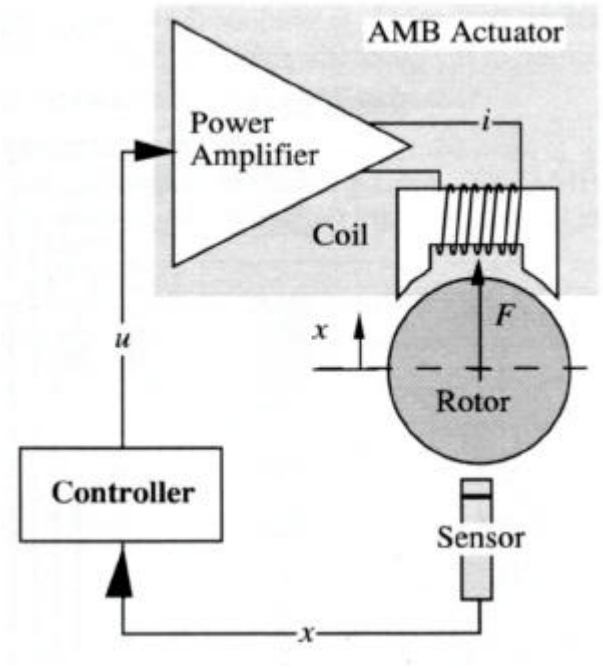
The basic idea of magnetic bearings was first shown to be possible in the 1930s. The system was however basically unstable because the additional control needed to tune the attractive forces acting on the rotor was not available. The progress in electronic and in particular digital control in the last 15 years means that magnetic bearing systems can now be considered for serious industrial applications. Magnetic bearings have wide spread use in applications such as Turbo molecular pumps, gas turbines and energy storage wheels along with gradual acceptance into areas such as machine tools and air conditioning units.

In Spring 2000 Mecos Koyo and FAG Barden came together to form a co-operation to pool their individual knowledge of digital control, active magnetic bearings and emergency touch down bearings into one system. With proven serial production capability in all areas the co-operation is able to offer an advanced system at competitive cost.

What are Active Magnetic Bearings

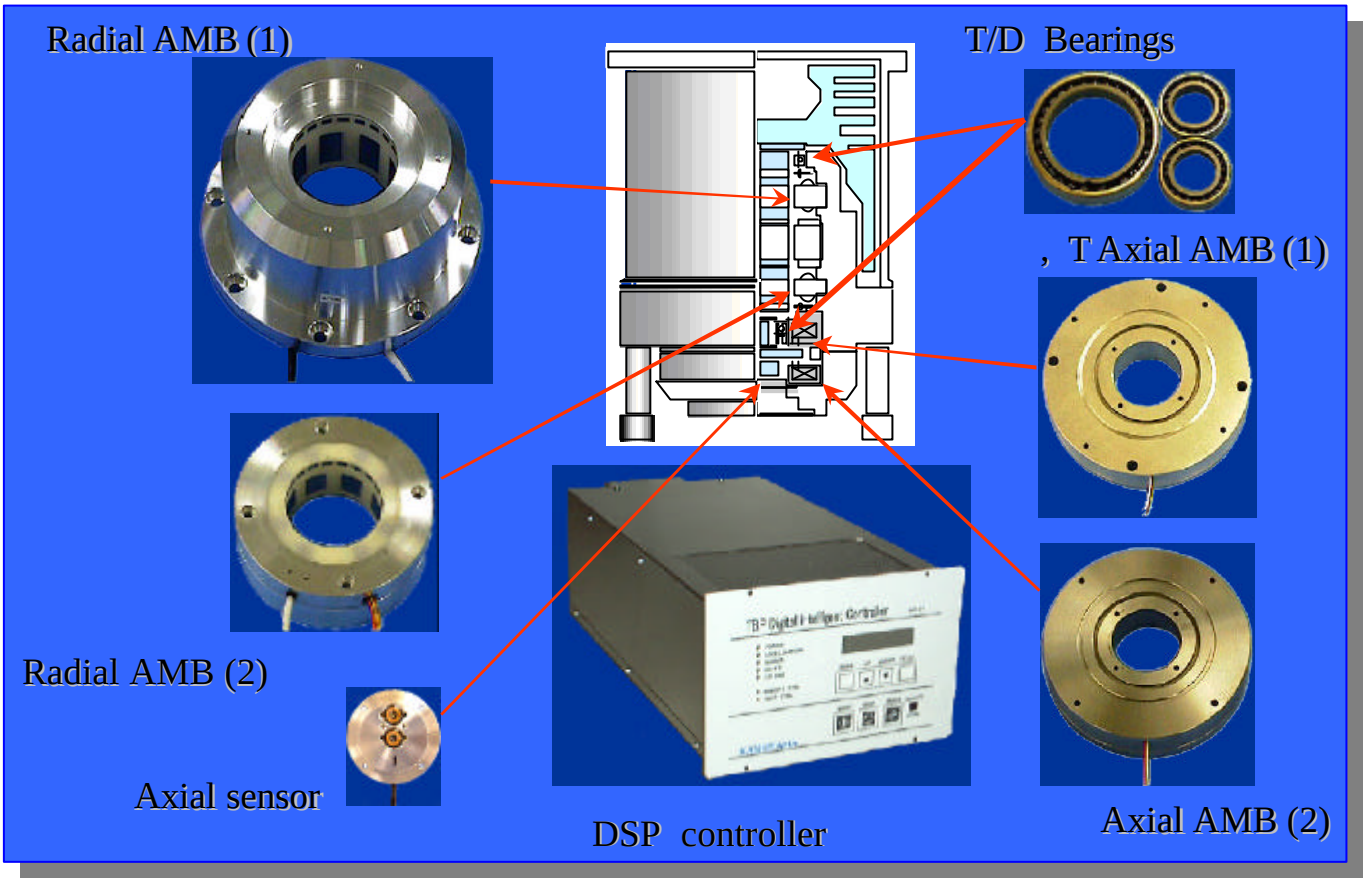
A means to support a rotor without mechanical contact using attractive magnetic forces based on servo feedback technology, consisting of sensors, electromagnets, power amplifiers, power supplies and controllers.



