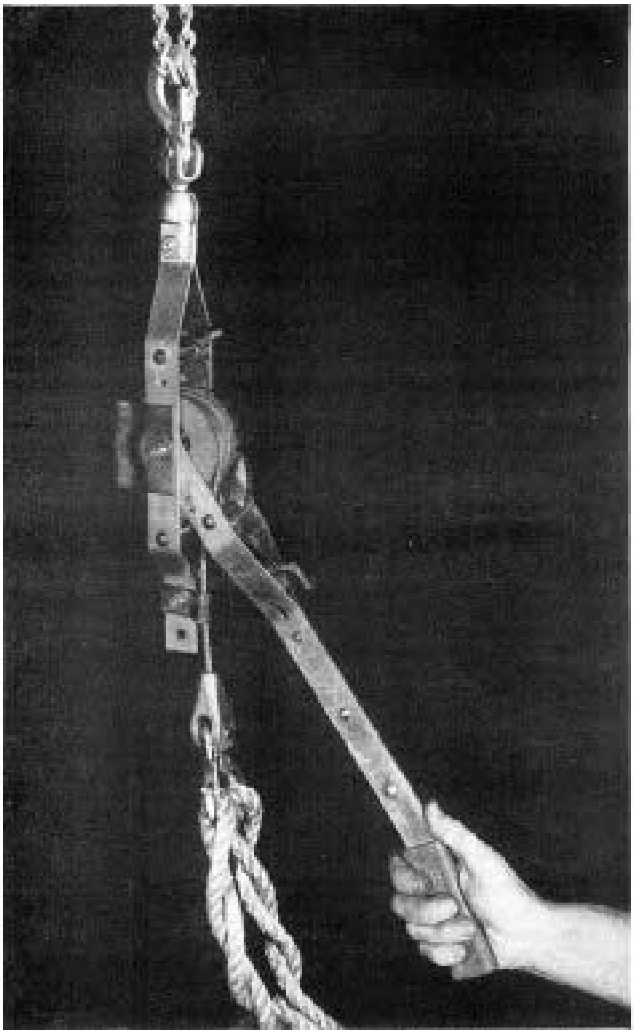
By E.F. Lindsley

JACKS, HOISTS & PULLEYS

Use brains, not brawn to move heavy loads safely.



A ratchet hoist uses the leverage principle to lift or pull a heavy load. It's safer than a block-and-tackle because the ratchet holds the load steady when you release the lever—allowing you to lower the load in small "clicks."

On my first construction job I learned that every crew had one or two macho types who loved to boost their egos by bear-hugging some heavy piece of material or equipment and Sumo wrestling it into place. As the years went by I observed that most of these human derricks ended up unable to work because of badly damaged backs, arthritic joints, or severe injuries from so-called "construction accidents." How many expensive items they damaged with their roughhouse tactics is another question.

Building construction, from the pyramid builders to the three-person crew erecting a modern home, frequently calls for moving or lifting heavy materials and objects. The tradesman who lifts "smart" by using the basic principles of mechanical advantage will build longer, stay healthier, and damage fewer things than his heave-ho counterpart. Mechanical advantage simply means using the timeless principles of engineering physics to multiply your own muscle power. When you have a heavy package-be it roofing materials, assembled millwork, an air-conditioning unit, or the like-to move or lift, don't think macho. Instead, think in terms of the

- jack
- inclined plane
- windlass or ratchet hoist
- pulley or block-and-tackle.

Jacks: Jacks come in many forms and sizes ranging from the common bumper jack to screw jacks, hydraulic jacks, and housemover's ratchet jacks. The basic job of a jack is to exert pressure, usually upwards or sideways. Their advantage is that the movement or pressure can be applied in totally controlled increments, one click, turn, or pump at a time. That done, the load stays put while you eyeball where you're headed and what's happening. This is important, for example, when you're maneuvering a piece of equipment into position or onto a level where it can be skidded into place.

Generally, jack techniques are slower than hoists, winches, and inclined planes. For example, assume that you have to lift a heavy boiler or a mantel stone for a fireplace several feet from ground level to building floor level. One way is to lift one side with a jack, slip a piece of timber under that side, ease off the jack and repeat the process on the other side. Repeat the sequence at each end. By working back and forth and end to end with the jack and successive crib timbers you can eventually bring the load to the desired level where it can be skidded into place. Although this method is commonly used by riggers for extremely heavy loads, it is slow.

