John Crane

# Hydrodynamic Bearings

## Multilobe, Tilting Pad and Combined Bearings

smiths
bringing technology to life

Bearing Technology

# Excellence in consulting, design, technical support and manufacturing


As part of the global John Crane group, John Crane Bearing Technology GmbH specialises in drive technologies for the power generation, oil, petrochemical and processing industries.

Originally conceived by one of Germany's most prestigious institutions, John Crane's hydrodynamic bearing business was developed throughout the 1940's by Nobel Prize Winner Otto Hahn. It quickly came to represent precision, reliability and advanced technology enabling it to satisfy many of the world's most demanding applications.

Having first achieved prominence for its multilobe bearings for high speed rotating machines, John Crane Bearing Technology is now focused on the development and production of high performance, technically sophisticated tilting pad bearings. It supplies to leading manufacturers of turbines, compressors, gearboxes, pumps and turbochargers around the globe, offering a combination of established standard products and individually tailored solutions.

A programme of continuous development based on customer requirements has resulted in the development of a range of products from standard bearings through to special designs such as spherically supported tilting pad journal bearings and self-equalizing tilting pad thrust bearings.

John Crane bearings are able to meet the highest technical demands. Designs for specific applications are individually tailored with all the relevant calculations, design, engineering and manufacturing operations being precisely matched to requirements.

- Bearings with complete cast-iron housings for steam turbine applications
- Customised combined journal thrust bearings for high perfomance turbo compressors
- P2 Series spherical bearings for gearbox applications which offer improved stability to balance edge loading



The wide range of applications supported by John Crane bearings underline the flexibility of these products and are supported by the company's outstanding technical support capabilities, modern production facilities and sophisticated inspection services.

Production of John Crane's hydrodynamic bearings takes place at the company's new Göttingen-based plant. Highly advanced CAD based engineering facilities ensure consistently high levels of quality, whilst continuous exchange of ideas with technical universities and institutes creates the basis for the successful transformation of a customers technical requirements into actual products.

# Global Support

All bearings are supported by John Crane's comprehensive service and support network. With over 4,000 staff operating from over 200 sales and service facilities that network is ideally placed to support customers on a truly global basis. Many of those facilities provide full engineering, design, manufacture and service capabilities at a local level, and on a round-the-clock basis.

# Multilobe Bearings

## High performance hydrodynamic bearings

John Crane hydrodynamic multilobe (MGF) bearings are the result of proven scientific research. Combined with consistent efforts to optimise their manufacturing quality has made it possible to achieve high levels of performance for high-speed rotating machine applications.

### Multilobe Journal and Thrust Bearings

The outstanding operational performance of John Crane multilobe bearings allows extreme running precision to be achieved. A key characteristic of the multilobe journal bearing is the non-cylindrical bearing bore, which deviates from conventional, cylindrical hydrodynamic bearings by featuring two or more lobes. The lobe radius (R) is larger than the shaft radius (r) by a specific amount and this results in the formation of a wedge gap in each arc. This gap begins at the oil inlet groove, 'a' axially positioned at the widest point of the respective arc. As a rule, the narrowest point of the gap lies in the centre of the lobe.

When the shaft begins rotating the lubricant's adhesive effect on the shaft and lobes forces the lubricant into this gap, which narrows in the direction of rotation. Once a preset peak pressure has developed between the shaft and the bearing the shaft is lifted off the bearing, as the shaft operates hydrodynamically with no metal-to-metal contact.

# Tilting Pad Bearings

## Optimised stability for high-speed applications

Tilting pad bearings are often chosen over classical multilobe bearings due to their improved stability, particularly on high speed rotors. John Crane tilting pad bearings have excellent stiffness and damping characteristics which create maximum stability.

