jected refined base stock shipments for off-spec color. Nowadays, refiners may not be able to maintain previous crude sources, and formulators have to accept whatever refined stocks they can get—if other specifications are met—and adjust their formulations to make the best of available stocks. As a result, lubricant colors are not necessarily the same, even though lubricating quality is identical.

Another factor that may affect the familiar color of a lubricant is a change in additives. For example, lead naphthenate has been used to help gear oils resist extreme pressure and impact loads. Recently, OSHA has urged that toxic or potentially toxic substances such as lead naphthenate be removed from industrial workplaces.

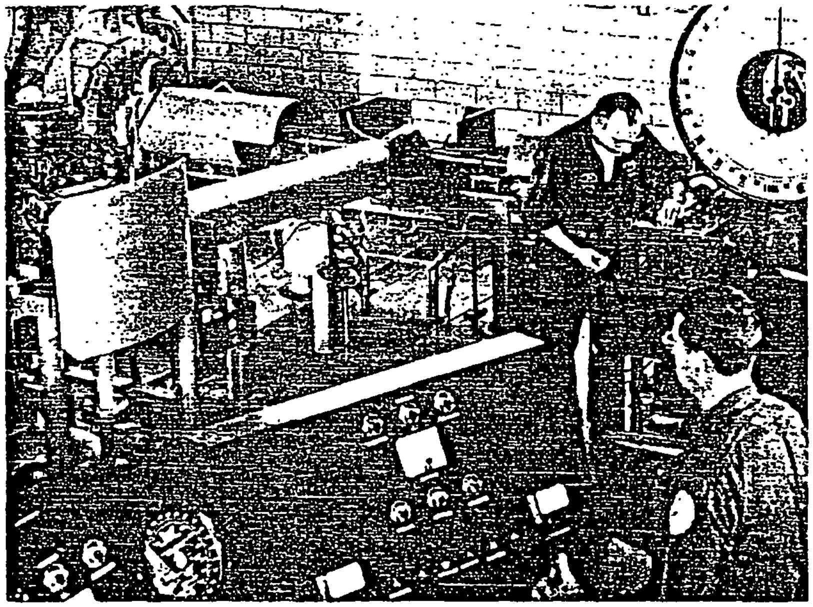
Changing additives is not an easy process. Laboratory data on potential replacements are only suggestive; performance is proven only after expensive and tedious field trials. Nevertheless, some synthetic extreme pressure agents, after field testing, are being phased in as replacements for the lead naphthenate. Since their color is not the same as the amber lead soap, they too can contribute to changes in traditional colors.

The net result is that color has even less value than it ever did as a guide to lubricant quality. Shop personnel must be more alert than ever to the requirements of the machinery they service and qualities of the oils they pour.

Safer brakes and clutches with lubrication

Changes in industrial and automotive friction materials are enlarging applications for solid lubricants such as molybdenum disulfide. This surprising application of lubricants in friction materials comes as a result of environmental pressures.

Asbestos is now a major component of friction materials, but industry anticipates an EPA ban on its use. Possible liability suits may be



Many lubricant manufacturers use dynamometer stands such as this to test gear oils.

an additional incentive to develop asbestos-free compositions.

The application for solid lubricants is as a *friction modifier*. Conventional friction materials have up to 15 components. Asbestos is by far the major component, comprising some 60 to 80% of friction materials. Phenolic resin is typically used as a binder. Various additives are incorporated—more on the basis of art than scientific knowledge. Other commonly used additives include ground rubber, for elasticity; coal, as a cheap source of graphite; gilsonite, as a friction modifier; and zinc oxide, as a corrosion inhibitor.

Asbestos is very difficult to replace, especially as a major component, because it uniquely combines a high, stable coefficient of friction with an almost ideal balance of abrasiveness and lubricity.

Semimetallic compositions, first used in Europe and Japan, are now coming into use here. In these compositions, also called "resin-mets", wool or shavings from steel or brass replace asbestos as the fibrous component. The resin-mets, however, have problems:

- "Morning sickness" — inadequate braking with cold starts.
- An appreciable increase in the coefficient of friction at higher temperatures. (Pads frequently get to 200+°F, and reach 400 to 500°F with prolonged downhill braking. Under severe braking, pads reach 1000°F, red heat.)
- High pad wear.
- Unacceptable noise.

Dow Corning Corporation, Midland, Michigan, has developed a new product, "Lubolid", to help solve these problems. Now in use, Lubolid is a mixture of molybdenum disulfide and other materials for use as a friction modifier in clutch and brake friction materials. According to George V. Kubczak, Development Engineer at Dow Corning, its benefits are:

- A more constant coefficient of friction.
- Reduced disc wear.
- Reduced noise.

The principal competitive material for this application is graphite. Graphite has useful properties to 2000°F: its cost depends on the specific grade used. However, graphite requires moisture for good lubricity—which may lead to corrosion problems. Also, any moisture initially present is lost when pad temperatures reach 212°F or higher.