AN IMPROVED SPECIFIC GRAVITY BALANCE

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An improved specific gravity balance has recently been developed for determinations of crystals, small masses of minerals, gem stones or other materials. The balance includes a number of features which appear to offer advantages over equipment generally in use and should be of interest to those who are concerned with specific gravity determinations of nonporous solids.

It is hardly necessary to review the various types of specific gravity apparatus used in mineralogical work. The Westphal balance, Jolly balance, Kraus Jolly balance, Newton scale, Penfield's balance and other balances have been in general use for some time. It has also been customary to utilize analytical balances in determining specific gravity. Small crystals and powdered minerals can probably be determined most accurately with the aid of a pycnometer. Notwithstanding the large amount of equipment available it frequently happens that no satisfactory balance is at hand for a rapid determination which at the same time furnishes the desired accuracy. The balance about to be described has been developed to meet this need. It is believed that it combines the accuracy of determination possible with a beam balance with the speed attainable with a Jolly balance.

The instrument represents the results of a development program undertaken in cooperation with Mr. J. E. Seederer and Mr. F. S. Arguelles of Seederer-Kohlbusch, Inc., extending over a period of about eighteen months. It has been rebuilt repeatedly in the interim with considerable improvement over the original design.

A specific gravity balance suitable for most gem stones should be equally suitable for routine determinations of minerals and in most instances also suitable for more refined work where results falling just short of pycnometer accuracy are satisfactory. The range should extend from about 1 carat (0.200 gram) to 125 carats (25 grams). Throughout this range it should be possible to make determinations of specific gravity with the maximum accuracy attainable with water suspension.

The balance developed has a weighing range from 0 to 150 carats (0 to 30 grams). Weighing is correct to the nearest milligram. Gems weighing as little as one-fifth of a carat have yielded reliable specific gravity determinations although it is necessary to estimate fractions of a milligram in weighing such small stones. Six small Montana sapphires were weighed (each less than one-fourth carat) and yielded an average specific gravity of 3.99. Two small Herkimer County, New York, quartz crystals each weighing about 1 carat yielded specific gravities of 2.67.

Above 5 carats (1 gram) specific gravity determinations have been found to agree reasonably well to the third place of decimals.

The balance is entirely a beam balance and weighing is accomplished without recourse to loose weights by means of a system of notches and sliding riders on the beam. The entire operation is based upon the arm and lever principle of mechanics, weight in air being determined by moving riders on the left-hand side of the balance beam, and loss of weight in water being determined by moving similar riders on the right-hand side of the balance beam. Use of this principle makes the weighing not only simple but accurate within the limits of error necessary for most practical purposes. Rapid check weighings to the nearest milligram have been obtained repeatedly. This is sufficient to give the specific gravity to the third decimal place for gem stones of commercial size. In the case of mineral specimens the accuracy appears to be considerably greater than is obtainable with scales employing the spring balance principle, particularly for minerals with a high specific gravity. At the same time, the speed of weighing is approximately the same.

The specimen is held during weighing in the usual way, first on a pan in air, second on a pan immersed in water suspended from the bottom of the first pan by means of a fine platinum wire. Two perforated pans of different sizes are provided for weighing specimens in water. When not in use the pans hang from hooks on one side of the balance frame.

The glass jar holding distilled water is arranged on an elevator platform so that the water level can be kept constant by raising and lowering the jar. A small pointer is attached to a standard by the side of the jar. The pointer is lowered into the jar to serve as a measure of the water level. Raising and lowering the jar is accomplished by turning a wheel just below the balance case on the right-hand side.

The arrangement of the riders on the balance beam is shown in Fig. 1. The beam is arranged in three levels on either side. The upper level on each side is graduated into 100 equal divisions each measuring one milligram. On the left side decimal parts of a carat are also indicated so that the scale may be used as a balance for weighing gem stones if desired. The second level on each side is cut with two sets of notches. One rider and a set of notches at 100 mg. intervals weighs from 0 to 1 gram. Another rider and another set of notches at 1 gram intervals weighs from 1 gram to 5 grams. The third level on the left-hand side has a single rider and notches arranged at 5 gram intervals from 0 gram to 25 grams. The third level on the right-hand side of the beam is arranged with one rider and cut with notches to weigh at 5 gram intervals from 0 to 10 grams. By using the second and third levels together it is possible to weigh from 0 to 30 grams on the left of the beam.

