oil begin to show. While at the end of the ninth or tenth day there would be no doubt left as to which is the most fluid, and which is the gummiest of the oils.

The figures here given are the results of tests made by this method, only flowing on an iron slab instead of a glass one. (See Thurston's "Friction and Lubrication.")

Description of Oil.	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day	8th Day	9th Day
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
Best Sperm Oil....	2 8½	4 2	4 5¾	4 6	4 6	4 6	4 6⅓	stat.	....
Com. " "	1 7	3 9	4 6¾	4 11	5 1½	5 4	5 6¾	5 7⅜	5 8
Galipoli "	0 10¼	1 2¼	1 6	1 6½	1 7⅝	1 8¾	1 9	1 9¼	1 9½
Lard "	0 10¼	0 10½	0 10¾	0 11¾	stat.	....	....	....	....
Rape "	1 2½	1 6¼	1 7	1 7⅛	1 7¼	1 7¼	1 7¼	1 7¾	stat.
Linseed "	1 5½	1 6	1 6¾	1 6¼	1 6¼	1 6¼	1 6¼	stat.	....

From these it can be seen that of the six oils, common sperm oil was by far the most fluid, while the best sperm oil, though very fluid for some time, eventually turned gummy and stopped running. On the other hand, Galipoli oil, though it did not flow as easily, yet it did not turn gummy as fast.

There are many other methods and modifications of the above for determining the fluidity of an oil, both physical and chemical, but one other very common and simple method may be mentioned.

It is to dip a piece of blotting-paper into the oil, and note the form of the drops which fall from it. If they fall in distinct symmetrical drops it is an indication of fluidity; if, however, they show a tendency to spread, it indicates viscosity. By keeping the oil on the paper for some days the rate of gumming can be obtained.

The flash and burning points are of great significance, for when bearings begin to run at all hot, the oil which is around them must not immediately commence to burn. A good lubricating oil will stand 400° Fah. before beginning to flash, while a good cylinder oil will go as high as 500°-600° Fah.

The next point mentioned, namely, the acidity of an oil, requires careful attention. No oil must contain an acid, for, it is needless to say, if it does, the machines upon which it is used will not be long before they show signs of being eaten by it.

A very simple test is to place a strip of clean bright copper in a small flask and surround it with the oil to be tested. Heat the oil gently, and allow it to stand for a while. If there is any acid present, it will show itself by the green color which it will give to the liquid. The reason for this is that the acid acts on the copper, and forms a compound with it.

And, finally, we come to the co-efficient of friction which an oil gives. It is not such an easy matter to test for this quality.

Mr. C. J. H. Woodbury has done considerable work in connection with this subject, for the Mill Mutual Insurance Company, of New England (see A.S.M.E., 1880-84), and the results of his work are given by himself in a paper read before the American Society of Mechanical Engineers.

The apparatus used by Mr. Woodbury (Figure 7) consisted of a hard, tool-steel, annular disc supported by an iron frame. Upon this disc rested one of hard bronze, in the form of a cylindrical box. The discs were kept at an even temperature by means of water fed into the top one. A diaphragm extended down into the water to keep it in circulation. A copper tube also extended into the water, and in it was placed the bulb of a thermometer, which gave the temperature of the discs. A glass tube ran to the centre of the discs to supply the oil.

The two discs were ground with the greatest accuracy. It is an interesting side point just to notice how they were done. Both rubbing surfaces were made to coincide with the standard surface plates in the physical laboratory in the Institute of Technology, and their contact with each other was considered perfect. When all was finished, the bronze disc was treated with bichloride of platinum; there was left a thin film of platinum upon the surface. When the two surfaces were rubbed together, the platinum was rubbed off the bronze disc in all parts.

The upper end of the lower shaft was rounded and fitted into a corresponding socket in the upper disc. The axes of the two discs were not in the same line, but were in parallel ones about an eighth of an inch apart. This gave a discoid motion when the discs rotated. The upper disc was pressed down by means of weights placed on the upper spindle which rested upon it.

An arm projected from the spindle, and engaged with projections on the disc. Upon this arm, which was in the arc of a circle, a thin wire was wrapped, which went to a dynamometer. The discs were surrounded by wool and flannel to prevent radiation of heat.

In experimenting, the greatest care was taken to have the two discs perfectly clean before starting. The oil used in the previous experiment had to be entirely removed, or it affected the results, for it formed a thin layer between the metal and the new oil. To do this benzine was used.

The accompanying curves (Figures 8 and 9), give some of the results which Mr. Woodbury obtained.

Besides being able to compare the results obtained with similar results made on other oils, they go to point out that, as the temperature increases, the co-efficient of friction decreases; also that, as the pressure increases, the co-efficient decreases, provided that the temperature remains constant.

A very practical method of testing a lubricant is by means of the Thurston Oil Testing Machine. There is one of these machines in the Mechanical Laboratory of McGill College. It is of the car-axle type (Figures 10a and 10b), and consists essentially of a journal corresponding in size to that of a car axle. This is partly surrounded by two brass bearings which support a pendulum. When the axle is turned it tends to rotate this pendulum. This angle of twist is read by means of a scale and pointer. The oil is fed in at the side, and the temperature of the bearing is taken by means of a thermometer, reaching down into the upper brass.

The lower brass can be applied or not, and can have its pressure regulated by a spring situated inside the lower part of the pendulum.

One great advantage of a machine of this kind is that the oil can be tested under conditions similar to those to which it is to be subjected afterwards.

Solid Lubricants.

There is another class of lubricants which differ somewhat from the above, namely, solid lubricants.

Among the principal lubricants of this class may be mentioned graphite, which, in a powdered form, is used where the oils have failed (i.e., where they have broken down under high pressure). It is sometimes mixed with certain oils, and used for both heavy and light pressures.

Soapstone is another solid lubricant, and is used generally in the form of powder mixed with oil or fat. Mixed with soap, it is used between wood and wood, or wood and iron. Among other solid lubricants used may be mentioned soap, lard, plumbago and tallow. The following table gives an idea of the relative value of lubricants to reduce friction (from Kent):—

Lubricant	Wood upon Wood	Wood upon Metal	Metal upon Metal
Dry Soap	.40	.32	.27
Lard	.82	.85	.70
Lard and Plumbago		.67	.96
Olive Oil		1.00	1.00
Tallow	1.00	.93	.80
Water	.22	.24	.18

Distribution of the Oil over the Bearing.

In making all these tests with journals, running in bearings, one of the most difficult things which has to be overcome is how to get the lubricant distributed evenly over the whole surface, and, in experimental work, to establish a standard which can be easily copied.

It has been found that the most perfect method to oil a bearing is to immerse the journal in oil. By this method the journal always has all the oil it can take. Besides it can always be kept at the same temperature by means of