Animal Power vs. Steam.

Mr. A. Sanson, in an article in a recent number of the *Revue Scientifique*, states that, from a comparison of animal and steam power, in France at least, the former is the cheaper motor. In the conversion of chemical to mechanical energy, 90 per cent is lost in the machine, against 68 in the animal. He finds that the steam horse power, contrary to what is generally believed, is often materially exceeded by the horse. The cost of traction on the Montparnasse-Bastille line of railway he found to be for each car, daily, 57 francs, while the same work done by the horse cost only 47 francs; and he believes that, for moderate powers, the conversion of chemical into mechanical energy is more economically effected through animals than through steam engines.

American Industries.—The Quality of Our Labor.

American mechanics are, as a class, says the Rev. W. V. Davis, in Cleveland *Plaindealer*, the most intelligent, ingenious, and instructive in the world. In 1884 our American Patent Office issued 20,297 patents. At the recent International Electric Exposition in Paris, five gold medals were given for the greatest inventions or discoveries, and all five crossed the ocean to the United States.

Even so strong a Britisher and calm a writer as Mr. Herbert Spencer says we have the best mechanical appliances and mechanics in the world. Now, any one of these advantages would insure ultimate supremacy if it be rightly used. What, then, if all three coincide? Plainly, it ought to give us the markets of the world. Already, six years ago, in 1880, we had surpassed in manufacture by $650,000,000 Great Britain, hitherto the imperial mistress among nations. So soon did Mr. Gladstone's keen forecast come true that we should ultimately become the head servant in the world's great household. From 1870 to 1880 the manufactures of France increased $230,000,000, of Germany $430,000,000, of Great Britain $580,000,000, and those of the United States increased $1,030,000,000. And think of it! We are just beginning to develop our resources, while many of these nations find many of theirs well nigh exhausted. Even now, the superior intelligence of our mechanics can compete against the cheaper labor of Europe. Even now, in spite of their cheap labor, we can lay down our steels in Sheffield, our certain lower grades of cotton in Manchester, our electroplate in Birmingham, our watches in Geneva, and undersell European manufacturers at their own doors. If this is the beginning, what, then, of the possible future? And then add to this how just now our markets are being rapidly extended under the impulse of electricity and steam as never before.

We are next neighbor to all the nations; to South America, just quivering with its new life; to Japan and China, just waking up from the sleep of ages; to Africa, with its wonderful and mysterious future greatness. Within these twenty years it was as if the dead bones of the nations had been flying into place and a living soul had entered them. It is the dawning of Christian civilization for a billion of people who do not yet enjoy it. And Christian civilization means higher, nobler material as well as intellectual and spiritual wants. After the missionary always goes commerce. Five hundred American steel plows went to the native negro Christians of Natal, South Africa, last year. All the millions of Asia and Africa are going to have their civilized cravings, as we do, some day. India, just beginning to be a little Christian, took $12,000,000 worth of cotton goods last year. What may all Asia want 100 years hence? What may Africa want 100 years hence? With those vast continents added to our market, and all our natural advantages realized, what is to prevent our country from becoming the mighty workshop of the world?

Realize the resources of our agriculture, and feed 1,000,000,000 souls! Fully develop our mining and manufacturing industries, which would be enough to sustain the whole billion; gain the pre-eminence in every market around the globe, and become the handmaid of the nations. Did not Mr. Matthew Arnold say right in his lecture to us a year and a half ago, that "America holds the future"?

Diminutive Mail Matter.

The postal service at Liverpool, England, recently had an experience which, if often repeated, would prove the reverse of amusing. Some one whose ingenuity or economy was searching for new fields wrote a message of twenty-six words on the back of a two cent stamp, which was duly posted and delivered. This success led to a second experiment and then to a third. But on the last occasion, a one cent stamp was chosen, and was accordingly held as an insufficiently prepaid letter.

THE STATUE OF LIBERTY NEARING COMPLETION.

