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 $2\frac{1}{2}$ 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 played an important part in the formation of the heavenly bodies, conducted us to the present time, where we pass from the darkness of hypothetical views to the brightness of knowledge. In what we have said, however, all that is hopothetical is the assumption of Kant and Laplace, that the masses of our system were once distributed as nebulæ in space.

TINNING SHEET IRON.

Dr. Ure, after giving a brief history of processes formerly in use, says:—"The process of cleaning and tinning at some of the best works now is as follows:—When the sheet iron leaves the plate mill, and after separating the plates, and sprinkling between each plate a little sawdust, the effect of which is to keep them separate, they are immersed, or, as technically termed, "pickled," in dilute sulphuric acid, and after this placed in the annealing pot, and left in the furnace about 24 hours; on coming out, the plates are passed through the cold rolls; after passing through the cold rolls, the plates seem to have too much the character of steel, and are not sufficiently ductile; to remedy this they are again annealed at a low heat, washed in dilute sulphuric acid, to remove any scale of oxide of iron, and scoured with sand and water; the plates in this state require to be perfectly clean and bright, and may be left for months immersed in pure water without rust or injury; but a few minutes' exposure to the air rusts them. With great care to have them perfectly clean they are taken to the stow.

The tinman's pan is full of melted grease; in this the plates are immersed, and left there until all aqueous moisture upon them is evaporated, and they are completely covered with the grease; from this they are taken to the tin pot. and there plunged into a bath of melted tin, which is covered with grease; but as in this first dipping the alloy is imperfect, and the surface not uniformly covered, the plates are removed to the dipping or wash pot; this contains a bath of melted tin covered with grease, and is divided into two compartments. In the larger compartment the plates are plunged, and left sufficiently long to make the alloy complete, and to separate any superfluous tin which may have adhered to the surface; the workman takes the plate and places it on a table, and wipes it on both sides with a brush of hemp; then to take away the marks of the brush, and give a polish to the surface, he dips it in the second compartment of the wash pot. This last always contains the purest tin, and as it becomes alloyed with the iron it is removed on to the first compartment, and after to the tin pot. The plate is now removed to the grease pot; this is filled with melted grease, and requires very skillful management as to the temperature it is to be kept at. The true object is to allow any superfluous tin to run off, and to prevent the alloy on the surface of the iron plate cooling quicker than the iron. If this were neglected the face of the plate would be cracked. The plate is removed to the cold pot; this is filled with tallow, heated to a comparatively low temperature. The use of the grease pots, is the process adopted in practice for annealing the alloyed plates. The list pot is used for the purpose of removing a small wire of tin, which adheres to the lower edge of the plate in all the foregoing processes. It is a small cast iron bath, kept at a sufficiently high temperature, and covered with tin about one-fourth of an inch deep. In this the edges of the plates are dipped, and left until the wire of tin is melted, and then detached by a quick blow on the plate with a stick. The plates are now carefully cleaned with bran to free them from grease. Lastly, they are taken to the sorting room, where every plate is separately examined and classed, and packed in boxes for market.

"The tests of quality for tin plates are—ductility, strength and color. To obtain these the iron must be of the best quality, and the manufacture must be conducted with proportionate skill. This necessity will explain to some extent the cause why nearly all the improvements in working iron during the past century have been either originated or first adopted by the tin-plate makers; and a sketch of the processes used at different times, in working iron for tin plates, will be, in fact, a history of the trade.

A PAIL of water will sometimes stop a squeaking journal when oil is of no avail.

THE LINEN MANUFACTURE IN IRELAND.

Sir Robert Kane, F. R. S., recently read before the Society of Arts a paper from which we take the following extracts:—

"Of all branches of industry, however, that which is of the most importance to Ireland, from the amount of capital it represents, and the number of persons to whom it gives occupation, is the linen trade. I am indebted to the kindness of Mr. M'Il wrath, secretary to the linen trade of Belfast, for much valuable information on that subject, and also to Mr. M Call, of Lisburn, for many interesting particulars, of which I shall endeavor to lay before the Society such general heads as our limited time may allow.

