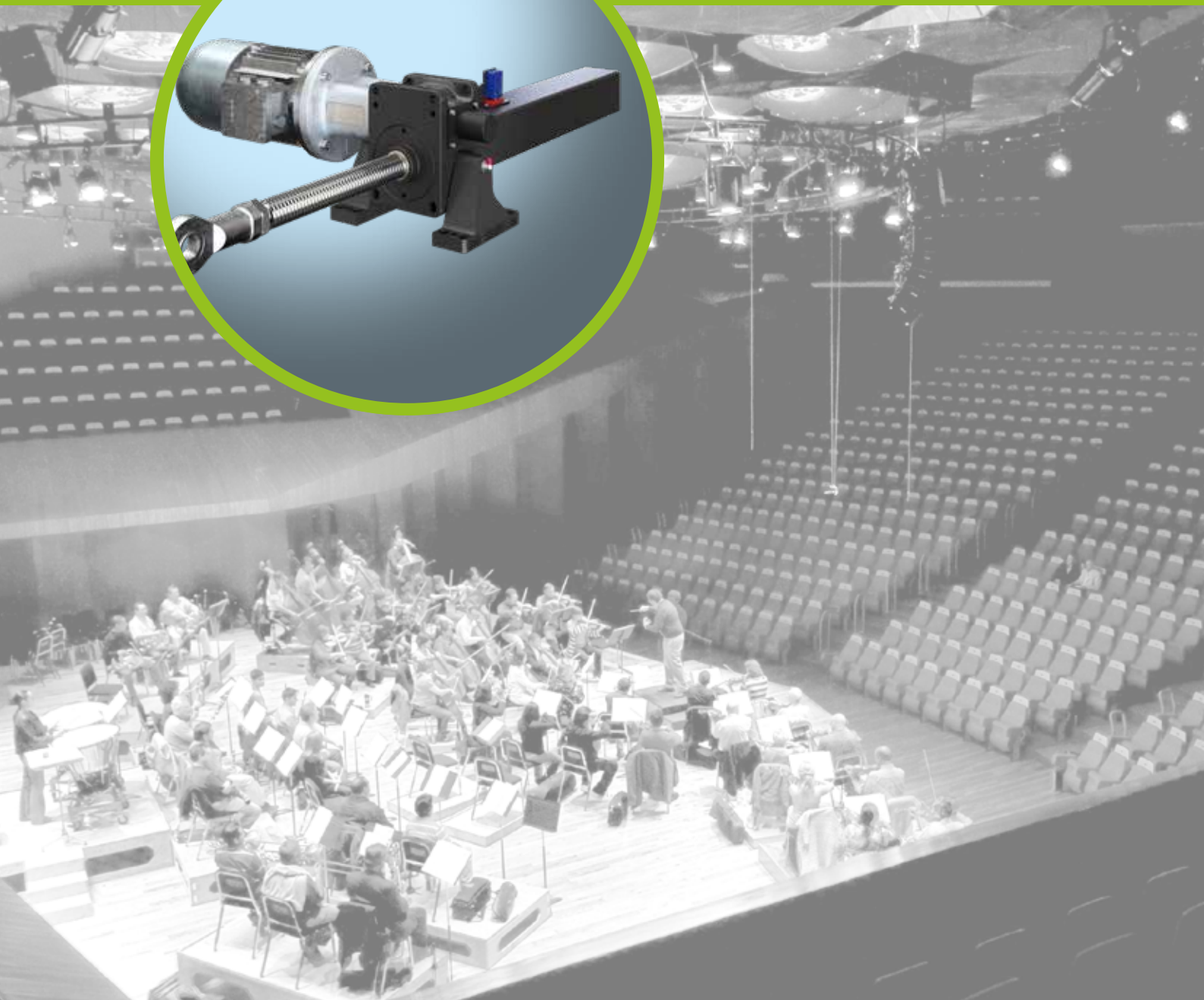
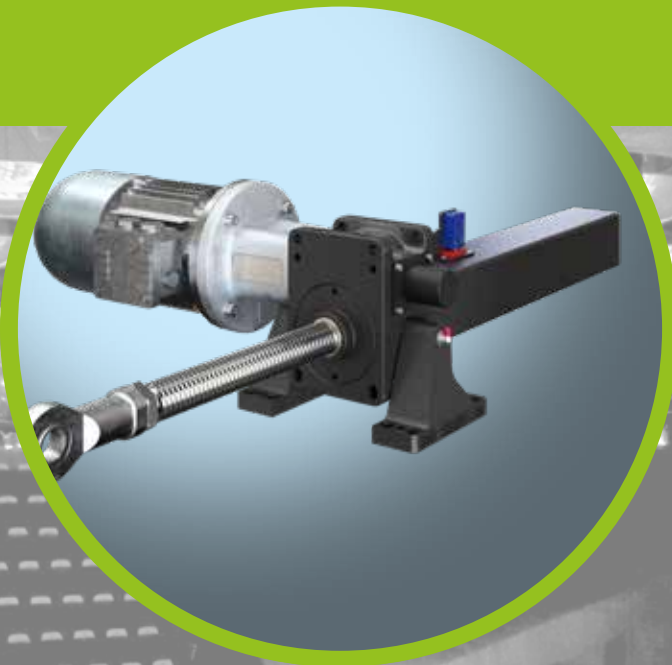


