thallium and lead are mentioned, and the possible use of some of them in analytical work, indicated.

4. A corresponding series of double salts with lead and the alkali metals has been prepared.

In conclusion we wish to state that we are continuing the study of cobaltinitrites and their application to analytical work—particularly the application of the silver-potassium cobaltinitrites to the quantitative determination of potassium.

A COLORIMETER FOR RAPID WORK WITH WIDELY VARYING STANDARDS.

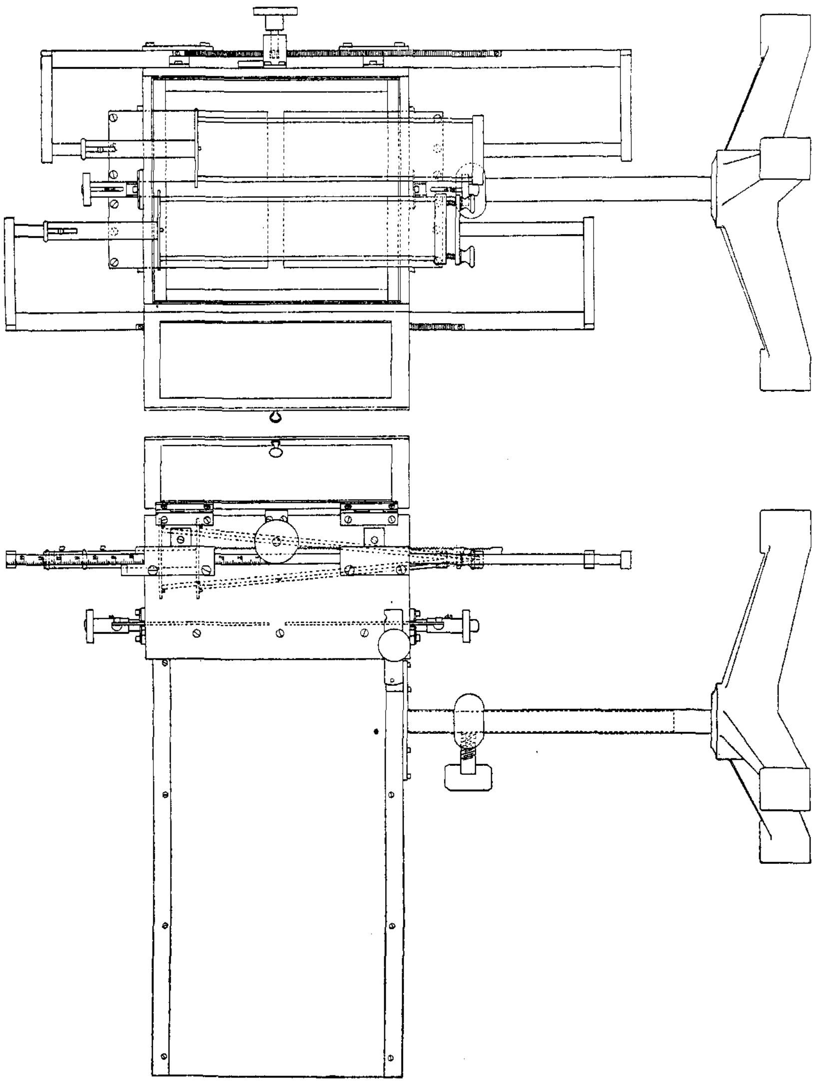
By Charles H. White.

The intensity of the color of a solution depends upon three elements, or factors. They are the quantity of coloring matter used, the volume of the solvent in which it is held, and the thickness of the solution through which the light passes before entering the eye. It is well known that if we keep two of these quantities constant and vary the third in a determinate way until two solutions are alike in color, we can estimate the quantity of coloring matter in one, if the quantity in the other is known. These three variables form the basis of the three classes of methods in colorimetry, and of the three types of colorimeters. When two solutions are brought to agreement in color by the addition of coloring matter to one, the amount added is the measure of that in the other. If the agreement is effected by dilution, the coloring matter is then proportional to the volumes. If they are brought to equality by changing the thickness of the sections observed, the quantity of coloring matter is then inversely proportional to the measurements of these sections.

This instrument is a modification of a colorimeter devised by the writer for the determination of carbon in steel.[1] With it comparisons are made by the third method: that is, the thickness of the section of solution examined is the variable. It consists essentially of two wedge-shaped hollow glass prisms of exactly equal dimensions and open at the large end for the introduction of the solutions to be tested. The wedges are held in a vertical position side by side in a camera and may be raised or lowered by rack and pinion actuated by thumb screws. The prisms are screened from view on the side towards the operator except for a narrow horizontal slit across the middle of the camera through which the solutions are observed when a test is being made. The carriers are graduated to correspond to the length of the wedges, the zero of the scale being opposit the index when the sharp edge of the wedge is opposit the narrow opening in the screen through which the color is observed. The screens are

[1] *Trans. Am. Inst. Min. Eng.*, 38, 559–564.

adjustable so that the opening may be varied to suit the operator. The ground glass shutter at the forward end of the camera for diffusing the light is hinged in the manner of a door to facilitate the transfer of the wedges to and from the camera. The camera is mounted on a stand upon which it is free to turn in a horizontal plane, which renders it unnecessary to lift the instrument from its position while in use.