Even those unacquainted with the details of such work may, by carefully considering all the conditions involved, form a tolerably accurate idea of the labor expended and the patience and skill exercised in the erection of such a structure as the Statue of Liberty. The last operation before the figure left France was the assembling of all of the many pieces comprising the shell or statue proper and the final fitting of each piece to each of its surrounding neighbors. Each piece was then marked with a particular number or figure, and every two meeting pieces were designated by the same character marked upon their adjoining edges; this of course was to serve as a guide when reassembling the statue upon its pedestal at Bedloe's Island. Surrounding each separate piece at a short distance from the edge is a row of small holes; when two pieces are joined together, the holes in one coincide with those in the other, so that the two may be firmly united together by rivets.

STATUE OF LIBERTY.—VIEW AT TOP OF PEDESTAL, SHOWING THE SHELL AND BRACING.

When the statue was taken down, in France, the pieces were packed in frames of wood, to prevent as much as possible their being bent by handling and during the passage to this country. But it was impossible to prevent a certain amount of distortion from taking place, so that the reassembling now in progress is to some extent also a work of refitting. This, together with the drawbacks under which the men labor, particularly the great height above ground, renders the otherwise simple work of erection one of great magnitude. The thousands of rivets add most materially to the labor, as they must be so driven as not to disfigure the statue by presenting conspicuous and unseemly lines.

The copper of the shell, being only about three thirty-seconds of an inch thick, lacks rigidity, so that it was necessary to increase the stiffness of every piece, particularly those of a large size, by means of iron bars secured to the interior surface. These bars are three-quarters thick by two inches wide, are bent to closely conform to the curves in the copper, to which they are fastened by copper bands whose ends are riveted to the shell, and are so disposed and united to each other as to form a most intricate network of bracing, covering and strengthening the entire statue. The interior view of the face, upon our first page, clearly illustrates the extent of this bracing and the manner of securing it to the shell.

This bracing is connected by bars with the main frame that holds the statue upon its pedestal, as shown by the engraving upon opposite page. By this means, the rigidity of the whole work is assured, and any wind pressure—the force most to be provided for—upon the pliable, paper-like shell is transmitted to the four massive iron corner posts of the frame, which are firmly anchored to the masonry.

All the framework in the interior of the statue was made in France; and while there is regularity in the main frame, there is nothing apparent in the connecting bracing but a seemingly confused collection of bars of all shapes and lengths, and extending in every conceivable direction. This is caused by the constant change in the direction assumed by the copper, and the endeavor not to have too large a surface unsupported.

No part of the ironwork is in direct contact with the copper, a thorough insulation being obtained by shellacking the adjoining surfaces and interposing a strip of asbestos. This is necessary to obviate the deleterious chemical action that would occur if the iron were in direct contact with the copper.

The method pursued in the erection of the statue may be briefly described. The framing has been finished with the exception of two small parts—that supporting the right hand and that of the head. The shell of the statue has been carried up only a little further than shown in the engravings.

The various pieces were temporarily stored in a shed between the base of the pedestal and the dock at which visitors are landed by the little tug plying between the Battery and the island. The piece wanted is carried to the foot of the pedestal, the face of which is protected from injury by a covering of wood, and is, if large, lashed to a wooden frame to which is attached the end of a rope passing over a derrick on top of the frame, and thence to a hoisting engine on the ground. The piece is then raised to a platform built around the top of the pedestal, and is carried to the place where its marks indicate that it belongs. When necessary, a rope and tackle are brought into play to raise the piece into position, and to hold it until enough rivets or small temporary bolts have been inserted to secure it. All the rivets are then driven, and the braces are bolted to the frame and stiffening bars. The shell is thus carried up, piece by piece, in horizontal courses. The difficulty of the work increases as the top is approached, mainly because of the increased height above ground, the top of the pedestal, where the statue begins, being 150 feet, and the torch 305 feet above water level.

There are three kinds of joints in the copper. Where it is particularly desirable that the joint should be concealed, the meeting edges are brought flush together, and are held by a double line of rivets through a strip covering the inside of the joint. In other cases one edge overlaps the other, a single line of rivets uniting them, and the outer edge is either hammered down to make a flush joint or is not touched further, the selection of the style of seam being governed by its location. The outer heads of the rivets, which are of copper, are countersunk.

