

closest competitors, each being valued in the aggregate at \$52,000,000. If flour be included with the grain, the total valuation would be brought up to \$85,000,000. For purposes of comparison it may be noted that the total value of all freight passing through the canal during the year was \$281,000,000. Some of the steel steamers engaged in carrying grain on the Great Lakes have made remarkable records. They are, many of them, vessels of 400 or 500 feet in length, in some instances towing another vessel almost as large behind them, and it is not an infrequent occurrence for one of these huge freighters to travel more than 40,000 miles during a season of ordinary length. The steamer "Malietoa," which is owned by the Minnesota Steamship Company, of Cleveland, enjoys the distinction of having carried the largest cargo of grain in the history of lake commerce. Some months ago she moved from Duluth to Buffalo 195,000 bushels of flaxseed and 70,000 bushels of wheat, the whole being equal to 7,500 net tons. The steamer "Superior City" carried 266,000 bushels of corn, equivalent to 7,460 tons, and third place must be accorded to the steamer "Andrew Carnegie," the 5,300-ton cargo of which consisted of 332,000 bushels of oats. If any evidence were lacking of the confidence of the men in the grain trade that its development has only just commenced, it might be found in the immense sums of money being invested in the construction of new elevators, particularly at Chicago and upper lake ports. Really magnificent structures many of them will be, constructed of steel throughout, with a capacity of from one to two and a half million bushels, operated by electricity, fitted with new, improved machinery for scouring, cleaning, and drying the grain, and fully protected against fire by most elaborate systems. The largest elevators now under construction are building at the head of Lake Superior and at Chicago. The present elevator capacity at the latter city amounts to about 65,000,000 bushels, and this will be somewhat increased by the new elevators, one of which will have facilities for unloading four hundred cars of grain every twenty-four hours. Undoubtedly the most interesting elevator

fireproof as possible. The entire plant when completed will have cost fully \$700,000. The Canadian ports, such as Owen Sound and Fort William, which constitute the gateway for the immense grain fields of the Canadian northwest, which hold such unlimited possibilities for the future, have also shown a marvelous development during the past few years. At Owen

thousand bushels as his net profit, that have caused the serious labor disturbances at Buffalo within the past year or two. When it is remembered that the largest grain-carrying vessels on the lakes are loaded or unloaded in the interval of a few hours, and that the cost of moving freight on the Great Lakes is only a fraction above a mill per ton per mile, whereas a cost of four mills per ton per mile is about the lowest reached on the railways, it will be appreciated that the water transportation of grain as conducted in the United States indeed constitutes one of the marvels of the commercial world. Moreover, improved unloading machinery and larger ships and elevators are coming, so that it is hard to predict the ultimate outcome.



A TYPICAL NAVAHO HOGAN.

HOUSES AND HOUSE DEDICATION OF THE NAVAHOES.

BY COSMOS MINDELEFF.

