late the distance from the earth when in a balloon; and not only this, but, as water is of less density than the earth, he can also calculate from its indications the depth of the ocean. Evidently the gravitation at the ocean's surface must decrease in proportion as the depth increases; because, when there is more water under the ship's bottom (water having less weight than earth) its attraction will be, proportionally to its mass, less. This instrument, which has been described in the SCIENTIFIC AMERICAN SUPPLEMENT (page 368, volume I), is thus constructed in entire accordance with the theory of the law of gravitation; and having been fully verified by experiment, it is an additional confirmation of this theory, of which the ultimate triumph is as complete as that of any theory in the whole field of Science.

New York city. P. H. VANDER WEYDE

[For the Scientific American.]

NICKEL AND ITS PREPARATION.

Nickel is not an abundant metal; and although it occurs in a dozen different ores, the number of localities where it it is found in paying quantities is very few. It is never found in a metallic state, except in meteorites. In ores, it is generally associated with iron and cobalt, both of which it resembles. The principal source of nickel is the native arsenide, a copper-colored mineral, called by the Germans *kupfer-nickel*, or false copper, because it contains no copper. This ore contains from 33 to 55 per cent of arsenic, 33 to 45 per cent of nickel, and small quantities of sulphur, iron, and other substances. Another compound of nickel and arsenic has received the name of cloanthite or white nickel. Annabergite, or nickel bloom, is a compound of arsenic acid with oxide of nickel, quite soft and of an apple green color. The most beautiful nickel mineral is the sulphide, or millerite. It has a brass yellow color and metallic luster, and usually occurs in capillary crystals, in the cavities and among the crystals of other minerals, hence called capillary pyrites. In this country it is found chiefly in Lancaster county, Pa. The other nickel minerals are breithauptite, nickel glance, ullmanite, emerald nickel, pyromelin, grunanite, pimelite, garnierite, and noumeite. Speiss is a deposit formed in the pots in which roasted arsenide of cobalt, mixed with copper nickel, is fused with carbonate of potassium and quartz, for the preparation of smalt, in the blue color works; it collects below the blue glass, in the form of a metallic alloy, the nickel not oxidizing so easily in roasting as the cobalt. It is an important source of nickel

Of the metallurgy of nickel little is known outside of the works, which are carefully guarded, although it is difficult to see of what use a knowledge of a process could be to those who have no source of material at hand, or why those who have a monopoly of the ore need fear competition. Professor C. Küntzel has, however, published some interesting facts in regard to the method used in the metallurgy of nickel, from which we glean the following:

The preparation of metallic nickel and cobalt is sometimes conducted in the dry way, by collecting and concentrating the nickel, cobalt, and copper, in an arsenical or sulphur compound (*speise* or stone), while, at the same time, the iron in the ores is removed by scorification; the cobalt is afterwards fluxed with pure quartz sand, and the protoxide of cobalt precipitated, from the silicate of cobalt thus formed, by fusion with excess of carbonate of soda; the sulphur or arsenic is expelled from the *speise*, which has had the cobalt removed by roasting and heating with soda and saltpeter, and finally reduced with carbon. It is more frequently obtained in the wet way, by dissolving the nickel and cobalt ores in acids and separating the dissolved metals; but the greater part of the iron should first be removed and the nickel and cobalt concentrated before dissolving. In the dry method the first step is also to get rid of the iron in the ore or *speise*. The complete separation of iron from arsenical compounds of nickel and cobalt is not very difficult, for iron has much less affinity for arsenic than cobalt or nickel; but to separate it from the sulphides was, until recently, very difficult, if not impossible. The reason of this is that nickel and cobalt have nearly the same affinity for sulphur that iron has. This operation is now accomplished by smelting the rawferruginous ore in a reverberatory furnace, with a mixture of two parts of fine barytes and one part quartz sand; for 1 per cent of iron, 18 to 19 per cent of this flux is required. A fusible ferro-silicate of barium is formed and sulphurous acid driven out. In 1870, Dr. R. Wagner proposed to make use of the oxidizing action of Chili saltpeter for removing the iron, sulphur, and arsenic. For arsenical products, this method is inferior to the one generally employed, namely, roasting the metallic arsenides after the iron has been removed, then heating with saltpeter and soda. Wagner's method may be employed with advantage when it is desired to smelt a nickel ore, which has been freed from iron, with a metal free from sulphur, provided it contains enough copper to prevent the resulting metal from being too infusible.

