THE PROTECTIVE WORKS OF THE ASSOUAN DAM.

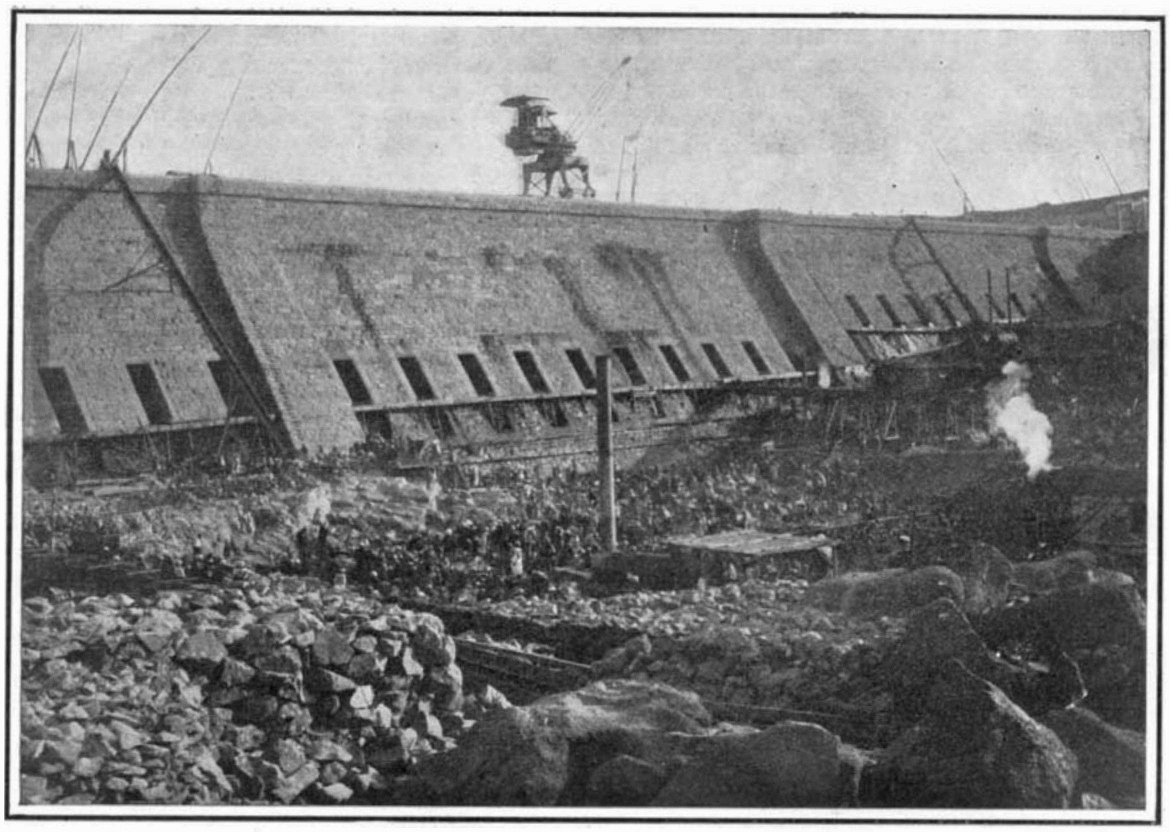
BY OUR LONDON CORRESPONDENT.

One of the greatest difficulties with which the engineers of the Egyptian Irrigation Department have had to contend in regard to the impounding and distribution of the water of the Nile by the barrage at Assouan, has been in connection with the severe and extensive erosion of the river bed below the works by the scouring action of the water released through the sluices. The river bed, though of rock formation, is of a most friable character, and the great pressure and high velocity of the water pouring through the sluices rapidly cleaned out the natural lines of cleavage in the rock, with the result that in a short space of time huge masses of rock were disintegrated, and either eroded away completely or carried farther downstream. The result was that huge holes were left in the river bed of considerable depth, many of these fissures extending below the level of the foundations of the dam. A short time ago we reproduced in these pages a photograph of a typical bowlder weighing several tons, that had been so dislodged and thrown upon one side.

