

who, on the 16th of December last, gave an exhibition of his machine, its powers being exerted on blocks of the hard Quincy granite. The principal part of Mr. Shelbourne's machine is a cast iron casing, in form a depressed semi-spheroid, or shallow inverted bowl, seven feet in diameter. It has three solid steel feet or toes by which its stability on the rock is secured. Rising from the upper part of the casting is a conical wrought iron frame, supporting the upper end of the drill shaft by means of two parallel rods entering into sockets in a cast ring at the top of the frame. The drill bar passing up through the centre of the top is furnished at the bottom with a bit, one and a half inches diameter, and having imbedded in its face nineteen diamonds, and rotating at the rate of from 300 to 500 revolutions per minute, advancing at the rate of from one to one and a half inches in the same time.

The feed is caused by a differential gearing which steadily operates to advance the drill into the rock, the debris being washed away by the water forced into contact with the bit through a small rubber hose. The water-tight chamber of the machine contains a pair of engines working at right angles to each other, with a horizontal stroke. As soon as the hole is completely drilled, and also when the drill-shaft is withdrawn from the rock, information of this is given by a magnetic bell which is acted upon by a double wire cord insulated from the water and passing down one of the parallel rods or tubs upon which the crosshead is fixed.

This drill weighs nearly five tons. It will be worked from a wrecking tug with a derrick by means of steam supplied from the boiler of the tug. To prevent this steam being condensed in its passage through the water to the engine it is conveyed in a hose surrounded by another through which the exhausted steam passes.

The rock which will be drilled in the Hell Gate is that known as the bastard granite, and is much softer than either the Quincy or Maine granite, on which the drill has been satisfactorily tested. After a number of holes are drilled over a certain space, a diver will descend and charge them with cartridges of nitro-glycerin, which will be exploded in the usual manner. In connection with the drill another very ingenious and automatic machine will be used to grapple and raise the fragments.

#### CONCEPTIONS OF THE INFINITE.

Try all we may, we fail to get even the most dim conception of the absolutely infinite—that which has no bound, no measure of comparison. We will cease to make any effort to conceive it as soon as we realize the fact that all our ideas are comparative. Size, color, form, weight, all the qualities in which material things differ from each other, are all judged by comparison with something else. A unit of comparison which answers well as a measure of some object or distance, may be found to be inadequate for the measure of a larger object or distance. To estimate the distances of very remote objects, as the fixed stars, it becomes necessary to take a very large unit of comparison, say the distance light travels in a single second.

Thus it has been estimated that Sirius the "dogstar" is at such a distance from the earth that light requires fourteen years to travel from it to our earth. When we reflect that light travels at the rate of 190,000 miles in a second, we can form a conception of this distance which would be impossible if we made a mile the unit of measurement. But this distance, large as it is, is rapidly increasing. It has been recently computed that Sirius is moving away from the earth at the rate of 144,000 miles per hour. The method by which this motion has been determined leaves no room for doubt as to its reality although it may well be doubted that the rate of recession is anything more than a rough approximation.

These illustrations, although they do not disprove the statement that the human mind cannot conceive infinity, show that the nearest approach to such a conception is in the study of that sublimescience, astronomy. No wonder that the devotees of astronomy are the most laborious of all the divisions of the grand army of science. No wonder that they who nightly gaze upon the mightiest of God's works, should have ever been the most unwilling to doubt the existence of a higher creative intelligence. No wonder that this grand study has attracted to itself and appropriated the best talent of every age, and that those who "nightly assault the heavens with the artillery of science," are humbled with the sense of their own weakness as they contemplate the stupendous machinery of the universe.

#### WHAT IS SCIENCE?

The primary signification of the word science is knowledge; but as generally accepted it means knowledge reduced to a system. All knowledge is comprised of facts and logical inferences from facts. The basis of all science then is fact, and the prime object to which all scientific research should be directed is the determination of facts. Facts, being the foundation upon which the logical superstructure must be reared, are of the most vital importance. They may not be assumed; all guesswork is to be strictly shunned.

People are too apt to forget that it is quite possible to reason correctly and ably upon totally false premises. The world is full of books that exemplify our proposition. Old libraries are filled with quaint and labored expositions of almost every subject upon which men can think, valueless now, because they have been found to conflict with facts. It is with feelings of admiration that we roam through a collection of these almost forgotten labors—admiration for the talents which in the light of the nineteenth century, would have made a brilliant display, and which, even in the darkness of medieval times, made a manly and brave struggle to reach truth.