Jacks are wonderfully handy, however, when you need a steady, graduated push. Even a bumper jack braced against a block nailed to a sub-floor can push a wall or stud frame into line. Or, when hardwood flooring is warped and refuses to snug up into the grooves, a jack against a brace block on the floor will squeeze it firmly into place for nailing.

Inclined Planes: Always use the most direct and easiest rig that's adequate and safe. The inclined plane or ramp often fills that bill. Assume that a heavy package, perhaps a combination heating and A/C unit, has been delivered and sits atop a couple of 4 x 4s on the site. It weighs 300 pounds or more and you want to get it off the ground, through an entrance way, and into place in the structure. The lift from ground to floor level is about 4 feet.

If you had four men you might sling some ropes around it and lift it bodily, but the chances of damage or injury are high. The answer is the inclined plane. The great advantage of a ramp or inclined plane is that you don't have to actually lift the full weight of the load. All you have to do is to overcome the friction of sliding over the plane surface. Rollers underneath can reduce the effort to very little. But if you have to stop and get another bite with your tackle the rollers can be dangerous because the load might roll back.

The easy way is to arrange a few 2x10s or 4x4s to form a ramp inclined at about 30 degrees. Anchor them with stakes or spikes so they can't kick free at the top. Now, you can use a ratchet hoist, a ratchet winch, or rope tackle, but usually you don't need all that. All it takes is an anchor point and a length of 1/2 inch rope, preferably nylon, rigged as a "Spanish windlass" (see Figure 1).

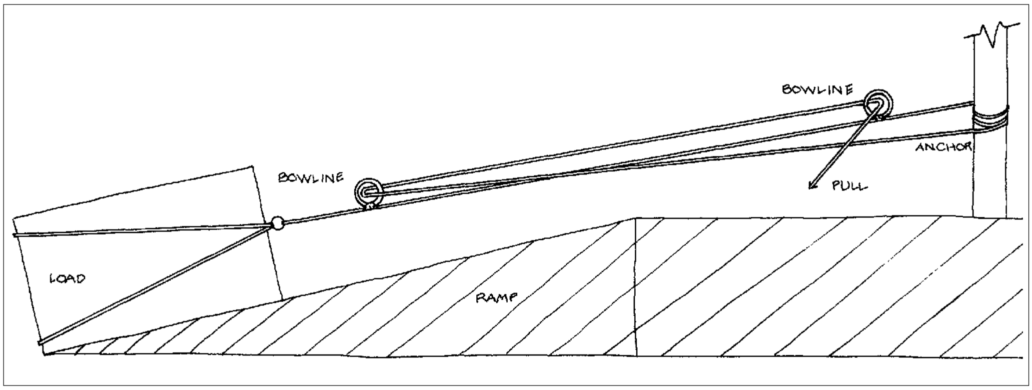


Figure 1. *The low-tech "Spanish windlass" provides the same mechanical advantage as a block-and-tackle without using hardware. The rope with two bowline knots forms a basic fixed and movable pully (although with a lot more friction). It's good for ramping up a load or pulling a frame wall into position. A chain or clevis could also be used at the anchor point.*

Sling one end of the rope securely around the load with several wraps. Tie an open-loop bowline knot (see Figure 2) in the rope near the load at the foot of the ramp and another inside the building near the anchor point. Cinch the free end of the rope around the anchor point and run it back through the first bowline eye near the load. Come back with the free end and run it through the anchor-end bowline loop. Make another pass through the load-end eye. You will now have a mechanical advantage when you pull on the free end. You could even repeat the passes through the bowline loops for more tugging power but that's seldom necessary.

True, the friction of the rope and eyes is greater than if you used a block and tackle, but for a one-shot job you'll be surprised how nicely this rig works—particularly if you use nylon rope. When you've slid your load into place, just loosen the knots, coil the rope, and throw it into your truck until next time.

If you expect to be moving such loads often, make up a permanent ramp. Select a couple of planks with smooth, straight grain, tie them together at the ends and middle with carriage bolts, and give them a few coats of boiled linseed oil. A couple of husky eye bolts at one end can be provided for stakes to prevent slipping. If you have some 1/2-inch or 5/8-inch steel rods bent with short "L"s at one end you can drive these through the eyes to prevent your ramp from slipping backwards.

