the air from speaker to hearer by means of waves, condensation and rarefaction, which affect the drum of the ear. Wheatstone, as early as 1831, showed that these waves could be transmitted from one place to another at a moderate distance through wooden rods, and afterward conveyed to the ear by the vibrations given to the air by the end of the rod. Similarly, vibrations given to one diaphragm to produce the corresponding vibrations in another diaphragm at a distance by means of electric currents was the problem of the electric telephone. The first to propose this appears to have been Charles Bourseul, who, in 1854, suggested the use of two plates, one at the transmitting station, which, by the varying pressure of the air due to the sound waves, would open and close an electric circuit, while the other was to be acted on at the receiving station by an electromagnet, through which the electric currents passed.

In 1861 Philip Reis, of Friedrichsdorf, proposed in a lecture delivered before the Physical Society of Frankfurt, to use an instrument which he called a telephone, for the production at a distance of music and human speech. The apparatus consisted of a flexible membrane, forming one side of a box, with which, by means of a mouthpiece, the sounds could be directed. This instrument was made to open and close an electric circuit at each vibration. At the receiving end an electromagnet consisting of a thin rod of iron surrounded by a coil was placed. The successive interruption and closing of the electric circuits was in accordance with a discovery made by Dr. Page, of Salem, Mass., in 1837. This method could not be successful for speaking for the simple reason that speech has more characteristics than pitch, and was only partially successful for musical sounds. To produce not only corresponding vibrations, but also loudness and quality of the sounds, evidently required a transmitter and receiver which did not depend for its action on such interruptions of the current, but which varied the current in a pulsatory manner similar to the variations of pressure on the diaphragm due to the waves.

Such an apparatus of a very perfect type was produced by Graham Bell in 1876, who, in the description of his apparatus given in his patents and elsewhere, shows that he thoroughly understood what had to be done. We all know that the instrument which he produced did it. Since the publication of Bell's invention a great many modifications have been produced. Most of them, however, have been held to be similar in principle to Bell's. One field of investigation has, however, been fruitful of improvement. In the original patent of Bell, and in a caveat filed almost simultaneously by Gray, it is pointed out that the variations of the current may be produced by causing the vibrations of the diaphragm to vary the resistance of the circuits. This idea has proved of great value in increasing the loudness of the sounds given out by the Bell telephone used as a receiver. A great many forms of these "microphone" transmitters have been invented. Among those who have made important contributions to this subject we may mention Berliner, Edison, Gray, Blake, Gower and Hunning.

Another form of telephone has been proposed by Prof. Dolbear. In this telephone system one diaphragm of the receiver is made to form one plate of an electric condenser, and the varying force on this plate due to the fluctuations of the charge causes it to vibrate in response to the varying electro-motive force produced by the transmitter. This condenser telephone can evidently be used either as a transmitter or receiver.

Another interesting discovery in this subject should be mentioned, namely, the transmission of speech from one place to another by variations in a beam of radiant heat or light. This is based on the discovery of the variation of the electric resistance of selenium when exposed to light or radiant heat. The experiments of Bell and Sumner Tainter have shown that, if a beam of light be reflected from a mirror to a bar of selenium which is in the circuit of a telephone and battery, the telephone will repeat words spoken to the mirror.

SUMMARY OF USEFUL TESTS WITH THE BLOWPIPE.*

By A. J. MOSES.

THE following selection includes only the tests used in the instruction at the Mineralogical Laboratory of the School of Mines. It is believed that the omitted tests have always been omitted for cause, either as less characteristic or less easily obtained, or from the need of some unusual or not easily handled reagent.

The details of ordinary manipulations, such as obtaining beads, flames, coatings, and sublimates, are omitted, and the results alone stated; unusual manipulations are described. The bead tests are supposed to be obtained with oxides; the other tests are, in general, true of all compounds not expressly excluded. The course to be followed in the case of interfering elements is briefly stated.†

ALUMINUM, Al.

With Soda.—Swells and forms an infusible compound.
With Borax or S. Ph.—Clear or cloudy, never opaque.
With Cobalt Solution.—Fine blue when cold.‡

AMMONIUM, NH₃.