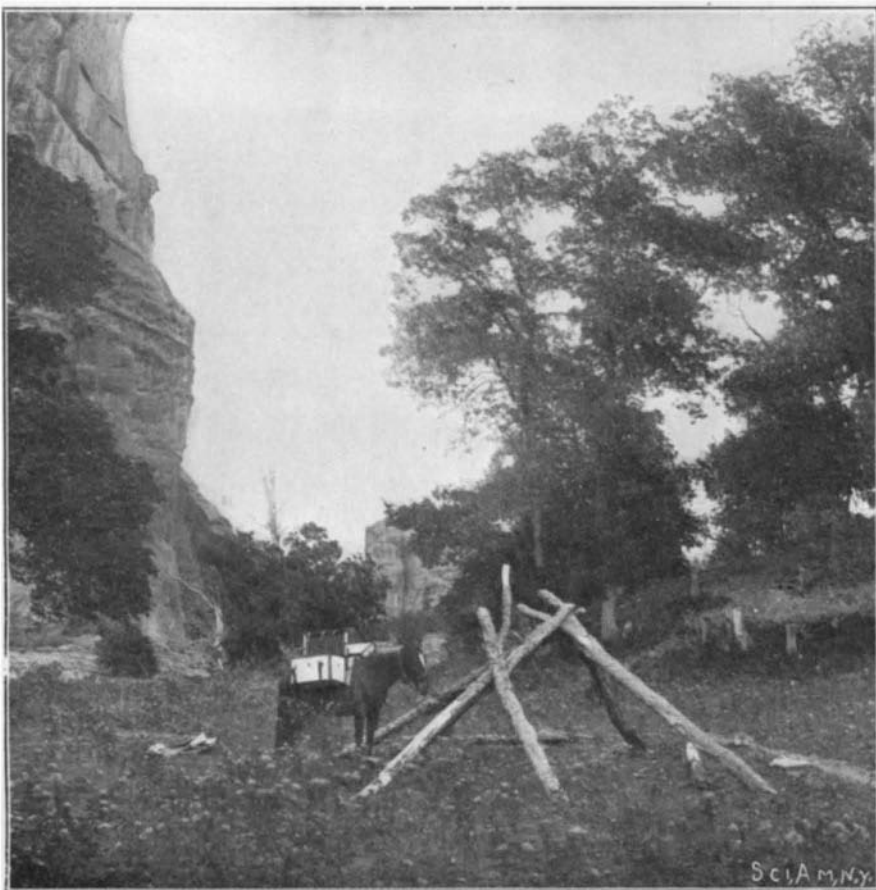
The study of the houses and house-life of the American aborigines, inaugurated by Lewis H. Morgan more than a quarter of a century ago, has progressed to that point that America is no longer open to the reproach made by Ferguson in his "History of Architecture," that the only chapter in the great work which could not be

Sound there have been erected elevators capable of holding between one and two million bushels of grain. At Fort William the Canadian Pacific Railroad Company has expended \$2,000,000 in providing four large elevators which have an aggregate storage capacity of considerably more than 5,000,000 bushels and the largest of which is capable of shipping 40,000 bushels per hour. This elevator is unique. It is constructed with two dozen cylindrical steel storage tanks, each 60 feet high and almost as broad, and which are not only absolutely fire and damp-proof, but are rendered impervious against rats, insects, etc. A distinctive feature of the structure is found in the fact that the machinery for cleaning, separating, and weighing the grain is in an entirely separate building.

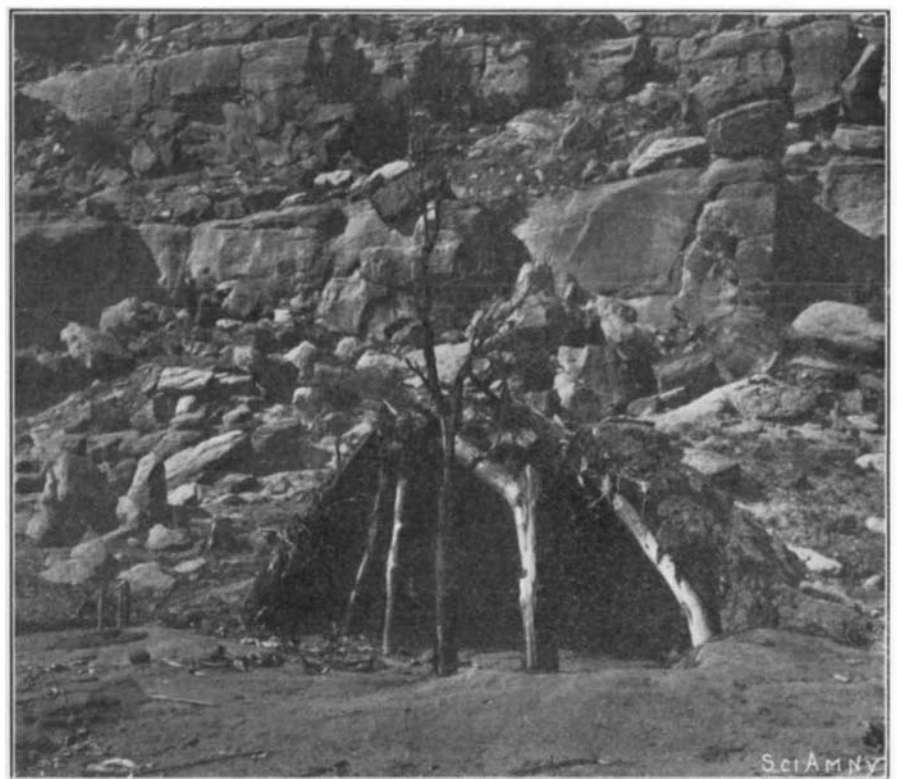
Possibly the most dramatic phase of the water transportation of grain is found in the unloading of the grain at the elevators. The grain is conveyed from the hold of the lake steamer by means of an endless chain of buckets working in a spout or "leg," which is lowered through a hatch. Inasmuch as the lake vessels have anywhere from