STAGE TECHNOLOGY

Precision & safety in the entertainment industry

ZIMM

Movement with precision



STAGE TECHNOLOGY & ENTERTAINMENT INDUSTRY

Changing entertainment experiences with electro-mechanical screw jacks

There has been a significant shift in the entertainment industry from manual and hydraulic operated systems to electro-mechanical screw jacks.. The key reasons are safety, cleanliness, sound and reliability. Providing the ultimate entertainment experience dates back to the colosseum days, where lifts and trap doors were all part of making people, animals and staging all of a sudden appear. The entertainment industry still uses these techniques today, but how they operate has changed dramatically in recent years by using electro-mechanical screw jack.

Safety

Safety is number one for not only the actors and performers but also for the audience and spectators. There are several ways screw jacks incorporate and ensure safe moving and holding position within an application. First, a safety nut for either a translating or a rotating version screw jack begins with a pre-determined measured gap that is then monitored.

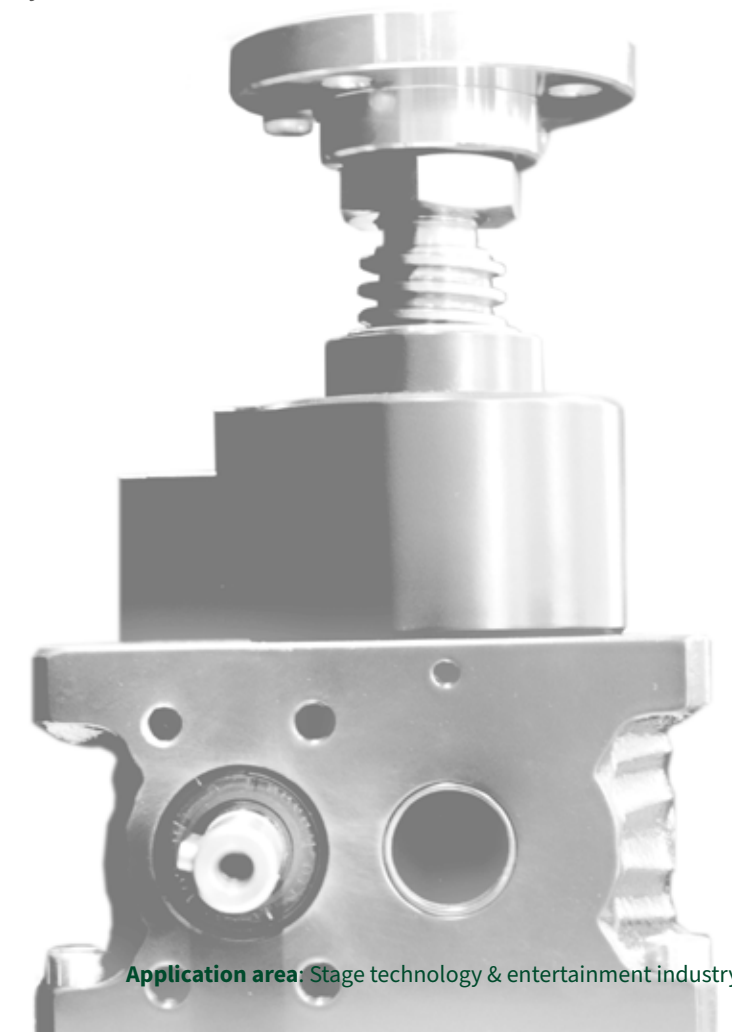
Monitoring can be done manually, where regular monitoring intervals track the decreasing wear gap and any value less than 25% wear is acceptable. Greater than 25% and the nut should be scheduled to be replaced.

