These investigators consider that Expt. 4 with chromium and Expt. 5 with copper fall in the range of concentration where the accuracy is constant and a maximum. The normal perceptible difference for chromium is therefore about 7 per cent. and for copper 8 per cent. This appears to be almost the same as for titanium, 6.5 per cent.

Summary.

The accuracy of the colorimetric estimation of titanium is practically constant over concentrations ranging from the strongest down to those containing about 1.5 mg. TiO_2 in 100 cc. The change in concentration required to produce a perceptible difference in intensity between two solutions, at favorable concentrations, was found to be about 6.5 per cent. which does not differ much from the results of others with chromium and copper solutions. With suitable precautions, such as comparing by substitution and taking the mean of several settings or of the two perceptibly different extremes, the accuracy of the colorimetric comparisons appears to be about 2 per cent.

WASHINGTON, LABORATORY OF THE U. S. GEOLOGICAL SURVEY.

[DIVISION OF CHEMISTRY, HYGIENIC LABORATORY, UNITED STATES PUBLIC HEALTH AND MARINE-HOSPITAL SERVICE.]

A CRUCIBLE FURNACE.

BY NORMAN ROBERTS AND F. ALEX. MCDERMOTT.

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The chief feature of this furnace consists in the replacement of the greater part of the usual solid clay or earthenware wall by an equal or greater thickness of a non-conducting refractory powder, such as light magnesia, kaolin, or even sifted ashes. As compared with a furnace having solid walls composed of clay or some similar substance, the furnace is lighter, cheaper in construction, quicker in heating, and better insulated—hence, it gives a higher temperature and is more economical as to fuel—and wear or damage of any kind is much more circumscribed and accessible and much more easily and cheaply repaired. The insulating layer can be made as thick as desired, with corresponding reduction in the leakage of heat, especially in the region of highest temperature; whereas the practicable thickness of a clay wall is sharply limited by the tendency to crack on change of temperature common to all large masses of poor heat conductors.

This furnace has so far been constructed only in the form of a small gas-fired crucible furnace, with the flame entering at the bottom. In its simplest form it can be improvised in a few minutes from the commonest and most worthless of waste materials. A large cylindrical ether or oil can serves for the outer container; a shovelful of sifted hard-coal ashes, for the insulator; and a bottomless tin can, or a sheet of iron (black, tinned or galvanized) rolled into a cylinder, or a short length of cylindrical iron rain spout or stove pipe, for the inner lining. For a more durable form the inner lining may be a cylinder of clay, graphite, etc., but for all temperatures below the melting point of iron, the sheet iron lining is most satisfactory, inasmuch as it can be replaced in a few seconds and at an infinitesimal cost when it burns out, can be handled with absolutely no danger of breaking, and heats up much faster than any more expensive and more massive lining.

The crucible is supported on a triangle of fireclay pipestems of uniform diameter, strung on a single piece of thick iron wire, the wire exposed at the bends being protected by asbestos paste or wrappings of asbestos twine. The triangle is supported on top of a short roll of sheet iron or a clay or iron cylinder (a short length of iron pipe of sufficient diameter will do) which rests on the bottom of the outer container (see Fig. 1).

The lid may be made merely of a circular disk of sheet iron, with a hole in the center, or it may be made of asbestos-board, or of several layers of asbestos-board reinforced with thin sheet iron, or of clay.

It is of advantage to cover the bottom of the outer container inside, under the powder insulation, with a layer of loose asbestos, to prevent the powder leaking out where the joints may not be tight.

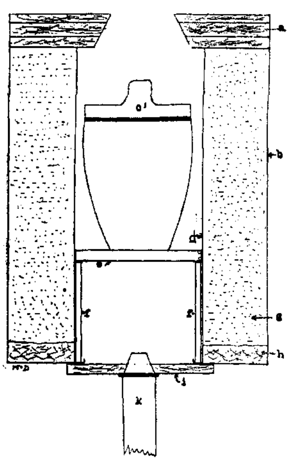

Fig. 1.—Simple form of furnace.

a, Cover, or lid, made of three sheets of asbestos board interspaced with thin sheet iron; *b*, outer container (tin can); *c*, crucible and *c′*, crucible cover; *d*, sheet iron lining (inner container); *e*, supporting triangle for crucible; *f*, iron ring supporting triangle, and resting on bottom of furnace; *g*, powder lining (insulator); *h*, asbestos mat at bottom of outer container; *i*, movable bottom, mounted on nozzle of burner; *k*, nozzle of Fletcher blast lamp.

The burner may be an ordinary Bunsen, a Teclu, or a blast lamp. In any case the burner supports a movable bottom which partially or entirely closes the bottom of the central tube (inner container). With the blast lamp this bottom is a disk of thick asbestos board, backed with sheet iron, with a hole in the center fitting closely around and sitting firmly on the conical nozzle of the lamp (Fletcher's compound No. 20), and approximated closely to the bottom of the outer container so as to exclude all air except that furnished by the blast. The natural-draft burners need additional air from outside, and hence with them the disk is mounted on a sliding tube provided with a set-screw, so that the whole may be moved up and down by burner tube, thus increasing or decreasing the amount of outside air drawn into the furnace.

