core of the magnet to keep the former from sticking after the exciting current is stopped. The current connections are shown in the diagram as dot and dash lines. The current passes from the switch to one side of the three heating coils. From the other side of the coils it passes through the interrupter back to the switch. All make-and-break contacts are made of platinum and where the wires or current-carrying bolts pass through the walls of the air bath they pass through glass bushings.

In the operation of the air bath the switch is closed and then the contact adjusting screw of the thermostat is turned until contact is made. This will be shown by the lamp lighting and if properly adjusted the magnet will draw the armature up and close the heating circuit. In a short

time the rise of temperature will break the thermostat circuit and the magnet being killed will release the armature so that the spring will pull the heating circuit contacts apart. To bring the air bath to the desired temperature the thermostat contact screw is turned until the make-and-break action occurs at that temperature as shown by a thermometer inserted in the air bath in the usual manner. The air bath constructed by the writer holds its temperature to within 1° . It requires 2.5 amperes of current at the start and drops to 2.35 at 100°C . The cost of the materials required to make the air bath electrically heated and controlled was \$1.50, exclusive of the platinum contact points.

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ADDRESSES

STELLITE AS A SUBSTITUTE FOR PLATINUM¹

By ELWOOD HAYNES

Owing to the great scarcity of platinum and its consequent high price, platinum substitutes have been eagerly sought, particularly within the last three or four years. From what has already been accomplished along this line it is evident that no single metal or combination of metals will fully take the place of platinum. There are certain other of the polyxene metals associated with platinum, which possess refractory power superior to those of platinum, but unfortunately these are out of the question, since the metals themselves are more costly than platinum.

The alloy of gold with palladium affords a partial substitute for crucibles and dishes, and perhaps comes more nearly filling the place of platinum in this respect than anything yet offered. The price of this alloy, however, is comparatively high, though bulk for bulk, it is only about half as costly as platinum.

The alloy of nickel with chromium, known as chromyl, discovered by the writer in 1899, though less refractory, affords a partial substitute for platinum for electric resistance coils employed as heating units for combustion tubes, small electric furnaces, etc. The same alloy, used in conjunction with pure nickel or certain nickel-silicon alloys, is also employed for making thermocouples for determining high temperatures.

The silicon-iron alloys are now employed to a considerable extent for evaporations, and even for concentrating the strong mineral acids, but they are rather heavy and somewhat easily broken or cracked.

Pure quartz or silica vessels give excellent results within certain limits, and while they are practically unbreakable under sudden changes of temperature, they are fragile when subjected to sudden shocks or blows, and while they may be used for evaporating solutions to dryness, they are likely to be cracked if the residue sticks to the vessel, particularly if the coefficient of expansion of the residue is higher than that of the vessel.

A short description of the Stellite alloys may be introduced to advantage at this point. First, it may be said that these alloys are not fixed or definite in their composition, and may be divided broadly into two classes: (1) those malleable at a red heat; and (2) those which can be worked into the desired form only by casting.

The MALLEABLE ALLOYS are composed almost entirely of cobalt and chromium only, though the proportion of the constituents may vary from 10 to 50 per cent chromium, with a corresponding variation in the cobalt. These alloys are all hard, and while they may be scratched by the file, none of them is practically workable by this means. They cannot be machined, but some of the softest ones may be drilled by means of a hard-carbon steel drill or a drill composed of hard stellite. They resist nitric acid almost perfectly, even when boiling, particularly if the chromium content is over 15 per cent. They forge with difficulty at temperatures ranging from 750 to 1200°C .

They have been forged into the following forms:

- (a) Tableware, such as spoons, forks, knives, ladles, etc.;
- (b) Surgical instruments, pocket knives, dental instruments, etc.;
- (c) Evaporating dishes, crucible supports, lamp stands, etc.;
- (d) Jewelry, including finger rings, cuff buttons, scarf pins, etc.