Owing to the severity and extensive continuance of this action, which might have possibly impaired the stability of the barrage itself, an elaborate scheme of protective work became imperative. As a result of the investigations that were conducted, the most satisfactory solution of the problem was conceded to be the construction of a heavy talus or apron in masonry, extending from the foot of the dam to a point some distance downstream, at which the water had lost the greater part of its scouring and eroding violence. Work was started upon the section of the river bed facing the set No. 16 sluices, and immediately this section was finished, the river was diverted from the east to the west side. By this means one half of the river bed was left dry, the whole of the supply passing through the sets of sluices 9 to 18. The western and central channels were then "sadded" off, so that operations could be carried out upon the facings to sluices, sets 1 to 8. The water within this inclosed area between the sadd and the dam was then pumped out, leaving the river bed quite dry. At this juncture, the late Sir Benjamin Baker visited the barrage, and in view of the crumbling nature of the river bed, not only approved of the projected protective works, but advocated their being carried out upon a more extensive scale than originally intended; which advice was duly accepted.

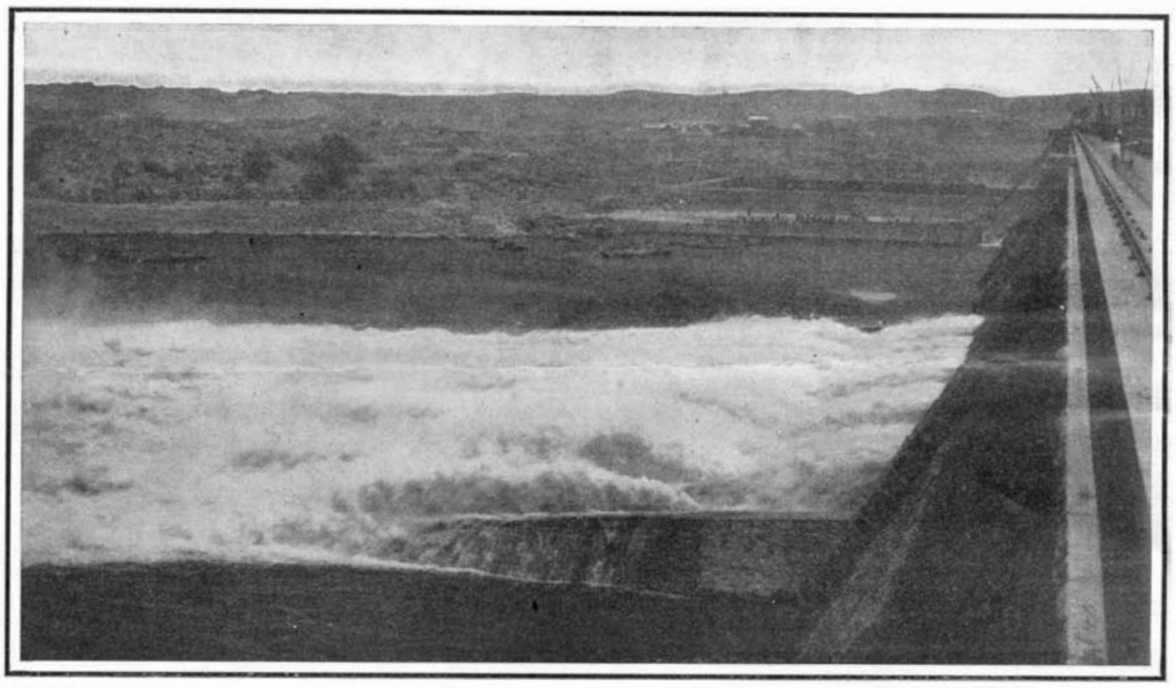
The work was done by large squads of men, ranging in number from 2,000 to 7,000, after pumping operations were completed, who were employed upon the river bed in removing the loosened bowlders and the large accumulations of gravel into which the rock had been pulverized by the water. Upon the removal of all the loose ballast, the river bed was thoroughly examined, and all faulty or bad rock was blasted out. This operation entailed in places some very heavy work, the excavation being carried to great depths.

The whole of these depressions and cavities had then to be filled up with masonry of a heavy and solid nature, the work being continued up to the lip of the sluices, from which the apron had a steady and suitable gradient to carry away the water to a point about 200 feet downstream, where the masonry joined the natural rock level. For the most part, the filling-in was effected with rubble masonry set in 4 to 1 cement mortar. At these points, however, where the talus was more than 10 feet in thickness, the proportion of cement mortar was made 6 to 1.



Excavating 390,000 Cubic Yards of Loose Rock and Gravel from the River Bed, Preparatory to Building the Masonry Apron.

Note in foreground huge masses of rock torn from river bed by the rush of water from the sluices.