In Closed Tube.—Evolution of gas with the characteristic odor. Soda or lime assists the reaction. The gas turns red litmus paper blue, and forms white clouds with HCl vapor.

ANTIMONY, Sb.

On Coal, R. F.§—Volatile white coat, bluish in thin layers, continues to form after cessation of blast.

With Bismuth Flux—

On Plaster.—Orange red coat, made orange by (NH₄)₂S.

On Coal.—Faint yellow or red coat.

In Open Tube.—Dense, white, non-volatile, amorphous sublimate. The sulphide, too rapidly heated, will yield spots of red.

In Closed Tube.—The oxide will yield a white fusible

sublimate of needle crystals, the sulphide a black sublimate red when cold.

Flame.—Pale yellow green.

With S. Ph.—Dissolved by O. F. and treated on coal with tin in R. F. becomes gray to black.

Interfering Elements.

Arsenic.—Remove by gentle O. F. on coal.

Arsenic with Sulphur.—Remove by gently heating in closed tube.

Copper.—The S. Ph. bead with tin in R. F. may be momentarily red, but will blacken.

Lead or Bismuth.—Retard formation of their coats by intermittent blast, or by boracic acid. Confirm coat by flame, not by S. Ph.

ARSENIC, AS.

On Smoked Plaster.—White coat of octahedral crystals.

On Coal.—Very volatile white coat and strong garlic odor. The oxide and sulphide should be mixed with soda.

With Bismuth Flux—

On Plaster.—Reddish orange coat made yellow by (NH₄)₂S.

On Coal.—Faint yellow coat.

In Open Tube.—White sublimate of octahedral crystals. Too high heat may form brown suboxide or red or yellow sulphide.

In Closed Tube.—May obtain white oxide, yellow or red sulphide, or black mirror of metal.

Flame.—Pale azure blue.

Interfering Elements.

Antimony.—Heat in closed tube with soda and charcoal, treat resulting mirror in O. F. for odor.

Cobalt or Nickel.—Fuse in O. F. with lead and recognize by odor.

Sulphur.—(a) Red to yellow sublimate of sulphide of arsenic in closed tube. (b) Odor when fused with soda on coal.

BARIUM, Ba.

On Coal with Soda.—Fuses and sinks into the coal.

Flame.—Yellowish green improved by moistening with HCl.

With Borax or S. Ph.—Clear and colorless, can be framed opaque white.

BISMUTH, Bi.

On Coal.—In either, flame is reduced to brittle metal and yields a volatile coat, dark orange yellow hot, lemon yellow cold, with yellowish white border.

With Bismuth Flux—

On Plaster.—Bright scarlet coat surrounded by chocolate brown, with sometimes a reddish border. The brown may be made red by ammonia.†

On Coal.—Bright red coat with sometimes an inner fringe of yellow.

With S. Ph.—Dissolved by O. F. and treated on coal with tin in R. F. is colorless hot, but blackish gray and opaque cold.

Interfering Elements.

Antimony.—Treat on coal with boracic acid, and treat the resulting slag on plaster with bismuth flux.

Lead.—Dissolve coat in S. Ph. as above.

BORON, B.

All borates intumesce and fuse to a bead.

Flame.—Yellowish green. May be assisted by—(a) Moistening with H₂SO₄; (b) Mixing to paste with water and boracic acid flux (4½ pts. KHSO₄, 1 pt. CaF₂); (c) By mixing to paste with H₂SO₄ and NH₄F.

BROMINE, Br.

With S. Ph. saturated with CuO.—Treated at tip of blue flame, the bead will be surrounded by greenish blue flame.

In Matraass with KHSO₄.—Brown choking vapor.

Interfering Elements.

Silver.—The bromide melts in KHSO₄ and forms a blood-red globule which cools yellow and becomes green in the sunlight.

CADMIUM, Cd.

On Coal, R. F.—Dark brown coat, greenish yellow in thin layers. Beyond the coat, at first part of operation, the coal shows a variegated tarnish.

On Smoked Plaster with Bismuth Flux.—White coat made orange by (NH₄)₂S.

With Borax or S. Ph.—O. F. clear yellow hot, colorless cold, can be flamed milk-white. The hot bead touched to Na₂S₂O₃ becomes yellow.