These malleable alloys are all slowly attacked by either hydrochloric, sulfuric, or hydrofluoric acid, but are nearly immune to all chemical combinations, as well as the fruit acids. As the evaporating dishes made of this metal take a bright polish, and can be made of comparatively light section, they will prove suitable for evaporating many chemical salts to dryness, and are particularly suitable for boiling the caustic alkalis. Substances may be evaporated to complete dryness in these vessels without any danger whatever of breaking the vessel, since the tensile strength of the alloy exceeds 100,000 lbs. to the sq. in., and it also shows considerable elongation before rupture. When a vessel made of this material is struck by a hammer, it emits a clear, musical tone, and continues to vibrate for a considerable length of time. The vessels retain their luster in the chemical laboratory under practically all conditions, since they are not affected in the slightest degree by sulfuretted hydrogen, ammonium chloride, or other vapors. Furthermore, they are practically immune to acid vapors. They give most excellent results in the form of lamp stands, supporting rings, triangles, etc. When these are heated to full redness, they become covered with a deep blue-black film, which does not change either in weight or appearance by repeated heating, and as no scale ever forms, these articles retain their weight, stability, and smooth surface indefinitely under all sorts of use. They can be subjected to temperatures up to 1200°C ., and still retain a considerable amount of strength. In fact, the Stellite alloys possess the highest "red hardness" of any of the alloys yet discovered.

¹ Presented at the Metallurgical Symposium, 55th Meeting of the American Chemical Society, Boston, September 10 to 13, 1917.

JEWELRY

The chemist is, as a rule, not much interested in jewelry excepting from a scientific standpoint. He is vitally interested, however, in the fact that the demand for platinum in jewelry has rendered the price of this material so high that it is almost unobtainable. Unfortunately, the demand for platinum in this line is largely based upon its high price. Comparatively a small amount was used in jewelry until after the price of platinum exceeded that of gold. It then became a fad, amounting almost to a mania, to substitute platinum for gold, wherever one's means would permit of doing so. All efforts to produce a substitute for platinum, which would give results equal or superior to that metal in many respects, have proved almost futile, since the very evil which these attempts have sought to remedy is held up by the purveyors of platinum jewelry as a virtue; namely, its high price; and notwithstanding "a rose by any other name would smell as sweet," it must in the eyes of fashion also *cost as much, or more*; in fact, the more the better. Whether this condition is to continue indefinitely or be limited by a legal enactment is a question for our Government to decide. Fashion, like fortune, is fickle, and may change radically at almost any instant.

Stellite would in many cases substitute to great advantage for platinum in jewelry. It is almost the same color, possesses a higher luster, and retains its luster very much better than platinum, since it is so hard that it is not easily scratched or abraded by ordinary use. It is absolutely immune against tarnish or corrosion in the air, and while it is not nearly so pliable as platinum, it can be worked into many of the forms used in jewelry without special difficulty. Finger rings can be made from it either in the plain form, or adapted to the Tiffany setting, so that it may be used in conjunction with any gem desired. If preferable, plain band rings can be made of the cast metal, which are practically file-proof, and at the same time possess a beautiful color and permanent luster.

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THE INFLUENCE OF ADDED SUBSTANCES ON THE END-POINT IN THE IODOMETRIC TITRATION OF HYDROGEN SULFIDE

By ALFRED R. JAYSON AND RALPH E. OESPER¹

INTRODUCTORY

Wide use is made of the reaction

in estimating the sulfur content of systems or materials containing this element either as hydrogen sulfide or as other compounds easily converted into hydrogen sulfide. Furthermore, such metals as zinc, cadmium,² etc., whose sulfides are readily soluble in acid, may be determined by isolating the sulfide, dissolving it, and titrating the resulting hydrogen sulfide with standard iodine.

The evolution methods of determining the sulfur content of irons and steels are in common use. The sample is dissolved in acid and the evolved hydrogen sulfide absorbed in a reagent whose nature is usually determined by whether the subsequent course of the analysis is to be a gravimetric, colorimetric or volumetric process. Numerous absorbents have been proposed,³

¹ The work reported in this article constitutes the basis of a thesis submitted by A. R. Jayson to the Faculty of the Graduate School of New York University, in part fulfillment of the requirements for the degree of Master of Science.

² von Berg, *Z. anal. Chem.*, **26** (1887), 23; Müller, *Bull. soc. chim.*, [4] **1** (1907), 13; Ibbotson and Aitchison, "Analysis of Non-Ferrous Alloys," **1915**, 168; Scott, "Standard Methods of Chemical Analysis," **1917**, 87.