Monitoring electrically is more ideal, especially if the screw jack is in an area with little or no easy access. It also, warns when 25% wear has been reached with a switch being tripped to create a warning alert. A second warning is tripped when the thread is worn through if the nut is not replaced. Regardless, if the main drive nut threads are worn through or another cause of failure, the safety nut will take over and carry the entire load.



Automated safety nut monitoring on a standing version

Manual safety nut monitoring on a rotating version



Hold precise position securely

When we need to safely hold a position, using a trapezoidal/acme spindle creates a natural self-locking occurrence created by friction when the screw jack has a load on it and is idle.

Another way to guarantee a holding position is by installing a spring brake on one of the screw jack input shafts. Recommended especially if the application has vibration in it and a must if a high pitch, double pitch or ball screw spindle is being used. The braking torque is created by high compression springs when the brake is de-energized and is released electromagnetically when DC or AC voltage is supplied. Spring brakes are able to hold in a torque range from 5Nm up to 250Nm. When power is turned off intentionally based on the application, an emergency stop, or a power failure, the spring brake automatically locks back onto the input shaft for secure holding engagement.



Clean



Clean operation is essential for a several reasons. First, all lubricated components are either housed within the gearbox or covered with a standard protection tube in standing versions. Optional bellows for the exposed spindle keep grease away from those performing and props as well as used to protect the screw jack spindle in areas that might see dirt, debris and moisture.

However, one of the most significant shifts evident today has Entertainment Engineers being tasked to „design out“ hydraulic systems and „design in“ screw jack systems for their pushing, pulling, lifting, holding and positioning application needs.

The main drive for moving away from hydraulic systems is for being environmentally friendly and for safety by eliminating hydraulic fluid spills, costly clean-up, dangerous working conditions and contamination to the performance areas. Every hydraulic fluid connection is viewed as a possible leak with unexpected, expensive interruptions, delaying or omitting performances elements. Engineers are also realizing that screw jack systems are generally easier to design, install, maintain, and more economical and reliable in the long run.

Screw jacks are also more accurate, offer greater repeatability compared to hydraulic systems with the speed and positioning of the system being controlled much easier.



A manual release is available in the event of a power failure, and the application needs to be manually raised or lowered.

If multiple screw jacks a line shaft connected, only one spring brake is necessary to hold the entire application.

Electric engines are also another area where brakes can be integrated as an option. It might make more sense to have the brake on the engine based on location.

Other times, both a spring brake and engine brake are used together for redundancy.



Quiet

With many live entertainment venues, there are often times of dead silence with building anticipation and nothing interrupts that more than the disruption of stagehands moving elements around or a hydraulic system starting up and running. Hydraulic systems require a reservoir, pump and engine, which are all typically housed in a cabinet that only amplifies the noise of an operating hydraulic system.

Screw jacks are designed with a worm-style gear set, which is one of the quietest with only a 55 dB rating. As a result, they are quiet and very smooth in operation, even when switching from forward to reverse.



Automated

Automating mechanical operations is just as key as the performance they are part of. Screw jack systems are easily programmed to precisely operate when needed to. Multiple screw jacks in a system can operate with a single engine while being connected to each other with line shafts, or they can each have their own independent engine and be controlled synchronously. Either way, the operation is smooth and doesn't require multiple stagehands moving and manually operating components into place.



Speed is often just as important as automation, and in areas where a movement needs to be done quickly the type of spindle and its pitch come into play. For example, on a trapezoidal spindle, we can go to a „double pitch“. With a ball screw spindle, we can travel three to four times faster as we have four to five faster pitches to choose from, not to mention a ball screw spindle has a .90 efficiency giving us a very low friction value.

What screw jacks are replacing?

Stage props, panels and curtains have long been moved in and out of place using manual systems which require multiple stagehands and precise timing to create a smooth movement. However, manual systems tend to be unreliable, take up more space and often present safety issues which the entertainment industry clearly understands.

In the 1940s and 1950s hydraulic systems began making their way into the entertainment industry to replace some manual systems and have long been the workhorse for heavier applications. However, they are now being replaced with safer, cleaner and more reliably screw jacks.



