POLYTECHNIC ASSOCIATION OF THE AMERICAN INSTITUTE.

The Association held its regular weekly meeting at its room at the Cooper Institute, on Thursday evening Jan. 19, 1865, the President, S. D. Tillman, Esq. in the chair.

After a long discussion on pumps in which no facts nor ideas were advanced which we suppose would be new to any of our readers, the President invited Mr. Murdock to exhibit drawings of

SHAW'S ENGINE.

This may be described as Roper's air engine, with the addition of a steam boiler in which steam is generated by the exhaust air. An air-tight vessel, corresponding to the boiler of a steam engine, has a furnace within it; the air to supply the fire being forced in by an air-pump. As the air is heated and expanded it is worked through a cylinder, driving a piston as in the steam engine. On its passage from the engine to the chimney the hot air passes through the tubes of a steam boiler, generating steam, which is led into the air chamber containing the furnace, where it is superheated, and then it is worked with the air through the engine. Mr. Murdock having stated that this engine received a Rumford prize of $600, the President invited Dr. Charles T. Jackson, who was present, to give a history of

THE RUMFORD PRIZE.

Dr. Jackson:—Count Rumford left a bequest to the American Academy of Arts and Sciences, of Boston, the oldest scientific association in the country, to be devoted to improvements in light and heat, especially such as should be useful to the middle classes of the people. The Academy unfortunately has not displayed proper activity in discharging the duties of this trust. For forty years the only prizes bestowed were the gold and the silver medal, awarded to Dr. Hare, for the discovery of the compound blow pipe and the calcium light—improperly called the Drummond light. The fund has now increased to $30,000, and recently the members of the Academy have been demanding more energy on the part of the Rumford committee. The gold medal was awarded to Capt. Ericsson for his engine, not because his was the best air engine, but because his inventions and exertions had given such an impetus to efforts in this department, that they might be considered as having led the way to all subsequent improvements. A committee of the Academy, by careful trial, found that Ericsson's engine yielded one horse power by the consumption of 14 lbs. of coal per hour, Roper's by the consumption of 5 lbs., and this of Shaw's by the consumption of 2½ lbs., all being small engines. I have no doubt that this is the best air engine that has ever been produced.

THE GREAT EMERY BED.

By request, Dr. Jackson gave a description of the great emery mine recently discovered by him in Chester, Mass. This description was precisely the same as that published on page 34 of our current volume. Dr. R. P. Stevens asked Dr. Jackson what is the geological formation of this deposit.

Dr. Jackson illustrated the formation by a drawing on the black-board, showing that it is among the metamorphic rocks.

Dr. Stevens:—Has Dr. Jackson any theory of the way these rocks were crystalized?

Dr. Jackson:—I have no doubt it was by the action of superheated water, as illustrated by the beautiful experiments of M. Daubree.

Dr. Stevens:—It would propably be very interesting to the meeting to hear an account of those experiments.

THE EXPERIMENTS OF DAUBREE.

Dr. Jackson:—There is no difference of opinion among geologists in regard to the original formation of the stratified rocks; they were deposited at the bottoms of lakes and oceans. But some of these, since their deposit, have been metamorphosed or changed to a crystalline structure, and there has been much discussion in relation to the agencies by which this metamorphism was effected. It seems to me that M. Daubree has cut the Gordian knot, and has shown that the crystallization was produced mainly by the action of superheated water, that is water heated above the boiling point. This can be done, as you are aware, by confining the water under pressure. M. Daubree enclosed various substances in strong iron tubes, filled the tubes with water, closed them tightly with screw plugs, and had them built into the brick work of gas furnaces, where they were exposed constantly to a high temperature for several weeks or months. Wood thus enclosed was first melted and compressed into a globular mass, and if longer exposed was finally converted into anthracite coal. Glass was decomposed and its silex formed into beautiful quartz crystals. M. Daubree found that if sufficient time was allowed it was not necessary even that the water should be superheated. The warm springs of Plombiers were used for baths by the Romans, who led the water through aqueducts constructed of brick or cement. On examining the material of these aqueducts, which had been subjected to the action of warm water for 2000 years, it was found to be transformed into the same crystalline minerals that occur in the metamorphic rocks.

HEAT AND FORCE OF THE SOLAR SYSTEM.

Professor Helmholtz, in his essay on The Interaction of Natural Forces, recently republished by D. Appleton & Co., presents these facts and calculations in regard to the heat and force developed in the solar system.

THE THEORY OF LAPLACE.

A number of singular peculiarities in the structure of our planetary system indicate that it was once a connected mass with a uniform motion of rotation. Without such an assumption, it is impossible to explain why all the planets move in the same direction round the sun, why they all rotate in the same direction round their axes, why the planes of their orbits, and those of their satellites and rings all nearly coincide, why all their orbits differ but little from circles, and much besides. From these remaining indications of a former state, astronomers have shaped an hypothesis regarding the formation of our planetary system, which, although from the nature of the case it must ever remain an hypothesis, still in its special traits is so well supported by analogy, that it certainly deserves our attention. It was Kant, who, feeling great interest in the physical description of the earth and the planetary system, undertook the labor of studying the works of Newton, and as an evidence of the depth to which he had penetrated into the fundamental ideas of Newton, seized the notion that the same attractive force of all ponderable matter which now supports the motion of the planets, must also aforetime have been able to form from matter loosely scattered in space the planetary system. Afterwards, and independent of Kant, Laplace, the great author of the *Mecanique Celeste*, laid hold of the same thought, and introduced it among astronomers.

