Winch Basics

What To Look For at the Heart of a Motorized Rigging System

by Tom Young

One of the questions I hear from dealers on a regular basis is, "I have a customer who wants to discuss motorized rigging—what do I need to know?" Motorized rigging is becoming more popular, and it's new territory for most dealers.

For years motorized rigging was considered something only government supported European opera houses could afford—so many of us never worried about learning much about this technology. As prices have come down, and concerns about the misuse of counterweight sets have increased, many users are now looking at motorized rigging.

So, what do you need to know to help your customers obtain the equipment that will meet their needs? This article explains what to look for in winches, the central element of any motorized rigging system.

Fixed Versus Variable Speed

This is the rigging equivalent of dimmer versus non-dim. A fixed speed set is running or it's not. It's great for equipment that does not move in front of the audience—things like electrics sets, speaker clusters, and orchestra shell ceilings. The speed is chosen for the application. Electrics sets typically fly at 20–30 fpm (0.1–0.15 m/sec). Moving any faster with a fixed speed winch will result in stops and starts that may be too abrupt for lighting fixtures. However, a fixed speed curtain winch could operate at 60 fpm (0.3 m/sec) without a problem.

Variable speed winches offer a tremendous speed range, making them ideal for use with scenery that must move in front of the audience. A winch that performs a subtle move at a slow creep can move a hundred times as fast in the next cue. This provides tremendous versatility.

Top speeds are dictated primarily by the user's requirements. Scenery sets in college or regional theatres may have a top speed of 120 fpm (0.6 m/sec) while major performing arts centers and opera houses may have speeds of up to 240 fpm (1.2 m/sec). Some of the newest international opera houses are using winches with speeds of up to 360 fpm (1.8 m/sec). Main curtain hoists may operate at even higher speeds.

Variable speed winches require solid state drives designed for hoisting duty and with the reliability and safety features necessary for use in a theatrical environment. The drives normally need to incorporate dynamic (electronic) braking for controlling rapidly descending objects. These factors make variable speed winches significantly more costly than fixed speed winches.

Capacity should be figured the same way you'd figure capacity for any other type of set. However, you need to remember that a winch provides its rated lifting capacity at all times. If you have a 50 pound load on a 1,000 pound capacity winch, and the batten catches on something, the winch has the ability to lift 950 more pounds—so fouling can be a serious concern. Keep capacity selections realistic.

Winch Types

The two most popular types of winches are single drum winches and line shafts. A drum winch (see figure 1) has a head block and loft blocks like a counterweight set, and places similar loads on the building. They are very cost effective.

A line shaft winch has a drum for each lift line (see figure 2), eliminating the need for blocks. As a result, the load on the building structure is essentially straight down, which makes structural engineers happy. While this is a very clean and simple way to build a winch, there are a couple of factors to take into account. First, most buildings flex. The loads applied by the rigging, wind and snow all cause the building structure to distort. These distortions in turn are applied to the line shaft winch causing misalignment of components, which may result in stresses that can break shafts or destroy couplings. The second drawback to line shaft winches is cost—a drum and shaft for each lift line costs more than loft blocks.

There are many other types of winches for special applications. Point hoists are single line winches, allowing you to have a separate motor for each lift line on a set. Rigging systems built with point hoists are tremendously versatile, but have a high initial cost. They also require a sophisticated control system to synchronize the hoists.

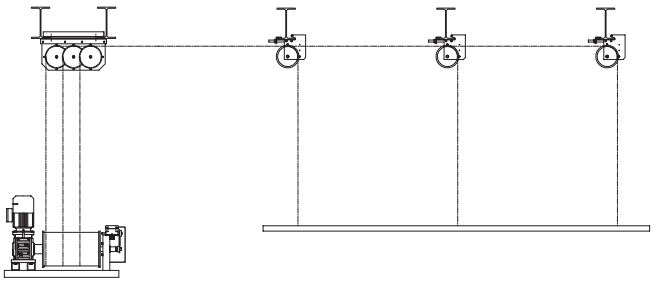

Figure 1.
Drum winches have a single drum long enough to accommodate all of the lift lines required for the set.

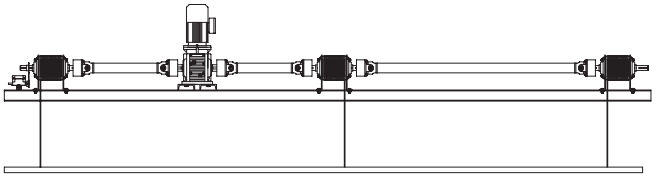

Figure 2.
Line shaft winches are self-contained units with a separate drum for each lift line.

