Gas-lubricated bearings

For high-speed equipment

The industrial world moves on bearings. In any operation where a reduction of friction is necessary to permit equipment or machinery to operate, some form of bearing must be used. Remove bearings from machinery and the industrial world would seize up.

The magnitude of the contribution that oil-lubricated journal and rolling element (ball or roller) bearings have made to industry and social progress is impossible to calculate. However, the time now has arrived when bearings of these types often are not suitable for modern sophisticated machinery, especially equipment operating at fantastically high speeds.

To overcome this problem, industry in the last few years has applied gas-lubricated bearings to a wide variety of industrial applications. Their range of application varies from miniature high-speed dental drills with rotors weighing a fraction of an ounce to gas circulators in nuclear power plants with rotors weighing several hundred pounds.

In particular, air-bearing technology has been exploited to a considerable extent by the machine tool industry. Commercially available hardware such as grinding wheel spindles and workheads fitted with air bearings have demonstrated a marked improvement in roundness and surface finish over the conventional oil journal or ball bearing units. Precision air bearing drill spindles which operate at speeds of up to 200,000 revolutions per minute have been incorporated in multi-spindle tape-controlled machines producing holes at a rate of 250,000 an hour. Air bearings have also been applied to machine tool slideways to allow accurate work-piece positioning, to roundness-measuring instruments and to form-measuring machinery.

There are two basic types of gas bearings — self-acting and externally pressurized, and this distinction must be made when discussing their relative merits. The self-acting (or hydrodynamic) bearings do not depend on an external supply of pressurized gas but instead rely on the viscous pumping of the gas in the clearance space between rotating parts to produce a load supporting pressure distribution. Stopping and starting of the shafts of these bearings is always accompanied by a small amount of wear in the rubbing surfaces. Because of this problem and because externally pressurized bearings are capable of much higher stiffnesses, the latter type has been used most frequently for industrial applications.

Externally pressurized (or hydrostatic) bearings have gas continuously supplied from an external reservoir. A supply of pressurized air is usually available in most engineering workshops and can be used for pressurized bearings provided it meets the basic requirements of cleanliness and moisture content. The support of the bearing does not depend on the rotation of the bearing so that there need be no contact between parts and no resultant wear. Starting friction is zero and the viscous running friction is very low, all these combining to allow minimal warm-up times for machinery. Also of importance in many industrial applications is the averaging effect which the air film has on irregularities in the geometry of the floated parts. This permits exceptional accuracies of positioning or run-out. The gas bearing also does not contaminate its environment, a distinct advantage in aerospace applications.

Because of the importance of air bearing technology to industry, the Gas Dynamics Laboratory of the Division of Mechanical Engineering of the National Research Council of Canada has been engaged in an active program of research and development for some years.

Current research by the laboratory is directed primarily at problems associated with the design of the externally pressurized type of bearing. Journal and thrust bearings of various configurations have been studied. Compliant surface bearings and hydrostatic gas seals for compressors are also subjects of special interest. Attention has been focussed on the

Dr. Ian R. Lowe (left) and E.H. Dudgeon examine an experimental air bearing which has a compliant surface. The use of a compliant elastomer greatly increases the load capacity of the bearing. • Le Dr Ian R. Lowe (à gauche) et M. E.H. Dudgeon examinent un roulement à air expérimental dont la surface en élastomère relativement élastique permet de beaucoup plus grandes charges.