written was that pertaining to the Western Hemisphere. Since that day a large amount of work in the way of investigation has been done and much has been written, but singularly enough attention has been largely confined to the Pueblo and Aztec architecture, while the more primitive, although not less interesting forms have been practically ignored, except by Morgan himself. No tribe of Indians offers a better opportunity to supply this deficiency than the Navahos of New Mexico and Arizona, who, until quite recently, were but little affected by the march of civilization, and in their houses retained almost unchanged the ideas and the customs of centuries ago. An exhaustive article on the subject by the writer is now in press and will soon be issued by the Smithsonian Institution.

Rude and primitive as the houses of the Navahos appear, or the hogans, as they themselves term them, every detail is dictated by rules rigidly adhered to, and the erection of one of them is a real ceremonial, almost always followed by an elaborate ritual of dedication. The omission of any part of the ceremony or of the ritual, or its performance out of its regular order, would be followed, it is believed, by the most disastrous consequences. It is only with the passing of this belief in



FRAMEWORK OF A HOGAN.



A HALF-HUT OR SUMMER SHELTER.

yet constructed will be the initial plant now under construction for the new American and Canadian syndicate at Montreal. The main structure will have a capacity of 1,000,000 bushels, and the annexes will provide storage for at least 2,000,000 bushels additional. Steel, concrete, and wood will be the materials used in the construction of the buildings, which will be as near

twelve to fifteen hatches, several of these legs may, of course, be operated simultaneously. Large gangs of men, assisted by steam shovels, must be employed to draw the grain to the mouths of the spouts, and it is the grievance of these men, who have objected to the plan of awarding the contract for unloading all the grain boats to one man, who retains several cents per

the last decade or so that variations from the fixed type have crept in, but thousands of examples of the old form are still to be found on the Navaho Reservation, and hundreds are built every year.

The hogans are usually hidden away so effectually that the traveler who is not familiar with the customs of the people might travel for days and not see more

than a dozen of them, and he might even get the impression that the country is practically uninhabited, yet the tribe numbers over 12,000 souls, and probably there was no time during the day when he was not under observation by several pairs of eyes. The site the Navaho prefers for his home is either some sheltered nook in a mesa or a southern slope on the edge of a grove of piñon or cedar. Very seldom is a house built close to a spring or other water. It is probable that this custom of half-concealed habitations is a survival from the time when the Navahos lived by plunder and momentarily expected reprisals from their victims.

When the site is selected the family moves to the place, taking all their possessions with them, including flocks of sheep, and goats and herds of horses and cattle. The hosteen, as the head of the family is called, drives the ponies and cattle; he carries his arms, for the coyotes may be troublesome at night, two or three blankets, and a buckskin on his saddle, but nothing more. After him comes a flock of sheep and goats, bleating and nibbling at the bushes and grass as they slowly trot along, urged by the dust-begrimed squaw and her children.

The selection of a site is by no means a simple matter, for, aside from convenience, a number of mythologic considerations enter into the problem.

A site having been found, search is made for suitable trees. Three of them must terminate in spreading forks, but the other two, which are intended for the door frame, are chosen for their straightness. The timbers are laid on the ground with their forked ends together, somewhat in the form of the letter T, extreme care being taken to have the butt of one log point exactly to the north, another to the south, and the third to the west. The straight timbers are then laid down with the small ends close to the forks of the north and south timbers, and their butt ends pointing due east.

A house building is a semi-social ceremony, something on the order of the "log-raising" in the early days in the West, and there is always an abundance of help for all the operations necessary.