Raking stage applications

Raking stages, literally puts the stage at a typical 2-to-5-degree angle and dates back to its first use back in the middle ages. It provides a 3D effect for the audience, making some performers and scenery towards the back seem closer, allowing for greater depth, better sightlines, and especially if any floor detail is shown.

It also provides an illusion of much higher jumps, especially in dance performances. From a director's point of view, raked stages create design flexibility for different scenes and different degrees provide unique stage options. However, raked stages are usually constructed for temporary use, costing time and resources, and set on top of a flat stage, only to be moved from scenes not using them and then having to be stored or dismantled after their use.

In raked stages using screw jacks, the entire stage can be designed into flat sections and when raked as needed. These sections are simply raised into place and then lowered when the scene or entire performance is completed. Automated raked stages also provide so much flexibility to a stage layout. The same concept can be used in a rolling platform version. When not raked, it serves as a riser and is raked only when needed.



Stage lifts

Integrating screw jacks to create stage lifts provides a dramatic impact in that the entire stage, as well as certain individual sections, can be raised or lowered to create multiple levels. Stage lifts can also have performers appear and disappear without walking on or off the set, whether subtle or part of an illusion.

Often stage lifts are used to change portions of the set where the lights go off from the particular set section. The section platform lowers, the old set removed, a new set is placed onto the platform and is raised back into position where the light goes back on – Voilà. The audience sees no stagehands or swapping sets and this dramatically reduces backstage logistics, which are always challenged by little space and lots of activities.

When more stage is need, screw jacks can be used to lower entire sections of seating or flip seating sections upside down as needed. Saving time and resources in removing rows of chairs anytime a seating configuration needs to be changed to accommodate stage configurations.



Orchestra pits

Common in theatre and concerts are orchestra pits, where these performers are seldom seen and usually only the director making a brief appearance coming up a small stairway. By creating a platform, the entire orchestra pit can be raised or lowered quietly with screw jacks at any time.

The pit can be raised before the performance begins playing music as guest finds their seats or lowered to create the typical orchestra pit theme of „heard but not seen“. During intermissions, the pit would be raised for the audience to see the music being played. At other times the pit can be partially lowered as to not interfere with the sightlines of the stage and raised at the Curtain Call for recognition.

Stadiums, convention centers, public venues

Multifunctional facilities need to be able to adapt between sporting events, trade shows, concerts and private events. The key is flexibility for smooth transitions between these events.

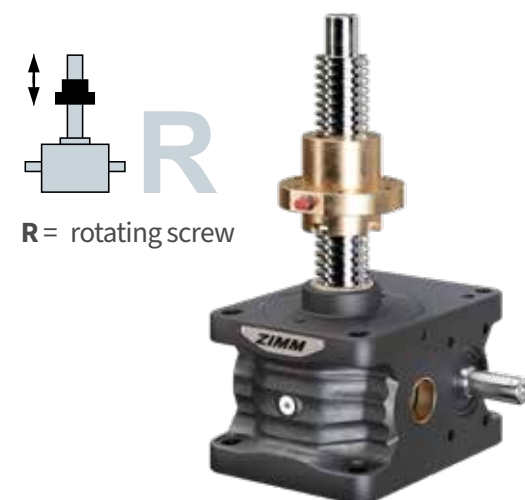
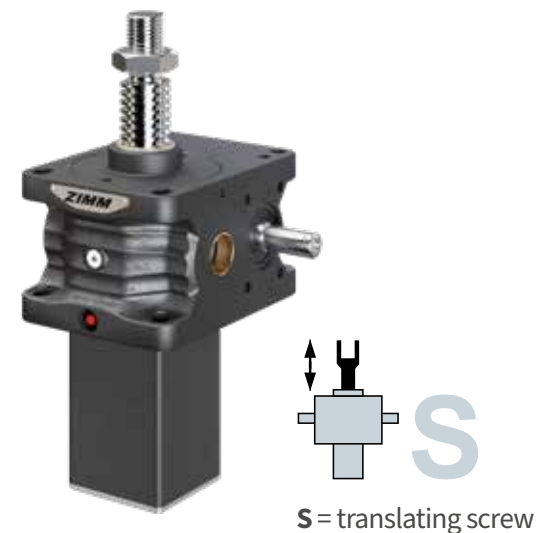
Screw jacks are commonly used to move dividers and panels to create different space configurations. Scoreboards and projection screens are raised or lowered to change the audience away from a sporting event look and also to protect these expensive pieces of equipment from damage when not being used. When it comes to creating more space or changing out a floor design or surface, screw jacks mounted horizontally can push or pull entire sections of seating or floor into place or to storage. Pivoting screw jacks are also used to rotate or flip entire seating sections as needed. To create an open atmosphere, pivoting, vertically or horizontally mounted screw jacks, move entire roof sections and window panels to create a new environment.