Active magnetic bearing systems have some clear advantages over conventional solutions such as rolling element bearings. These advantages include a complete absence of mechanical contact with no wear or friction and no need for lubricant, active vibration control, system diagnosis and monitoring and unbalance compensation.

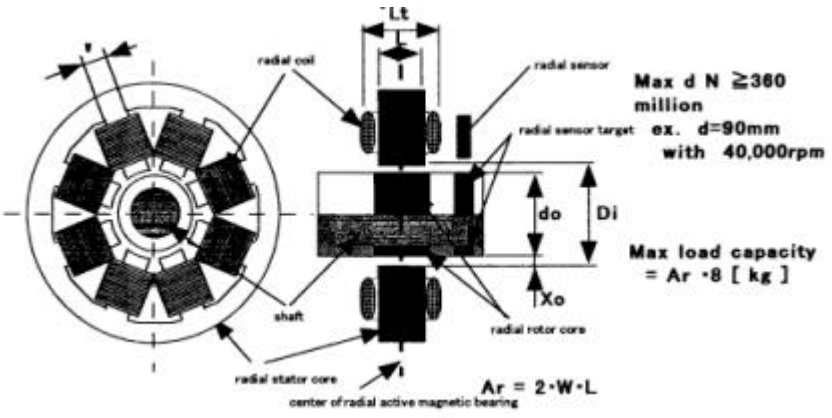
The system developed by FAG Barden, Mecos and Koyo has been researched and developed since 1983 into the serial robust system of today. It has uses in many applications such as Turbomolecular pumps, machine tool spindle, turbo blowers and compressors.

The main components required for a full five axis system (i.e. A system that controls five degrees of freedom) are shown below.



