might be expected to appear in the functional equation for elliptic functions over these fields.

M. C. GOODALL

Massachusetts Institute of Technology,
Cambridge, Mass.

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ENGINEERING

An Elastohydrodynamic Lubrication Experiment

THE thickness and shape of the lubricant film between highly loaded rollers is the feature of elasto-hydrodynamic lubrication which has received most attention in recent years. The efficacy of hydrodynamic lubrication in such contacts is directly related to the thickness of the lubricant film compared with the surface irregularities on the solids, and the recent activity reflects the significance of this quantity to the designer of machine components.

Another aspect of elasto-hydrodynamic lubrication which is of interest to the designer is the stress field within the solids. In this respect the distribution of pressure within the lubricant is of paramount importance, and it is the purpose of this communication to report a preliminary investigation of the pressure and temperature distributions in a highly loaded sliding contact.

One of the difficulties associated with the measurement of pressure and temperature profiles in contacts representative of gear teeth is the very small width of the contact zone in relation to the size of conventional sensing elements. Higginson[1] overcame this difficulty by using a low modulus elastic solid for the stationary component in a sliding contact. In order to examine the pressure and temperature distributions in a highly loaded metal contact a novel disk machine has been constructed which opens out the contact zone and yet retains the essential features of elastohydrodynamic conditions. A stationary phosphor bronze shoe having a 6·5-in. concave radius is loaded against the periphery of a rotating phosphor bronze disk of 6-in. radius in the manner of a brake shoe as shown in Fig. 1. A mineral oil supplied to the disk surface ensures the existence of a coherent oil film between the shoe and the disk. The shoe is provided with a small central oil pressure tapping and four thermocouples buried at various depths below the working surface. The pressure tapping hole communicates with a cylindrical, wire wound pressure transducer. The position of the shoe is varied circumferentially with respect to the line of action of the applied load, thus traversing the pressure tapping and thermocouples through the pressure zone.

Results have been obtained for various speeds and loads. A typical pressure traverse is shown in Fig. 2 for a load of 1·35 tons per in. of face width and a disk peripheral speed of 64 in./sec. Also shown in Fig. 2 are contours of rise in temperature above ambient for the bulk metal of the shoe. The lower curves show the distribution of shoe surface temperature and the lubricant viscosity related to the local pressure and the shoe surface temperature.

The shape of the pressure curve is consistent with the predictions of elasto-hydrodynamic theory[2], the most notable feature being the very steep pressure gradient at the outlet end of the zone. If side leakage is neglected, the shape of the oil film corresponding to the measured pressure distribution can be determined according to a method described in ref. 2. The shape of the oil film shown in Fig. 2 exhibits the well-known characteristics of elasto-hydrodynamic films. The similarity between this shape and the picture presented by Crook[3] based on a direct measurement is striking. This result demonstrates that the local restriction in film thickness at the outlet end of the zone does not necessarily imply the existence of the pressure spike exhibited by some theoretical solutions. It should be recalled that theoretical solutions demonstrate the dependence of the pressure spike on material properties[4]. An interesting feature of the surface temperature profile is that the maximum temperature is attained before the end of the pressure zone is reached; a result attributable to the rise in lubricant viscosity in the vicinity of the peak pressure.

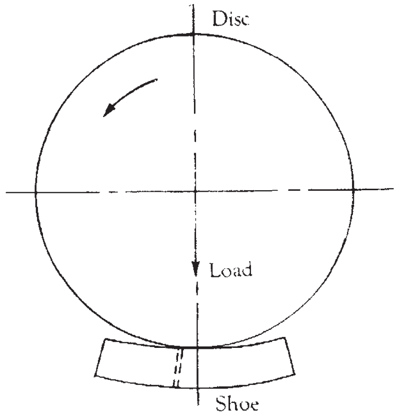

Fig. 1. Disk machine

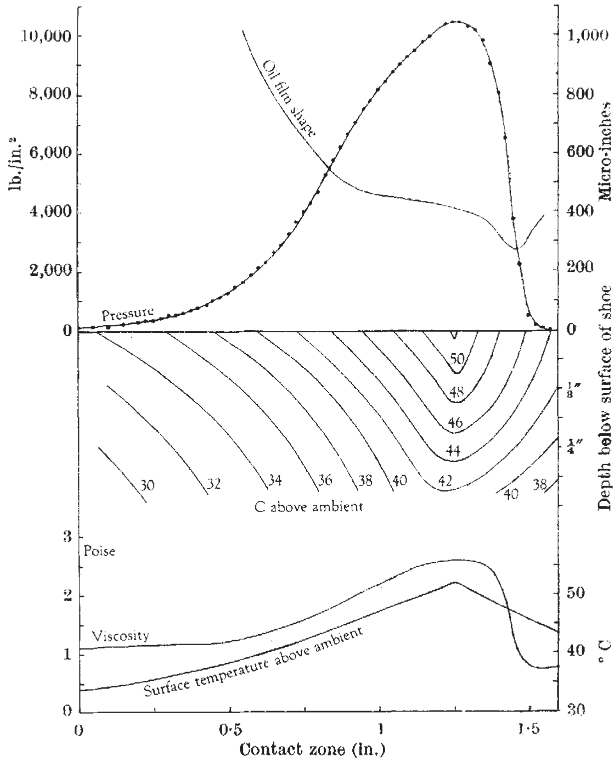

Fig. 2. Pressure and temperature profiles

D. DOWSON
M. D. LONGFIELD

Department of Mechanical Engineering,
University of Leeds.

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