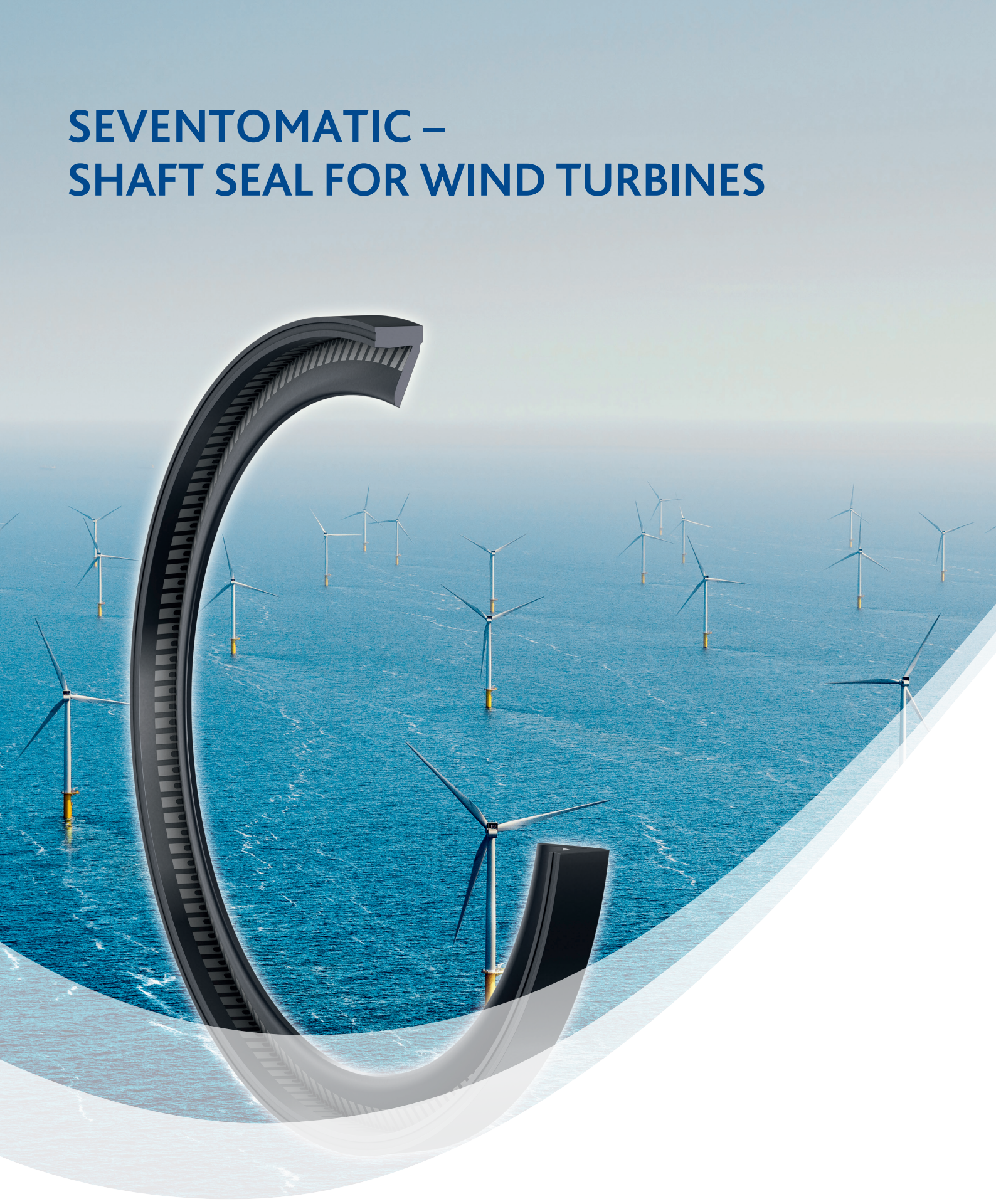
SEVENTOMATIC – SHAFT SEAL FOR WIND TURBINES



FREUDENBERG
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PERFORMANCE FOR LARGE, GREASE LUBRICATED MAIN BEARINGS

Finding solutions for special challenges in sealing technology has a long tradition at Freudenberg Sealing Technologies. In addition to decades of experience, Freudenberg's engineers make use of the enormous material expertise of their globally active company. The development of the new radial shaft seal Seventomatic for the wind industry combines new and proven elements with the precision of today's manufacturing processes.