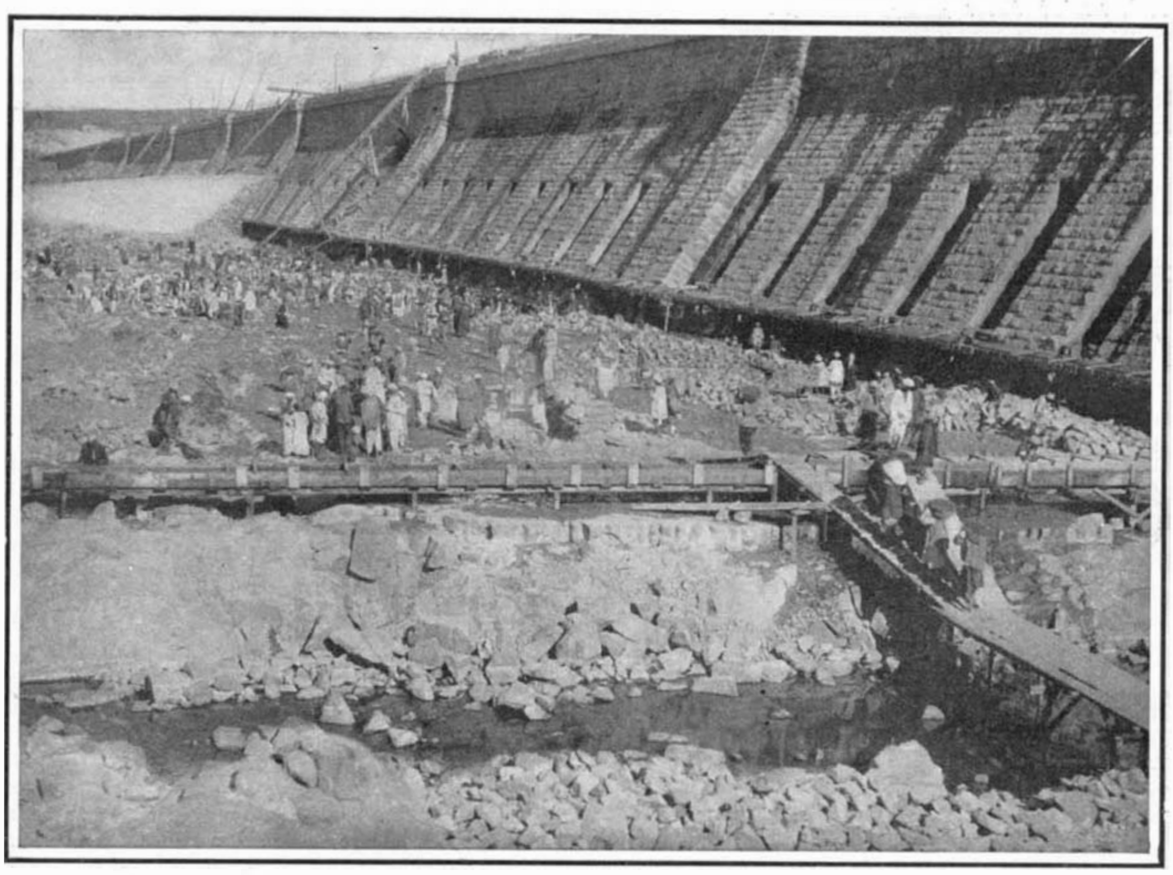


Testing a Portion of the New Protecting Apron Below the Dam. Note the Violence With Which the Water Rushes Through the Sluiceways.

The whole of this masonry was then faced with squared, fine-grained, granite blocks. These blocks were 15¾ inches deep, with heading courses in four sets, 31½ inches deep, and they were all laid in a 2 to 1 cement mortar. Altogether, the total area of facing completed for the sluices sets 1 to 8 amounted to approximately 290,630 square feet. A comprehensive idea of the magnitude of the task involved in the carrying out of the protective work may be had from the fact that the building of the talus across one-half of the barrage entailed the building of 517,350 cubic feet of sadds, the excavation of 1,818,671 cubic feet of soft ballast, and 3,566,254 cubic feet of rock. For filling up 1,165,362 cubic feet of rock and 3,135,494 cubic feet of rubble masonry were used. There was 288,937 square feet of facework and 53,820 square feet of pointing.