R. F. becomes slowly colorless.

Interfering Elements.

Lead, Bismuth, Zinc.—Collect the coat, mix with charcoal dust, and heat gently in a closed tube. Cadmium will yield either a reddish brown ring or a metallic mirror. Before collecting coat, treat it with O. F. to remove arsenic.

CALCIUM, Ca.

On Coal with Soda.—Insoluble and not absorbed by the coal.

Flame.—Yellowish red, improved by moistening with HCl.

With Borax or S. Ph.—Clear and colorless, can be flamed opaque.

CARBONIC ACID, CO₂.

With Nitric Acid.—Heat with water and then with dilute acid. CO₂ will be set free with effervescence. The escaping gas will render lime water turbid.

With Borax or S. Ph.—After the flux has been fused to a clear bead, the addition of a carbonate will cause effervescence during further fusion.

CHLORINE, Cl.

With S. Ph. saturated with CuO.—Treated at tip of blue flame, the bead will be surrounded by an intense azure blue flame.

On Coal with CuO.—Grind with a drop of H₂SO₄, spread the paste on coal, dry gently in O. F., and treat

* Sulphur two parts, potassic iodide one part, potassic bisulphate one part.
† May be obtained by heating S. Ph. on the assay.

with blue flame, which will be colored greenish blue and then azure blue.

CHROMIUM, Cr.

With Borax or S. Ph.—O. F. reddish hot, fine yellow-green cold.

R. F. in borax, green hot and cold. In S. Ph., red hot, green cold.

With Soda.—O. F., dark yellow hot, opaque and light yellow cold.

R. F. opaque and yellowish green cold.

Interfering Elements.

Manganese.—The soda bead in O. F. will be bright yellowish green.

COBALT, Co.

On Coal R. F.—The oxide becomes magnetic metal. The solution in HCl will be rose red, but on evaporation will be blue.

With Borax or S. Ph.—Pure blue in either flame.

Interfering Elements.

Arsenic.—Roast and scorify with successive additions of borax. There may be, in order given: Yellow (iron), green (iron and cobalt), blue (cobalt), reddish brown (nickel), green (nickel and copper), blue (copper).

Copper and other Elements which Color Strongly.—Fuse with borax and lead on coal in R. F. The borax on platinum wire in O. F. will show the cobalt, except when obscured by much iron or chromium.

Iron, Nickel, or Chromium.—Fuse in R. F. with a little metallic arsenic, then treat as an arsenide.

Sulphur of Selenium.—Roast and scorify with borax, as before described.

COPPER, Cu.

On Coal R. F.—Formation of red malleable metal.

* *Flame.*—Emerald green or azure blue, according to compound.

The azure blue flame may be obtained—

(a) By moistening with HCl or aqua regia, drying gently in O. F., and heating strongly in R. F.

(b) By saturating S. Ph. bead with substance, adding common salt, and treating with blue flame.

With Borax † or S. Ph.—O. F., green hot, blue or greenish blue cold.

R. F. greenish or colorless hot, opaque and brownish red cold. With tin on coal this reaction is more delicate.

Interfering Elements.

† *General Method.*—Roast thoroughly, treat with borax on coal in strong R. F., and—

If Button Forms, separate the button from the slag, remove any lead from it by O. F., and make either S. Ph. or flame test upon residual button.

If no Visible Button Forms, add test lead to the borax fusion, continue the reduction, separate the button, and treat as in next test (lead alloy).

Lead or Bismuth Alloys.—Treat with frequently changed boracic acid in strong R. F., noting the appearance of slag and residual button.

Trace.—A red spot in the slag.

Over One Per Cent.—The residual button will be bluish green when melted, will dissolve in the slag and color it red upon application of the O. F., or may be removed from the slag and be submitted to either the S. Ph. or the flame test.

FLUORINE, F.

Etching Test.—If fluorine is released, it will corrode glass in cloudy patches, and in presence of silica there will be a deposit on the glass. According to the refractoriness of the compound, the fluorine may be released—

(a) In closed tube by heat.

(b) In closed tube by heat and KHSO₄.