The cross section of the new seal is reminiscent of the number 7 and inspired the naming of the new seal, in combination with the Latin word 'ventus' for wind.

A mere scaling up of seals when diameter increases often runs into unsatisfying results. A traditional radial shaft seal with a garter spring at the sealing lip, for example, loses performance at larger diameters. Shaft deflection at large sizes is often an issue for the seals as well.

Imagine a new sealing solution, completely free of any limiting factors – discover the new Seventomatic shaft seal.

SEVENTOMATIC

NO LIMITS FOR EVER-INCREASING SHAFT DIAMETERS

Fig. 1:
Profile of the new Seventomatic seal: a meander spring firmly connected to the rubber body during the vulcanization process

THE *SEVEN* FACTS

- Outstanding sealing function for grease lubrication, regardless of diameter
- Compensation of large shaft deflection
- Omnidirectional set up of the sealing lip for maximum design flexibility
- Very good media & ageing resistance
- Large diameter range with virtually no limit at the upper end
- Single-piece seal for high safety during installation
- Can be joined on site, if required

Grease as a lubricant has become standard in wind turbines. The main challenge is always to keep the media inside the bearing. Traditional shaft seals with a garter spring reach their functional limit with larger diameters. The radial force component of the spring that is relevant for the lip force towards the shaft gradually turns to zero. Even larger and stronger coil springs won't overcome this geometrical issue. In addition, the garter spring design can only work towards the inside radial direction.

The integrated meander spring of the newly developed seal type Seventomatic instead, ensures a constant lip force regardless of diameter. The functional behavior of the spring provides various seal arrangements and sealing directions, giving design engineers of wind turbines unprecedented flexibility.
Large shaft offset is also no obstacle. Unlike the known increase of a springs' preload when activated, **the force of the sealing lip of the new Seventomatic always stays constant, even up to a shaft deflection of +/- 6 mm.**

SAFE, OMNIDIRECTIONAL, LONG-LASTING

GREASE AS THE BEARING LUBRICANT NEEDS A STRONG PARTNER

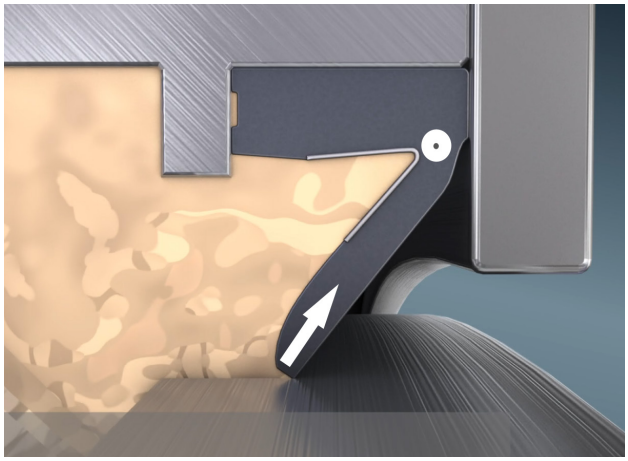

Fig. 2: No lever torque at the sealing lip: the force of the outward-pressing grease is directed to the hinge

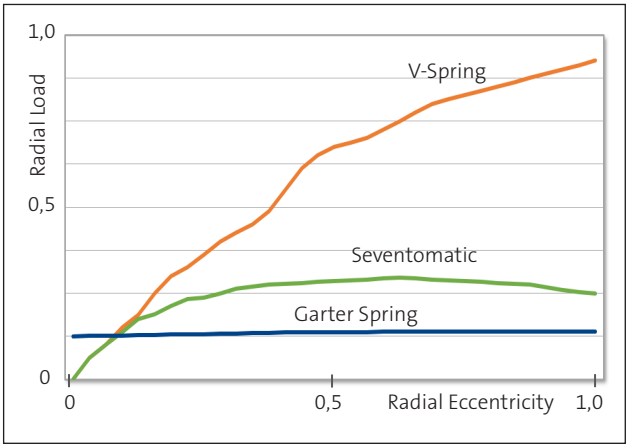

Fig. 3: Ideal preload of the Seventomatic sealing lip with regard to maximum value resp. distribution at shaft deflection