We pride ourselves upon the progress of the times, and we

have good reason to do so; at the same time it is not by any means improbable, that many of our views upon subjects relating to the sciences will be discovered to be fallacious by a future generation, as those of a past age have been by us. It seems to us that there is too much inquiry as to why things are and too little as to how they are. What is of practical value is how things occur—what are the invariable laws that govern their occurrence. Had Newton set himself to speculating as to why gravitation takes place, rather than to the investigation of the laws which govern the attraction of masses to each other, his labors upon that subject would have been altogether vain and worthless. But his was a mind that applied itself to the investigation of facts. It is true he hazarded some hypotheses, but they were only entertained by him as being what might ultimately be demonstrated by experiment to be true, not made the basis of system. The world has had too much theorizing and is now getting down to the true foundation, the veritable hardpan of all science facts.

#### REMINISCENCES OF TRAVEL IN SPAIN.

NO. III.

DUCCAL PALACES—THE ESCORIAL OF PHILIP THE SECOND. The public buildings of Madrid are unusually good, and there are many grand ducal palaces fitted and furnished in sumptuous style, the most interesting of which are those of the celebrated Duke of Alva, and Cardinal Ximenes, the latter in some respects the ablest man which Spain has ever produced. Ximenes began his career by entering a Franciscan monastery. During the reign of Ferdinand and Isabella, over whom he exercised a strong influence, his mind more than any other, controlled the policy of the kingdom, and to this day his memory is revered as a saint. The gloomy old palace is a fitting reflex of the rigorous habits of the Cardinal. The palace of the Duke of Medina Celi, facing the Prado, covers an area of 245,000 square feet, and is fitted up with all that taste, skill, and love of display which characterize the wealthy classes of Spain. The Marquis of Salamanca has two elegant palaces; and until recently his picture gallery was looked upon as containing one of the finest private collections in Europe. Some of our readers will remember the Marquis as having been an active promoter of the Atlantic and Great Western Railway; and the town of Salamanca, Pa., was named after him. It is reported that he lost heavily by his railway schemes, and that in order to repair the drain made upon his fortunes, he had sold at the recent Paris exhibition many of his valuable pictures, from which he realized upwards of three hundred thousand dollars.

Wealth in Spain, as in most monarchical countries, is very unequally distributed. The grandees are usually very rich in landed estates and other property, while the poor are very poor. In point of squalid poverty, the streets of Madrid are full of picturesque effects. Vice and immorality run through all classes of society, and yield their bitter fruits. The more common outward vice of the lower classes consists in their passion for bull-fights, cock-fights, and lotteries. It is a common thing to witness upon the streets, old men, women, and young children hawking about lottery tickets, from the sale of which they gain a miserable pittance.

Spanish history abounds in great mysterious characters, and we are obliged to confess that there was something strangely fascinating connected with our trip through that romantic country, which we can only explain by the fact that in early life we had read with interest "Don Quixote," Prescott's histories of "Ferdinand and Isabella," "Charles the Fifth," and "Philip the Second," also Irving's "Conquest of Grenada" and the "Tales of the Alhambra." The reader can therefore readily imagine with what eagerness we sought out the Audiencia where Ferdinand and Isabella were married; the old palace where Philip the Second was born; the little chapel at Seville, where Columbus met Isabella on his return from San Salvador; the house where he died, and the parochial church where his funeral obsequies were celebrated, also the many exquisite edifices left by the exiled Moors. Perhaps, however, there is no single pile of architecture remaining in Spain so interesting as the Escorial—about two hours' ride by railway from Madrid, and regarded by the Spaniards as the eighth marvel of the world. The Escorial was designed and built by Philip the Second, a cold, haughty, intellectual bigot, who, after burying one youthful queen, went over to England and married "Bloody Mary." Philip does not appear to have been greatly afflicted when Mary died, for history represents him so very anxious to obtain another queen that he could scarcely wait for the six months' official mourning to cease before he sent his ambassador to claim the hand of Elizabeth of Valois, daughter of Catherine de Medicis, then in her sixteenth year, and knowing all the while that his unfortunate son, Don Carlos, had a strong passion for the beautiful princess.

History says that Philip was induced to found the Escorial as an act of gratitude to God, and especially to his patron, St. Lawrence, who inspired the victory of St. Quintin, in 1557. The buildings, which comprise a palace, temple, and monastery, cover 500,000 feet, and cost upwards of four millions of dollars in those times, when it is said that the laborers received but six cents per day for their work. The situation of the Escorial, under the shadow of the Guadarama mountains, is desolate and melancholy in the extreme. The mountains are one mass of bare gray granite, and the wide sweep of country lying in front is a monotony of rocks and stunted trees. Philip was two years in hunting out this situation, and if he had searched for two years more he could scarcely have made a selection more desolate. St. Lawrence suffered martyrdom by being roasted upon a gridiron, and it is thought that Philip had the form of that instrument in his head when he drew the plan, which no doubt was supplemented by a granite boulder in his hat, if one may judge from the immense piles of stone blocks employed in its construction.