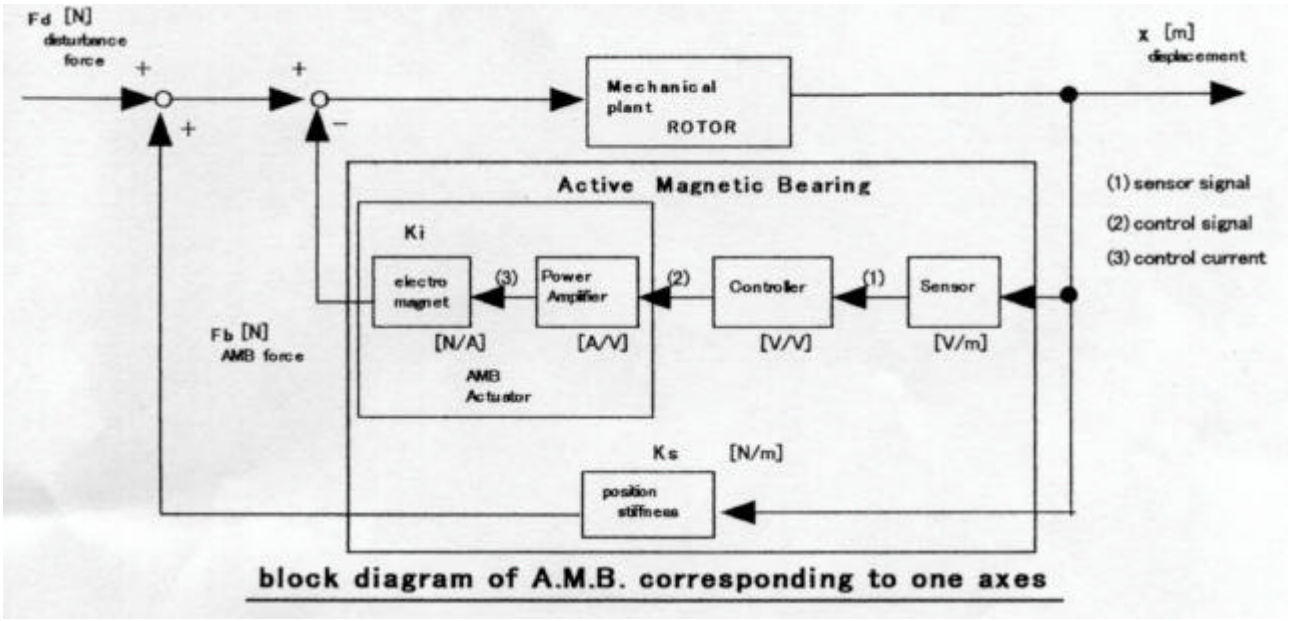
By using two radial bearings and two axial bearings it is possible to control exactly the spindle position at all times. The emergency touchdown bearings will support the shaft in case of complete power failure and allow the shaft to coast to a stop in a controlled manner.

Basic Construction of A.M.B. Actuator

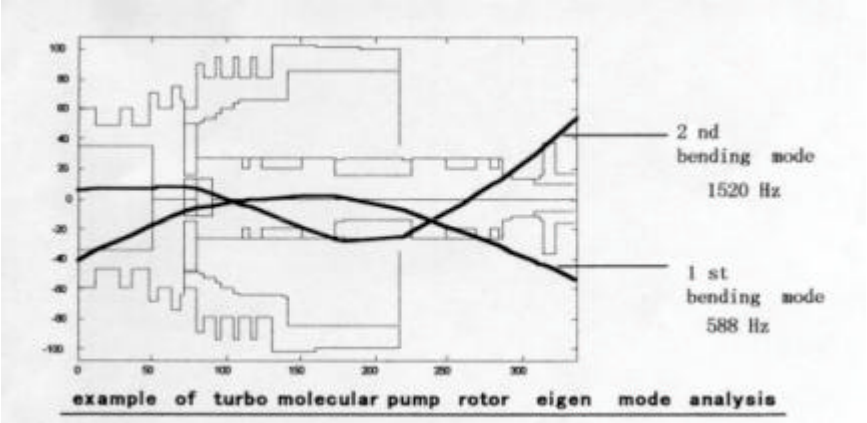


The basic construction of the Radial AMB actuator is shown below. The actuator consists of a radial stator made up from a ferromagnetic core and coil windings and a radial rotor core also made from a ferromagnetic material core shrunk fitted to the rotor shaft. Both parts are made from thin silicon plate with insulation film on its surface to eliminate eddy current loss in the material.

Total System Design for AMB including Optimisation of the Rotor



block diagram of A.M.B. corresponding to one axes



example of turbo molecular pump rotor eigen mode analysis

The FAG Barden, Koyo, Mecos system uses a digital controller at the heart of the system. However not only are the electronics, electromechanical parts and the emergency bearings optimised but also the rotor dynamics and the control thereof. Using mathematical models calculated from finite element methods the system response and model correction is designed into the controller software.

Standardisation and Advantages

By using digital systems it has been possible to optimise the control electronics and reduce the number of boards required for full control. A series of standard components have been developed to further help drive down cost and offer an " off the shelf solution" although tailor made solutions are also possible.

The system can bring a number of basic advantages:

Vibration Free – Automatic balancing and perfect compensation against large gyroscopic effects.

Easy Set up – Tuning free operation of AMB, remote control operation via remote controller

Safety – Detection of power failure, immediate breaking of operation in case of emergency and highly reliable touch down bearings using Cronidur 30 and ceramic balls.

Other advantages include sophisticated motor power control, integral half size rack controller unit and battery less converter (i.e. generator mode operation during emergency)