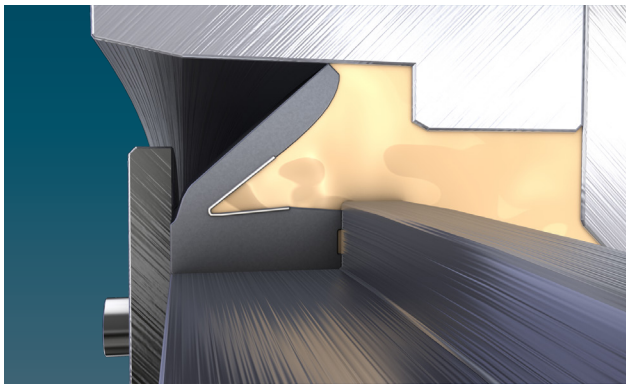

Fig. 4: Sealing arrangement in a roller bearing for a direct drive turbine - sealing towards the outside diameter

Operators of large size wind turbines appreciate reliability and leakage-free performance. Based on our findings, traditional sealing solutions for XXL dimensions do not fulfill these needs. This also comprises standard finger spring type of seals with their enormous range of preload at large shaft deflection. Big differences in lip force either lead to leakage or to unwanted high friction and wear.

Grease as lubricant is quite sturdy and partially gets pasty under heavy load in large size roller bearings. At a sealing lip with too little pressure on the shaft, pasty grease partially lifts up the sealing edge and lets grease pass underneath. The flat angle of a standard sealing lip is not able to cope with this lever torque created by the outward pressing grease. And as soon as the diameter grows, the further loss of radial force of a garter spring favors the unwanted lifting of the sealing lip.

The high-placed hinge of the Seventomatic design avoids any lifting of the sealing lip. The stemming set-up of the lip compensates the forces of the outward-pressing grease (see figure no. 2).

For superior functionality, the lip force of the new Seventomatic is set-up about twice as high compared to garter spring versions. The linear distribution of the lip force at shaft deflection is the major benefit compared to standard V-spring seal types (see figure no. 3).

Note

A benchmark test at one of our customer sites attests to the new Seventomatic best marks for sealing tightness compared to garter spring versions, respectively a finger spring seal.

Seventomatic seals for direct drive turbines either operate towards the inside diameter or their sealing lip performs towards the outside (Figure no. 4). Sealing in axial direction is a further option. **Generally, the design and manufacturing method of the new Seventomatic offers an omnidirectional setup.**

INSPIRED BY NATURE

ADAPTIVE BEHAVIOR OF THE MEANDER SPRING

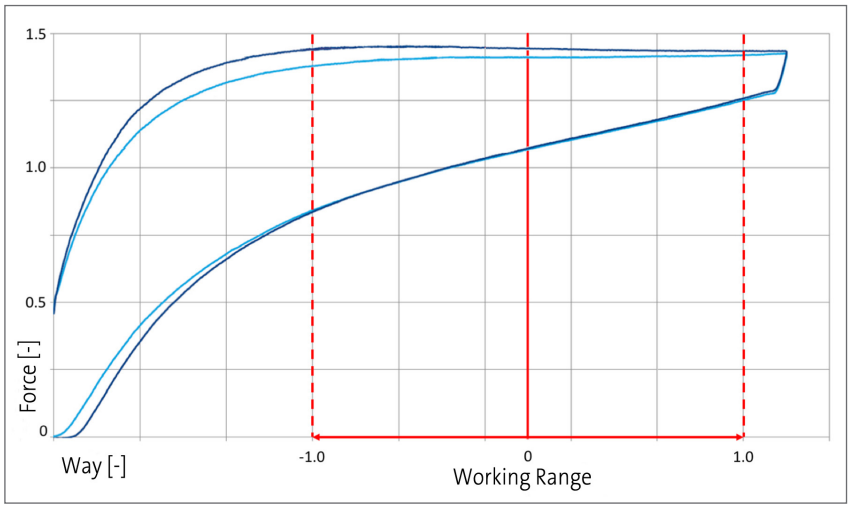

Fig. 5: Standardized Force/Way diagram of the new Seventomatic S71

Constant pressure on the shaft over the complete working range of the sealing lip.
The new Seventomatic S71 in its largest profile is able to handle +/- 6 mm shaft offset. A standard seal with a conventional spring characteristic faced with this offset would either lose contact to the shaft or would apply an excessive, wear relevant preload.
The special arrangement of a meander spring in combination with the FEM designed hinge area of the sealing lip completely eliminates any increasing or decreasing factors on the preload within the working range of the sealing lip. (see figure no. 5)
This is unique in sealing technology, offering most stable performance.

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