

scale photographs (on 5 × 7 plates) of the corona and surrounding stars (and possibly comets); and at least two of these plates will be impressed with squares of 1s, 2s, 4s, 8s, 16s, exposure from a standard lamp before they are exposed to the light of the corona. When they are developed, the squares of standard intensity will appear at the same time with the image of the corona, and a photometric measure of the brightness of the latter is thus possible, in terms of the brightness of the standard lamp. This plan (first carried out by the Harvard College Observatory) has been followed at all the eclipses observed by Lick Observatory parties, viz., January, 1889; December, 1889; and April, 1893.

The portrait lens will serve to register the extension of the corona and a wide field of stars (and any possible new planet).

Messrs. G. E. Shuey and Louis C. Masten will go with the party as volunteer assistants and will be in charge of the smaller instruments. Prof. H. Terao, director of the Imperial Observatory of Tokyo, has kindly offered to select a member of the staff of his observatory to accompany the Lick Observatory expedition, as one of its members.

The Hon. Secretary of State, the United States Minister and Consul-General in Japan will do all in their power to forward our plans. It is to be hoped that the expedition may meet with good weather and return with results which will reward its labors.

THE MANUFACTURE OF PAPER.

Prominent among the greater industries of the United States, which have grown to large proportions during the past twenty-five years, is that which is devoted to the manufacture of paper. At a recent meeting of the American Paper Manufacturers' Association the president stated that the association was formed about eighteen years ago, and that the paper business had since taken on a rapid growth. At that time the manufacture of paper in the United States had grown to such an extent after the war that the capacity of the mills in 1878 in the production of paper amounted to nearly 3,000 tons of product per day. To-day the capacity of the mill product in this country is about 12,000 tons per day.

The general public has little idea of the size and cost of an average paper mill. The finished product, as we see it in our books and our daily newspaper, is so familiar, and the materials of which it is popularly supposed to be made are so cheap, and for most other purposes worthless, that to many it will be a surprise to learn that an average paper mill costs from \$1,000,000 to \$3,000,000 to build and equip. It is capable of turning out some 40 tons of paper per day, and to run the machinery requires boilers and engines of not less than 3,000 horse power. For washing the pulp, etc., there will be required 4,000,000 gallons of water per day, or enough to supply a city of 50,000 inhabitants, and the whole of that supply must be filtered by the most approved modern processes.

The manufacture of the paper may be broadly separated into two processes, consisting, first, in the preparation of the pulp, and secondly, in the formation of the paper from the pulp.

I. The Preparation of the Pulp.—The popular idea that paper is made from rags is true only of fine writing paper, which is made entirely from this material; but newspapers and most book papers are made entirely from wood. The better class of book paper is made from wood and a small percentage of rag. There are two kinds of wood pulp.

1. Ground or Mechanical Wood Pulp.—This is made by grinding the ends of spruce wood logs against revolving emery wheels. This is done under water, and the result is a finely divided wet sawdust. The wood retains all its natural gums and acids and has no fiber. It must be used with some more fibrous material, such as chemical wood pulp. This is the cheapest form of pulp, and it is therefore only used for newspapers and so-called manila wrappings.

2. Chemical Wood Pulp is made from spruce or poplar. The timber comes to the mill in barked logs, which are four feet long, and have had all the knots carefully bored out. The logs are fed into a "chipper," in which the knives are arranged at an angle of 45 degrees to the center line of the machine. These knives cut the logs diagonally to the grain into "chips" which are half an inch long. The chips are conveyed to "digesters," which are upright cylinders 7 or 8 feet in diameter and 30 feet long. If spruce wood chips are being used, they are treated by the acid process, the digesters being lined with acidproof brick. The acid liquor is obtained by mechanically combining sulphurous acid gas with milk of lime, and forming a bisulphite of lime. The digesters are filled with chips and liquor in proper proportions, and are then hermetically sealed. Live steam is introduced, and the chips are boiled for eight hours under a pressure of 110 pounds to the square inch.

If the chips are made from poplar, the process is the same, except that the liquid is made from caustic soda ash and water.

