No dramas: Reliable energy supply for various stage technology demands with igus e-chains and e-spools

Complicated stage applications can be implemented even in confined spaces and with high loads using moving energy supply systems such as the e-spool and the zig-zag systems.

The challenge for every stage and set builder is to design and build the perfect stage. Every job is different because stages are not off-the-shelf. Every stage is unique, meaning that every component not only has to be powerful, durable and efficient but must also work together perfectly. To achieve this builders need a competent partner who both understands the specific problems of stage technology and offers a wide range of products that match any stage application.

igus are experts in the field of energy supply and provide highly flexible cables for dynamic applications. Motion plastics, i.e., low-friction maintenance-free plastic products, offer new solutions, especially for theatre and stage technology where there are very demanding technical requirements. These challenges include high loads, such as those found in sound and lighting systems, in stage sets or entire stage platforms, which must move safely and reliably. Whether for vertical, horizontal or rotary movement, theatre technologies have advanced hugely since the heyday of the early 19th century. Back then, when the Deus ex machina was still moved by hand using winches and pulleys using brute strength, while today several motors and cables working together are usually used to move stage machinery.

However, what has not changed are the basic challenges of dynamic applications. Physical and technical effects still need to be moved across the stage, but the systems themselves should remain unseen and silent so as not to interfere with the performance. The best solutions for stage technology are well hidden ones, with cables guided invisibly and silently. However, there is often only a small amount of space available to work in. Energy and data

supply systems should therefore be silent, space-saving and also able to withstand high dynamic loads. They must be strong and hard wearing. The stage engineer needs systems that are easy to assemble, require little maintenance, and promise maximum service life. Otherwise the curtain risks falling at the worst possible moment and there is an important safety aspect too. igus offers system solutions that are engineered for the special conditions in stage technology. As igus provides modular systems and a wide range of components, theatres and stage operators can implement customised applications quickly and easily, which is deal for an industry where every theatre, every opera and every stage is unique and serial production is not possible.

e-spool: the alternative to the cable reel – without slip rings

Traditionally, cable reeling drums of various sizes are used for cable guidance on stages. But they are reaching their technical limits in many respects, especially in the capacity to accommodate different cable types, and they also generate noise. The igus e-spool provides an operationally reliable alternative that is ideally suited for complex and noise-sensitive applications.

The system is very compact and can guide many different energy, data, control, or pneumatic cables together in very confined spaces. The design is a combination of two proven igus product families: long-lasting e-chains and the flexible "twisterband". The continuous movement of the cables is reliable and safe due to the robust e-chain, which offers protection from external interference, wear, and tensile strain, and significantly increases the service life of the cables. And cable safety can be further enhanced by using igus' own chainflex cables designed specifically for moving applications in energy chains.

As part of the readychain product range, harnessed energy chain systems, plug-in connectors and highly flexible cables are available from a single source – these are high quality, complete systems. The e-spool in turn protects the e-chain, which is safely stored on a drum. During the reeling, an integrated retaining spring maintains the correct tension on the chain at all times. The most important innovation is the use of the twisterband, which connects the spool to the shaft end block and forms the interface between fixed and moving

cables. The twisterband allows continuous cable guidance during rotational movements without needing a slip ring, important because a slip ring has serious disadvantages due to the sliding contact. The abrasion created leads to wear, which in turn worsens the electrical power and signal transmission. If fast and trouble-free data transmission is required, cable drums with slip rings are not ideal and must be "upgraded" with a special accessory. The e-spool is much simpler and more efficient, giving high technical quality and reliability.

A solution for upper and lower machinery

Usually, stage technology operates in two locations: upper and lower machinery. The e-spool is suitable for both. A key reason for this is its noise, whereas systems with slip rings are often noisy during operation. As tests in the igus noise chamber have proven, the e-spool is clearly the quieter option: the noise level could be below 46 dB (A).

When it comes to the best signal and sound quality, such as in the upper machinery in Mountford Hall, one of the largest concert halls in Liverpool, the lack of slip rings pays off. There a customised cable guidance system with four e-spools supplying power and instructional signals for the entire loudspeaker system, so that the best possible sound balance is always achieved in halls of different sizes and during different events. The uninterrupted connection between amplifiers and speakers ensures the optimum sound. The e-spools make as little noise as possible and are visually discreet. Even when using more e-spools in the upper machinery, the energy supply remains completely hidden from view.

At the Culture and Congress Centre in Torun, Poland, 10 e-spools move the power cables for the lighting trusses. As the room configuration can be changed, the cables and connections have to be highly flexible and resilient – requirements that the e-spool system is designed precisely for. The Sydney Opera House also uses the e-spool for its upper machinery. But the e-spool is also suitable for lower machinery, as seen in the Cologne Opera House. A total of 18 e-spools are located in the stage pit to deliver the necessary energy supply for stage floor operations. At the same time, all cables for control, lighting technology, audio and video cables as well as the electrical power supply must be cleanly routed. But here there is only a very limited vertical

installation space available; conditions that the e-spool meets with its compact design. Routed on the side of the podium legs to save space, they deliver totally concealed cable guidance, so that despite having 18 e-spools there is no visual obstruction and passageways remain free.

