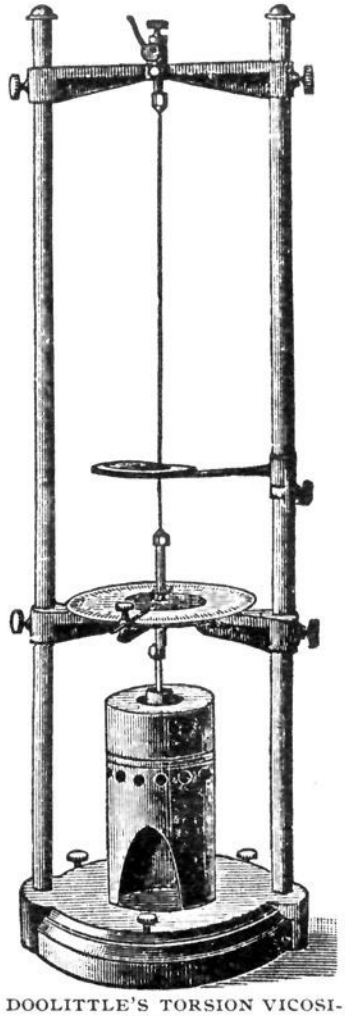
THE TORSION VISCOSIMETER.

By O. S. Doolittle.

THE viscosity of an oil is recognized to-day by both the producer and consumer as the most valuable measure of its lubricating power, and yet we find no uniformity whatever in the manner of determining this essential property.

There are numerous vicosimeters in use, but no one of them has commended itself to the trade sufficiently to be adopted as a standard.

Many of them have their good features, but all have objections which have prevented any one from being accepted as standard and universally used.



DOOLITTLE'S TORSION VICOSIMETER.

The essentials of a good viscosimeter are:

(1) Accuracy, including both the ability to duplicate results obtained with an oil on the same instrument, and also on different instruments of the same make.

(2) Ease and rapidity of cleaning and manipulating, and the reducing of personal error to a minimum.

(3) Adaptability of a single instrument to all kinds of oil at all desirable temperatures.

The great majority of viscosimeters are built on the principle of allowing the oil *to flow through an orifice and counting* the number of seconds required for a certain quantity to flow out. Instruments constructed on this plan cannot be made to conform satisfactorily to all the above requirements.

As a rule it takes more time to clean and get the viscosimeters of this class ready for a test, than for the test itself. If the instrument is made with great care good duplicate results can be obtained with a perfectly clean oil,

[1] *Drugs, Oils and Paints*, June, 1893.

but if by any chance a slight particle of dirt gets into the oil the orifice is liable to become obstructed and the results vitiated.

At the same time these results are but comparative, and poorly comparative at the best, as the head of oil is constantly changing from the moment the flow begins, and the rapidity of the flow must necessarily depend more or less upon the specific gravity of the oil.

That the personal error is a large one will hardly be disputed by any who have worked with these instruments. Again, you will find as a rule several different viscosimeters with varying orifices required for the different oils, a small hole being the best for light oils and a large one for the heavy products.

Thus we have no regular scale of viscosities ranging upward from some recognized zero point, which by the way water furnishes admirably.

This is a most unfortunate state of affairs, as it deprives us of a standard by which the value of all oils could be readily recognized and intelligently understood. When we speak of a temperature of 212° it is well understood because the Fahrenheit thermometer is recognized as a standard in this country, but when we refer to a viscosity of 125 seconds it has no meaning whatever unless it is accompanied by the name of the instrument on which it was obtained, and oftentimes the name of the observer as well, thus necessitating the carrying in mind of the ratio of numerous instruments to each other, a very perplexing and unsatisfactory task.

Having experimented with a number of these viscosimeters in the laboratory of the Philadelphia and Reading railroad, we found them so very unsatisfactory where rapid and accurate work is required that we abandoned them all and designed an instrument on an old principle which has been used in measuring almost everything from a delicate electrical current to the quantity of cream in milk, an operation at times requiring a still more sensitive instrument, *i. e.*, that of the torsion balance.

The principle has not failed us in this case, and in the torsion viscosimeter we have an instrument which, during the year we have had it in daily use, has proved itself reliable, accurate, and satisfactory in every way.

It is very easy to clean and manipulate, is adapted to oils of all ranges of viscosity from kerosene up, and reduces the personal error to a minimum.

A glance at the cut will show how the principle has been applied.

A steel wire is suspended from a firm support and fastened to a stem which passes through a graduated horizontal disk, thus allowing us to measure accurately the torsion of the wire. The disk is adjusted so that the index point reads exactly zero, thus showing that there is no torsion in the wire.