After the boiling is completed, the contents of the digesters are blown out into a receiver, where it presents the appearance of a mass of soft pulp. The liquor is then washed out; and after the pulp has been bleached, it so closely resembles the rag pulp, which is used in the manufacture of fine book paper and writing paper, that only an expert can tell the difference, both being a pure vegetable cellulose. The pulp is now subjected to a process of beating and macerating, to reduce it to the proper consistency; and at this stage coloring may be added to give any desired shade. A certain amount of sizing is also introduced—the sizing being made from resin "cut" with soda ash—for the purpose of giving impermeability to moisture and a firm surface; otherwise the product would be a simple blotting paper.

The pulp is now ready to go to the paper machine. It should be noted here that newspaper pulp is formed of 80 per cent ground pulp and 20 per cent chemical pulp. Book paper is formed entirely of chemical pulp.

II. The Paper Machine.—If he bear in mind the frail nature of the article which it is designed to handle, the visitor to a paper mill will be astonished at the great size and weight and the massive strength of a paper mill.

At first sight, the massive cast iron and steel frame, from eight to ten feet wide, and from one hundred and fifty to one hundred and seventy-five feet long, appears to be better fitted to manufacture iron and steel than to handle the thin, milky fluid which stands ready for manipulation at the upper end of the machine. The wet pulp, of which 95 per cent is water, first passes through a screen, where it is cleaned. It then flows into a vat, at the further edge of which is provided an outflow, which consists of a true, level, edge or lip which forms a kind of weir, over which a broad, thin stream of pulp flows onto the paper machine proper. This stream is the full width of the machine, and its depth has to be kept perfectly true and even throughout. The pulp falls onto what is known as the Fourdrinier wire. This is an endless wire cloth, seventy meshes to the inch, which is the full width of the machine, and travels continuously over a set of parallel rolls, passing around an end "couch roll," and returning again under the machine. In addition to its forward motion, this wire cloth or screen has a lateral rocking motion across the machine. As the pulp flows onto this wire a large portion of the water, assisted by the shaking, strains through and passes away, leaving a thin film of pulp, which is the future sheet of paper. This film is picked up off the "couch roll" by an endless woolen felt, which carries the wet sheet between several gun metal "squeeze rolls" or "press rods," which force out a sufficient amount of water for the sheet to be able to sustain its own weight.

At this point the sheet is transferred to an endless cotton felt, which supports it while they both pass over and around a dozen or more driers, which are hollow cylinders 3 feet in diameter and extending the full width of the machine, through which a constant flow of live steam is maintained. These thoroughly dry out the paper.

At this stage of the process the sheet is rough and uneven, presenting very much the appearance of a sheet of paper that has been wetted and allowed to dry out again. It now has to be ironed out, as it were, and the desired finish imparted to its surface. For this purpose it is passed through the calenders, which consist of two vertical standards which carry usually 11 superimposed chilled steel rolls of the very highest possible polish. The paper is inserted between the upper two and passes down through the whole set, the desired pressure being obtained by means of powerful screws. This process is repeated in a second stack of rolls, after which the finished paper is wound into a large roll. It is then passed through the cutters and out to the required width and length.

If a highly finished surface is desired, the paper is passed through what are known as super-calenders, which consist of 7 rolls, 4 of chilled steel and 4 of pressed paper, arranged alternately, the combination of the two materials in the rolls giving a high finish. The whole machine is run at a very high speed, 300 to 350 feet per minute being common. There are some machines that run the paper out at the rate of 400 feet per minute, or between 4 and 5 miles per hour, and such a machine will frequently run an entire day without a break in the paper.

These speeds are only possible in the manufacture of common news paper. In making the finer grade of paper, with high finish, such for instance as is used for the SCIENTIFIC AMERICAN, the mill can only be run at about one-half the above speed.

The whole machine has to be adjusted with the greatest care and nicety. It runs at so high a speed, and the material upon which it operates is so frail, that any unevenness in the rolls, or an irregularity in the speed of any particular part of the machine, would break the sheet, and throw the work into confusion.