(c) In open tube by heat and glass of S. Ph.

With Conc. H₂SO₄ and SiO₂.—If heated and the fumes condensed by a drop of water upon a platinum wire, a film of silicic acid will form upon the water.

IODINE, I.

With S. Ph. saturated with CuO.—Treated at the tip of the blue flame, the bead is surrounded by an intense emerald green flame.

In Matraass with KHSO₄.—Violet choking vapor and brown sublimate.

In Open Tube with Equal Parts Bismuth Oxide, Sulphur, and Soda.—A brick red sublimate.

With Starch Paper.—The vapor turns the paper dark purple.

Interfering Elements.

Silver.—The iodide melts in KHSO₄ to a dark red globule, yellow on cooling, and unchanged by sunlight.

IRON, Fe.

On Coal.—R. F. Many compounds become magnetic. Soda assists the reaction.

§ *With Borax.*—O. F., yellow to red hot, colorless to yellow cold.

R. F., bottle green. With tin on coal, vitriol green.

With S. Ph.—O. F., yellow to red hot, greenish while cooling, colorless to yellow cold.

State of the Iron.—A borax bead blue from CuO is made red by FeO and greenish by Fe₂O₃.

Interfering Elements.

Chromium.—Fuse with nitrate and carbonate of soda on platinum, dissolve in water, and test residue for iron.

Cobalt.—By dilution the blue of cobalt in borax may often be lost before the yellow of iron.

Copper.—May be removed from borax bead by fusion with lead on coal in R. F.

Manganese.—(a) May be faded from borax bead by treatment with tin on coal in R. F. (b) May be faded from S. Ph. bead by R. F.

Nickel.—May be faded from borax bead by R. F.

* Sulphur, selenium, and arsenic should be removed by roasting. Lead necessitates a gentle heat.

† By repeated slow oxidation and reduction a borax bead becomes ruby red.

‡ Oxides, sulphides, and sulphates are best reduced by a mixture of soda and borax.

§ A slight yellow color can only be attributed to iron when there is no decided color produced by either flame in highly charged beads of borax and S. Ph.

* From the *School of Mines Quarterly*, vol. xi., No. 1.

† *School of Mines Quarterly*, vol. viii., p. 259, and vol. x., p. 321.

‡ Certain phosphates, borates, and fusible silicates become blue in absence of alumina.

§ This coat may be further tested by S. Ph. or flame.

Tungsten or Titanium.—The S. Ph. bead in R. F. will be reddish brown instead of blue or violet.
Uranium.—As with chromium.
Alloys, Sulphides, Arsenides, etc.—Roast, treat with borax on coal in R. F., then treat borax in R. F. to remove reducible metals.

LEAD, Pb.

On Coal.*—In either flame is reduced to malleable metal, and yields near the assay a dark lemon yellow coat, sulphur yellow cold, and bluish white at border.
With Bismuth Flux:
On Plaster.—Chrome yellow coat, blackened by (NH₄)₂S.

On Coal.—Volatile yellow coat, darker hot.
Flame.—Azure blue.
With Borax or S. Ph.—O. F., yellow hot, colorless cold, flames opaque yellow.
R. F. Borax bead becomes clear, S. Ph. bead cloudy.

Interfering Elements.

Antimony.—Treat on coal with boracic acid, and treat the resulting slag on plaster with bismuth flux.
Arsenic Sulphide.—Remove by gentle O. F.
Cadmium.—Remove by R. F.
Bismuth.—Usually the bismuth flux tests on plaster are sufficient. In addition the lead coat should color the R. F. blue.

LITHIUM, Li.

Flame.—Crimson, best obtained by gentle heating near the wick.

Interfering Elements.

Sodium.—(a) Use a gentle flame and heat near the wick. (b) Fuse on platinum wire with baric chloride in O. F. The flame will be first strong yellow, then green, and lastly crimson.

Calcium or Strontium.—As these elements do not color the flame in the presence of baric chloride, the above test will answer.

Silicon.—Make into a paste with boracic acid flux and water, and fuse in the blue flame. Just after the flux fuses the red flame will appear.

MAGNESIUM, Mg.