The architecture of the Escorial is severely simple, grand and gloomy. Philip built it not for a prince, but for a monk, and wanted for himself only a cell, where he could live and die, in the palace he had built to God; and certainly, we never before saw so much simplicity and solidity in any other similar structure. The palace was originally very plainly fitted up. Philip's cheerless cell, where he was accustomed to pass a good deal of his time, had four common-looking pictures hung upon the walls, a plain board table, a single chair, and a stool upon which he used to rest his gouty foot, the sacking still showing the stains from the remedies employed to kill the pain. These relics of the monarch are reverently shown, and attest the rigid austerities practiced by him after his retirement to the Escorial.

The treasures of the Escorial are very numerous. There are many fine paintings, statues, and tapestries, curious pieces of furniture, elegant and costly church vestments, beside several thousand saintly relics, highly venerated, among which are ten complete skeletons, more than a hundred heads, and several hundred bones. Philip had a passion for these things.

Just back of the choir of the temple, there is suspended a marble crucifix of life size, done by that famous man Benvenuto Cellini of Florence. He worked upon it, he says, "with the diligence, and love, that so precious an object deserves, and because I know myself to be the first who ever executed crucifixes in marble."

The library is a splendid room two hundred feet in length, and contains many rare and beautiful books, among which is a splendid Old Testament of the eleventh century in letters of gold with exquisite paintings; also, a tastefully decorated copy of the Koran which is very old. We asked the custodian, what value was put upon the Old Testament, and he replied that a million dollars would not buy it. The fine, sharp portrait of Philip, which hangs in this library, represents a pale, bloodless, careworn man of seventy-two, about to bid adieu to all his grandeur and renown. Such a picture, in such a place, makes it one of the most interesting portraits in existence.

The Monastery was shut to our observation, but we heard the solemn chanting of a few monks who are permitted to occupy its cells and cloisters. Upwards of seventeen hundred mass services are required to be performed every year in the Escorial, and following the custom of her predecessors, the late Queen, when she visited the place, was in the habit of hearing midnight mass at the altar of the pantheon under the temple.

The palace "is tenantless of its heroic dwellers," the courts are deserted, and the mind of the visitor is oppressed by the gloom which hangs heavily over a venerable pile that illustrates better than books, the character of the man who built it.

The palace is now very elegantly furnished—four of the apartments, afterward fitted up by a subsequent king, in marquetry, with gold and steel door and window trimmings, cost upward of one million dollars. The temple is an enormous structure of massive granite, and beneath the high altar is a gorgeous pantheon fitted up as a burial place for the Spanish kings and queens. Philip died upon a couch within a small side chapel, through the window of which he could survey the splendid follies which he had created; and his worn-out body was carried down and deposited within a recess of the pantheon. Twenty-one years were employed in the construction of the Escorial, and Philip was accustomed to ride from Madrid on horseback to superintend the work, perching himself on an elevation where he could overlook the situation and development of his costly gridiron.

We spent five hours' hard work in wandering about the vast buildings of the Escorial.

#### American Institute Lectures.

Dec. 30.—Mr. James Hall, State Geologist, Albany; "On the Evolution of the North American Continent."

Jan. 6, 1869.—Prof. Horsford, Cambridge, Mass.; "On the Philosophy of the Oven."

Jan. 13.—Dr. T. Sterry Hunt, Montreal, Canada; "On Primitive Chemistry."

Jan. 22.—Prof. Doremus, College of the City of New York; "On the Photometer."

Jan. 27.—Mr. Waterhouse Hawkins, of London; "On Comparative Zoology."

Feb. 3.—Prof. Cooke, Harvard College, Mass.; "On the Spectroscope."

Feb. 10.—Wm. J. McAlpine, Pres. Am. Soc. of U. E.; "On Modern Engineering."

#### The Late King of Siam.

The name of the late King of Siam was Phra-Bard Sam-detch-Phra-Pharamend-Maha-Monkut. He was seventy years of age, and had some taste for civilization, having dug canals, built forts, railways, steamboats, founded a printing office at Bangkok, and paid some attention to education. These peculiarities probably came from reading the *Evening Post*, to which he was for many years a subscriber.

The king leaves an extensive family of widows, said to be two thousand in number, to mourn his loss. He spent the last years of his life chiefly in studying Siamese theology, and in photographing his wives.

We have a very high respect for the *Evening Post*, and it is therefore with some hesitation that we disturb its theory respecting the progress made in civilization by Phra-Bard Monkut, of Siam. His late highness was a regular reader of the *SCIENTIFIC AMERICAN*, and it seems to us very likely that he learned more from its columns about forts, steamboats, railways, canals, and photography, than from the *Post*; but so far as his knowledge of theology and social science is concerned, we have no doubt that he found the *Post* an able assistant, and we hope our cotemporary will forward a copy of the paper containing the notice to each of the two thousand bereaved widows.