³ Compilations and abstracts of the various proposals have been made by Brearley, *Chem. News*, **82** (1900), 306; Pulsifer, *THIS JOURNAL*, **8** (1916), 1119.

but those most generally employed in connection with the iodometric estimation of the hydrogen sulfide liberated are: sodium or potassium hydroxide; ammoniacal zinc solution or ammoniacal cadmium solutions. After absorption, these solutions or suspensions are made strongly acid and titrated with iodine in the presence of starch. The reaction between iodine and hydrogen sulfide takes place in the presence of a considerable quantity of acid and under these conditions the end-point is uncertain, for an excess of iodine is not made manifest by a sudden change from colorless to blue, but even in the early part of the titration the solution turns yellow, and passing through orange, red and purplish red, deepens, and forms a final purple instead of a pure blue. This difficulty may be overcome in part by standardizing the iodine solution by means of a sample of known sulfur content carried through the same procedure, but this is often inconvenient. It is better to add an excess of iodine to the acidified solution and titrate back with thiosulfate, as this gives a sharp end-point.

The appearance of the interfering colors is a matter of common knowledge and is usually ascribed to the presence of erythro-dextrin or similar products of the hydrolysis of starch, though this is still an open question. Indeed, the real nature of the blue color produced by starch itself and iodine is still a matter of dispute.¹ Some have asserted that it is a mere physical phenomenon; others claim the existence of a definite compound, though the actual composition appears to vary with the concentration, temperature, etc., while still others view this as a case of adsorption. Harrison,² in particular, holds this latter view. He claims that the blue material is a colloidal suspension of iodine, starch acting as a protective colloid. He further states that starch, dextrans, starch-celluloses, etc., do not differ chemically but are merely different degrees of dispersion of the same substance. The various colors produced by these materials and iodine may be produced by addition of alcohol to aqueous starch iodide suspensions and *vice versa*; by warming and cooling; by addition of salts; processes which he holds merely change the degree of dispersion and consequently the protective action of the starch. As this decreases, iodine tends more and more to form true solution, and hence the color changes.

The influence of salts and other added substances upon the color produced by iodine and starch has been studied by Fresenius,³ Meineke,⁴ Pinnow,⁵ Lonnes,⁶ Burgstaller,⁷ and others. In general, salts increase the sensitiveness of the action and potassium iodide is particularly effective.⁸ However, excessive salt addition decreases the sensibility and often leads to changes in the starch so that yellows and reds appear when iodine is added. Meineke claims that large quantities of salts bring about a partial change of starch into materials less sensitive to iodine or into dextrans coloring red or yellow, *i. e.*, shades less noticeable than blue. Harrison ascribes this action of salts to changes in the degree of dispersion of starch. Hale⁹ found that ordinary starch contains as impurities, erythrodextrin, coloring red with iodine, and amidulin, coloring blue. The change of amidulin to erythrodextrin is catalyzed by potassium bicarbonate in the presence of an oxidizing agent and he thus explained the red

¹ Comments and references to the original papers may be found in Dammer, "Handbuch der anorganischen Chemie," **1** (1892), 549; **4** (1902), 229; Beilstein, *Ibid.*, **1** (1893), 1085; Suppl. I (1901), 588; Thorpe, "Dictionary of Applied Chemistry," **5** (1913), 157; Katayama, *Z. anorg. Chem.*, **56** (1907), 209.

² *Z. Koll. Chem.*, **9** (1911), 5; *Proc. Chem. Soc.*, **26** (1910), 252.

³ *Ann.*, **102** (1857), 184.

⁴ *Chem.-Ztg.*, **18** (1894), 157.

⁵ *Z. anal. Chem.*, **41** (1902), 485.

⁶ *Ibid.*, **33** (1894), 409.

⁷ *Chem.-Ztg.*, **36** (1912), 589.

⁸ Washburn, *J. Am. Chem. Soc.*, **30** (1908), 45; Treadwell and Hall, "Analytical Chemistry," **2** (1907), 513.

⁹ *Am. J. Sci.*, [4] **13** (1902), 379.