On Coal with Soda.—Insoluble, and not absorbed by the coal.

With Borax or S. Ph.—Clear and colorless, can be flamed opaque white.

With Cobalt Solution.—Strongly heated becomes a pale flesh color.

MANGANESE, Mn.

† **With Borax or S. Ph.** O. F., amethystine hot reddens on cooling. With much is black and opaque. If a hot bead is touched to a crystal of sodic nitrate, an amethystine or rose colored froth is formed.

R. F., colorless or with black spots.
With Soda.—O. F., bluish green and opaque when cold. Sodic nitrate assists the reaction.

Interfering Elements.

Chromium.—The soda bead in O. F. will be bright yellowish green instead of bluish green.

Silicon.—Dissolve in borax, then make soda fusion.

MERCURY, Hg.

With Bismuth Flux.
On Plaster.—Volatile yellow and scarlet coat. If too strongly heated, the coat is black and yellow.

On Coal.—Faint yellow coat at a distance.

§ **In Matraass with dry Soda or with Litharge.**—Mirror like sublimate, which may be collected in globules.

MOLYBDENUM, Mo.

On Coal.—O. F., a coat yellowish hot, white cold, crystalline near assay.

R. F., the coat is turned in part deep blue, in part dark copper red.

Flame.—Yellowish green.

With Borax.—O. F., yellow hot, colorless cold.

R. F., brown to black and opaque.

With S. Ph.—O. F., yellowish green hot, colorless cold.

R. F., emerald green.

Dilute (¼) HCl Solutions.—If insoluble, the substance may first be fused with S. Ph. in O. F. If then dissolved in the acid and heated with metallic tin, zinc, or copper, the solutions will be successively blue, green, and brown.

If the S. Ph. bead has been treated in R. F., the solution will become brown.

NICKEL, Ni.

On Coal.—R. F., the oxide becomes magnetic.

With Borax.—O. F., violet hot, reddish brown cold.

R. F., cloudy and finally clear and colorless.

With S. Ph.—O. F., red hot, yellow cold.

R. F., red hot, yellow cold. On coal with tin becomes colorless.

Interfering Elements.

General Method.—Saturate two or three borax beads with roasted substance, and treat on coal with a strong R. F. If a visible button results, separate it from the borax and treat with S. Ph. in the O. F., replacing the S. Ph. when a color is obtained.

If no visible button results, add either a small gold button or a few grains of test lead. Continue the reduction and—

With Gold.—Treat the gold alloy on coal with S. Ph. in strong O. F.

With Lead.—Scorify button with boracic acid to small size, complete the removal of lead by O. F., on coal, and treat residual button with S. Ph. in O. F.

Arsenic.—Roast thoroughly, treat with borax in R. F., as long as it shows color, treat residual button with S. Ph. in O. F.

Alloys.—Roast and melt with frequently changed borax in R. F., adding a little lead if infusible. When the borax is no longer colored, treat residual button with S. Ph. in O. F.

* The phosphate yields no coat without the aid of a flux.

† With silicates this reaction is of use only in the absence of coloring oxides. The phosphate, arsenate, and borate become violet red.

‡ The colors are more intense with borax than with S. Ph.

§ Gold leaf is whitened by the slightest trace of vapor of mercury.

|| Crushed between damp unglazed paper becomes red, brown, purple, or blue, according to amount present.

NITRIC ACID, HNO₃.

In Matraass with KHSO₄ or in Closed Tube with Litharge.—Brown fumes with characteristic odor. The fumes will turn ferrous sulphate paper brown.

PHOSPHORUS, P.

Flame.—Greenish blue, momentary. Improved by conc. H₂SO₄.

In Closed Tube with Dry Soda and Magnesium.—The soda and substance are mixed in equal parts and dried, and made to cover the magnesium. Upon strongly heating, there will be a vivid incandescence, and the resulting mass, crushed and moistened, will yield the odor of phosphureted hydrogen.

POTASSIUM, K.

Flame.—Violet, except borates and phosphates.

Interfering Elements.

Sodium.—(a) The flame, through blue glass, will be violet or blue. (b) A bead of borax and a little boracic acid, made brown by nickel, will become blue on addition of a potassium compound.

