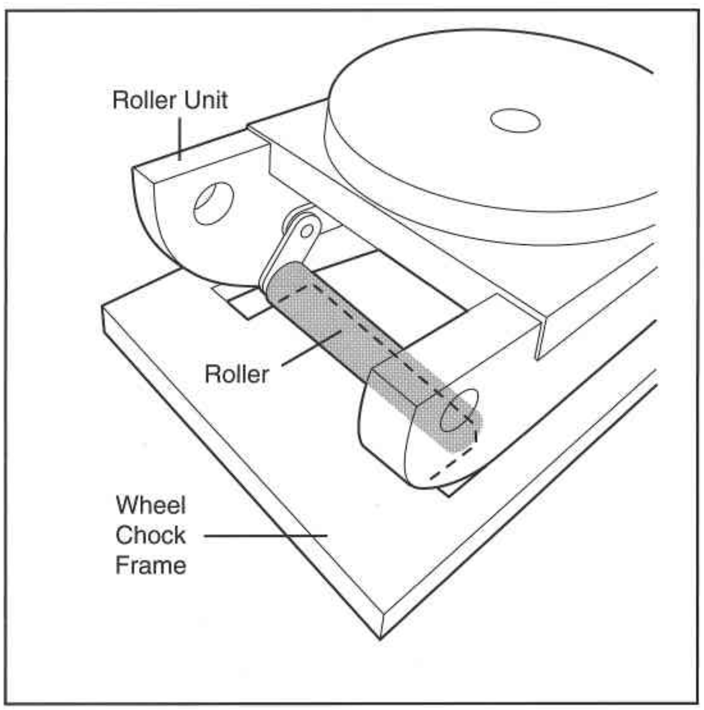

Figure 7 - Lock-Up: A Cylindrical Roller Climbs On Top Of The Wheel Chock

CONCLUSIONS

1. To transport heavy loads over floors with inclines and imperfections, manufacturers of roller skids provide warnings that admonish users to move slowly, constantly monitor the roller units, strive for absolute cleanliness, and employ holdbacks. The limited movement devices proposed in this paper provide design solutions rather than instructions, recommendations, and warnings. Recall that the Safety Hierarchy ranks safeguard devices ahead of warnings (Ref. 3).

2. The stop block and the double wheel chock frame both provide an inchmeal motion with full braking every few inches of travel. Further, each concept demands constant resetting which provides an opportunity to reorient the roller units.

3. Roller units manufactured by Hilman Incorporated provide drag coefficients for both breakaway and dynamic conditions that are approximately 2% at capacity loading (Ref. 4).

4. For the stop block concept, the travel interval may be selected by adjusting the width of the stop block and the number of rollers removed from the roller chain. In Fig. 3, it is indicated that the maximum clearance D between the rollers and the stop block is half the corresponding movement of the roller unit.

5. The roller units addressed in this paper resist vertical loads by direct diametrical compression of solid cylinders. Alternate roller skid designs employ wheels, as in children's roller skates; their structural integrity is limited by the shear strength of their axles. Diametrical compression is the superior concept for heavy loads.

6. The stop block is an intrinsic design feature. On the other hand, the double wheel chock frame is a supplementary device the use of which is elective. Failure to employ the frame may have product liability implications arising from the doctrine of Reasonably Foreseeable Use (Ref. 5).

7. Resetting the double wheel chock frame at the end of each locomotion interval is much easier and faster than resetting the stop block design.

8. When the double wheel chock frame is used with wheeled roller skids, the usual shapes of the wheel chock faces must be adopted: circular arc, wedge shaped, or polygonal. For the roller unit shown in Fig. 1, a vertical flat face is more desirable since it pushes the frame along a bit before a roller descends on top of the frame.

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September, 2004 – Volume 26, No. 4

Editor: Paula L. Barnett

Illustrated and Produced by

Triodyne Graphic Communication