When the work was completed the apron was subjected to test, the water pressure at first being comparatively slight, and the head being gradually increased until the maximum was attained. At intervals, the various sets of sluices were shut off, so that the effect, if any, of the heavy impact of the water flowing through might be ascertained, and in order to repoint up immediately any joints that might have been washed out in the first instance owing to defective construction. Out of the whole 290,630 square feet of talus completed in the first half of the work, only about 1,000 square feet failed to resist the maximum head of water that could be delivered upon it; and in view of the enormous area so covered, the failure of this small portion, considering that native labor was employed, was not surprising. Owing to the lateness of the season, the point at which the failure occurred could not be reached until the following

(Continued on page 490.)



Building Up the Excavated River Bed With 405,000 Cubic Yards of Solid Rock Masonry Paved With a Granite Facing, Which Is Carried Up to the Lips of the Sluices, as Shown.

THE PROTECTIVE WORKS OF THE ASSOUAN DAM.

the "home" section of the apparatus coming into action, the "distant" part of the mechanism is similarly operated, so that the two semaphores within the cab have their arms set at danger, as in ordinary railroad signaling work.

The track mechanism consists of trippers comprising balanced pendulums swinging in cases, there being sets of trippers for home and distant signals, and each working in conjunction with its respective striker on the locomotive. These trippers are placed to one side of the road, so as to clear coupling chains, hooks, etc., carried on the rolling stock. These trippers are connected with the semaphores, and should the latter be at "danger" position they project upward, the upper parts being struck by the projecting levers of the locomotive mechanism. If the line is "clear" and the semaphore arm depressed, in setting the latter the signalman also draws the trippers down clear of the strikers on the engine.

The track part of the apparatus is electrically connected to the signal cabin, these connections being of a simple character, so as to be as immune from breakdown as possible. In the signal cabin is a dial with a repeater, which indicates whether the semaphore arm is set "clear" or at "danger" positions, and if the apparatus from some cause or another breaks down, the record "out of order" is indicated. In connection with this dial is the electric bell, which continues ringing after an operation until the signalman releases the train out of his section. It will thus be realized that it is impossible for a signalman to forget that a train is blocked at one of the signals in his section even though he be prevented from seeing, owing to thick or foggy weather.

To reset the apparatus on the locomotive, the engineer simply turns a three-way cock, which renews the vacuum in *D* under the piston *C*, thereby causing the horizontal lever *B* and the vertical striker *A* to revert to their normal or set position, the arms of the semaphore indicator being depressed to the "line clear" position, and the blowing of the whistle stopped thereby. In the event of any part of the mechanism suddenly failing through breakage, the piston *C* immediately rises, drawing the engineer's attention to the fact that something is amiss. Similarly, in the event of the striker becoming fractured by the force of an abnormally hard blow against the triggers on the track, or the lower point becoming so worn under repeated contacts as to miss striking, the same effect results. In this case the spring, which is compressed between the upper ends of the scissor limbs of the vertical striking lever, forces the two members open, with the result that the weighted end of the lever *B* falls between the two opened parts, and cannot be removed until the broken striker is replaced.

At first sight it may appear that the risk of breakage, which is always existent in signaling systems depending upon the contact of a striker with a tripper, constitutes an inherent weakness of the Phillips invention, inasmuch as when, say, a striker breaks, the locomotive engineer would be liable to frequent false indications, and the application of the brakes when in reality the line is quite clear. Such, however, is not the case. The integral parts of the apparatus are all standardized, and any fractured part can be replaced in a few seconds. In the event of a breakage occurring in the engine mechanism, the indicating semaphore arms immediately rise to "danger," the siren sounds, and the brakes are applied as already mentioned. The engineer would then, after seeing that the line is actually clear, though his apparatus indicates the reverse state of affairs, endeavor to remedy the wrong reading by setting the apparatus with the three-way cock provided for the purpose. But the handle of this three-way cock is painted and shaped like an ordinary semaphore arm, so that although the engineer would reset his indicating semaphore arms to "line clear" position, the handle of the three-way cock would remain at "danger" position. Thus the apparatus would show two different readings, and from this the engineer would immediately realize that the apparatus was at fault, would stop his train, and ascertain the defect. Should he ignore the divergent readings, he would be running against "danger signals." Before an engineer actually gets the "line clear" position, the brakes must first be released, the gage indicators must show line "clear," and the handle of the controlling or resetting three-way cock must show the same reading. False indications are thus impossible. For the past two years the appliance has been in daily use upon a stretch of the North Staffordshire Railroad, and never on a single occasion has the slightest breakage occurred to either the engine or track portions of the apparatus, nor has a solitary instance of failure to act been recorded. In fact, owing to the unique success of the system, it was removed to the important and busy junction at Stoke-on-Trent, where it is subjected to far heavier and rougher usage. On this system so far the highest speed at which the train has passed over the apparatus has been 45 miles per hour, at which speed the apparatus has withstood the shocks of contacts remarkably well; and though the working parts have been in use for two years, no appreciable signs of wear are perceptible. The removal of this particular installation to a busy junction has imposed a supreme test upon the invention, since the trains travel at high speeds over a network of crossovers and switches, in negotiation of which under such conditions considerable oscillations and vibrations are produced.