Reprinted from *PROTOCOL*, the Journal of the Entertainment Services & Technology Association – Fall 2001 issue.

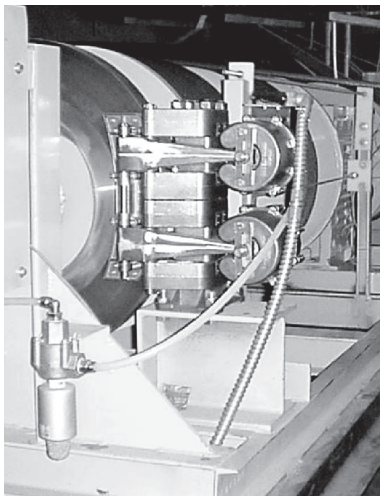

Figure 3. Pneumatic load brakes are employed on the drum flange of this winch.

Yo-yo (or pile up) winches have a drum with a narrow slot that causes the lift line to stack on top of itself. This eliminates many fleet angle problems, but leads to some deformation of the cable. These are generally used for light capacity applications such as banner hoists that may be part of a building's acoustical system. For very heavy loads, counterweight assisted winches may be used in order to reduce the size and cost of the motor and gearbox.

What Should I Look For In A Winch?

First, look for a manufacturer with a history of building winches for overhead lifting in the entertainment industry. Extensive experience and engineering knowledge is required to build winches that you'll want to offer to your customers. Talk to manufacturers and make sure that they have the experience and knowledge that makes you feel comfortable.

You should expect the manufacturer to provide motors and brakes that have been selected to provide stopping without slippage. Brakes should be spring applied and electrically (or hydraulically) released, so that you have to apply power to release the brake. Gearboxes and brakes should be positively connected to the motor shaft to ensure they're all turning together. The ideal solution is to use a single shaft (without any couplings) for the brake, motor, and input stage of the gearbox. This may cost a little more, but adds reliability.

Gearboxes should have a service factor of 1.0 or higher. The required service factor is determined by the number of hours the winch is used each day, the frequency of stops and starts, and the type of usage. For typical theatrical usage a service factor of 1.0 is generally sufficient, while theme park usage may require a higher service factor. Find out how your customer plans to use the winch, and discuss this with the winch manufacturer. You should expect the manufacturer to have a licensed Professional Engineer who supervises the winch design.

Motors generally should have a service factor of 1.0. Anything higher simply increases the motor capacity, which is frequently more harmful than good.

Drums should be grooved, as the life of wire rope is shortened when it's distorted by being wound on a flat drum. There will be special cases, such as banner curtain winches with small loads, where yo-yo drums or un-grooved drums may be acceptable.

As mentioned previously, the alignment of winch components is a big concern. Any misalignment results in mechanical stress on components, which can cause them to break. The manufacturer of a line shaft winch may try to build a backbone that is sufficiently sturdy to prevent the winch from flexing, or may chose to use universal joints on the shafts, offering almost unlimited flexibility. For drum winches the manufacturer should carefully align all of the rotating components. (At J.R. Clancy we laser align our winch assemblies; and on high speed winches we also spin balance the drums.)

Load Brakes

We've discussed the primary brake, which is generally on the motor or high speed side of the gearbox. Since most winches are dead haul devices (and therefore always out of balance) you may also want to have a second brake on the load side of the gearbox. In order to provide the greatest redundancy, this brake should be at the farthest end of the mechanical drive train from the motor. Since load brakes act on the high torque side of the gearbox, they must be quite powerful which makes them costly.

Load brakes may be parking brakes, which are released before a move starts and applied after it is completed. Parking brakes ensure that the load is held redundantly and are common on high capacity winches. These may be electrical, pneumatic or hydraulic brakes. Figure 3 shows air brakes operating on the drum flange of a 6,000 pound capacity fixed speed winch.

Another commonly used load brake is the overspeed brake. This is usually a mechanical brake that applies itself when an overspeed condition occurs, allowing it to catch and stop a runaway set on its own. Generally, these brakes only act in the case of an overspeed condition, and do not provide a parking function.

Electrical Components

There should be four limit switches on any winch used for lifting. In addition to the end of travel limits, there should be overtravel (ultimate) limits to stop the unit should the normal end of travel limit become inoperative. Rotary limits should be positively driven, with couplings or sprockets pinned (not set screwed) to the shafts.

In addition to limit switches, there are other important electrical components in a winch. The starters and drives are vital to the operation of winches. You may also require overload detectors, slack line detectors, phase monitors, and other electrical monitoring and safety components.

Additional components of a motorized rigging system beyond the scope of this article include the key electrical and related safety features you should also take into consideration when buying motorized rigging equipment.