The two systems of heavy girders, whose ends are embedded in the masonry in the interior of the pedestal, one at the top and the other sixty feet below, together with the four sets of eyebars that unite the two systems, have been placed in position, as shown in one of the accompanying views. These girders extend across the well at right angles to each other, and, being connected at the top with the main frame, serve to anchor the statue to the pedestal.

Lightning has several times struck the ironwork, but, owing to the means that were early taken to lead the current away, not the slightest damage has been done. Extending down each inside wall of the pedestal is a copper rod five-eighths of an inch in diameter. The lower ends of these four rods are joined to plates that were buried in wet earth beneath the bottom of the foundation before building was commenced. The upper ends are united to the frame, but will, upon the completion of the statue, be joined to four diametrically opposite points of the shell.

Up to the present time, no portion of the foundation has settled; and the solid concrete foundation proper, which is easily the largest single block of artificial stone in the world, being ninety feet square at the base, sixty-five feet square at the top, and fifty-two feet ten inches in height, with a central well-hole ten feet square, is without crack or flaw of any description. The inside of the pedestal walls are also of concrete, the face being granite, and they display the same perfection in both material and workmanship.

It is extremely doubtful if the statue can be finished by the 3d of next month, the date set for what we may term the unveiling. There is much to be done, and the rate of progress is slow, as it is impossible to employ a great number of men.

In the SCIENTIFIC AMERICAN of June 13, 1885, we illustrated and described very thoroughly the foundation, pedestal, and frame.

THE GREAT LOG JAM IN THE ST. CROIX RIVER.

BY H. C. HOVEY.

In order to comprehend the full significance of the great log jam which it is the main object of this article to describe, we must first consider the nature of the surrounding region and the stream that flows through it. The St. Croix was, in geological times, a mighty river, through whose channel the overflow of Lake Superior, and indeed the whole drainage of the interior of North America, was carried down to the Mississippi, and thence to the ocean. At present, however, it is a comparatively small but highly picturesque stream, navigable from its mouth, which is fifty miles below Fort Snelling, up to Taylor's Falls. Just below these falls are what are known as the Dalles of the St. Croix, where the channel, instead of being cut, as elsewhere, through a light-colored and soft sandstone, is suddenly confined between precipitous walls of basaltic rock, one or two hundred feet high, while the river itself has a depth of from forty to seventy feet, and yet flows with much velocity. These mural precipices are carved into caves, fissures, and curious potholes, testifying to the aqueous energy of the ancient stream by which they were made. The largest pothole observed by me was estimated to be as much as thirty feet in diameter, while many others are from five to ten feet across and from ten to twenty feet deep. There seem at first to be two distinct dikes of trap, the one at Taylor's Falls and the other at the falls of St. Croix, about a mile above the former. But more careful examination leads to the conclusion that they are portions of one dike, the intervening valley being filled in with drift. The tall cliffs are everywhere exceedingly broken and wild, with many detached fragments, and standing basaltic columns, highly angular, and even prismatic in shape. The rock is remarkably amygdaloidal, and contains copper, though hardly in paying quantities. It is undoubtedly a continuation of the famous Keweenawan formation, so extensively developed about Lake Superior.

THE GREAT LOG JAM, ST. CROIX RIVER.

The first steamboat that ever ascended the St. Croix reached the falls in July, 1838, and brought the news that the treaty made the preceding year between Governor Dodge and the Ojibways had been duly ratified, by which were ceded to the United States the extensive pine forests of the St. Croix and its tributaries. A claim was made at once around the falls by Messrs. Baker, Steele, and Taylor. The steamboat mentioned brought men and machinery for erecting here the first sawmill ever built in Minnesota. And then the crash of the woodman's ax and the splash of the mill wheel were first heard in this region, that has since become so famous for its lumber and its mills of various kinds.