The electrical connections of the tripper, and those running to the signal cabin repeater, are so arranged that so long as the trippers remain either at the "danger" or "line clear" positions the circuit is closed, the indicators in the cabin being held up by magnets. Directly the tripper arm is struck by the lever on the engine the circuit is automatically opened, thereby causing the indicator to fall, and thus showing whether the tripper acted upon is either the "distant" or "home" signal. In the act of falling the indicator also closes a local circuit, causing the bell to ring, and this action continues until the indicator is restored to its position by means of a plunger provided for the purpose in the repeater. In the tripper the wire connecting the contacts is carried over the top of the arm internally, so that in the event of the arm being broken the conductor is also broken, thereby cutting off the current, and thus the indicator pointer within the signal cabin falls to its middle position, marked "out of order." The bell, however, is set in action and continues ringing until the tripper is repaired. In this it will thus be seen the signal operator is duly warned of the failure of the apparatus, and cannot in the event of an accident to the train in his section attribute the cause thereof to the failure of the apparatus.

The invention is also so devised that the locomotive engineer can apply his brakes without causing any movement of the semaphore indicator within his cab, or by the pulling of the communication cord extending throughout the train. This end is assured by means of a check valve, which is placed between the braking pipe of the train and the reservoir, which works in conjunction with the indicators in the cab of the engine.

THE PROTECTIVE WORKS OF THE ASSOUAN DAM.

(*Continued from page 488.*)

year, when it was replaced and the second half of the river bed similarly treated.

The whole task has now been successfully completed; there being a granite and masonry apron stretching from one side of the river to the other, from the lips of the sluices to points ranging from 100 feet to 200 feet downstream, according to the conditions prevailing. So efficient have the earlier sections of the apron proved in resisting the heavy impact of the water rushing through the sluices that no doubt is entertained as to the permanence of this work. The apron will necessitate but little attention beyond periodical examination, and the possible renewal of the pointing.

Sir William Garstin, the well-known irrigation engineer and adviser to the Egyptian Ministry of Public Works, who has been closely identified with the barrage since its inception, considers that the completion of this protective masonry apron has completely removed any apprehensions that might have prevailed concerning the stability of the barrage itself. The construction of the apron, which was carried out by the Irrigation Department's engineers under Mr. Macdonald, the resident engineer, is a remarkable feat considering the difficulties that had to be surmounted both in the use of native labor, and in the short space of time available for the completion of the undertaking.

It is due to the thorough nature of the work that the raising of the barrage itself is considered to be feasible and is now being pushed forward with all speed. This work in itself will be a remarkable one. The extension is not to be built immediately upon the old work; but the whole cross section of the dam is to be increased from top to bottom. There will be a space of about 8 inches between the old and the new walls, which will be connected by steel ties, the intervening space being subsequently filled with cement grouting, and the whole structure thus converted into one homogeneous whole. The total cost of building the masonry apron has approximated $1,500,000.

Official Meteorological Summary, New York, N. Y., May, 1907.

Atmospheric pressure: Highest, 30.33; lowest, 29.70; mean, 30.00. Temperature: Highest, 83; date, 14th; lowest, 36; date, 12th; mean of warmest day, 70; date, 19th; coolest day, 44; date, 12th; mean of maximum for the month, 62.8; mean of minimum, 47.8; absolute mean, 55.3; normal, 59.7; deficiency compared with mean of 37 years, —4.4. Warmest mean temperature of May, 65, in 1880. Coldest mean, 54, in 1882. Absolute maximum and minimum of this month of 37 years, 95 and 34. Average daily deficiency since January 1, —1.8. Precipitation: 4.08; greatest in 24 hours, 1.10; date, 16th and 17th; average of this month for 37 years, 3.18. Excess, +0.90. Accumulated deficiency since January 1, —0.58. Greatest precipitation, 7.01, in 1901; least, 0.33, in 1903. Wind: Prevailing direction, N. W.; total movement, 8,683 miles; average hourly velocity, 11.7; maximum velocity, 48 miles per hour. Weather: Clear days, 9; cloudy, 10; partly cloudy, 12; on which 0.01 inch, or more, of precipitation occurred, 12. Thunderstorms, 10th, 11th, 16th, 19th, 20th, 27th. Frost, light, 5th, 12th. Remarks: Coldest May with the exception of May, 1882, in 37 years.