When the tsadi, or frame of five timbers, is completed the sides of the structure are filled in with smaller poles and branches of trees, set as closely as possible on the ground and laced and bound together. At the same time other workers construct the door frame, which, in appearance, is like a dormer window. Two straight poles, with forked tops, are driven into the ground at the base of and close inside of the doorway timbers, a cross stick is placed in the forks and another on the doorway timbers, at the same level. This provides the basis for a flat roof, the space between it and the apex of the hogan, on the sloping side, being left open for a smoke hole. The sides of the projecting doorway are filled in with upright sticks.

The entire structure is next covered with cedar bark, and earth is then thrown on to a thickness of about six inches, making the hut perfectly wind and water proof. This completes the house. In the building all the proceedings are conducted on a definite, pre-determined plan, and in the order sketched above. No such rigid rules are followed, however, in the construction of summer shelters, usually half-huts, put up on some sloping hillside overlooking fields under cultivation. These temporary shelters are generally constructed on the "lean-to" principle, the roof being covered with straw, corn-stalks, or other available material and finished with earth, or sometimes left unfinished.

With the hogan completed by evening, everything is ready for the dedication. The wife sweeps out the house with a wisp of grass and makes a fire directly under the smoke-hole. She then goes to her bundles which are still outside and procures a quantity of white corn meal, which she pours into a saucer-shaped bowl and hands to the hosteen, or head of the family. Taking it, he enters the hogan and rubs a handful of the dry meal on each of the five principal timbers that form the frame. Beginning at the south doorway timbers he does this successively at the west, north, east timbers, and the north doorway pole, putting the meal as high as he can reach conveniently. While making these "gifts," as the proceeding is called, the man preserves a strict silence, but as, with a sweeping motion of his right hand from left to right, "as the sun travels," he sprinkles the meal around the outer circumference of the floor, he says, in a low chanting tone:

May it be delightful, my house;
From my head, may it be delightful;
To my feet, may it be delightful;
Where I lie, may it be delightful;
All above me, may it be delightful;
All around me, may it be delightful.

A similar invocation is addressed to the fire, into which a little of the meal is flung, a handful or two is tossed up through the smoke-hole, and two or three handfuls are sprinkled out of the doorway, with other invocations.

The woman also makes an offering to the fire by throwing meal upon it and repeats invocations resembling those of the man. When a hogan is built for a woman who has no husband, or when the husband is

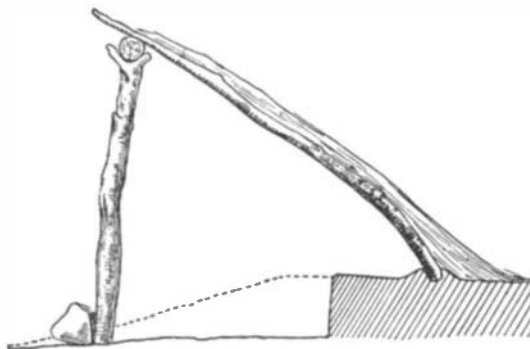
absent, the woman herself performs all the ceremonies. This ceremony is called the "salutation to the house."

Occasionally on the same evening, but usually after an interval of two or three days, the "house devotions" take place. This ceremony is a more elaborate one, and all the friends of the family from far and near are invited. Although analogous to the Anglo-Saxon house-warming, the house devotions of the Navahos, while serving as an occasion for merry-making to the young people, have a very solemn significance to the elders. If it be not observed soon after the house is built, bad dreams will plague the dwellers therein, toothache, dreaded for mystic reasons, will torture them, evil influences from the north will bring all kinds of bodily ill, the flocks will dwindle, ill luck will come, ghosts will haunt the place, and the house will become an evil thing, tabooed.