Lithium.—The flame, through green glass, will be bluish green.

SELENIUM, Se.

On Coal, R. F.—Disagreeable horse-radish odor, brown fumes, and a volatile steel gray coat, with a red border.

In Open Tube.—Steel gray sublimate, with red border, sometimes white crystals.

In Closed Tube.—Dark red sublimate and horse-radish odor.

Flame.—Azure blue.

On Coal with Soda.—Thoroughly fuse in R. F., place on bright silver, moisten, crush, and let stand. The silver will be blackened.

SILICON, Si.

On Coal with Soda.—With its own volume of soda dissolves with effervescence to a clear bead. With more soda the bead is opaque.

With Borax.—Clear and colorless.

With S. Ph.—Insoluble. The test made upon a small fragment will usually show a translucent mass of undissolved matter of the shape of the original fragment.

When not decomposed by S. Ph., dissolve in borax nearly to saturation, add S. Ph., and reheat for a moment. The bead will become milky or opaque white.

SILVER, Ag.

On Coal.—Reduction to malleable white metal.
With Borax or S. Ph.—O. F., opalescent.

Cupellation.—Fuse on coal with 1 vol. of borax glass and 1 to 2 vols. of test lead in R. F., for about two minutes. Remove button and scorify it in R. F., with fresh borax, then place button on cupel and blow O. F. across it, using as strong blast and as little flame as are consistent with keeping button melted.

If the litharge is dark, or if the button freezes before brightening, or if it brightens but is not spherical, rescorify it on coal with borax, add more test lead, and again cupel until there remains only a white spherical button of silver.

SODIUM, Na.

Flame.—Strong reddish yellow.

STRONTIUM, Sr.

On Coal with Soda.—Insoluble, absorbed by the coal.

Flame.—Intense crimson, improved by moistening with HCl.

With Borax or S. Ph.—Clear and colorless; can be flamed opaque.

Interfering Elements.

Barium.—The red flame may show upon first introduction of the sample into the flame, but it is afterward turned brownish yellow.

Lithium.—Fuse with baric chloride, by which the lithium flame is unchanged.

SULPHUR, S.

On Coal with Soda and a Little Borax.—Thoroughly fuse in the R. F., and either—

(a) Place on bright silver, moisten, crush and let stand. The silver will become brown to black. Or (b) heat with dilute HCl (sometimes with powdered zinc); the odor of H₂S will be observed.

In Open Tube.—Suffocating fumes. Some sulphates are unaffected.

In Closed Tube.—May have sublimate red when hot, yellow cold, or sublimate of undecomposed sulphide, or the substance may be unaffected.

With Soda and Silica (equal parts).—A yellow or red bead.

To Determine whether Sulphide or Sulphate.—Fuse with soda on platinum foil. The sulphide only will stain silver.

TELLURIUM, Te.

On Coal.—Volatile white coat with red or yellow border. If the fumes are caught on porcelain, the resulting gray or brown film may be turned crimson when moistened with conc. H₂SO₄ and gently heated.

On Coal with Soda.—Thoroughly fuse in R. F. Place on bright silver, moisten, crush and let stand. The silver will be blackened.

Flame.—Green.

In Open Tube.—Gray sublimate fusible to clear drops.

With H₂SO₄ (conc.)—Boiled a moment, there results a purple violet solution, which loses its color on further heating or on dilution.

TIN, Sn.

On Coal.—O. F., the oxide becomes yellow and luminous.

R. F., a slight coat, assisted by addition of sulphur or soda.

With Cobalt Solution.—Moisten the coal in front of the assay with the solution, and blow a strong R. F. upon the assay. The coat will be bluish green when cold.

With CuO in Borax Bead.—A faint blue bead is

made reddish brown or ruby red by heating a moment in R. F. with a tin compound.

Interfering Elements.

Lead or Bismuth (Alloys).—It is fair proof of tin if such an alloy oxidizes rapidly with sprouting and cannot be kept fused.

Zinc.—On coal with soda, borax and charcoal in R. F. the tin will be reduced, the zinc volatilized; the tin may then be washed from the fused mass.

TITANIUM, Ti.