Santos Dumont's Airship No. 16.

Santos Dumont is not only engaged in perfecting his new aeroplane which we already had occasion to mention, but is also constructing a new airship which has some interesting points. We expect to give a more complete account of the airship, but at present will speak of its leading features. As regards the balloon body, it is one of the smallest in cubic contents that has ever been constructed, seeing that it gages but 99 cubic meters (349.7 cubic feet), but on the contrary it is to carry a light-weight motor of no less than 50 horse-power. No doubt it will be able to reach a high speed under these conditions. The balloon envelope is of varished Japan silk, and the total length of the balloon, which is a very long cigar shape, is 21 meters (68.9 feet). The surface is 151 square meters (1,625 square feet). The main balloon contains a ballonet which measures 2 meters (6.6 feet) in diameter. There is a single propeller which is mounted upon the light framework below the balloon body. The propeller is mounted direct upon the motor shaft and is 2.05 meters (6.76 feet) in diameter with a pitch of 1.70 meters (5.8 feet). In front of the propeller and attached to the framework is a movable plane formed of a frame covered with canvas which measures 3 meters (9.8 feet) in length across the balloon and 0.50 meter (1.64 feet) in width. Toward the rear is placed a second and similar plane which is 4 meters (13.1 feet) in length and 1.20 meters (3.9 feet) wide. Behind it lies the rudder, which is formed of a circular frame and is 2 meters (6.6 feet) in diameter. The aeronaut will be seated on a simple bicycle saddle, which is suspended, as is also the mechanical part, to a frame made of light steel tubes placed vertically and fixed from a bamboo pole, the latter being held just under the balloon body. The center of resistance is placed as nearly as possible in coincidence with the center of traction. As the propeller is mounted quite near the balloon, it will almost touch it when it is running. Good protection is afforded to the motor by a wire gauze covering which surrounds the carbureter, thus avoiding any risk of fire to the gas escaping from the balloon. The new airship is to be known as the "Santos Dumont No. 16," and it is now in construction at the shed which had been erected again at Neuilly near the Bois de Boulogne. To the same shed is soon to be brought the new aeroplane "No. 14." Its sustaining planes have been modified since the last accident it had at St. Cyr.

The Current Supplement.

The highlands east of the Jordan River are strewn with ruins marking the rise and fall of successive civilizations. The strangest and most beautiful of these ancient ruins is the Rock City of Petra, described in the current SUPPLEMENT, No. 1641. Dr. Franklin E. Hoskins writes most interestingly on the old town. Exceptionally handsome illustrations accompany his description. An important article on the compression of steel ingots by wire drawing, with cuts, is given. Mr. Hall's excellent paper on artificial fertilizers is continued. W. F. Badgley tells us something on the shape of molecules. By far the most valuable article in the SUPPLEMENT to the amateur is undoubtedly Mr. E. F. Lake's description of how a 5-horse-power stationary gas engine can be built at home. He describes clearly and simply how each part is made and what metal must be used. The usual notes will be found in their accustomed places.

Consumption of Pulp Wood in 1906.

The Census Bureau has prepared a preliminary report on the consumption of pulp wood in the United States for the calendar year ended December 31, 1906, which shows that during that period 3,646,693 cords were used, as compared with 3,192,123 cords utilized in the previous year. This is an increase of 454,570 cords. The principal wood used in 1906 was domestic spruce, of which 1,785,680 cords were consumed. Classified according to methods of reducing into pulp, the mechanical process took 1,197,780 cords; the sulphite process, 1,944,136 cords, and the soda process, 504,777 cords. The figures cover the operations of 250 mills in 1906 and 237 in 1905.

A new 72-inch plate mill at the Homestead works of the Carnegie Steel Company has been put in operation. The mill, it is said, will have a capacity of 60,000 tons annually.