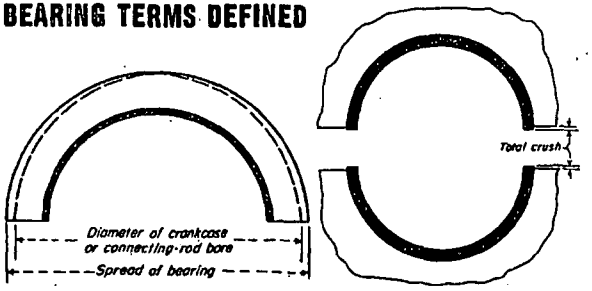
BEARING TERMS DEFINED



SPREAD is making the bearing wider at parting faces than actual maximum saddle-bore size. This creates an initial side pressure so any tendency on part of ends to curl after assembly is avoided

CRUSH is the term used to describe the excess in height of a bearing over full half. At assembly, pressure at parting face forces equivalent of press fit, insuring close contact between back, bore

PARTING RELIEF, incorporated in some precision bearings, makes sure that bearing's sharp edge does not rub on shaft if there is sidewise misalignment

ages made it possible to reduce lining thickness still further.

Hand scraping, necessary to some extent in all these designs, is expensive and time consuming. Successful operation depends on the skill of the scraper. To get rid of these troubles, manufacturers developed accurate ways of boring bearings at assembly, and today's *precision-insert* bearing.

Today's Bearings. As its name implies, the precision bearing is an accurately finished unit consisting of a bronze or steel backing to which is bonded a lining material. Mated to saddle bores, journals and crankpins held to equally close tolerances in manufacture, such bearings are completely interchangeable and directly replaceable. They can be stocked as spares and bearing replacement can be made with comparatively little shutdown time. If the shaft is not damaged or worn excessively, clearance is restored accurately without machining or hand fitting.

Precision bearings are available with either steel or bronze backs, choice being sometimes dictated by engine builders' preferences, and sometimes by lining material required. A recent development is the bearing made of a single material, such as one of several aluminum alloys. These combine sufficient strength and rigidity with suitable antifriction characteristics.

THEORY OF BEARINGS

Improvements in bearing design have gone hand in hand with gains in knowledge of what happens in operation, although much remains to be learned. The formation of an oil film is usually pictured by simplified diagrams such as those on the preceding page. In commercial engines, however, there are some parts of the pressure area where oil film is so thin it must be measured in molecules, and others where metal-to-metal contact exists. Such thin-film (boundary layer) and metal-to-metal conditions also exist during starting and stopping.

Dry-Friction Theory. A theory of dry friction developed by Dr F P Bowden helps to explain further the operation of bearings. As pictured on the preceding page, frictional resistance is proportional to the area of real contact between the metals *A*, and the shear strength of the softer metal *S*. When a hard substance rubs another hard one, contact area is small but shear strength is high and so is frictional resistance. With a hard substance rubbing on a soft one, the low shear strength of the soft metal is offset by the greater area of contact.

But if a hard material rubs on a thin film of a soft one over a hard back, both area and shear strength are low, giving low frictional drag. Extensive plastic deformation and penetration of the hard material cannot occur so even with heavy loads real contact area stays low. Resistance to shear is fixed by the softer metal, so this provides an artificial method of keeping both *A* and *S* small.

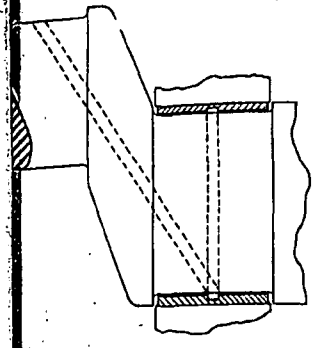
In actual practice, small areas of metal-to-metal contact set to melt the thin film in spots, providing contact area necessary to support the load, thus actually tending to form a uniform bearing area conforming more to the shaft and its deflections, and housing distortion, than the original. This dry-friction theory helps to explain success of thin plated films as "run in" surfaces and as means of adding corrosion resistance to known bearing metals.