"The linen trade of which Belfast has been the long established head quarters in Ireland had been rather falling off in amount, until the interruption of the supply of cotton by the American war called it into immensely increased activity. The contrast in this regard is well shown by the following figures:—In 1859 there were in Ireland 82 flax-spinning mills, containing 651,872 spindles, of which 91,230 were unemployed; whilst in 1864 there were 74 spinning mills with 650,744 spindles, of which but 8,860 were unemployed, whilst 50,638 additional spindles were in May last being set to work. Further, in addition to the above there were employed in 1864, 14,648 spindles occupied in making thread, and five mills were in course of erection to contain 45,000 spindles. In regard to power-loom factories for linen, a similar remarkable increase is shown for the same period. Thus, in 1859, there were 28 factories with 3,633 looms, of which 509 were unemployed; whilst in 1864 there were 42 factories with 8,187 looms, of which but 258 are unemployed; 1,685 additional looms were about being set to work at the date of the return in May last. The introduction of the factory system into the linen trade, and especially the power-loom, is comparatively modern, the first spinning mills for flax in Ireland having been established about 1828, previously to which time cotton spinning was much more extensively carried on in Belfast than it has since been.

The great extension of trade and the benefit to the operative classes which followed this change, may be illustrated by the following fact:—When spinning and weaving were done by hand, the firm of Richardsons, of Lisburn, turned out from 15,000 to 20,000 pieces of goods in twelve months; that firm can now deliver 250,000 pieces of bleached goods in the same time.

As to wages in the old day of spinning on the domestic wheel, the earnings were from 2s. 6d. to 4s. (62 cts. to $1.00) weekly, whilst at present in spinning mills the ordinary work-women make from 3s. 6d. to 6s. (86 cts. to $1 50) per week, and superior hands from 6s. to 8s. ($1 50 to $2). The best hand loom weaver can only make 6s. per week, out of which he has to pay charges which leave him only 5s, ($1 25) whereas an expert girl, who can attend to two power looms, can make 10s. ($2 50) per week clear. Thus the earnings of individuals have been materially increased by the introduction of steam machinery in the linen trade; and in regard to the total amount of employment, there were ten years ago, 17,000 persons employed in this trade in and about Belfast, whereas in the present year the number employed in the mills is 25,000, exclusive of the vast number of outsiders who indirectly derive their subsistence from that branch of manufacture.

Coupled with this development of the linen trade there has taken place a great increase in the quantity of flax cultivated in Ireland. During the Crimean war, when the Baltic trade was subjected to certain impediments, the quantity of land under flax was increased, and amounted, in 1853, to 174,579 acres, but on the restoration of peace, the Baltic trade being resumed, the demand for home grown flax diminished, and the cultivation fell off to 91,646 acres in 1858. Since that time it has progressively increased, and has now assumed proportions entirely unprecedented, the quantity in 1863 having been 214,-099 acres, and in the present year having increased to 301,942 acres, which at an average of 35 stone of clean scutched flax to the acre, gives the produce of fiber at 10,557,070 stones, or 66,050 tuns; and at an average price of 7s. 6d. per stone, the total value of the crop of the present year is £3,962,989. This great increase of production is accompanied of course with corresponding increase of the export trade.

THE MANUFACTURE OF STARCH.

The extensive discussion of the manufacture of sirup from the starch contained in Indian corn naturally gives an interest to the methods employed for extracting the starch. It is a maxim among chemists never to employ chemical processes when the result can be reached by a mechanical process. Starch exists in grain and can be separated by simply washing. Any one attempting to make sugar or sirup from corn will doubtless find it best to separate the starch first by approved methods, and then treat this pure starch with sulphuric acid to convert it into sugar. We extract from Ure the method practiced in England for separating starch from wheat, and we take from Appleton's Cyclopaedia some statements in regard to the manufacture of starch in this conntry from Indian corn:—