The stage platform of the Cologne Opera House also benefits from the free choice of colours for e-spools and e-chains. All cable guides were kept in neutral black. For safety reasons, yellow was used for the e-spools in the stage pit. In general, igus provides the option to choose the colour that best suits the function and the background. All applications in the upper or lower machinery show that e-spools ensure uninterrupted cable guidance with high transmission reliability, even with limited space and tight radii, as well as the minimum of visual and acoustic interference. These plus points also won the e-spool the iF product design award.

Performance features and variants for the stage: the e-spool power

The igus e-spool is extremely flexible. It can guide different types of cables and diameters, both vertically and horizontally. Cable diameters up to 17mm can be accommodated. The e-chain’s sections are easily openable and can be quickly filled with cables, allowing a smooth and easy installation and also allows quick access for maintenance or repair in case of damage. Cable retrofitting is possible in many cases, so that more cables can be changed or added to the system later.

The e-chains can be quickly retracted up to their original position. Extension lengths from 4m to 14m are standard in the product range, and igus can produce extension lengths of up to 50 metres for special projects. The maximum extension and retraction speed is 1 m/s. Accelerations up to 2 m/s^2 are possible. For lateral speed, a maximum value of 1 m/s applies and for lateral acceleration a maximum of 1 m/s^2 (radial) or 0.25 m/s^2 (axial).

The e-spool was also intensively tested for durability and service life at the igus test laboratory, the industry's largest testing facility with a floor area of 2,750 m^2. 24,000 double strokes were completed at maximum rotational movement without any problems. Depending on the application and filling, predicted service life is up to about one million strokes. After about 75,000

double strokes, the retraction spring must be replaced. Optionally, operators can equip the standard e-spool with one or two twisterbands. An e-spool with only one twisterband has a drum diameter of 600mm and can weigh from 13.5kg to 48kg. If you want to carry more cables, it is advisable to use an e-spool with two twisterbands. This version has a drum diameter of 850mm and weighs 40kg up to a maximum of 55kg.

For heavy-duty applications, there is a special HD version of the e-spool standard, with an extra-strong spring. The retraction force can be increased, especially for heavy, vertical applications, for example in acoustic and lighting installations. Again, the e-spool HD offers a choice of one or two twisterbands. In general, all components of an e-spool are halogen-free and comply with the general fire protection standards for building technology and machines as well as those for building materials and components (DIN 4102 or DIN EN 13501).

In addition to the standard options for the e-spool, it is also available in various special variants that can meet the individual needs of a stage application. The **e-spool** mini was developed for very small installation spaces. As the drum and shaft block are made of aluminium, it is extremely light (only 3.3kg) and can be integrated almost anywhere. It is designed for extension lengths up to two metres and is ideal for small circular movements. If only one cable is required, the e-spool can also be used with manual extension. A *detent* mechanism reduces strain on the cable and prevents unwanted rewinding. Despite an extension length of 5m, the diameter of the spool is only 300mm.

However, the e-spool variant with the greatest relevance for stage technology is probably the **e-spool power**, which has a motorised retraction system. As a result, high fill weights and movements in all directions are possible. Instead of a retaining spring used in the standard e-spool, a motor retracts the spool, thus overcoming the technical limitations of the standard systems, made possible because the motor increases the power and allows a higher cable fill weight. This means more cables and larger diameters can be carried. At the same time, longer travels of up to 50m and more are now possible. With a maximum extension and retraction speed of 1.2 m/s, every additional metre is managed quickly. As the e-spool power does not require retraction springs, the maintenance intervals are further apart. And there is no tensile strain on the

cables. Therefore, the e-spool power ensures a longer service life for both itself and the cables. Since it is supplied with a drive and control system, it can be integrated quickly into the respective stage machinery.

Zig-zag: Unconventional solutions for unconventional theatres

The modular design and flexibility of the e-chains allow a creative solution for vertically hanging applications that is not only cost-effective, but also very space-saving and inconspicuous. If stages or heavy stage platforms must be moved, lifting heights of many metres and heavy cable loads must be managed. So far, systems that have been used are noisy, space-consuming and visually intrusive. With the "zig-zag" installation method using e-chains from igus, there is an effective alternative in a compact design.