The commencement of our planetary system, including the sun, must, according to this, be regarded as an immense nebulous mass which filled the portion of space which is now occupied by our system, far beyond the limits of Neptune, our most distant planet. Even now we perhaps see similar masses in the distant regions of the firmament, as patches of nebulæ, and nebulous stars; within our system also, comets, the zodiacal light, the corona of the sun during a total eclipse, exhibit remnants of a nebulous substance, which is so thin that the light of the stars passes through it unenfeebled and unrefracted. If we calculate the density of the mass of our planetary system, according to the above assumption, for the time when it was a nebulous sphere, which reached to the path of the outmost planet, we should find that it would require several cubic miles of such matter to weigh a single grain.

EFFECT OF CONTRACTION.

Let us make this addition to our assumption; that, at the commencement, the density of the nebulous matter was a vanishing quantity, as compared with the present density of the sun and planets; we can then calculate how much work has been performed by the condensation; we can further calculate how much of this work still exists in the form of mechanical force, as attraction of the planets towards the sun, and as *vis viva* of their motion, and find, by this, how much of the force has been converted into heat.

The result of this calculation is, that only about the 454th part of the original mechanical force remains as such, and that the remainder, converted into heat, would be sufficient to raise a mass of water equal to the sun and planets taken together, not less than twenty-eight millions of degrees of the centigrade scale. For the sake of comparison, I will mention that the highest temperature which we can produce by the oxyhydrogen blowpipe, which is sufficient to fuse and vaporize even platina, and which but few bodies can endure, is estimated at about two thousand centigrade degrees. Of the action of a temperature of twenty-eight millions of such degrees we can form no notion. If the mass of our entire system were pure coal, by the combustion of the whole of it only the 3500th part of the above quantity would be generated. This is also clear, that such a development of heat must have presented the greatest obstacle to the speedy union of the masses, that the larger part of the heat must have been diffused by radiation into space, before the masses could form bodies possessing the present density of the sun and planets, and that these bodies must once have been in a state of fiery fluidity. This notion is corroborated by the geological phenomena of our planet; and with regard to the other planetary bodies, the flattened form of the sphere, which is the form of equilibrium of a fluid mass, is indicative of a former state of fluidity. If I thus permit an immense quantity of heat to disappear without compensation from our system, the principle of the conservation of force is not thereby invaded. Certainly for our planet it is lost, but not for the universe. It has proceeded outwards, and daily proceeds outwards into infinite space; and we know not whether the medium which transmits the undulations of light and heat possesses an end where the rays must return, or whether they eternally pursue their way through infinitude.

QUANTITY OF HEAT IN THE EARTH'S MOTION.

The store of force at present possessed by our system, is also equivalent to immense quantities of heat. If our earth were by a sudden shock brought to rest on her orbit—which is not to be feared in the existing arrangements of our system—by such a shock a quantity of heat would be generated equal to that produced by the combustion of fourteen such earths of solid coal. Making the most unfavorable assumption as to its capacity for heat, that is, placing it equal to that of water, the mass of the earth would thereby be heated 17,200 degrees; it would therefore be quite fused and for the most part reduced to vapor. If, then, the earth, after having been thus brought to rest, should fall into the sun, which of course would be the case, the quantity of heat developed by the shock would be four hundred times greater.

METEORS.

Even now, from time to time, such a process is repeated on a small scale. There can hardly be a doubt that meteors, fire-balls, and meteoric stones, are masses which belong to the universe, and before coming into the domain of our earth, moved like the planets round the sun. Only when they enter our atmosphere do they become visible and fall sometimes to the earth. In order to explain the emission of light by these bodies, and the fact that for some time after their descent they are very hot, the friction was long ago thought of which they experience in passing through the air. We can now calculate that a velocity of 3000 feet a second, supposing the whole of the friction to be expended in heating the solid mass, would raise a piece of meteoric iron 1000° C. in temperature, or, in other words, to a vivid red heat. Now the average velocity of the meteors seems to be thirty or forty times the above amount. To compensate this, however, the greater portion of the heat is, doubtless, carried away by the condensed mass of air which the meteor drives before it. It is known that bright meteors generally leave a luminous trail behind them, which probably consists of several portions of the red-hot surfaces. Meteoric masses which fall to the earth often burst with a violent explosion, which may be regarded as a result of the quick heating. The newly-fallen pieces have been for the most part found hot, but not red-hot, which is easily explainable by the circumstance, that during the short time occupied by the meteor in passing through the atmosphere, only a thin, superficial layer is heated to redness, while but a small quantity of heat has been able to penetrate to the interior of the mass. For this reason the red heat can speedily disappear.

Thus has the falling of the meteoric stone, the minute remnant of processes which seem to have