Weight in air is obtained on the left-hand side of the balance beam and loss in water on the right-hand side of the beam. Dividing the weight in air by the loss in water yields the specific gravity in the usual way. Temperature corrections may be applied as in any specific gravity determinations.

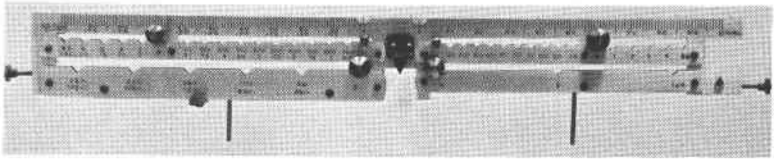

FIG. 1. The balance beam showing the arrangement of the notches and riders adopted in order to avoid the use of loose weights in specific gravity weighings.

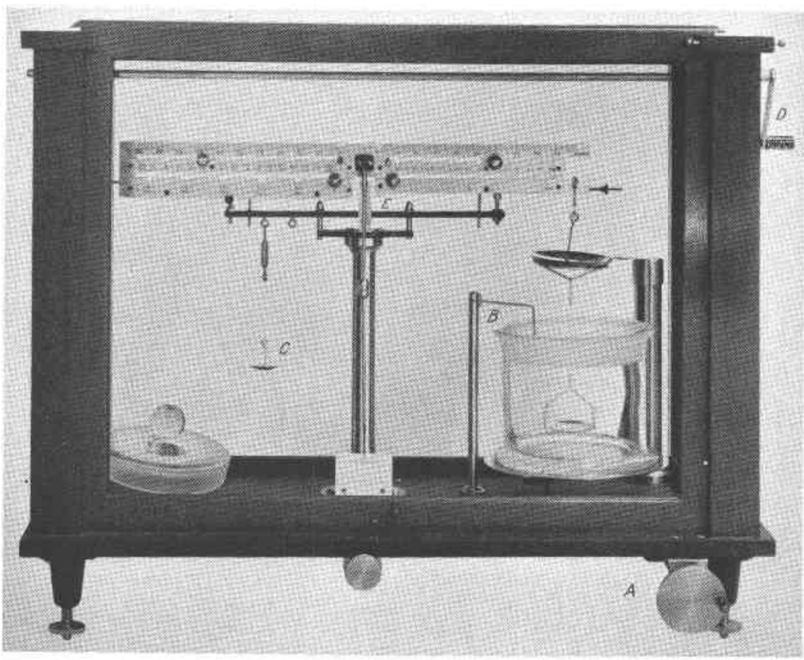

FIG. 2. The complete specific gravity balance assembled in a glass case.
A—Motion for raising and lowering the water jar.
B—Pointer for keeping the water level in the jar at a uniform elevation.
C—Extra pan with a counter balance for weighing small solids.
D—Arm connected to a pulley for raising and lowering the front of the balance case.
E—Balance beam.

The entire assembly is shown housed in a glass case in Fig. 2. The balance can be operated without a case, however, it has been found necessary to provide protection against air currents and dust if reasonable accuracy is desired. The housing is an ordinary balance case and the standard holding the beam is also of the type usually provided for chemical balances.

A considerable number of determinations have been tried with the balance under a variety of conditions, in order to ascertain not only the probable accuracy of determinations to be expected but in an attempt to find out whether any of the ordinary materials apt to be encountered would be beyond the range of the instrument. A few examples of such determinations are shown in table 1. Two sets of weighings and the resulting specific gravity are given for each sample. The different weighings were made on different days and with one exception by different individuals.

In conclusion thanks should be given to both Mr. Arguelles and Mr. Seederer of Seederer-Kohlbusch, Inc., for their kindness and cooperation in developing the instrument.

TABLE 1

EXAMPLES OF SP. GR. DETERMINATIONS WITH IMPROVED BALANCE

	Wt.	Sp. Gr. at 4° C
Quartz, clear crystal Ellenville, N. Y.	25.018	2.647
	25.017	2.647
Iceland spar	2.837	2.708
	2.839	2.704
Synthetic ruby	5.302	3.989
	5.303	3.989
Galena, Galena, Kansas	18.269	7.584
	18.271	7.586
Gold nugget	25.203	15.971
	25.203	15.960