A SINTERED BEARING WITH A PLASTICS COATING
AND A COMPENSATING RESERVOIR

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It is generally considered that porous sintered bearings made by the powder metallurgy method have a particularly valuable property in that, because of the presence of oil in their pores, they are capable of operating for a long period of time without additional lubrication. In view of this characteristic, such bearings are frequently termed self-lubricating. However, it has been shown in a number of investigations [1] that self-lubricating bearings operate satisfactorily only at low values of the characteristic product PV. This is due to the fact that the natural reserve of oil in a porous bearing is small, and may become exhausted within a relatively short initial period of operation (frequently during running-in).

The temperature rise taking place during the operation of a porous bearing is responsible for the self-regulation of lubricant (usually machine oil) supply to the friction surface. To increase the service life of porous self-lubricating bearings, the latter may be provided with a lubricant reservoir. As the lubricant content of a porous sintered bearing is used up, the lubricant in the compensating reservoir is sucked up by the capillary passages of the bearing and is fed to the friction surface. At high loads and velocities, the temperature on the friction surface is higher, and lubricant consumption increases; with decreasing temperature, the amount of lubricant consumed decreases. In addition, lubricant consumption is influenced by the porosity of the bearing, the viscosity of the oil, and the friction surface area.

At the present time, porous iron-graphite materials are frequently used for journal bearings. The advantage of these bearings is that their graphite constituent substantially improves their antifriction and running-in characteristics, and increases their wear and seizure resistance. By altering the porosity, graphite content, and structure of the material, it is possible to change the mechanical characteristics of bearings. The manufacturing technology of such bearings is relatively simple, and their cost is low.

However, the life and load-carrying capacity of iron-graphite bearings are limited, although their wear is slight (according to some sources, approximately one-tenth of the wear of babbitt bearings). For example, satisfactory operation of an iron-graphite bearing of 20% porosity can only be assured when the value of its characteristic product PV is not greater than 2.5 MN-m/m^2-sec.

Although more complicated from the design point of view, bearing units with sintered bearings in the form of a reversed pair possess economic advantages [2, 3]. The principal advantage of a reversed pair is that, as a result of the constant renewal of the contact surface of the antifriction material, the wear of the surface is uniform, and the operating conditions are improved. The use of reversed bearings with compensating reservoirs is particularly beneficial when such bearings are mounted on rapidly rotating shafts at low loads. In such cases, the capillary self-regulation of lubricant feed to the surface is improved, since the lubricant under the influence of centrifugal forces copiously wets the inner, prefeding surface of the porous sintered bearings.

The use of reversed sintered bearings with a compensating reservoir slightly raises the permissible characteristic product PV. Thus, for instance, a reversed sintered bearing of 20% porosity, made from ZhG-2 material, operates satisfactorily on unhardened steel 45 (0.45% C grade) at PV = 3.0 MN-m/m^2-sec. Lubricant consumption in this case is 0.15-0.20 g per 1 cm^2 of the bearing friction surface area in 300 h [4]. The main drawback of sintered reversed bearings with compensating reservoirs is the relatively low load-carrying capacity and wear resistance of iron-graphite materials and the high lubricant consumption at elevated temperatures.
As a result of an analysis of the advantages and disadvantages of such bearings, a new design of reversed sintered bearing with a compensating reservoir has been proposed. This bearing may be made in two forms. In one form, the bearing is forced into the housing of the friction unit. A clearance is formed between the shaft and the bearing. In this case, the bearing operates satisfactorily when either the shaft or the housing with the bearing rotates. The second type, in which the bearing is forced onto the shaft, operates satisfactorily when the shaft rotates together with the bearing. Results of laboratory tests of an experimental bearing of the second type will now be described.

The new bearing (Fig. 1) is distinguished by the fact that, to increase its wear resistance and load-carrying capacity, the sintered surface 2 is coated with a plastics layer 1. The part of the sintered surface which forms the lubricating groove 4 remains uncoated. The uncoated part 4 of the surface acts as a source of lubricant from the compensating reservoir to the friction surface.

The iron-graphite ZhG-2 material of 20 ± 1% porosity, having a pearlitic structure with up to 20% ferrite, was selected for the sintered bearing base. An antifriction coating of caprone was deposited on the porous sintered base by impingement in the form of a pseudo-fluid layer. The thickness of such a layer is 0.25-0.35 mm. The principle of this method consists in heating the part to 240-250°C and immersing it in caprone powder, which is agitated in a special apparatus. Powder particles hitting the surface of the part fuse and form a uniform coating.

Initially, tests were made of the adhesion of the plastics coating to sintered metal surfaces. Caprone powder with particles 0.25 mm in size or smaller was used for the deposition of the coating. The tests, which were carried out in a special device, consisted in shearing two cylinders of 21.5 mm diameter, the end faces of which were joined by a caprone film. The force (in kilograms) per unit shear surface area is a measure of the adhesion of the caprone coating to the test material. The surfaces on which deposition was performed had a finish of the order of V5-V6.

The results obtained have shown that the adhesion of a caprone coating to a sintered metal base attains a value of 35.0-40.0 MN/m², and is thus less strong than the adhesion of such a coating to steel (50.0-60.0 MN/m², determined in pulling apart along the normal).

The bearing was tested both without and with lubricant (machine oil L), which was supplied from the compensating reservoir through the body of the bearing. Under these conditions, a colloidal mixture was formed on the friction surface, consisting of oil and the graphite washed out from the capillary passages of the porous base by the oil flowing to the friction surface. The presence of graphite not only lowers the coefficient of friction, but also helps to retain the lubricant on the friction surface.

The tests were carried out in an Ml-1M friction machine. The test specimen (see Fig. 1) was mounted on the shaft of the machine and rotated together with the shaft. It operated against a lap from steel 45 (0.45% C grade), made in the form of a half-ring fixed on the carriage of the machine. The temperature on the friction surface was measured with a thermometer inserted into a socket drilled out in the lap. The thermometer indicated the temperature at a distance of 1-1.5 mm from the friction surface.

In the tests, friction torque and temperature were recorded as functions of specific pressure, both without lubricant and in the presence of lubricant in the compensating reservoir. In the unlubricated tests, coefficient of friction and temperature determinations were made with and without the removal of the wear debris. The results of these tests are shown in Figs. 2 and 3.

Figure 2 shows the effect of specific pressure on the friction surface on the coefficient of friction of bearings for different operating conditions: with or without lubricant and with or without the removal of wear debris. The tests were carried out at velocities of 0.85 and 0.46 m/sec. Figure 3 illustrates the effect of specific pressure on temperature in the friction zone under the same operating conditions.