The following material is consumed every month in

a paper mill of 40 tons per day, or 1,000 tons per month capacity:

Coal	15 tons.
Wood	2,432 cords.
Bleaching powder (chloride of lime)	142 tons.
Sulphur	77 "
Lime (milk of lime)	57 "
Resin (sizing)	17½ "
Soda ash	12½ "
English clay	200 "

Many a paper mill is run continuously from 12 P. M. Sunday night until 12 P. M. on the next Saturday, two sets of operatives being employed. From the time the log of wood is put into the chipper to the time the paper is cut up into sheets, the material is never handled, but passes through a continuous mechanical process.

Obituary.

DEATH OF GENERAL CASEY.

Brigadier-General Thomas Lincoln Casey (retired), late Chief of Engineers, United States Army, died at his residence in Washington, on March 25. General Casey was the son and grandson of soldiers. His father was General Silas Casey. General T. L. Casey was born at Madison Barracks, Sackett's Harbor, N. Y., in 1831. In 1848 he received an appointment to the United States Military Academy. Four years later he graduated at the head of his class. He entered the engineer corps as second lieutenant in 1852. He was assigned to duty in connection with works of improvement on the Delaware River and Bay. When the civil war broke out he was sent to New England, as superintending engineer of the permanent defenses and field fortifications on the coast of Maine. In March, 1865, he was breveted lieutenant-colonel for faithful and meritorious services during the war. He was then appointed superintending engineer of public buildings and grounds for the District of Columbia. He had charge of the Potomac Aqueduct, and to him also was committed the completion of the State War and Navy Department building, in Washington, the Washington Monument and the construction of the Medical Museum and Library. He was president of the Board of Engineers for fortifications and other public works at New York from 1886 to 1888, when he was appointed brigadier general and chief of engineers by President Cleveland. In 1889 he was charged by an act of Congress with the construction of the new Congressional Library building, and in recognition of his integrity and ability, Congress continued him in charge of the work after he was retired in 1895. The death of General Casey removes one of the best known and active government officers. He took great pride in the progress and economy of the work on the new library building, and was to have completed it within the time limit and for less than the original estimates, which speaks well for his ability. He always directed in person the contract work for which he was responsible.

The Strength of Ice.

The army rules are that 2 inch ice will sustain a man or properly spaced infantry; 4 inch ice will carry a man on horseback, or cavalry, or light guns; 6 inch ice, heavy field guns, such as 80 pounders; 8 inch ice, a battery of artillery, with carriages and horses, but not over 1,000 pounds per square foot on sledges; and 10 inch ice sustains an army or an innumerable multitude. On 15 inch ice railroad tracks are often laid and operated for months, and 2 foot thick ice withstood the impact of a loaded passenger car, after a 60 foot fall (or, perhaps, 1,500 foot tons), but broke under that of the locomotive and tender (or, perhaps, 3,000 foot tons). Trautwine gives the crushing strength of firm ice as 167 to 250 pounds per square inch. Col. Ludlow, in his experiments in 1881, on 6 to 12 inch cubes, found 292 to 889 pounds for pure hard ice, and 222 to 820 pounds for inferior grades, and on the Delaware River, 700 pounds for clear ice and 400 pounds or less for the ice near the mouth, where it is more or less disintegrated by the action of salt water, etc. Experiments of Gzowski gave 208 pounds; those of others, 310 to 320 pounds. The tensile strength was found by German experiments to be 142 to 223 pounds per square inch. The shearing strength has been given as 75 to 119 pounds per square inch. The average specific gravity of ice is 0.92. In freezing, water increases in volume from 1.0 to 1.18, or an average of 1.11; when floating, 1.1-1.2 is immersed.—Engineering Mechanics.

Earthquake in Maine.

Reports from Machias and Calais, Me., state that a violent shock of earthquake was felt on the evening of March 22 at 8 o'clock. The direction of disturbance was from the south toward the north at Machias and from west to east at Calais. At Machias houses trembled, dishes and windows rattled, and clocks were stopped. People rushed from their houses in alarm. At Calais the shock lasted from four to five seconds. No damage was recorded.

DEEP and rapid breathing is recommended as a means of stopping hiccough.