is propylamin. It is a volatile, watery liquid, with a strong odor of herring pickle, and was found by Dr. Winckler in distilling a watery extract of ergot with potassa, also in distilling cod liver oil with ammonia. But the most effective way of obtaining this substance is that of Wertheim, who prepared it by the decomposition of narcotine and codeine by alkalies. Its name is based on its chemical composition; it is a combination of the third member of the hydrocarbon series (methyl, ethyl, propyl, amyl, etc.) with a derivative of the ammonia (amidogen, mentioned on pages 20 and 144 of our current volume). There is, however, still some doubt about its true chemical composition, so that some chemists suppose it to be trimethylamin; in the mean time, its specific effect on most forms of rheumatism has been established. By taking five drops in a tablespoonful of peppermint water every two hours, the pains usually abate after twelve doses.

NATURE AND ART--THE MYSTERY OF THE MAGNETO-ELECTRIC MACHINE.

In the SCIENTIFIC AMERICAN, volume XVI, page 406, we quoted from an English contemporary a description of the electric machine of Professor Wheatstone; and a reader, who evidently preserves his copies of our paper, requests us to explain the action of that class of machines more fully.

The development of a current of electricity by a machine without either a voltaic battery or preëxisting magnetism as its primary source is so remarkable that our correspondent is justified in viewing it with wonder and in considering the mystery to be equal to that of the Giffard injector, described on page 48, current volume, and we are justified in the endeavor to make its operation clear.

The generation of electrical currents by the relative motion of a conductor and a magnet was discovered many years ago, the earliest known "magneto-electric machine" being constructed in 1832 by Pixie; and improvements were made by Ritchie, Saxton, Clarke, Henry and others, all of whom used permanent magnets, in front of which they rotated bobbins wound with conducting wire, covered with silk or other material to secure proper insulation of the several portions of the wire from each other. Subsequently, Siemens devised an improved form of bobbin, on which the wire was wound longitudinally, instead of transversely. This invention is a cylinder of soft iron having deep grooves cut on opposite sides, and the two grooves are connected at each end by similar transverse cuts. The insulated wire, forming the conductor, is wound upon the core in these grooves, and lies buried in the cylinder, confined by three or more bands; a brass disk, at one end, carries the commutator, by means of which the currents, which reverse their direction at each half revolution of the bobbin, are so sorted out that the same external wire always conducts from the machine a current of the same kind while the machine continues in motion in one direction, the positive currents going through one conductor and the negative through the other.

This form of bobbin allows the use of a large number of small magnets, side by side, in place of one very large; and since small magnets are far more powerful in proportion to their magnitude than large ones, it follows that the Siemens armature allows the machine to be made far more efficient.

The next important step in the improvement of these machines was made by a British inventor, Mr. Wilde, who constructed machines of, until his time, unprecedented power. Instead of using directly, the induced current of electricity, which he obtained from the permanent magnets, he led it through the coils of great electro-magnets, thus producing a new set of magnets, for induction, of immensely greater power. This current, obtained from the new "magnetic battery," was, in one instance, used in a similar manner upon a still larger electro-magnet, and this process of intensifying the power of the machine could of course be carried to any extent. The current generated in the armature of the last set of electro-magnets was applied to the production of light or heat, or in electro-plating, as might be desired. From the largest of Mr. Wilde's machines, a powerful electric light and tremendous heating effects were obtained. This machine had coils 4 feet high and 10 inches thick on the large electro-magnet, the coils containing 1,400 pounds of copper wire. The armatures were driven by a steam engine of 15 horse power.

The electric light obtained from the machine was so powerful as to cause the flame of the street lamps of Manchester, (England) to cast a shadow at the distance of a quarter of a mile (London *Athenæum*). The heat could be felt at a distance of 50 yards, and long wires and thick rods of iron, a foot long and two tenths of an inch in diameter, were raised to a white heat and melted by the current. A rod of platinum, the most infusible of all metals, was melted down. Several of these machines were used, or proposed to be used, in foreign lighthouses, but the expense of the apparatus and of its accompanying steam engine, as well as the necessary skilled attendance, were serious objections.

The well known electrician, Moses G. Farmer, in a letter addressed to us and published in the SCIENTIFIC AMERICAN, pointed out the fact that, could this method of producing light be perfected so far as to avoid the loss of more than three fourths of the energy condensed in each pound of coal, the electric light would cost but about one tenth of a mill, per candle power per hour. He estimates that a pound of coal carbon, converted into light without loss, would, if burned in one hour, yield a light equal to that of 12,410 candles

It is evident that inventors who are familiar with the science of electricity have before them a field in which they can labor with profit to the world, if not to themselves, and we expect ere long to see the pound of coal which, consumed in one hour today, gives us about 15 or 20 candles, made to surrender a much larger percentage of the figure, given above as possible.