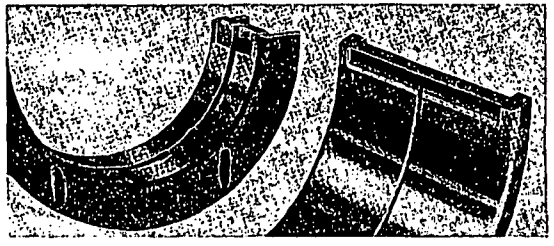
Trend in Linings. It has been seen that the trend is toward thinner linings and, in some cases, backs. This permits casting bearing material with increased soundness and uniformity, more advantageous engine assembly and improved operation, and lower cost. Selection of lining material (to be discussed in detail later) and its final thickness is not haphazard. It is based on study of loads, speed, oiling conditions and other factors governing behavior of the bearing in the engine. Such items as engine cleanliness, crankshaft deflection and other unpredictable factors require that past experience also be considered.

Based on test results and successful experience, lining thicknesses have moved steadily downward in the past few years. In automotive practice, thickness runs as low as 0.004 in. nominal, about a practical minimum from the standpoint of bearing manufacturing economy. In diesel bearings the trend is also toward thinner linings since a thin lining is subjected to less stress and has greater flow resistance. In diesels, however, manufacturing economy is not usually the determining factor. When thin linings become excessively worn they ruin expensive crankshafts quicker, so a compromise in lining thickness to provide a greater margin of safety is desirable. Present-day diesel-bearing linings range in thickness from 0.015 to 0.040 in., depending on bearing size and to some degree on the kind of lining material.

Half bearings for diesel connecting

OIL-GROOVE POINTERS





GROOVING TO CONVEY OIL: In conventional main-bearing design, full peripheral groove is supplied with oil for transfer to connecting-rod bearing through crankshaft oilway. Rule of thumb says cross-sectional area of groove should be at least ¼ area of the crankshaft oilway

GROOVING FOR OIL DISTRIBUTION: Grooving in highly loaded areas is discouraged, but it is often desirable in low-load areas to aid in properly distributing lubricant. At right, above, is grooving for long or large bearings; at left, "thumbnail" grooving for flanged bearings

rods and mains are purposely made with certain dimensional peculiarities to render them more substantial when assembled. Operators should know what these are and what they accomplish.

Bearings are usually made wider across the parting faces than actual saddle-bore size, as shown above. This is known as *spread*. It creates initial side pressure so that, after assembly with the opposite half, any tendency for the ends to curl is eliminated. The fact that this also assures firm seating proves helpful to the mechanic, as housing and bearing can be inverted without the latter falling out.

Bearing Definitions. *Crush* is the term to describe the excess in height of a bearing over the full half. It imposes pressure against the parting faces of a pair of bearings after assembly in the housing, creating an equivalent press fit and assuring good contact between bearing back and housing-bore surface.

Excessive crush can be more harmful than it would seem, causing distortion and thickening of the wall, thus impairing the oil clearance. In manufacture, this half height must be held rather close, between 0.0005 and 0.001 in. total tolerance. Special fixtures are used to check this dimension under known loading.

Flanged bearings with proportionately large flanges require an additional relief of the flange at the parting faces to a depth of 0.002 to 0.005 in. Because the flange has no backing support and the remainder of the bearing is practically press fitted in the housing, the flange tends to warp if this precaution is not taken.

Another feature frequently incorporated in precision bearings is *parting-face relief*. This is so small as to be indistinguishable in the finished bearing. Its purpose is to make certain that the sharp edge of the bearing does not rub against the shaft because of slight sidewise misalignment at assembly. If this occurred, the oil film would be scraped off. This relief also assures that any slight burr set up at the parting faces by the crush will not touch the shaft. Amount and length of taper depends on bearing and shaft size.

Oil Grooves. Oil grooving is a specific problem for each bearing as related to the total installation. The day is gone when indiscriminate "lattice-work" grooving was considered smart design. Instead, we have learned that each groove reduces allowable local load-carrying ability because the oil-film pressure ordinarily built up to high intensities is reduced by the swath cut into the otherwise uninterrupted surface of the bearing.

Oil grooves must be used sparingly and judiciously. This does not imply that they should be eliminated entirely for, when properly applied, they assist in formation of oil films. Wherever

(*Continued on page* 160)