A cylinder two inches long by one and a half inches in diameter, having a slender stem by which to suspend it, is then immersed in the oil and fastened by a thumb-screw on the lower part of the stem to the disk. The oil is surrounded by a bath of water or paraffine wax according to the temperature at which it is desired to take the viscosity. This temperature being obtained, while the disk is resting on its supports, the wire is twisted 360° by means of the knob at the top. The disk being released, the cylinder rotates in the oil by virtue of the torsion of the wire.

The action now observed is identical with that of the pendulum.

If there was no resistance to be overcome, the disk would revolve back to zero, and the momentum thus acquired would carry it to 360° in the opposite direction. What we find is that the resistance of the oil to the rotation of the cylinder causes the revolution to fall short of 360°, and that the greater the viscosity of the oil the greater will be the resistance and hence the retardation. We find this retardation to be a very delicate measure of the viscosity of an oil.

There are a number of ways in which this viscosity may be expressed, but the simplest we have found to be directly in the number of degrees of retardation between the first and second complete arcs covered by our pendulum. For example, suppose we twist the wire 360° and release the disk so that rotation begins. In order to obtain an absolute reading to start from, which shall be independent of any slight error in adjustment, we ignore the fact that we have started from 360°, and

take as our first reading the end of the first swing. Suppose our readings are as follows:

Right, 350; left, 338; right, 328, and keeping in mind the vibrations of the simple pendulum we will see at once that we have read two complete arcs whose difference is 22° computed as follows:

1st arc, Right 350 + Left 338 = 688
2d arc, Left 338 + Right 328 = 666
22° retardation

In order to secure freedom from error we take two tests—one by rotating the wire to the right, and the second to the left. If the instrument is in exact adjustment these two results will be the same, but if it is slightly out, the mean of the two readings will be the correct reading.

It will also be noticed that if the exact retardation due to the oil alone is to be obtained we must subtract the factor for the resistance due to the air and the wire itself. These are readily obtained by allowing the cylinder to rotate in the air and determining the retardation exactly as we have done above. This factor remains constant for each instrument and is simply deducted from all results obtained.

The torsion viscosimeter is free from many of the objections noticed in other instruments, and has given entire satisfaction during the period it has been in use. It is independent of the gravity of the oil and of any reasonable amount of dirt which may get into it. It is applicable to all grades of oil regardless of their character or fluidity. The viscosity of an oil can be taken at any temperature as many times as may be desired without any inconvenience from being obliged to handle the hot oil.

This I think is an important point, as the practice in common use of determining the viscosity of a cylinder stock at 212° Fahrenheit does not tell us what we want to know. We should know the viscosity of an oil at the temperature at which it is to be used, which, in the case of cylinder stock, is in the neighborhood of 350°. I have repeatedly found oils tested at 212° simply reversing their comparative values when heated to 350°.

We need a viscosimeter with which the viscosity can readily

be determined at a high temperature with a minimum amount of trouble. By means of a paraffine bath for our oil we have no trouble whatever in doing this with the torsion viscosimeter.

When one oil has been tested sufficiently the cylinder can be taken out in a moment, wiped off, and is then ready for another oil.

The necessity of a standard instrument which shall be recognized by the trade as such cannot be too forcibly emphasized, as the present state of affairs is most annoying to both producer and consumer, leading as it so often does to misunderstanding and financial loss.

The torsion viscosimeter is the standard instrument of the Philadelphia and Reading railroad, but this simply means that it is the best we know of at present. We are, however, always open to conviction, and if any better method of determining the viscosity of an oil is invented we will be very glad to adopt it.

FIFTH GENERAL MEETING.

THE following resolution was adopted by the Council of the American Chemical Society, June 7, 1893:

Resolved, That the General Meeting of the American Chemical Society for the summer of 1893 be held in Chicago at such date as may be determined by the committee appointed by the society to co-operate with the World's Fair Auxiliary of the Columbian Exposition in arranging for an International Congress of Chemists.

In accordance with the terms of this resolution the committee to co-operate with the World's Fair Auxiliary have determined that the Fifth General Meeting of the Society shall be held during a period beginning August 21, 1893, in conjunction with the World's Congress of Chemists to be held under the auspices of the World's Fair Auxiliary and the American Chemical Society.

The committee desire to call to the attention of the members of the society and of American chemists generally, the fact that in view of the large number of eminent chemists, home and foreign, who have already signified an intention to attend the World's Congress of Chemists, and the valuable character of