Improvements in the construction of the magneto-electric machine have progressed as described, but a single step remained to be taken to bring it to the latest form now known, is that which appears so mysterious in its operation.

Professor Wheatstone and Mr. Siemens both suggested, at about the same time, that, if a part of the induced current were diverted and made to excite a separate small electro-magnet, the latter might be substituted for the equally feeble permanent magnets, in which the whole energy of the apparatus originated, and thus a machine might be made of equal efficiency and without permanent magnets. Such a machine would, at first glance, seem very like a perpetual motion apparatus, and the scheme a most absurd one. The thing was done, however, by the invention of the Wheatstone-Siemens machine as built by Mr. Ladd, of London. It consists simply of an electro-magnet, with a Siemens armature, containing two bobbins, of different sizes. The wire from the smaller bobbin connects with the electro-magnet, its current keeping that excited, while the current induced in the larger bobbin is used for other purposes as may be desired. The armature is driven at a high speed by means of a crank and a band wheel carried in bearings on the electro-magnet.

The electro-magnet almost invariably contains enough residual magnetism to start the action of the machine; and, during its operation, it simply furnishes an illustration of the conversion of the mechanical energy into electricity, light and heat. We cannot, however, as in the case of the Giffard injector, trace every step in the process with mathematical exactness; and the conversion of the one form of energy into the other is to us, and to men of science, as well one of those great mysteries of nature which we are everyday fathoming more and more deeply, and which still present as wonderful a depth of the unknown as ever.

THE MOVEMENTS OF THE STARS.

We are but upon the threshold of the vast store house of which that most wonderful of modern discoveries, the spectroscope, has given us the key. Each day brings us nearer and nearer to the solution of problems which have vexed the master minds of the world for centuries, and science is permitted to advance still further into the realms of the unknown, pressing closer upon those which it is impossible for the human mind to transcend. We have placed other worlds as it were in the balance and weighed them by our infinitesimal standards; by the aid of light originated when our earth was but an unpeopled mass, we have recognized the components and structures of orbs beside the magnitude of which we are as a grain of sand; we have determined and set bounds to the wanderings of the vagrant spheres which circle round our sun; extending further into the infinite, we have looked upon the nebulous chaos which was in the beginning, and lastly, armed with precepts drawn from analogy and theory, we have boldly traced, to a glimmering star in the Pleiades, the central point of our material universe.

With the erratic motion of the planets astronomers have long been familiar, and the name itself, derived from the Greek verb meaning to wander, was given in contradistinction to that of those stars to which the term "fixed" was applied. But later discovery overthrows this discrimination. The fixed stars are known no longer to be motionless, but to travel over distances so great and at such rapidity that the mind fails in their contemplation; and yet the observations of centuries have failed to detect real changes in position other than are extremely small—so minute indeed that only about 30 stars have, by astronomical calculation, been shown to have moved more than one second of arc annually, while in others a motion of but a few seconds in a century has been detected. In the year 1868 Mr. William Huggins, a noted English astronomer, while comparing the spectrum of Sirius with that of hydrogen, by means of a spectroscope of large dispersive power, found that a line on the stellar spectrum was displaced by about $\frac{1}{250}$ of an inch. This displacement occurring toward the red end of the spectrum, showed that the refrangibility of the light of Sirius was diminishing, as the red rays are the least refrangible. The star, therefore, was receding from the earth. Following out the calculation and allowing for the movement of our sphere, Mr. Huggins found that Sirius was moving through space, directly away from us, at the rate of 24½ miles per second, or, taking the resultant of this motion with the transverse movement of the star, previously observed and approximately calculated by other means, the real motion of Sirius was computed at 29 miles per second, or 900,000,000 miles per year, while its distance is estimated at over 128 trillions of miles—numbers of which we can obviously form no conception.