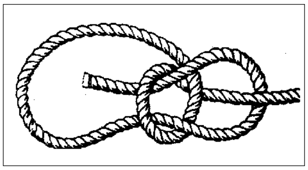


Figure 2. *The bowline is the most useful all-purpose knot. It does not jam or slip. Use it at the end of a rope for eyes and clevises, and at any point along the rope for a cinch point or Spanish windlass.*

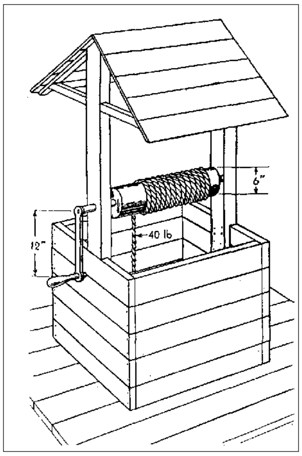


Figure 3. *The windlass principle is used in many forms. Here, the effort distance is 3 inches (half the 6-inch diameter of the drum). With a 12-inch crank handle, the load at the crank is reduced to 10 pounds.*

Ratchet Hoists: Actually, a ratchet hoist uses the same mechanical principle as a simple windlass (see Figure 3). A simple windlass—with a drum for a cable or rope—uses the crank arm as a lever for mechanical advantage. For a more powerful advantage you can use a geared windlass, a device familiar to most of us who trailer a boat.

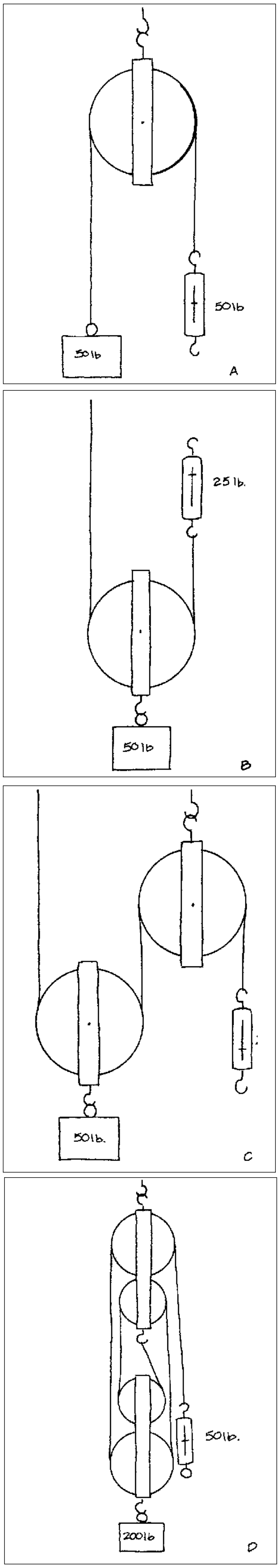
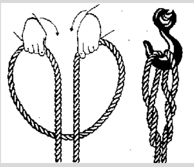


Figure 4. *The single-fixed pully (a) gives no mechanical advantage, but changes the direction of the load. One movable pully (b) offers 2:1 advantage, but is awkward for most uses. A fixed plus a movable pully (c) again gives 2:1, but lets you stand on the ground and use body weight to help pull. The number of strands supporting the movable block tells you the mechanical advantage of a tackle rig. For example, four strands (d) gives 4:1. Don't count the rope end you pull on.*

RIGGING TIP



Avoid concentrating strain on a single line of rope by making several wraps around anchor points. Where rope attaches to a hoist hook, use a cat's paw. Form this knot by dropping the top of the loop to form two loops; twist each loop twice as shown. In addition to spreading the load, this also limits the tendency of the rope to slip sideways on the hook.

Both the windlass and the ratchet hoist would be extremely dangerous without some sort of a *dog* or latching device to prevent the load from running backwards. In the case of a winch dog which runs freely in the lift direction but prevents back slipping, it's important to make sure that it's oiled and works reliably. Having a rusted up winch dog stick and allowing several hundred pounds of roofing or millwork to rush groundward with the winch crank whirling madly can truly ruin your day.

The dog-type windlass—commonly called a winch—is often rigged with a jib boom extended over the edge of a roof and used to raise loads to the roof. But this arrangement is not safe with loads that must be lowered carefully because it's too tricky when the dog is released. This act requires that you have a firm grip on the crank handle before releasing the dog and from there on the entire control of the load depends on your management of the crank. If the load wants to twist or swing in the wind and bash into something, you've got trouble. Here, if at all possible, you should have a helper holding a guy rope to stabilize and guide the load and pull it over the edge of the roof or deck.

The ratchet hoist also coils a cable on a drum in windlass-fashion, but it does so in small clicks or increments as you work the handle back and forth. Such devices have spring-loaded dogs to prevent back slippage and work fine as long as the parts are in good mechanical condition and aren't rusted or gummed up.