Screw jack basics and types

There are two versions of screw jacks, „Translating“, also referred to as „Standing“, and the „Rotating“ version. Both versions are driven with a precision ground input shaft. However, the internal gear sets are different in interacting with the spindle.

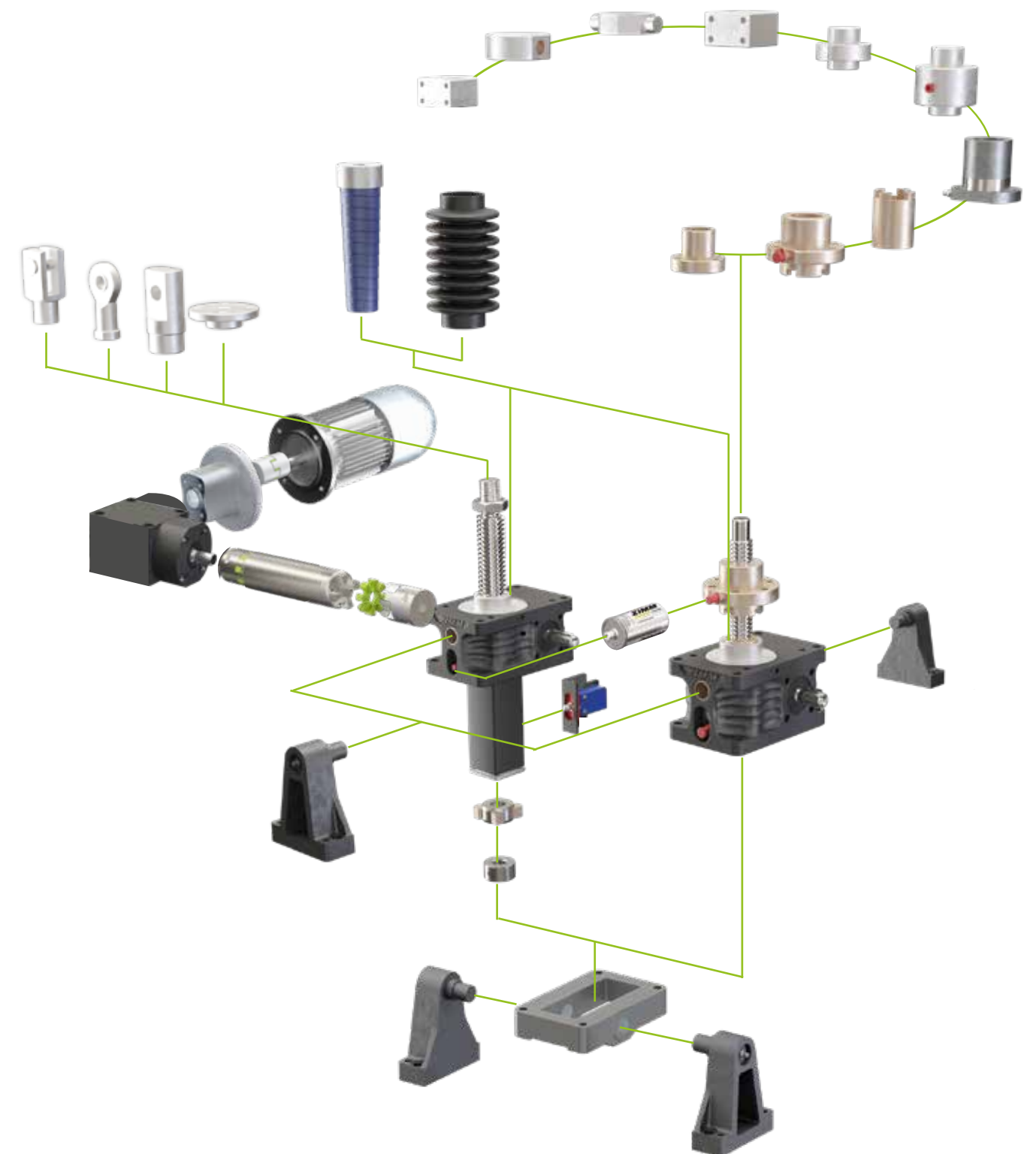
In the translating or standing screw jack, the input gear set drives the spindle up and down through the gearbox, requiring space above and below, allowing for spindle travel. There are several mounting hardware options to attach the load to the end of the spindle. When looking at a rotating screw jack, the input gear set rotates the spindle on its axis and a nut moves up and down on the spindle. The end of the spindle is secured to the system framework with a bearing plate, and there are several different designs of the traveling nut that move the load up and down.