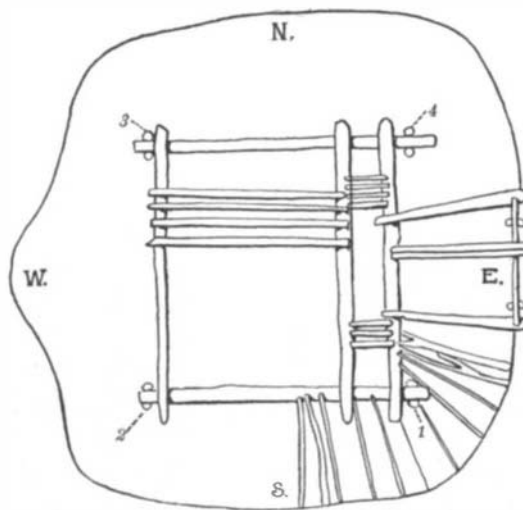
For the house devotions arrangement is made with some Katalchi, or medicine man, to come and sing the house songs. For this service he always receives a fee, sometimes a few sheep or their value, perhaps three or four horses, according to the means of the house builder. The songs are sung by all the men present, the medicine man merely leading and directing them. Each one, and there are many of them in the tribe, has



FRAME OF A HOGAN, SEEN FROM BELOW.



SECTION OF A SUMMER HUT.



GROUND PLAN OF YEBITCAI HOUSE.

his own particular songs, differing in minor details from those of others, although of similar import, and after he has pitched the tune, he listens closely to hear whether the exact words are sung. This is a matter of great importance, as the omission of part of a song, or its incorrect rendering, would bring evil, it is believed, to the house and its occupants.

The first song is addressed to the east and is as follows:

Far in the east, far below, there a house was made;
Delightful house.
God of Dawn, there his house was made;
Delightful house.
The Dawn, there his house was made;
Delightful house.
White corn, there his house was made;
Delightful house.
Soft possessions, for them a house was made;
Delightful house.
Water in plenty surrounding, for it a house was made;
Delightful house.
Corn pollen, for it a house was made;
Delightful house.
The Ancients make their presence delightful;
Delightful house.

Immediately following this song, but in a much livelier measure, a benedictory chant is sung, which closely resembles the song of invocation. After an interval a song of similar import is sung to the west.

These two songs are repeated until each one has been

sung three times to each cardinal point, the benedictory chant occurring between each song. The songs must be addressed to each of the cardinal points, because, under the Navaho system, different groups of deities are assigned to each of these points.

These songs are known as the "Twelve House Songs," although there are only two of them, each repeated many times. After they are finished, many other songs are sung, to the benignant goddess of the west and to the complimentary goddess of the east, to the sun, the dawn, and the twilight: to the light and to the darkness, to the six sacred mountains, and to many other members of a numerous theogony. Other song prayers are chanted directly to malign influences, beseeching them to remain far off; to evil in general, to coughs and lung evils, and to the sorcerers, praying them not to come near the dwelling. The singing is so timed that the last song is delivered just as the first gray streaks of dawn appear, and the visitors round up their horses and ride home.

It frequently happens that, in spite of the ceremonies that have been performed, malign influences affect the new dwelling. The inmates suffer from sore eyes or toothache, or bad dreams trouble them, or ghosts are heard in the night. The house ceremony is then repeated. If, after this, the bad conditions still prevail, or bad omens are noted, recourse must be had to a very elaborate ceremony, the dance of the Yebichai. For this ceremony a separate structure must be erected, much more elaborate than the regular hogans. It is a flat-roofed hut, called in the Navaho tongue *inyadaskuni*, literally "under the flat." The roof is nearly square, as well as flat, and the shape suggests a truncated pyramid, but as it is covered with earth heaped over the entire structure, it is externally little more than a shapeless mound.

When the Yebichai ceremony is in progress, the hut is occupied by the medicine man and his assistants, and by the young men who assume the sacred masks and personate various deities in an elaborate series of nightly dances. In the mornings the medicine man sits under the western side of the hut and directs the young men in the process of sand painting, the making of curious sand mosaics delineating mythologic subjects. No special reverence attaches to these structures, except when a ceremony is in progress. They are not held to be the exclusive property of any particular person or persons, but are for the use of the neighborhood. When not otherwise occupied, the *inyadaskuni* may be used as a traveler's house, or for any other purpose. Indeed, the women often erect their vertical blanket looms there and use the place as a work room, but it is rarely used as a dwelling in winter, as it would have to be vacated whenever needed for the Yebichai.

Congresses at Paris.