The manufacture of nickel in the wet way varies with the material or source. The principal steps are the following: 1. Dissolving the roasted products in hydrochloric or sulphuric acids. 2. Precipitation of the iron by means of lime or carbonate of lime, or soda, after oxidizing, if necessary, with chlorine or chloride of lime. 3. Precipitation of the copper with sulphuretted hydrogen, or alkaline sulphides. 4. Precipitation of the cobalt as sesquioxide by means of chloride of lime. 5. Precipitation of the nickel as hydrated oxide or carbonate with milk of lime or carbonate of soda. 6. Igniting this precipitate so as to obtain anhydrous oxide of nickel, insoluble in dilute acids. 7. Leaching out the excess of lime and gypsum from the ignited oxide of nickel. 8. Reduction of the pure oxide of nickel by ignition with charcoal.

In dissolving nickel ore, care should be taken to prevent silica going into the nickel solution, for, on neutralizing the previously acid solution, all the silica is precipitated in the form of silicate of nickel. Sometimes in analyses a small quantity of silicic acid runs through all the operations, and there is no simpler method of removing it entirely at the start than by adding to the neutral solution some neutral nickel salt.

For precipitating the copper with sulphuretted hydrogen, Gerstenhoefer's precipitating tower, which was first employed at Freiburg to precipitate arsenic from sulphuric acid, may be employed. Such an apparatus avoids any escape of the gas, and precipitates the metals in the shortest possible time. The solution enters automatically at the top of the tower, which has an hydraulic seal. It falls, drop by drop, down into an atmosphere of sulphuretted hydrogen, passing from one platform to another: and if it does not contain too much copper, it passes out at the bottom free from copper. The gas, which is absorbed by the nickel solution, is expelled by heating it with steam. If a soda ash works is near, the waste sulphide of calcium may be employed with profit for precipitating the copper. Injury to the workmen from inhaling sulphuretted hydrogen can be prevented by the use of wine or spirits; sulphuretted hydrogen retards the circulation of the blood, which is neutralized by the property that alcohol has of accelerating the circulation.

Nitrite of potash cannot be employed to separate nickel and cobalt when there is lime in the solution. In this case it cannot even be used as a test; for in the presence of lime or other alkaline earth, a yellow precipitate is formed, similar to the nitrite of cobalt and potash, and said to have the composition $K_2\,Ca\,Ni\,(NO_2)_6$. If there is enough lime present, all the nickel is thrown down as a double nitrite.

Cobalt and nickel may be separated by means of sulphate of ammonia and sulphuric acid, if the quantity of cobalt is not too small relatively. The separation is quite exact if the solution is sufficiently concentrated. The nickel separates as a difficultly soluble double sulphate of nickel and ammonia, while the double salt of cobalt remains in solution. From the former the sulphate of ammonia is expelled by heating in clay pipes. The sulphate of nickel is almost entirely converted into oxide by roasting with charcoal; the last trace of sulphur is removed by igniting with soda and saltpeter.

The best method of removing the sulphate of lime is to extract the excess of lime added with hydrochloric acid water, then to boil the oxide with steam, and add slowly such a quantity of carbonate of soda that, after boiling a quarter of an hour, there is still an excess of the carbonate in the solution. Sulphate of soda and carbonate of lime are formed; the first is washed out with water, and the latter with water acidified with hydrochloric acid.

Oxide of nickel can be reduced at a bright red heat by simple contact with coarse broken charcoal. The reduction extends inwardly from the surface of the cubes. If left in contact with the carbon after it is entirely reduced, it absorbs more and more carbon. The reduction usually takes place on the clay crucibles on the hearth of a flame furnace. At Val Benoit, near Lüttich, a continuously working furnace is used, the reduction being accomplished in upright tubes. E. J. H.

[For the Scientific American.]

SCIENTIFIC APPARATUS.

At the loan exhibition of scientific apparatus, now open at the South Kensington Museum, London, free evening lectures are delivered on scientific subjects. The collection includes apparatus of the most primitive and ancient forms, with specimens of the successive improvements down to the present time. Many of these articles have a great personal interest, as associated with the names, labors, and discoveries of eminent scientific men, mechanicians, discoverers, and inventors. On a recent occasion, the lecturer, Mr. Chandler Roberts, F.R.S., chemist of the mint, took for his theme: "The Apparatus Employed in the Researches of the late Master of the Mint, Mr. Graham." The name of Thomas Graham is well known as the author of "Elements of Chemistry." His scientific papers, published in the transaction of societies, range in date from 1834 down to 1869, the year of his death

The lecturer, with specimens of apparatus before him, both that of Mr. Graham and of others, gave a very interesting discourse. In its scientific aspects, and in its comparison of the processes followed, the reasoning employed, and the results obtained, the lecture was very interesting. But there is another respect in which the lecture has a general interest, as demonstrating that the essential apparatus for scientific researches is found in the mind, the memory, the power of analysis and comparison, in the ingenious adaptation of means and implements: in a word, in the genius of the discoverer.