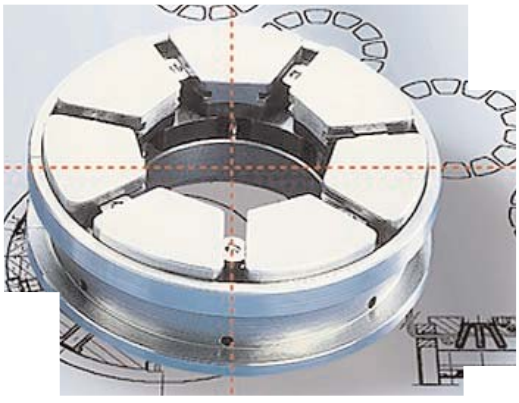
Their load capacity is determined by the oil temperature generated and to maximise this, several alternatives are offered:

- Optimised lubrication systems which reduce power loss and temperature
- Offset pivoting of pads to reduce the temperature generated at the sliding surface
- A choice of pad material to permit higher operating temperatures

### Tilting Pad Journal Bearings

**Providing the optimum in rotor stability**
Of all hydrodynamic slide bearing types, tilting pad journal bearings offer the maximum rotor stability thanks to their exceptional stiffness and damping characteristics. This makes them ideal for use in high-speed machinery operating under low to high loads, e.g., turbines, turbo compressors, pumps and high-speed gearboxes.

### Tilting Pad Thrust Bearings



**Automatic adjustment to suit varying conditions**
These bearings are generally used in high-speed machinery operating under low to high loads, e.g. turbines, pumps, turbo compressors and high-speed gearboxes. They offer the optimum solution to any requirement as they can automatically adjust to suit varying conditions. John Crane offers different thrust bearing types which can feature a wide range of pad sizes in order to suit any given application.

# Combined Bearings

## Customised solutions for specialist applications

John Crane combined bearings provide bespoke solutions for special applications which have restricted assembly and mounting conditions. They are designed to fulfil the customer's specific operational requirements in terms of performance, space and running conditions.

Whether the requirement is for high-speed tilting pad journal bearings with spherical support, high load self-equalizing thrust bearings, or multilobe bearings for lower peripheral speeds and reduced loads, each customer's needs are thoroughly examined with the emphasis on both technical and commercial considerations. Close liaison with the customer allows John Crane to provide detailed bearing calculations and technical proposals which allow the customer to maximise the performance of their processes.

### Hydrostatic Jacking

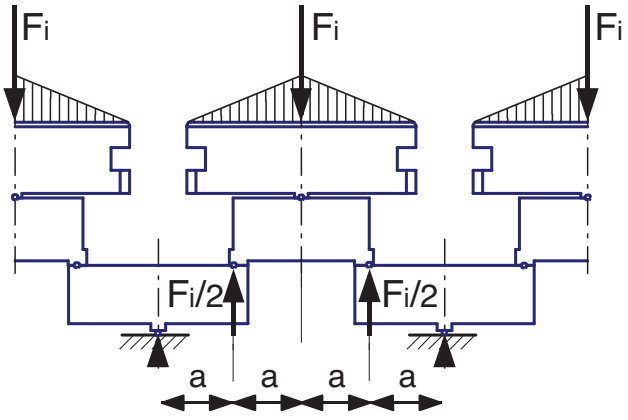
High start-up loads can sometimes induce bearing wear which causes poor hydrodynamic behaviour or even a bearing failure. John Crane's hydrostatic jacking systems can be fitted to both new and existing bearing designs to eliminate start up torque, thereby dramatically cutting the power requirement of the prime mover. The necessary hydrostatic pocket parameters such as oil flow and pressure are calculated using John Crane's specially developed software to ensure that the ideal system is provided for each application.

### Self-Equalizing Tilting Pad Thrust Bearings

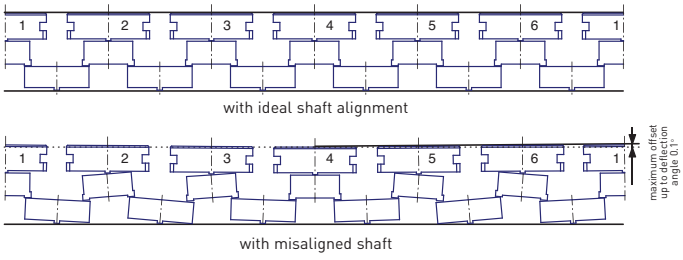
Ideally, standard thrust bearings need an almost perfect installation environment without any shaft or housing misalignment. The maximum allowed variations are given in DIN standard 31699 WELLEN, BUNDE, SPURSCHEIBEN. Maximum load capacity can only be achieved by a perfectly aligned bearing as even small shaft misalignment can cause abrasion and consequent damage.

