its reactions. The sulphate ($CaSO_4$) is more soluble, and its solution is precipitated by ammonic oxalate.

The materials of this group are also distinguished by their spectra, and by the colours they impart to a colourless flame. Barium gives a green flame, strontium a carmine red, and calcium a yellowish red. In making this test a clean platinum wire is dipped in a solution of the chloride, and held in the flame of an alcohol lamp or Bunsen burner.

### Separating Metals of Group Fourth.

To a solution containing the chlorides of the three metals, Ba, Sr, and Ca, is added a little sal ammoniac, and some ammonic carbonate. The white precipitate is collected upon a filter and carefully washed. It is then dissolved in dilute muriatic acid, and some alcohol and hydrofluosilicic acid added. The barium is thus all precipitated The filtrate is divided into two portions; to one add ammonia and sulphate of lime solution; if a precipitate forms in half an hour, the presence of strontium is proven. To the other portion add sulphuric acid and filter. This removes nearly all the strontium and a large portion of the lime. In the filtrate, however, there will remain enough lime to yield a precipitate with ammonic oxalate.

If hydrofluosilicic acid is not to be had, barium may be tested for with sulphate of strontium, or, in acetic acid solution, with chromate of potash.

The following table gives the usual method of separating these metals as above described :—

| Precipitated by $(NH_4)_2CO_3$. | | |
|---|---|---|
| Barium. | Strontium. | Calcium. |
| White. | White. | White. |
| Dissolve in HCl and add $H_2SiF_6$. | | |
| Precipitate. | | Solution. |
| Barium. $BaSiF_6$ | Strontium. | Calcium. |
| White. | Divided in two portions. | |
| | I. | II. |
| | Ammonia and sulphate of lime. in 30 min. | Add $H_2SO_4$ |
| | | Filter and add ammonic oxalate. |
| | Strontium. | Lime. |
| | White. | White. |

When the metals of this group exist in combination with phosphoric, oxalic, or boracic acids, they are precipitated in group third, and require a special method of separation to be described in a future article.

### Group Fifth.

This group embraces magnesium, sodium, and potassium, with the rare metal lithium. With the exception of the first they are characterised by their flame reactions.

Sulphate of magnesium $MgSO_4$, or Epsom salts, yields a white precipitate with ammonia, but if the solution contains ammonic chloride (sal ammoniac), a soluble double salt is formed. In general analysis it is necessary to add ammonic chloride before testing for group third, to prevent magnesium being precipitated in that group. With phosphate of soda $NA^2HPO^4$, a white precipitate is formed, characteristic of this metal.

Potassic chloride, KCl, in acid and neutral solutions, yields a yellow precipitate with perchloride of platinum. The most delicate way of testing for potassium is to evaporate the solution to be tested with the reagent nearly to dryness on a water-bath, and to treat the residue with a little alcohol, when the precipitate will remain undissolved. Tartaric acid produces a crystalline precipitate in strong neutral solutions. Compounds of potassium colour the flame violet, which appears red through a piece of blue glass. Hydrofluosilicic acid gives a white precipitate in strong solutions.

Sodium salts colour the flames intensely yellow.

Ammonium salts, heated with potash or lime, liberate free ammonia, which may be recognised by its smell, its action on test-paper, and its fumes when a rod moistened with muriatic acid is brought near it.

### Analysis of Alloys.

Having become familiar with the reactions of all the principal metals when in solution, the student is prepared to begin the complete analysis of any alloy.

In dissolving a metal or alloy, nitric acid is usually employed. A small quantity of the finely divided alloy is covered with concentrated nitric acid, and gently heated under a hood, in a fire place, or out of doors, for half an hour. If it dissolves completely, gold, platinum, tin and antimony are probably absent. The acid solution may now be placed in a porcelain dish, and evaporated almost to dryness, then diluted and analysed in the manner already described. The separation into groups is conducted according to the table :—

| Add HCl to solution. | | | | | |
|---|---|---|---|---|---|
| Solution. | | | | | |
| Group I.—Hg, Pb, and Ag. | Groups II., III., IV., and V. Add $H_2S$ to filtrate. | | | | |
| | Prec. | Solution. | | | |
| | Group II.—Hg, Pb, Bi, Cd, Cu, As, Sb, Sn, Au, Pt. | Groups III., IV., and V. Add $NH_4HO$ and $(NH_4)_2S$. | | | |
| | | Prec. | Solution. | | |
| | | Group III.—Fe, Co, Ni, Mn, Zn, Al, Cr, U. | Groups IV., and V. Add $(NH_4)_2CO_3$. | | |
| | | | Prec. | Solution. | |
| | | | Group IV.—Ba, Sr, Ca. | Group V. Mg, K, Na, Li. | |

## THE MACHINE ROOM AT THE VIENNA EXHIBITION

Our engraving on page 295 is from the *Illustrirte Zeitung* of Leipsic and represents a view in the machinery department at Vienna. The large machine on the right is a double steam engine of one hundred horse power, by Sigl, of Berlin. Near to this is the great sugar refining apparatus by Heckmann, of Berlin.

The sign *Oesterreich* at the left, signifies Austria; that under the banners, *Deutsches Reich*, signifies German Empire.

## THE MONONGAHELA BRIDGE.

The Pennsylvania Railroad crosses the Monongahela river at Pittsburg by a bridge of eleven spans, amounting to a total length of 1622 feet. The superstructure was at first constructed of timber with the exception of the channel span, 260 ft. long which was built of iron. The East span has lately been replaced by an iron structure which we illustrate on page 294 The illustration is from the columns of *Engineering*. The following are the principal dimensions:

| | ft. | in. |
|---|---|---|
| Length of span, centre to centre of end pins.... | 182 | 0 |
| Number of trusses in span ..... 2 | | |
| " main panels in each truss..... 6 | | |
| " sub " " ..... 12 | | |
| Length of main " " ..... | 30 | 4 |
| Distance centre to centre of trusses..... | 19 | 0 |
| Height of truss, centre to centre of chord pins... | 22 | 10 |
| Height from top of masonry on bridge seat to base of rail..... | 4 | 11 |