From that time to this the forests along the St. Croix have been frequented by lumbermen, whose custom it has been to fell the trees in winter, cut the logs into suitable lengths for the mill, and then depend on the spring floods to carry them down to the mills below. From the falls upstream extend such interminable rapids as almost to justify the voyageur Du Luth's statement to La Salle, that, in descending it, he had "passed forty leagues of rapids." This description also applies to some extent to its tributaries, which are, in order of ascent, the Snake, the Kettle, the Clam, the Yellow, and the Nemakagon rivers.

In each of these tributaries lay last spring what is termed a heavy drive of logs; the entire aggregate being known to be about 300,000,000 feet. When the time came for sending them down the St. Croix, there first came out from the Kettle River about 75,000,000 feet of logs, which passed the rapids and the falls safely. But nearly all the remaining drives came out at once, leaving only about 14,000,000 behind. Imagine 200,000,000 feet of logs swimming together down that crooked, tumultuous river, jostling each other, playing at leap frog, diving beneath the flood, and vaulting into the air. The van at length leaped the upper and lower falls safely, but when they entered the deep and narrow canon known as the Dalles, they were piled in a heap, and at the bend of the river, about a furlong below Taylor's Falls, they were jammed into a hopeless mass, wedged firmly amid the crags. Down came the myriads of logs hurrying from upstream. The cliffs were lined with eager spectators of a scene that meant ruin to many of them; but what mortal power could stay that impetuous march? The jam was piled as high as the suspension bridge spanning the falls. Above the bridge the mass extended, very much resembling the glacier of the Rhone in shape—a glacier of logs instead of ice—for the distance of nearly three miles. I traversed it from end to end, measuring at various points, reaching the conclusion that the average thickness was about thirty feet, and the average breadth about three or four hundred feet. In several places, owing to the force of some whirlpool or the obstruction of jutting rocks or little islands, the logs are heaped up to the height of forty feet. In other places eye witnesses told me that they saw the strong current suck hundreds of logs under the upper mass, burying them in the waters below. Strange sights are to be seen. Here is a log caught by one end, and the other reared high in midair, like a huge flagstaff. There the case is reversed, and you just see the end of some log, whose length is vertically plunged into the mass below. Of course, the logs are of every size, from that of a telegraph pole to monstrous specimens sixty feet long and four feet through. And these are tossed about at every possible angle. Here and there may be seen some unfortunate log that was snapped in twain by being caught at a disadvantage.

As soon as the jam was judged to be done forming, so as to make it safe to experiment with it, steamboats were brought up to attack its lower end, in a faint hope of breaking it so as to cause a general drive. This was partly accomplished so as to clear the mass away that hung below the bridge, and for some distance above it. But when the foot of the falls of St. Croix was reached, the work had to be done by other methods. Dynamite was tried; but the materials were so elastic as to prevent that powerful agent from accomplishing very marked results.

The sight is highly picturesque, as one now looks up the river, seeing as far as the eye can reach that huge mass of logs, lying so wildly in grotesque confusion between the black cliffs of basalt, while troops of lumbermen, all dressed in red flannel, swarm along the front of the jam. These men select the logs that will in their judgment be most likely to set loose a number of others. A cut is made by an ax, and a heavy iron hook driven in. Word is then sent ashore by a loud shout, and the drivers whip up their horses, four of which work at a time; the cable is drawn taut, and the log thus attacked is drawn out, unless too tightly wedged in. Sometimes it shoots out alone into the stream, and again it carries with it a dozen others, and perhaps same luckless lumberman tumbles in, and is rescued amid the merriment of his comrades. Now and then a submerged log suddenly leaps to the surface and into the air like a huge porpoise. Thus the work goes on of picking the jam to pieces.

There yet remains in it fully 150,000,000 feet of logs. It is impossible to form a safe conjecture as to the length of time that may be required to release this vast accumulation of material. Meanwhile a great fortune is locked up, and the plans of thousands of people may have to be modified for a year to come by reason of this unexpected and strange calamity. The general opinion seems to be that the great bulk of the