Mr. Roberts concluded his lecture by saying that, although for delicate researches or measurements complicated instruments are necessary, still the most ordinary appliances, in the hands of a man of genius, are capable of yielding very important results. With a glass tube and a plug of plaster of Paris, Mr. Graham discovered and verified the law of the diffusion of gases. With a tobacco pipe, he gave additional evidence that atmospheric air is a mechanical mixture of its constituent gases. By the aid of a tambourine and a basin of water, he divided bodies into crystalloids and colloids, and obtained silicic acid, and oxide of iron soluble in water. With a toy balloon of india rubber, filled with carbonic acid gas, he separated oxygen from atmospheric air, and developed points, the importance of which it is impossible to overrate from a physiological point of view. By the expan sion of a wire which attended its absorption of a gas, he did much to prove that hydrogen is the gas of a white metal.

Such facts as these are of great interest to mechanics and operative chemists, whose daily occupation is the proof of mechanical and scientific discoveries, the application of laws and facts already discovered. Their daily employment is suggestive; and if they have active minds and patient habits of observation, there are frequent chances for testing the value of their thoughts and the possibilities of improvements in machinery and processes. "If" they had only such and such tools, or apparatus! The "if" must be met as Thomas Graham met it. *

Liquid Indicator.

Dr. Siemens has designed an instrument by which a stream of alcohol and water mixed in any proportion is measured in such a manner that one train of counter wheels records the volume of the mixed liquor, while a second counter gives a true record of the amount of alcohol contained in it. The principle on which this measuring apparatus acts may be shortly described thus: The volume of liquid is passed through a revolving drum, divided into three compartments by radial divisions, and not dissimilar in appearance to an ordinary wet gas meter; the revolutions of this drum produce a record of the total volume of passing liquid. The liquid, on its way to the measuring drum, passes through a receiver containing a float of thin metal filled with proof spirit, which float is partially supported by means of a carefully adjusted spring, and its position determines that of a lever, the angular position of which causes the alcohol counter to rotate more or less for every revolution of the measuring drum. Thus, if water only passes through the apparatus, the lever in question stands at its lowest position, when the rotation motion of the drum will not be communicated to the alcohol counter; but in proportion as the lever ascends, a greater proportion of the motion of the drum will be communicated to the alcohol counter, and this motion is rendered strictly proportionate to the alcohol contained in the liquid, allowance being made in the instrument for the change of volume due to chemical affinity between the two liquids. Several thousand instruments of this description are employed by the Russian government in controlling the production of spirits in that empire, whereby a large staff of officials is saved, and a perfectly just and technically unobjectionable method is established for levying the excise dues.—*Nature.*

Naval Items.

REDUCTION OF PAY AND MEN.

"Abstract of general order No. 216, dated August 12, 1876: The estimates made for pay of the navy for the current year were $7,600,000. Congress, however, determined that by a very rigid enforcement of a somewhat disused power on the part of the secretary of the navy to furlough officers, instead of having them under the heads of "other duty" or "waiting orders," a very considerable reduction could be made; and appropriated for the current year, for the pay of the navy to be administered upon this plan, and also reduced by cutting off 1,000 from its former complement of 8,500 men, the sum of $5,750,000, or nearly $2,000,000 less than the amount of the estimates. Under these circumstances, the department, although entertaining different views, feels bound to make, in good faith, the effort to bring the actual expenses of this branch of the service as near as possible to the amount appropriated by Congress. This can only be done by reducing the number of officers employed, to those absolutely needed to meet the daily pressing requirements of the service, and by putting those unemployed upon the lowest pay recognized by the provisions of existing laws.

"It is therefore ordered that: Until further orders, all officers not on duty on September 1 next, and all on leave, will, at the expiration of leave or waiting orders, be regarded as on furlough, and will be so paid.

"The foregoing applies only to the active list of the navy, the pay of retired officers being fixed by special provision of law."

NAVAL ENGINEER CORPS GAZETTE.

Chief Engineer James B. Kimball, detached from the U. S. steamer Hartford, and as Fleet Engineer of the North Atlantic Station, and placed on waiting orders.

Chief Engineer A. J. Kiersted, detached from the U. S. steamer Vandalia, and ordered to the Hartford, and also to discharge the duties of Fleet Engineer of the North Atlantic Station.

Chief Engineer Joseph Trilley to the Vandalia.

Cadet Engineer George S. Willits, detached from the Vandalia and placed on waiting orders.

A Panic among Sponge Divers.

Mr. Vice-Consul Jago, writing from Beyrout, says that the last crop of Turkey sponge was very deficient, and prices of ordinary and common sponges have greatly risen in consequence. The deficiency is attributed to a panic among the divers, caused by the appearance in the neighborhood of Batroun, Mount Lebanon, the chief sponge fishing locality, of a sea monster, alleged to have been equal in size to a small boat. Its actual depredations among the divers appear at the present time to have been limited to one man, whom he is said to have swallowed whole.

A SQUARE of 208·72 feet each way covers one acre, so also does a circle 235·5 feet in diameter.