There are also two versions of spindles to keep in mind, Trapezoidal and Ball Screw, each having pros and cons. A trapezoidal spindle also referred to as an Acme or mechanical screw, is a common choice with a simple design while being economical and robust. It also has a unique added benefit: when not moving, the load causes a self-locking type friction between the spindle and the worm gear, which is an excellent advantage, especially if there is a loss of power to the engine driving the screw jacks.

Ball Screw spindles, on the other hand, provide greater positional accuracy and repeatability. They are highly efficient with less friction, which extends duty cycles and provides for longer strokes and faster speeds. Due to the nature of a ball screw design, a brake system is required to ensure the load is locked safely when not in motion.

ZIMM configurator



Products and features

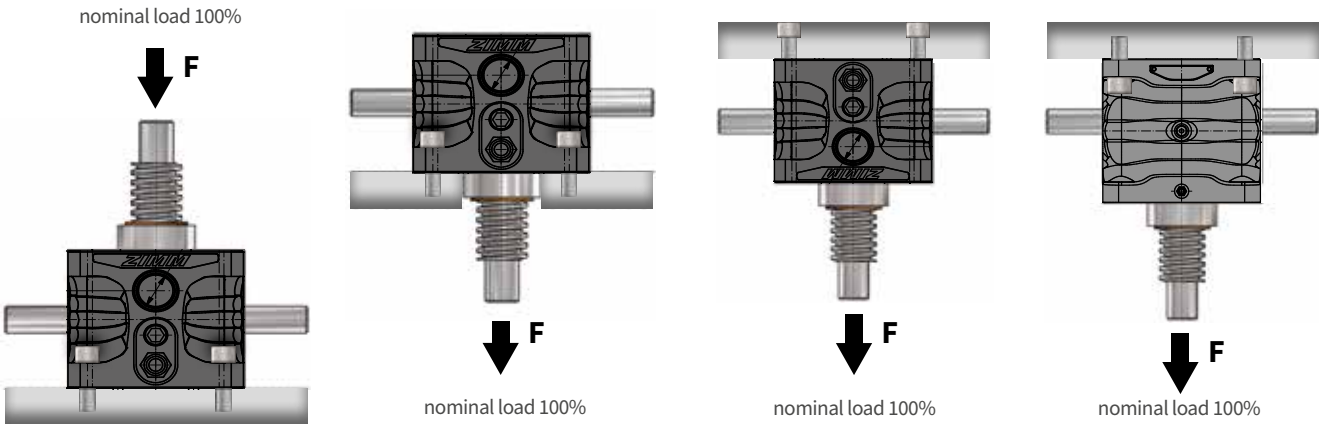
Within screw jacks themselves, there are several features and benefits to be thinking about when approaching an application. On the ZE and Z Series, one key ZIMM feature is that the gearbox lubrication and spindle lubrication systems are separate.

This separation allows different types of lubricants to be used in the gearbox and the spindle, depending on the application requirements. However, the most realized advantage of having separate lubrication systems is eliminating cross-contamination within the gearbox lubrication. This is especially important on the translating version, where the spindle travels through the gearbox, getting exposed to all the dirt and surrounding manufacturing debris, only to pull those foreign particles back through the gearbox.



On a conventional screw jack, this operation tends to contaminate the gearbox grease. The ZE Series has a larger gearbox lubrication capacity, allowing for increased duty cycles along with greater heat dissipation. Smooth housing surfaces, like on the GSZ Series, are ideal for wash-down applications, leading us to whether a stainless spindle should be considered. So, knowing what product options there are will help guide what we should consider during the selection and sizing process.