By using reverse bend radii, the e-chains can be stored in a zig-zag pattern, meaning very little space is required. When the stage or platform is raised, the e-chain unfolds with little noise. This installation method is possible with all e-chains of the E4 series. The entire e-chain practically disappears, as it is stored automatically in a standardised zig-zag box, which can be integrated in the stage pit or fixed on movable lighting trusses. This box can optionally be chosen in matt black or another custom colour.

The e-chains are available in external dimensions of 75 to 500 mm with box lengths of 600 to 3,000 mm and box heights of up to 2,000mm. As standard, travels of up to 40m can be implemented at speeds of up to 0.4 m/s and accelerations of up to 1 m/s^2. Even higher values are possible to custom engineer. The zig-zag principle has already proven itself in practice in a wide variety of applications. An example from theatre technology is again at Mountford Hall in Liverpool, where zig-zag e-chains are successfully used to supply lighting trusses with energy. At maximum height, the e-chains are fully retracted in their baskets directly above the crossbeam. If these are lowered, the e-chains unfold automatically. Every part of the design is space-saving and as unobtrusive as possible for the audience. An all-round flexible system that, as a specific customer solution, could only be created through close cooperation in design and execution.

Roger Kirby, installations director at Adlib Audio, the company responsible for it, praised the good collaboration: "We were able to work closely with the igus engineers at all times."

The slim alternative to zig-zag: The igus Liftband

The igus Liftband was designed for similar applications but following a different approach than the zig-zag method.

It was developed for vertical applications up to 13m with lower cable loads, although higher fill weights are still possible with the use of nylon bands. It moves very quietly and has a modular design that can be easily adapted to different heights. Energy, data, and pneumatic cables can be moved together. E-chain speeds up to 1 m/s and acceleration up to 2 m/s² are possible. With a cable bend radius up to 250mm, the space requirement of the Liftband is exceptionally low. The Liftband is therefore the perfect alternative to zig-zag solutions, where very little space is available.

The chain is stored in a solid steel basket, so that the retracted system is barely visible. However, for both the zig-zag box and the Liftband it is necessary to configure every application individually. Therefore, an igus designer should be consulted in the project planning. Only a small amount of time is needed from configuration to delivery – the simplest option is a ready-to-install, plug-and-play system with pre-assembled cables and connectors.

Versatile and robust cables for stage technology: chainflex cables

With the zig-zag principle, not only can different e-chains be used, but all media cables (energy, data, hydraulics, pneumatics) are also guided in one system. In stage construction in particular, a variety of sensitive devices such as cameras and speakers are in use that require a wide variety of cable types. Energy, data and signals must be transported just as reliably as, in some cases, water or compressed air.

With the chainflex product range, there is a choice of 1,354 cable and hose types available from stock: from motor, control, servo, bus, data and encoder cables to modern fibre-optic cables, with cable lengths of one to several

hundred metres available. chainflex cables have been specifically developed for movement in energy chains and to withstand very high mechanical stresses in moving applications, even with twisting movements. Designed for many cycles, high speeds and accelerations as well as long travels, they work reliably without failure over long periods of time. They therefore have a unique 36-month guarantee.

In addition to these general advantages, certain chainflex cables have performance features that are particularly interesting in stage technology. Examples of this are the extremely bend-resistant and flexible chainflex types, which can be safely used in confined spaces. Because of the "low bending" concept, which is available for all cable types, the smallest bend radii are possible, even down to four times the cable diameter. Cables with a TPE outer jacket are halogen-free and flame-retardant, thus meeting the required fire protection standards.
Even more time can be saved with ready-to-connect cables from the readycable range or with completely pre-assembled e-chain systems, including matching plugs, from the readychain range.

Components for camera robots and guidance systems from igus
In addition to theatre applications, "motion plastics" can be used in a variety of related applications for example cameras or moving screens. An example of this are the energy supply systems of the **E6 series**, which are in use in the studio of ARD-aktuell (ARD current news), where, among other things, the Tagesschau (daily news) and the Tagesthemen (daily prime time news) are produced. The former independent specialist for studio technology, Camerarobot Systems GmbH, was looking for a reliable guidance system for its three camera robots, that guaranteed both long service life at high loads and can work very quietly.

The E6 modular system, which can be ideally adjusted to different travels, has chain links with a special design with abrasion-resistant connections, which ensure extremely low-noise and low-vibration operation. Additional noise-damping mats in the guide troughs ensure very high smoothness during tracking shots. Since the E6 can also be used laterally, it is well-matched for applications with tight design and space requirements.

Another compact and silent total energy and data supply system ideal for camera systems is the very small **microflizz**, proving even the smallest e-chains can master even long travels in a guide channel. Virtually no noise is emitted since a plastic spring attenuates the rolling noise of the chain in the channel. With an acceleration of up to 50 m/s^2, an operating speed of up to 6 m/s and data rates up to 10 Gbit/s, the micro flizz can execute fast tracking shots safely, and all of these in the smallest of spaces.

ENDS

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