Self-equalizing tilting pad thrust bearings can automatically adjust to accommodate geometrical misalignments up to 0.1°.This self-equalizing function creates an even load and therefore an equal minimum oil film thickness on each pad. As all tilting pads are loaded equally, they offer greater operational safety than standard thrust bearings.

**Distribution of forces**




**Working principle**



## Self-Aligning Tilting Pad Journal Bearings

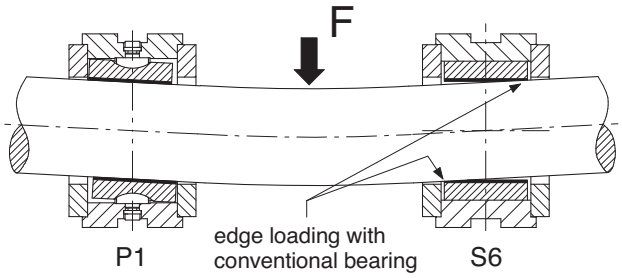
As operators of high speed rotating machinery have demanded more performance, so the demands placed on hydrodynamic bearings have increased. Bearing materials and lubricants must provide better load, speed and thermal performance as today's high power transfer levels result in large mechanical and thermal deformations of such parts as shafts and gear-boxes.

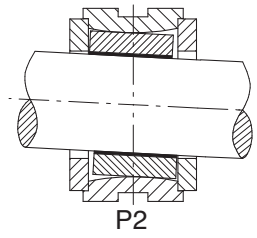
John Crane offers Standard P1 (ball and socket contact) and Standard P2 (point contact) journal tilting pad bearings which provide:

- Interchangeability with the S6 series
- A maximum deflection angle of ±0,15°
- The ability to avoid hot spots at the loaded edge

The Standard P2 also provides a friction-free contact area which improves rotor behaviour.

**Working principle**




| type | pad support |
|---|---|
| S6 | line contact |
| P1 | ball and socket |
| P2 | point contact |

## Quality Control

To meet today's stringent quality control and associated certification requirements John Crane bearings must pass inspection. All functional dimensions are recorded, and material certificates are issued where required.

Ultra-sonic inspection guarantees a perfect bond between steel and white metal and the bearings undergo a dye penetration test to ensure that no defects are present. All quality control procedures are reported on individual certificates, and if required, bearings can be marked with the relevant customer identification codes.

John Crane can also reproduce the bearing geometry by means of a form tester. This quality device is mainly used on orders in process or undergoing final inspection, and especially on high-value and complex gas turbine bearings to ensure that they conform geometrically to the original drawings.

## Production Process Management

In addition to developing its products, bearing concepts and technical consultation procedures, John Crane's production and quality management functions undergo continuous improvement and this is reflected in the use of the latest machining centres which have expanded the possibilities for the manufacture of larger and more complex bearing types. Increasing customer demands for ever tighter production and quality tolerances are satisfied by the creation of climate-controlled production zones for sensitive bearings and component parts.