Among the numerous congresses which are to be held this year in Paris in connection with the Exposition, the following list includes the principal subjects and dates, and will, no doubt, be found convenient for reference:

June 8-12.	Congress of Stock Companies.
18-23.	Mines and Metallurgy.
25-30.	Accidents to Workmen and Insurance.
25-30.	Aeronautics.
July 8-11.	Commercial Travelers and Representatives.
9-13.	Automobiles.
9-13.	Strength of Materials; Methods of Testing.
16-18.	Steam Apparatus; Surveillance and Security.
19-25.	Applied Mechanics.
23-28.	Commerce and Industry.
23-28.	Photography.
23-28.	Proprietary Rights, Trademarks, etc.
23-31.	Applied Chemistry.
27-Aug. 1.	Electricity as Applied to Medicine; Radiography, etc.
28-Aug. 3.	Navigation.
30-Aug. 4.	Architects.
30-Aug. 4.	Custom House Regulations.
Aug. 6-11.	Chemistry.
6-11.	Technical, Commercial, and Industrial Education.
6-11.	Mathematics.
6-11.	Physics.
16-18.	Bibliography.
18-25.	Electricity.
Sept. 3-5.	Gas.
20-23.	Railroads.

Success of the Parcels Post.

The parcel-post systems for conveying small packages between New York and Germany is very successful. The system has been in operation since October 1, 1899, and it was tried as an experiment. According to the terms of agreement, it was to continue in force until terminated by mutual agreement, and can be annulled upon six months' notice by either country. The parcels post system is in force between the United States and eighteen countries, but the volume of mail exchanged is small, and the business with Germany is larger than all the others combined. Packages are sometimes as long as 6 feet in length and girth combined, 11 pounds is the limit in weight. The Germans have been quick to appreciate the advantages of the system. The number of parcels post packages dispatched and received from Germany, October, 1899 to June, 1900: Dispatched—pieces, 6,461; bags, 350; registered bags, 484. Received—pieces, 10,320; bags, 465; registered pieces, 950; registered bags, 67. Total pieces handled, 16,781.

The Government Work for Good Roads.

The work of the Office of Public Road Inquiries, under the direction of Gen. Roy Stone, has been marked during the past year by steady progress along its well-established lines. A great deal of work is accomplished by correspondence and by the gathering and disseminating of important information relating to various phases of the road subject. Many thousand copies of "good roads" literature have been distributed among farmers and other persons interested, and important road conventions have been attended by representatives of the Office, and many State legislatures have asked for and received assistance in framing new road legislation. Examples of steel road tracks have been completed in a number of different localities, and these experimental sections of steel road clearly demonstrated their usefulness for the Western States and for other places which are but sparingly supplied with good stone and gravel. When steel becomes cheap once more, the manufacturers can take the matter up and make a series of special shapes. The object lessons furnished by sample roads have been extensive, and sections have been built in several parts of the country. As a result of the investigations, the Office considers that for local needs as well as for our material development and prosperity a well-regulated system of public roads through the whole country is, day by day, becoming more necessary. While we have the most perfect railway system in the world, our public highways are and always have been inferior to those of any other country in the civilized old world. As our public roads are the veins and arteries of our agricultural, commercial, and social life, they are not yet receiving the consideration that their great importance deserves. Much has been done in the United States toward road building during the last few years, but much more needs to be done.

REPRODUCTION OF WORKING DRAWINGS.