In England, wheat crushed between iron rollers is laid to steep in as much water as will wet it thoroughly; in four or five days the mixture ferments, soon afterwards settles, and is ready to be washed out with a quantity of water into the proper fermenting vats. The common time allowed for the steep, is from 14 to 20 days. The next process consists in removing the stuff from the vats into a stout, round basket set across a back below a pump. One or two men keep going round the basket, stirring up the stuff with strong wooden shovels, while another keeps pnmping water, till all the farina is completely washed from the bran. Whenever the subjacent back is filled, the liquor is taken out and strained through hair sieves into square frames or cisterns, where it is allowed to settle for 24 hours; after which the water is run off from the deposited starch by plugtaps at different levels in the side. The thin stuff called slimes, upon the surface of the starch. is removed by a tray of peculiar form. Fresh water is now introduced, and the whole being well mixed by proper agitation, is then poured upon fine silk sieves. What passes through is allowed to settle for 24 hours; the liquor being withdrawn, and then the slimes, as before, more water is again poured in, with agitation, when the mixture is again thrown upon the silk sieve. The milky liquor is now suffered to rest for several days, four or five, till the starch becomes settled pretty firmly at the bottom of the square cistern. If the starch is to have the blue tint, called Poland, fine salt mustbe mixed in the liquor of the last sieve, in the proportion of two to three pounds to the cwt. A considerable portion of these slimes may, by good management, be worked up into starch by elutriation and straining.

The starch is now fit for boxing, by shoveling the cleaned deposit into wooden chests, about four feet long, twelve inches broad, and six inches deep, perforated throughout, and lined with canvass. When it is drained and dried into a perfect mass, it is turned out by inverting the chests upon a clean table, where it is broken into pieces four or five inches square, by laying a ruler underneath the cake, and giving its surface a cut with a knife, after which the slightest pressure with the hand will make the fracture. These pieces are set upon half burned bricks, which by their porous capillarity imbibe the moisture of the starch, so that its under surface may not become hard and horny. When sufficiently dried upon the bricks, it is put into a stove (which resembles that of a sugar refinery,) and left there till tolerably dry. It is now removed to a table, when all the sides are carefully scraped with a knife; it is next packed up in the papers in which it is sold; these packages are returned into the stove, and subjected to a gentle heat during some days; a point which requires to be skilfully regulated.

In the United States Indian corn and potatoes are most commonly used for starch. The application of the former to this use was patented by James Colman, in 1841, and was successfully practised by Thomas Kingsford, of Oswego, N. Y., in 1842. In 1849 he had a large factory at that place, which is still in successful operation under the direction of Messrs. T. Kingsford and Son, having up to the end of the year 1860 made nearly 30,000 tuns of starch. Its annual production for five years was as follows:—1856, 6,328,453 lbs.; 1857, 8,018,-778 lbs.; 1858, 8,686,516 lbs.; 1859, 6,747,586 lbs.; 1860, 8,500,000 lbs.; far exceeding that of any other starch factory in the world for the same time. The total consumption of raw material in the twelve years from Jan. 1, 1849, was 2,476,000 bushels of Indian corn and 164,-448 bushels of wheat, besides some damaged flour. The boxes for packing the starch have required 15,000,-000 feet of bass-wood, supplied chiefly by the farmers in the neighborhood. The building has a front of 510 feet, and extends back over the Oswego river 250 feet. Its flooring covers 250.600 feet, or nearly six acres. For grinding the corn there are fifteen pairs of buhrstones, and six pairs of large, heavy iron rollers. The river furnishes the power to drive the machinery, and a steam engine of 140 horse power is provided to make up any deficiency in very dry seasons. The vats employed in purifying the starch have a capacity of 2,200,-000 gallons, and the length of gutters for conveying and distributing the starch waters is over three miles. A similar factory, almost or quite similar to this in capacity, commenced operations at Glen Cove, on Long Island, in 1858. This also uses Indian corn, which is more cheaply transported from the western states than the starch from it would be. The product of each bushel is about 23 lbs., and the boxes of the starch, on account of their bulk and the extra care they require, make more expensive freight than the raw material. Potato starch factories re more numerous but not so