With every entertainment application being unique, ZIMM’s screw jack systems use a „Building Block“ approach in their design, starting with the screw jack gearbox itself. The same gearbox can be mounted in compression or tension, above or below its mounting surface, using thru-holes or tapped holes, integrated into the gearbox body. We then add the necessary „modular“ accessory components such as connection line shafts, bevel gearboxes, couplings, spindle bellows, drive engines and connecting hardware. We need to know how many jacks are required to lift the load and the environment in which it must operate.



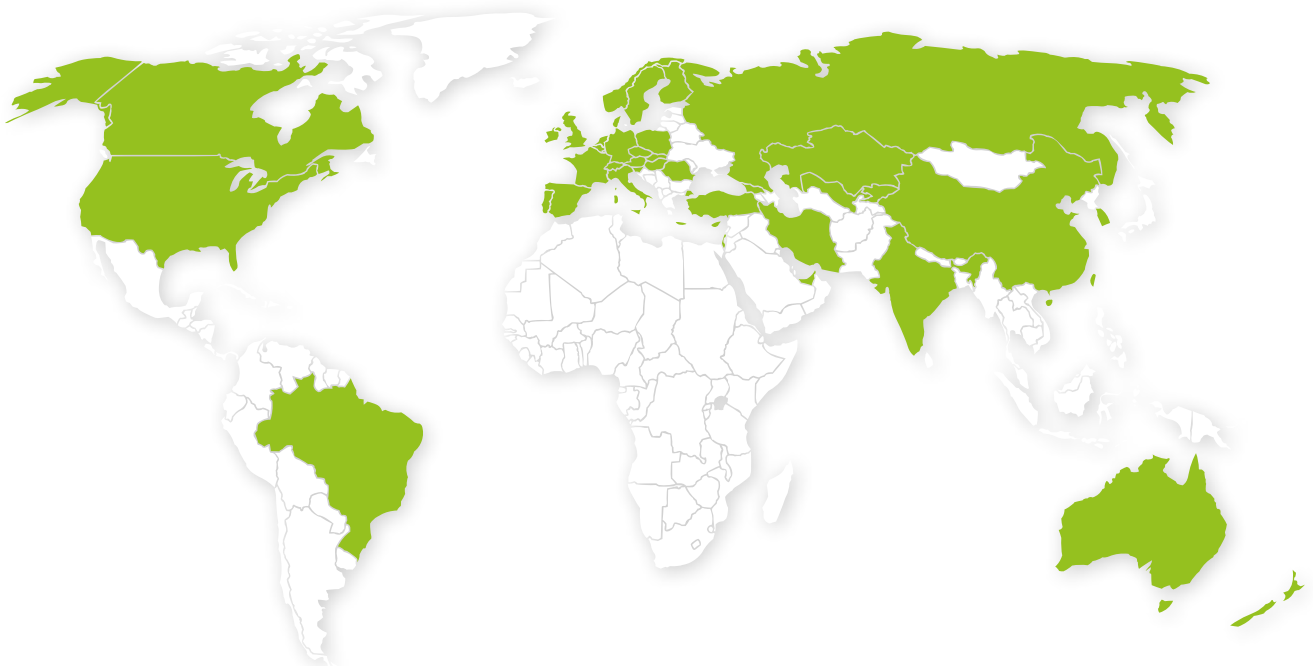
The key to successful sizing

Properly sizing any screw jack system for any entertainment applications is vital to safely move the load, safety to those working in the area, as well as the longevity of the screw jack system itself. The screw jacks we offer handle anywhere from a few pounds up to sizes capable of moving 100 tons with a single jack. That’s why it is vital to collect all the pertinent information upfront and be familiar with the different screw jack versions and available options.

Load	Ratio	Housing material	
2,5 kN	4:1 16:1	aluminium	
5 kN			
10 kN			
25 kN	6:1 24:1		
35 kN	7:1 28:1	GGG steel	
50 kN			
100 kN	9:1 36:1		
150 kN	8:1 24:1		
200 kN			
250 kN	10,66:1 32:1		
350 kN			
500 kN	13,33:1 40:1		
750 kN			
1000 kN			



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Lustenau, Austria

ZIMM Group headquarters
Development, production and
sales of screw jack gearboxes

ZIMM USA Inc.
Bloomington/Chicago
Sales and service
subsidiary

ZIMM Turkey
Ankara, Turkey
Sales and production

Your enquiry is our drive

ZIMM Group GmbH
Millennium Park 3, 6890 Lustenau/Austria
T +43 5577 806-0, E info@zimm.com