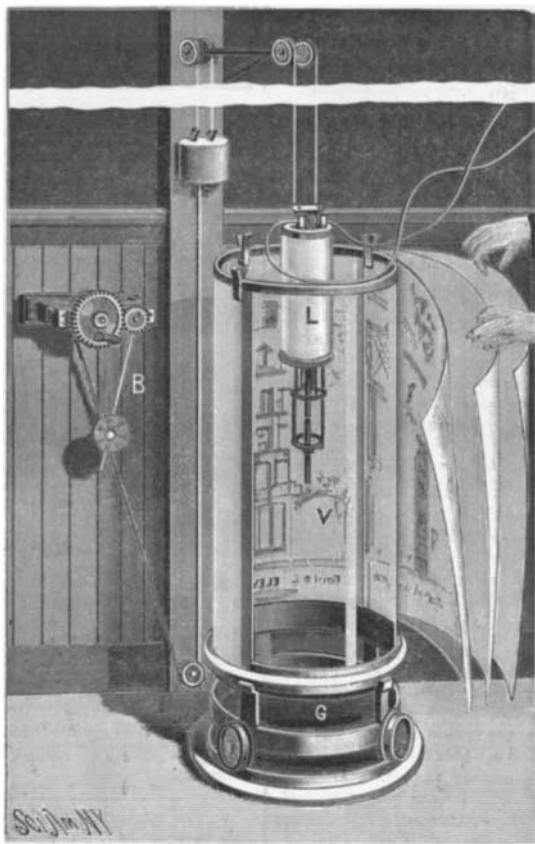
In the industries, there is a constant need of quite a large number of copies of drawings. In the building of an engine, for example, every piece is the object of a separate drawing that must be placed in the hands of the workmen who are to take part in its production. The original drawing would be quickly destroyed were it to pass in succession through the various shops, and it would be still worse with tracings, which it costs considerable to make. It has, therefore, become customary to make hasty photographic reproductions called "blue prints." For this photographic operation, neither camera nor objective is used. The drawing is traced, and the tracing serves as a negative. The printing is done in a frame through simple exposure to light, as in ordinary photo-copying. The paper used is sensitized with salts of iron, which are cheaper than those having silver as a base. The papers most widely used are those prepared with red prussiate of potash and ammoniacal citrate of iron. The solution is spread over the paper and allowed to dry in darkness. After exposure to sunlight under the negative, it suffices to wash the print with a large quantity of water in order to cause the drawing to appear in white lines upon a blue ground. The manipulation is, therefore, very simple, and so such paper is manufactured in large quantities for use in the industries. There are, moreover, varieties of which the composition is a little more complicated than that of the kind we have just mentioned, and which are more sensitive and require a shorter time of exposure. It will be readily understood, in fact, that in large manufacturing establishments rapidity of printing is a factor to be taken into consideration, and that, in winter, the want of sufficient light often causes much inconvenience. Besides, frames are always cumbersome and expensive, and become quickly deteriorated, since they are often handled without much care and are exposed to humidity as well as to the mid-day sun. In certain works, the electric light is used; but the ordinary flat frames do not lend themselves well to this kind of printing.

In the Panhard establishment, so celebrated for its automobile carriages, a very large number of blue prints is required, more than two hundred a day sometimes being made for the use of the different shops. As these must be made whatever be the state of the atmosphere, the house uses the electric light exclusively, but along with it an interesting apparatus of English manufacture that permits of easily turning out daily the number of prints above mentioned.

This apparatus consists of a cylinder, V, formed of two semi-cylindrical sheets of thick glass mounted in a metallic frame. The whole rests upon a base, G, provided with wheels that roll upon a circular rail. The tracing of the drawing to be reproduced is applied against the exterior surface of the glass cylinder and over it is placed the sensitized paper. The whole is then surrounded with a cloth which is fastened tightly with buckles. In the interior of the cylinder, is suspended an electric lamp which serves as a weight for actuating a simple clockwork mechanism, B, fixed to the wall. After the card has been wound around the drum of the mechanism and the drawings have been put in place, the pendulum is set in motion, and the lamp, L, then gradually descends in the cylinder, thus

lighting the entire surface uniformly. The lamp is made to move more or less quickly, according to the degree of translucency of the tracing and the sensitiveness of the photographic paper, by regulating the position of the pendulum bob. It may also be made to travel up and down a second time if it is found that the impression is not sufficient.

The lamp employed operates with 10 amperes, and 120 volts. Two sheets of paper, 29.52 x 41.33 inches, are



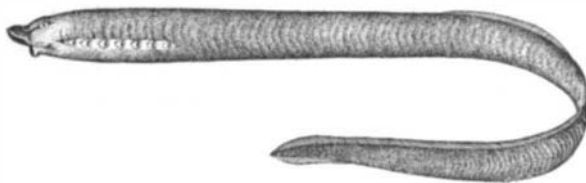
APPARATUS FOR PRINTING WORKING DRAWINGS.

printed at the same time, and forty prints can be made per hour. For the foregoing particulars and the illustration, we are indebted to La Nature.

THE THREE-TOOTHED LAMPREY.

BY HUGH M. SMITH.