In case the furnace is to be worked at a temperature approaching the melting point of iron, the lining and crucible support must be of more refractory construction. To this end the lining may be improvised of two graphite crucibles placed vertically bottom to bottom, a large hole being cut through both bottoms. This makes a "corset-shaped" chamber, the upper compartment being large for the crucible containing the material being heated, and the lower compartment being smaller for the flame. Just above the "waist" three projecting knobs (*a*, Fig. 2) of graphite, 120° apart in a horizontal circle, are set into the walls at such a point as to hold the bottom of the crucible well above the "waist," and leave three narrow but sufficient channels for the flame.

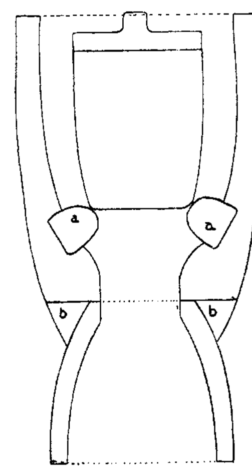

Fig. 2.—"Corset-shaped" graphite lining, composed of two graphite crucibles, base to base, showing supporting plugs (*a*), and small crucible in place. *b* is a ring of asbestos plaster around the joint between the two crucibles.

To minimize the effects of cracking, which may occur with a non-metallic lining, the lining is wrapped with asbestos cord, with or without a thin coat of asbestos plaster. If the graphite linings were made to order, better results would doubtless be had. We are now in correspondence with a well-known graphite firm, to this end.

This form of furnace lends itself readily to the addition of arrangements for preheating, the air or both the air and gas being heated in coils of pipe in a chimney above the combustion chamber, and led down in pipes through the powder just outside the lining, to the bottom. The preheating coils are thus readily accessible.

Of course the crucible may be supported in other ways than as described. If obtainable, a circular support of graphite, clay, or iron, with three prongs projecting inwards, or inward and upward, may be used with advantage, instead of the triangle. Further, either this support or the triangle arrangement might be so adapted as to be attached to the movable bottom fastened to the burner, thus admitting of the removal of the furnace from around the crucible without disturbing the latter, which is sometimes of advantage. Or by using a crucible molded with projecting lugs near its upper edge, fitting into corresponding lugs on the interior of the furnace, the entire bottom and sides of the crucible could be exposed to the flame, without the intervention of any supporting points.

This furnace, with both iron and graphite linings, has been used a number of times, and has shown its ability to melt copper and brass readily, and with more difficulty, cast iron.

It has been observed in the use of this furnace, that paper pasted on the outside of the outer container was charred only to a light brown, even when the furnace was maintained for several hours at the melting point of copper or even cast iron, during a part of which time a portion of the flame played about the outside of the flame-opening at the bottom; the powder lining in this case was an inch and a quarter thick. On the other hand, a furnace with solid clay walls one and one-quarter inches thick (Hoskins No. 2), when maintained at a similar temperature for an hour, completely blackened paper pasted on the outside.

For small work, a convenient size for the outside container is that of a 5-pound ether can, six inches in diameter by seven inches high, while the sheet-iron lining may be made two and one-half to three inches in diameter, and seven inches high. The same principles of construction may be applied to furnaces of practically any size and shape.

The drawings are self-explanatory.

WASHINGTON, D. C.

SULFITE METHOD FOR SEPARATING AND IDENTIFYING CALCIUM AND STRONTIUM.

BY J. I. D. HINDS.

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The difficulty which beginners in qualitative analysis experience in the separation and identification of calcium and strontium has led me to seek a method which might be easier and more satisfactory than those now in use. By study of the table of aqueous solubilities we learn that strontium sulfite is sparingly soluble (0.033 gram to the liter), while calcium sulfite is quite soluble (1.2 gram to the liter), and that strontium sulfite is considerably less soluble than strontium sulfate (0.11 gram to the liter). As to barium and strontium sulfites, the difference in solubility is small and not sufficient for separation. All these solubilities are increased in acid solutions, but not to the same degree. In the presence of sufficient hydrochloric acid barium ion is precipitated by sulfite ion, while strontium ion is not; in dilute acetic acid solution barium and strontium ions are precipitated, while calcium ion is not.

In this investigation I used a freshly prepared concentrated (nearly saturated) solution of sodium sulfite. If the solution is kept long, the sulfate in it is increased by oxidation and the reactions are not typical. In finding the precipitation limits I used standard solutions of calcium and strontium chlorides.

In order to compare the efficiency of the commonly used calcium sulfate with that of sodium sulfite, which I propose as the precipitant, I