The want of instruments of sufficient delicacy and exactitude has until quite recently prevented further researches, but the necessary implements have at length been made, and we are in possession of the more accurate results. The motion of Sirius has been determined as less than that above given—22 instead of 29 miles per second—the difference being due to the more perfect instruments. Other stars, however, however, have also been examined and their movements relative to the earth fixed. The lines of sedium and magnesium were compared with similar lines which indicated the presence of these terrestrial substances in the spectrum of Betelgeuse, (*α Orionis*), and the star was found to be receding at a velocity of 22 miles per second. The spectrum of Rigel was compared with that of hydrogen and indicated also retrograde motion, of 15 miles per second. The double star Castor, Regulus, *β* and *δ Leonis*, *β*, *γ*, *δ*, *ε*, *ζ*, and *η* of the Great Bear, Spica, *α* in *Corona Borealis*, were all examined in connection with the spectrum of hydrogen and found to be receding at rates varying from 15 to 22 miles per second. In the case of the stars that appear to be approaching the earth, the velocity is much greater. Arcturus, the spectrum of which was compared with that of magnesium, travels at the rate of 55 miles per second: Vega at 50 miles; *α Cygni*, 39 miles; Pollux, 49 miles; *α* of the Great Bear, 61 miles; and *γ Leonis*, *ε Bootis*, *γ Cygni*, *α* and *γ Pegasi*, and *α Andromedæ* were undetermined. *γ Cassiopeiæ* is believed to have a very slow movement from the earth. In making the calculations the velocity of light was taken at 185,000 miles per second, and it is stated that the above given velocities, in relation to the movement of the stars relative to the earth, are equally true as to their motion in regard to the sun. It is interesting to notice that in general the stars which the spectroscope shows us are receding from the earth (Sirius, Betelgeuse, Rigel, Procyon) are situated in a region opposite to the constellation toward which the sun is advancing, while those near to the former (Arcturus, Vega and others) are approaching our globe. "There are, however," says Mr. Huggins, "exceptions to this rule:" and in his memoir to the Royal Society, he points out that the movement of the sun is not the only nor even the principal cause of the true or apparent motions of the stars. "It is hardly possible to doubt," he continues, "that the stars have two distinct motions, one common to all stars of a certain group, and another confined to each particular star. Remarkable examples of this fact are shown in the group *β*, *γ*, *δ*, *ε*, *ζ*, of the Great Bear, which have a common movement, while *α* and *η* of the same constellation have a proper motion in an opposite direction. Again and more remarkable is it that the five first mentioned stars recede from the earth, while *α* is approaching; and *η*, although apparently receding, is at too great a distance from *α* to permit us to consider the two stars in connection.

SCIENTIFIC AND PRACTICAL INFORMATION.

AN EXPERIMENT WITH PHOSPHATE OF LIME.

If a small quantity of phosphate of soda is added to a dilute solution of chloride of calcium, a white precipitate is formed which dissolves on stirring. The addition of more phosphate of soda forms a permanent precipitate; if now a current of carbonic acid gas be passed into the liquid in which the precipitate is suspended, the precipitate dissolves again, in the same way as carbonate of lime does in water containing excess of carbonic acid. The addition of a fresh quantity of phosphate of soda produces a fresh precipitate, which can be again dissolved by carbonic acid. There is, however, a limit to the operation, for having repeated it a few times, crystals form which do not dissolve, and which may be caught on a filter and washed. They consist of the bibasic phosphate of lime with four molecules of water of crystalization. If these crystals be put in water freed from carbonic acid by boiling, and frequently shaken for 24 hours, a salt is formed which contains three equivalents of phosphoric acid to four of carbonic acid ($4\,CaO, 3PO_5$): a salt richer in phosphoric acid than the bibasic salt with which we started, yet not so rich as a monobasic salt.

ACTION OF SULPHUROUS ACID UPON INSOLUBLE SULPHIDES.

Langlois having proved that alkaline sulphites are converted into hyposulphites by the action of sulphurous acid, another chemist named Guerout has repeated the experiment with the sulphides of other metals, and finds that the sulphides of copper, silver, gold, platinum, and mercury are not attacked. The sulphides of manganese, zinc, and iron readily dissolve in a strong solution of sulphurous acid, being at the same time converted into hyposulphites. The sulphides of cobalt, nickel, cadmium, bismuth, tin, arsenic, and antimony are slightly soluble and undergo the same change into hyposulphites; varying quantities of sulphuretted hydrogen are evolved, and sulphur separates. Further experiments, however, indicate that the sulphides are not converted directly into hyposulphites, but are first converted into sulphites which are afterwards changed into hyposulphites.

This easy and rapid method of preparing hyposulphite of iron, zinc, etc., having been discovered, it remains to apply it to new and important uses, and such we doubt not will soon be found.

THE PHOTO-HELIOGRAPH.

A correspondent of the *Photographic Bulletin* describes a new instrument made by Dallmeyer, of England, and called the photo-heliograph. It is to be used during the coming transit of Venus, and consists in a telescope, mounted for photography, about eight feet in length and having an object glass of four inches in diameter and five feet focal length. At the focus is placed an instantaneous shutter which serves to increase or diminish an aperture, behind which is placed a combination of lenses, corrected for the chemical rays. The image passing through is enlarged to four inches. The instrument is mounted on an equatorial stand and actuated by suitable clock work. Five have been ordered by the British government, to be supplied to the different observing stations.

OZONE.

M. Boillot, on submitting pure oxygen and atmospheric oxygen alternately to the action of the electric current, has discovered that 58 cubic inches of pure oxygen yields but ⅓ of a grain of ozone, while the same amount of atmospheric oxygen gives ½ of a grain. Oxygen mingled in the air is therefore in a condition more favorable for its transformation into ozone.