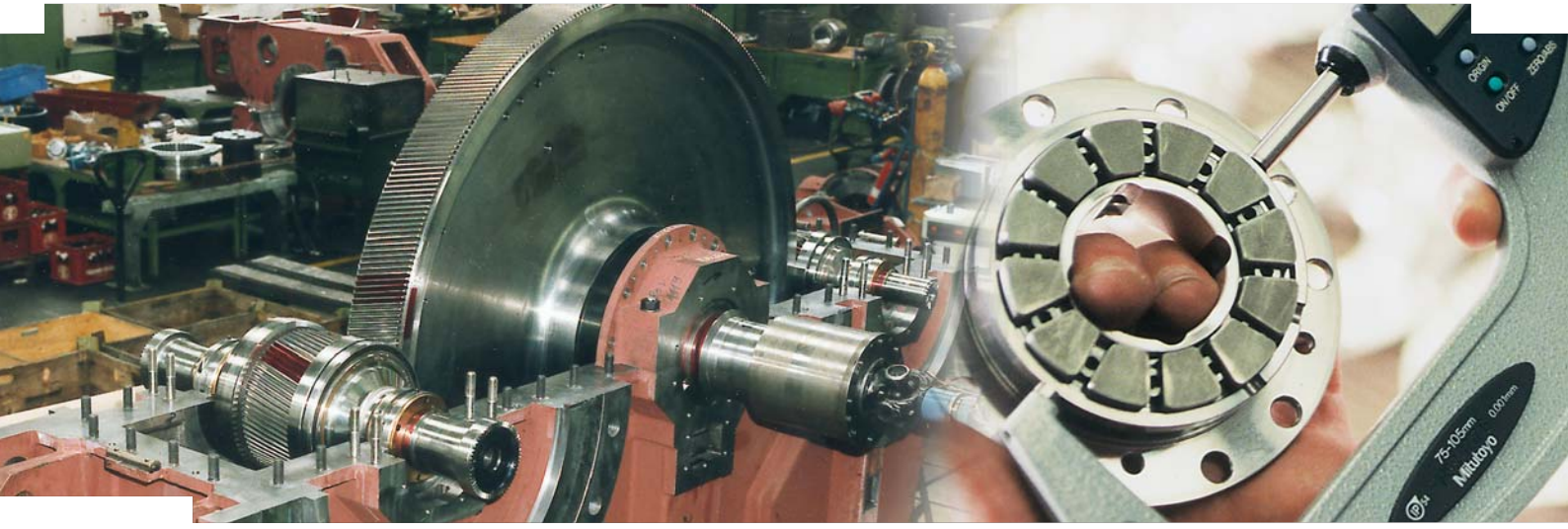
The introduction of a pre-tool setting-machine has further enhanced John Crane's product quality. This ensures that all functional tool characteristics are measured, with this data then being fed directly into the production machine programs.

In batch production, and especially critical bearing parts, dedicated process control plans ensure 100% process integrity. The use of FMEA principles increases process optimisation and also helps maintain high quality levels. John Crane's SAP order processing department ensures that on-time delivery performance is provided as standard.

John Crane Bearing Technology has been certified to DIN EN ISO 9001:2000 and DIN EN ISO 14001. It also boasts customer-specific certification which is regularly updated. In 2003 the company also became able to comply with the EU ATEX Directive.

John Crane also applies a 100% traceability principle to its material procurement processes, and to both individual production steps and overall production mechanisms.

Acknowledging the increasing complexity and critical nature of customer requirements, John Crane has invested heavily in additional control techniques and measurement technology, and each bearing or component undergoes non-destructive testing procedures to ensure that it is of the highest possible quality.




**Customer reference list:**

**Steamturbines**
MAN Turbo AG, Oberhausen
MAN Turbo AG, Hamburg
Siemens AG PG, Mülheim

**Gasturbines**
Siemens Industrial
Turbomachinery Ltd., Lincoln

**Turbogears**
Voith Turbo BHS Getriebe GmbH, Sonthofen
Renk AG, Augsburg and Rheine
Flender-Graffenstaden S.A.S., Illkirch
MAAG-Gear AG, Winterthur

**Turbocompressors**
MAN Turbo AG, Zürich
MAN Turbo AG, Oberhausen
MAN Turbo AG, Berlin
Siemens AG PGI, Duisburg

**Turbochargers**
MAN Diesel SE, Augsburg
Siemens Industrial
Turbomachinery Ltd., Lincoln

**Turbopumps**
Sulzer Pumpen GmbH, Bruchsal
Sulzer Pumps Ltd., Leeds
Termomeccanica Pompe S.p.A., La Spezia

**Refrigerationturbines**
MAN Turbo AG, Ravensburg
Friotherm AG, Winterthur

**Expansionturbines**
Atlas Copco Energas GmbH, Köln
Cryostar France S.A., Hesingue

John Crane

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