With Borax.—O. F., colorless to yellow hot, colorless cold, opalescent or opaque white by flaming.

R. F., yellow to brown, enamel blue by flaming.

With S. Ph.—O. F., as with borax.

R. F., yellow hot, violet cold.

HCl Solutions.—If insoluble, the substance may first be fused with S. Ph. or with soda and reduced. If then dissolved in dilute acid and heated with metallic tin, the solution will become violet after standing. Usually there will also be a turbid violet precipitate, which becomes white.

Interfering Elements.

Iron.—The S. Ph. bead in R. F. is yellow hot, brownish red cold.

TUNGSTEN, W.

With Borax.—O. F., colorless to yellow hot, colorless cold, can be flamed opaque white.

R. F., colorless to yellow hot, yellowish brown cold.

With S. Ph.—O. F., clear and colorless.

R. F., greenish hot, blue cold. On long blowing or with tin on coal, becomes dark green.

With Dilute HCl.—If insoluble, the substance may first be fused with S. Ph. The solution heated with tin becomes dark blue; with zinc it becomes purple and then reddish brown.

Interfering Elements.

Iron.—The S. Ph. in R. F. is yellow hot, blood red cold.

URANIUM, U.

With Borax.—O. F. yellow hot, colorless cold, can be flamed enamel yellow.

R. F., bottle green, can be flamed black, but not enamelled.

With S. Ph.—O. F., yellow hot, yellowish green cold.

R. F., emerald green.

Interfering Elements.

Iron.—With S. Ph. in R. F. is green hot, red cold.

VANADIUM, V.

With Borax.—O. F., colorless or yellow hot, greenish yellow cold.

R. F., brownish hot, emerald green cold.

With S. Ph.—O. F., dark yellow hot, light yellow cold.

R. F., brown hot, emerald green cold.

H₂SO₄ Solutions.—Reduced by Zn become successively yellow, green, bluish green, blue, greenish blue, bluish violet and lavender.

ZINC, Zn.

On Coal.—O. F., the oxide becomes yellow and luminous.

R. F., yellow coat, white when cold, assisted by soda and a little borax.

With Cobalt Solution.—Moisten the coal in front of the assay with the solution, and blow a strong R. F. upon the assay. The coat will be bright yellow green when cold.

Interfering Elements.

Antimony.—Remove by strong O. F. or by heating with sulphur in closed tube.

Cadmium Lead or Bismuth.—The combined coats will not prevent the cobalt solution test.

Tin.—The coats heated in an open tube with charcoal dust by the O. F. may yield white sublimate of zinc.

GALVANIZED IRON PIPES FOR ARTESIAN WELLS AND FOR THE CONVEYANCE OF DRINKING WATER.

By R. HAINES.

THE author analyzed a sample of water from an artesian well, recently sunk, 78 ft. deep, of which both the outer and inner casing were made of galvanized iron. There was no source of sewage contamination near the well, yet its composition showed per 100,000 parts 0.473 part free ammonia, and 0.008 albuminoid ammonia, only faint traces of nitrates being present, but there was a large amount of zinc in solution. The solids consisted of:

	Grains per Gall.
SiO ₂ , Al ₂ O ₃ , and Fe ₂ O ₃	0.85
NaCl.....	0.77
CaCO ₃	1.30
(NH ₄) ₂ CO ₃	1.25
ZnCO ₃	6.52
Total solids.....	10.69

The analysis shows that the free ammonia has evidently been increased by reduction of nitrates of iron and zinc, and that the water undoubtedly had been previously contaminated by animal sewage.

On heating the sample the zinc separated out as a film on the surface. The author considers that the oxide and carbonate of zinc have combined with the ammonium carbonate to form the double zinc and ammonium carbonate which is insoluble in water but very soluble in ammonium carbonate, the excess of ammonium carbonate in the water holding it in solution. This combination of salts is decomposed on heating.

Experiments showed that commercial zinc and chemically pure zinc were rapidly acted on by a cold dilute solution of ammonium carbonate, which after twenty-four hours' contact gave a copious precipitate with sulphureted hydrogen on acidifying with acetic acid.

Zinc not being so accumulative as lead is less injuri-