The fascinating pastime of photographing living animals is now receiving an unusual amount of attention and is contributing not a little to a knowledge of their habits and peculiarities. A class which has great attractions, and at the same time presents special difficulties is the fishes, which have been made the subject of recent photographic experiments in the United



THREE-TOOTHED LAMPREY.



LAMPREYS ASCENDING WILLAMETTE FALLS, OREGON.

States and Europe. Most of the camera studies of fishes have necessarily been addressed to fish in aquaria, as the opportunity rarely presents itself for getting satisfactory views of fish in a wild state. How many really good photographs of fish in the native waters have been made?

Some years ago, while fishing for salmon at the Falls of the Willamette River, near Portland, Oregon, the writer was able to take an instantaneous view of a group of curious fish-like animals which were endeavoring to surmount the falls; these were three-toothed lampreys, and the photograph is here reproduced.

The three-toothed lamprey (*Entosphenus tridentatus*) which is called "eel" everywhere on the west coast, inhabits the waters of the Pacific States from the Aleutian Islands to Southern California, and is a large anadromous species, especially abundant in the basin of the Columbia River. It is not eaten, but is considered a good bait for sturgeon, and was at one time extensively used for this purpose.

The lampreys in spring and summer ascend the Columbia in large bodies, and push their way to the headwaters of many of the tributaries for the purpose of spawning, many being then caught in salmon wheels. The furthest point to which they have been known to migrate is Lower Salmon Falls, Idaho, on the Snake River, 1,000 miles from the ocean. They are frequently seen at falls, dams, and other obstructions, which they assiduously endeavor to surmount, clinging to the rocks and so engrossed with their efforts that they are oblivious to the presence of man and may be picked off by hand.

In June, 1894, the rocks in the particular part of the Willamette Falls where the salmon are wont to ascend were at times completely covered with large-size lampreys. In places where the force of the water was least, they formed a slimy, wriggling mass several layers deep, and at a short distance the rocks looked as though covered with a profuse growth of coarse seaweed. A lamprey dislodged by the current or by an angling rod, or forced to give up its hold by exhaustion, would sometimes carry half a dozen others with it to the bottom of the falls. At the side of the cascade, where the rocky walls were quite steep, numbers of lampreys, to avoid the current, had drawn themselves entirely out of the water or remained hanging from the rocks with only their tails in the water; some of these are shown in the engraving. In the turbid water beneath the falls hundreds could be seen trying to secure a position on the rocks, some being those which had been swept down in previous attempts and some fresh arrivals from salt water. This noteworthy run had been in progress for about a week. It seemed to the writer that only a very small part of the run could ever surmount these falls, over which salmon must have been able to pass with the greatest difficulty. The bodies of many of the lampreys showed the effects of their trying ordeal; the posterior part of some of them was worn off fully one-fourth the body length by being whipped against the rocks while their heads remained fixed; and numbers were seen to lose their hold and float away, emaciated, covered with ulcers and fungus, and apparently dead. During a number of hours, not more than two or three were seen to reach the crest of the falls and disappear over the edge.

The upward progress of the lampreys was accomplished by fastening themselves to the rock by means of their suckorial mouth and gradually working their way upward by loosening their hold for an instant while propelled by a sudden springing movement of the body. In the face of such a torrent of water, their upward course was necessarily very slow, as their hold on the rocks could be relaxed for only the briefest period.

Associated with the species are the names of a number of persons prominent in the early exploration of the great Northwest. The first specimen known to science was obtained at the Falls of the Willamette about 1830, by Dr. Meredith Gairdner, an employee of the Hudson Bay Company at Fort Vancouver (Wash.), whose manuscript description of the species was published by Sir John Richardson in 1836. About 20 years later, Dr. Charles Girard, the ichthyologist of the great Pacific Railroad surveys, redescribed the species from Astoria, naming it in honor of John Jacob Astor.

The Current Supplement.

The current SUPPLEMENT, No. 1267, has as a frontispiece a view of the foyer of the Théâtre Français at Paris. "The Facilities Afforded by the Office of Standard Weights and Measures for the Verification of Electrical Standards and Electrical Measuring Apparatus" is an important paper. "A Simple Illumination Photometer" gives working drawings. "The German Antarctic Expedition" is a very full paper.

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