Sometimes called come-alongs or pullers, ratchet hoists, unlike chain hoists, work fine either vertically or sideways and can thus be used for skidding, ramping, pulling trucks or machinery out of the mud, and the like. Most importantly, a flip of a lever puts them in ratchet-down mode. This is much safer than a free running windlass and enables you to line up your load precisely, for example, when you have anchor bolts over which you want to drop the load and the holes must be lined up while lowering.

My own experience with ratchet hoists has taught me the importance of keeping an eye on the cable as it spools on the drum. As long as it spools on freely and evenly all is well, but watch out for kinks, overlaps, and loose wraps. Sometimes these form because the load twists and the swivel hook supporting the load sticks and doesn't swivel. This causes the cable to twist on its own strands and later kink. Again, a load guyed off or steadied by a helper can be a big safety factor.

Once a hoist cable has gotten itself into a series of overlapping wraps so it doesn't unspool freely you have almost the equivalent of a backlashed fishing reel. The only cure is to disassemble the spool and ratchet and untangle the mess. Unless the cable can be laid out straight and flat on the ground and rewound cleanly you might as well buy a new cable; it can never be trusted again.

Ropes and Pulley Blocks: Figure 4 shows several tackle arrangements and their relative mechanical advantages. Truthfully, in light construction, this complexity is seldom needed, especially if you can make use of a ratchet hoist. On the other hand, a small, store-bought tackle set using 3/8-inch rope, and with a built-in pinch-lock device, can be extremely useful. You can recognize this rig because the pull rope emerges through a small collar. In use, with the load supported, pull out sideways on the rope and the lock takes hold; pull straight down and it releases. This is fine—but once the load is free, nothing but your grip on the rope controls the lowering of the load.

The lack of a locking mechanism can be even more of a problem with a standard block and tackle, sometimes called a "set of falls." Use such multiple block rigs for extremely heavy loads such as I beams and heavy machinery, but check all the parts very carefully before subjecting the rig to such loads. In light construction the typical contractor uses tackle and ropes so rarely that they tend to deteriorate in storage. Pulley bearings rust or corrode and lose their smooth running qualities. Ropes age, rot, and are perhaps gnawed by mice. And, somehow the blocks get flip-flopped and the ropes become tangled and criss-crossed. This latter condition must always be straightened out because a rope that isn't running true can work out of the groove in the pulley and jam with the load halfway up. This is an extremely dangerous situation and may even call for re-rigging with a second set of blocks and removal of the jammed set while the load is suspended—a ticklish job at best.

Anchor Points: Physics teaches us that for every action there's an opposite reaction, and this is absolutely true in hoisting a load. The best hoist rig you can buy is no better than the dead-end anchor. In some cases this anchor may be the top of a boom or gin pole but in most light construction, you'll use some part of the structure, a beam, joists, or the like.

Two principles prevail here. First, do not assume that the anchor support structure will be subjected to only the dead weight of the load. Inertia enters the picture each time you tug on the rope or work the hoist lever. This is somewhat like a lightly constructed floor that seems perfectly solid when you stand on it but flexes and bounces under your feet if you bounce up and down. Be assured that when you hoist, your anchor point will be subjected to repeated "bounce" loads, which multiply the dead weight substantially.

The second principle is to distribute the load at the anchor point. It's fine, for example, to put support columns temporarily under a beam to help support the weight. But don't wrap a chain or cable around just one structural member, particularly one which is nailed into place. Try to do whatever is necessary to spread the load over several structural members such as joists or headers so a number of structural pieces share the load.

Although you can use looped rope to hold the upper hook of your hoist, a good quality, welded link chain is better. Use a chain that fits but nearly fills the hoist hook. Again, to divide up the load, take several wraps around the anchor timber or beam. Never, but *never*, resort to tying a chain. After making several wraps around the anchor point wrap the free end a few times around the load bearing part and run a bolt through adjoining chain links and secure it with a nut. Play around a bit with the chain to be sure it's not kinked or twisted and that it's evenly distributed so all wraps will pick up the load. If you hear a sudden clunk and the load drops a fraction when you start to hoist you didn't get the chain rigged properly. Stop and check to see what's wrong.

Also, any slippage of the chain or attempted rolling of the anchor timbers is cause for some renegotiating. This often happens if the load is not directly under the anchor point and part of the lift is directed towards a sideways component. It sometimes helps to ease the load partially off the ground and gently lever the load over until it is centered under the hoist anchor. All of this is to avoid any slipping or sliding once the load is suspended. Such unwanted movement of the anchor point introduces dangerous "jerk" loads which can break down the entire system.

Remember, think first, then lift smart—smooth and easy does it. ■

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