To guard against improperly calibrated specific gravity apparatus, the tester should either check the volume of the bulb of the Le Chatelier apparatus and of the flask of the Jackson apparatus, or else request the maker of the apparatus to furnish with the same a certificate from the U. S. Bureau of Standards testifying to its trustworthiness. Of the four forms of apparatus, three are affected by any change in the temperature of the liquid between the two readings. With the Jackson apparatus, a table is supplied which gives the correction to be applied. In the other forms of apparatus, precautions are usually taken to guard against changes in temperature, such as immersing the instruments in a jar of water.

The coefficient of expansion of kerosene is 0.0009 per degree C., or 0.0005 per degree F. The Le Chatelier apparatus has a volume of 139 cc., consequently the expansion due to a rise of one degree C. amounts to 0.12 cc., after deducting for the expansion of the glass, or an error of approximately .018 in specific gravity.

The Schumann apparatus holds from 110 to 150 cc., and hence has about the same error. The McKenna apparatus, however, has a volume of 300 cc., and, since the stem is graduated into only 11 cc., the sample is smaller (between 30-35 grams) than that used for either the Le Chatelier or the Schumann apparatus. The expansion per degree C. rise with this apparatus amounts to 0.27 cc., or an error of approximately 0.07 in specific gravity. Dr. McKenna has now improved his apparatus by blowing a thermometer into the bulb between the two tubes, allowing temperature corrections to be easily made. The bulb itself is much smaller, doing away with the large error due to expansion, and the graduated tube is narrower and longer, making the apparatus much more delicate.

Since it is by no means an easy matter to keep the temperature constant during a determination, unless water, oil, cement and apparatus are allowed to remain side by side for some time, I have usually found it more convenient to take the temperature of the oil just before bringing it to the zero point and just after making the final reading. With the Le Chatelier apparatus 0.12 is then deducted from the final reading for every degree C. rise or added for every degree drop in temperature of the second reading over the first.

The chief objections I have found to the standard Le Chatelier apparatus is the time and care necessary to run the cement into the apparatus. The same objection holds good for both the Schumann and McKenna forms of specific gravity apparatus. McKenna's apparatus must also be protected from even slight changes of temperature, and requires a higher degree of manipulative skill than any of the other three forms. The Jackson apparatus is much more convenient than any of the others, and is just as accurate, provided it is properly graduated. This latter may be made sure of, as I have suggested, by having it certified to by the U. S. Bureau of Standards. The makers could have this done at small cost in lots of ten or more. The greatest objection to the Jackson apparatus when properly graduated is the necessity of drying the flask before each determination. This can be gotten around by graduating the flask wet (with kerosene), say, after draining two minutes in an inclined position so as to allow the bottom also to drain and removing the suspended drop. Flasks so graduated give just as accurate results as do dry flasks, and time may be saved by using the wet flask.

It is sometimes necessary to take the specific gravity of samples of cement after ignition at a low red heat. With the appliances at hand in the ordinary cement testing laboratory it is a difficult matter to ignite more than 5 or 10 grams at one time. None of the forms of apparatus ordinarily used for taking the specific gravity of cement is suited to the use of such a small sample. For this purpose I have used the method given below:—

From one arm, **a** (the left), of the balance take off the balance pan and in its place suspend from the stirrup, as shown in Fig. 5, a 50-gram weight, **b** (or any weight sufficient to more than balance this pan, such as a lead fishing sinker). Take the weight of this on the other pan, and call this weight "A." Now, attach to this by a fine silk thread or wire a 50 or 100 cc. pycnometer, **c** (a small 100 cc. Erlenmeyer flask with a narrow mouth will also do). Weigh the pycnometer so suspended and call the total weight "B." B—A will then be the weight of the pycnometer in air. Now, fill the pycnometer with water in the usual way, carefully forcing out all air, and weigh suspended in a tall, narrow breaker or jar, **d**, of water. Call this weight "C." "Loss in water" = (B — A) — (C — A). Now, dry the pycnometer, fill with oil and weigh suspended in kerosene. Call this weight "D." "Loss in kerosene" = (B — A) — (D — A).

Specific gravity of the kerosene =

$$\frac{\text{"Loss in Kerosene"}}{\text{"Loss in Water."}}$$

Now, remove the pycnometer and pour out half of the kerosene, introduce W (usually 5 to 10) grams of the ignited cement and mix thoroughly by twirling around the contents of the pycnometer. Fill the pycnometer to the neck with oil and allow a few minutes for the contents to settle. Fill the neck fully by pouring down the sides, suspend in kerosene and weigh as before. Call weight "E."

Specific gravity of the cement =

$$\frac{W \times \text{Specific Gracity of the Oil}}{(W + D) - E.}$$

The temperature of the oil should not change more than 2° C. during the time between the taking of its own density and that of the cement. The weight of the pycnometer suspended in water need be taken but once. After this is done a determination can be easily made in ten minutes. Even the finest particles of the cement settle in a few minutes, and results obtained by the method are very trustworthy, as the following will show:—