To carry out a determination with this instrument it is only necessary to dissolve and dilute to equal volumes equal quantities of the standard and of the material to be tested. Pour into the wedges convenient amounts of the two solutions, set the wedge containing the unknown at the graduation representing the percentage—or some multiple of it—of the coloring matter in the standard. Adjust the wedge containing the standard until the two agree in color. The percentage of coloring matter in the unknown is then indicated by the reading of the scale on the carrier containing the standard. Vertical sections through the two solutions parallel with the line of sight are similar triangles, the base of each being the thickness of solution at the point compared. It follows then that the readings on the graduated scales, since they represent the altitudes of these triangles, are measures which express the ratio existing between the amounts of coloring matter in the two solutions.

A colorimeter for general use, especially where a great many determinations have to be made in the shortest possible time, should be designed with not only the theoretical perfection of the instrument itself in mind, but also with regard to the effect of its use upon the operator. The operation of the instrument must not unduly fatigue the eye, for the most skilled operator with the best apparatus cannot produce accurate results if his eye loses its sensitiveness to changes of color. It has been learned by experience that the eye is little fatigued and therefore retains its sensitiveness if the apparatus is so constructed that both eyes are used in making the tests, also that the eyes should be protected by a camera from side lights, that the colored areas compared should not be too far apart —though it is unnecessary to have them separated only by an invisible line—and that uniform white light should be visible around the colored spots compared. My experience has indicated that the eye is not rendered sensitive to color by darkness, but that it is rendered so by light, and I have obtained better results by looking directly at the solutions than by bringing the colors into juxtaposition by the use of any optical device that I have tried so far.

As a result of experience, the original design of this instrument has been modified to conform to these ideas. In its present form the instrument has been tested, chiefly in the determination of carbon in steel, and these tests indicate that it has several features to recommend it. The accuracy of the work done with it appears to be limited only by the sensitivity of the eye to color changes. The maximum error, as far as tests have been made, has been 0.6% in a single reading, and this was considerably reduced by averaging several readings. The majority of the determinations of carbon have agreed with the percentages obtained by combustion to the second decimal place. The comparisons are made with great rapidity. After the material is in solution the test can be completed within half a minute, and any number of readings may be taken and the results averaged without changing the volume of the solutions. The operator can not see the graduated scales while making the comparison and, therefore, can not be influenced by preconceived ideas. The work may be checked by making tests at different points throughout the length of the wedges, especially in cases where the color is too dense or too faint for the most accurate comparison at the first point tested.

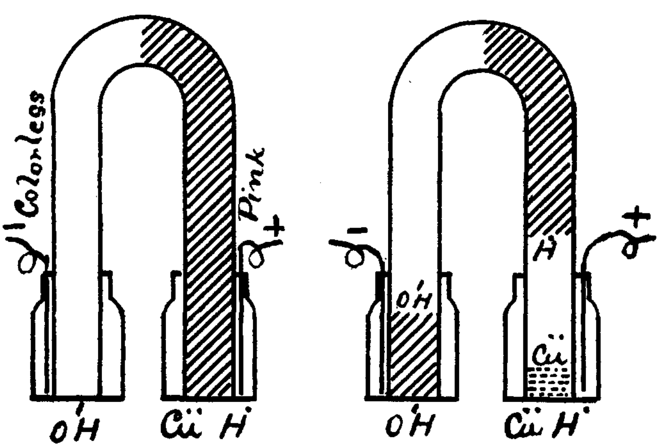
The wedges are as easily emptied and filled as test tubes so that passing from one determination to the next is quickly and easily effected. If great rapidity is desired more than one set of wedges can be used. While one operator makes the comparisons, others can be preparing the determinations which are to follow. The possibility of using any section of the wedge from its thinnest to its thickest part renders the apparatus adaptable to a wide range of determinations, and permits of much variation in the quantity of substance taken for the test.

The colorimeter is sold by Eimer and Amend of New York City.

HARVARD UNIVERSITY, CAMBRIDGE, MASS.

NOTES.

A Modification of a Previously Described Experiment on the Migration of Ions.—A lecture experiment illustrating the rates of migration of different ions was described some years ago by Noyes and Blanchard.[1] Unless this experiment is very carefully performed, it sometimes happens that the demonstration of the direction and relative speed of migration of the copper, hydrogen and hydroxyl ions is rendered inconclusive by the



uneven front presented by the line of march. There frequently happens an irregular diffusion downward into spaces between the agar-agar and the walls of the U tube.

[1] THIS JOURNAL, 22, 726 (1900).