RECONSTRUCTION OF THE DISMAL SWAMP CANAL.

The dividing line between the States of Virginia and North Carolina intercepts at its eastern extremity a vast morass or swamp, which extends from near the town of Norfolk in the north toward Albemarle Sound in the south, a distance of forty miles. In an east and west direction it measures some twenty-five miles. The soil of the swamp is made up largely of black vegetable matter, often saturated with water and during a large part of the year covered in places with stagnant pools. The greater part of the swamp is covered with a dense growth of timber, in which is found the cypress, juniper and cedar, with beech and oak upon the higher ridges. In the center is Lake Drummond, a body of fresh water measuring about five square miles in area and having a depth of about ten feet.

It will be seen from the accompanying map (Fig. 5) that two rivers of considerable size flow from the swamp to deep water; Elizabeth River flowing north and discharging into Hampton Roads and the Pasquotank River flowing south into Albemarle Sound. The intervening distance across the swamp between the navigable points on these rivers is about twenty-five miles, and it is evident that the situation is such as would naturally suggest the construction of a canal to connect such important bodies of water as Chesapeake Bay and Hampton Roads with Albemarle Sound.

The old Dismal Swamp Canal was built with the assistance of the national government and the State of Virginia, and as far as its limited capacity would allow, it has served as an outlet for the timber and for a certain amount of the agricultural produce of the eastern districts of North Carolina. It extended from Elizabeth River, at a point a few miles south of Norfolk, to the Pasquotank River, and covered a distance of 29·10 miles. The first section of the canal from Gilmerton Locks to Deep Creek Lock was 2·75 miles in length, the level being 5·93 feet above low water in the Elizabeth River. The next section extended from Deep Creek Lock to Northwest Lock, was 9·75 miles long and had a level of 16·20 feet. From Northwest Lock to Culpeper Lock, 8·79 miles was the summit level, 19·73 feet above Elizabeth River low water. The South Level, 3·61 miles in length, terminated at South Locks, where the canal was continued at tide level through Turner's Cut, a distance of 4·21 miles, to the Pasquotank River.

This description and the accompanying profile show the condition of the canal when the present improvements were started. The original canal only connected the waters of Deep Creek, a tributary of the Elizabeth River, with Joyce Creek, a tributary of the Pasquotank River, and was but 22·15 miles in length. The Gilmerton Level and Turner's Cut were added at a later date. This canal followed the course of a former lumber ditch which owed its inception to the wants of the early settlers upon Deep Creek and the Pasquotank Rivers, who built separate ditches from the neighborhood of Lake Drummond to float out the timber. These were eventually joined and developed into the present canal, and it is these circumstances that account for the angle in the canal where it passes the lake. Water for the supply of the canal was taken from the lake by a feeder at the Summit Level, 3·46 miles in length.

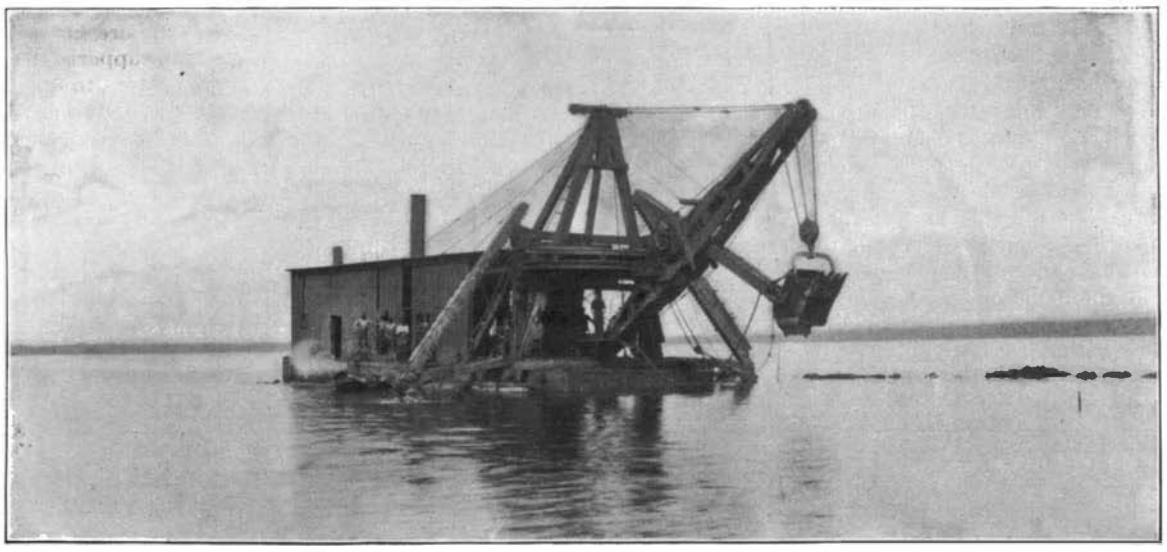

Fig. 1.—DREDGING ENTRANCE TO FEEDER CANAL, LAKE DRUMMOND.

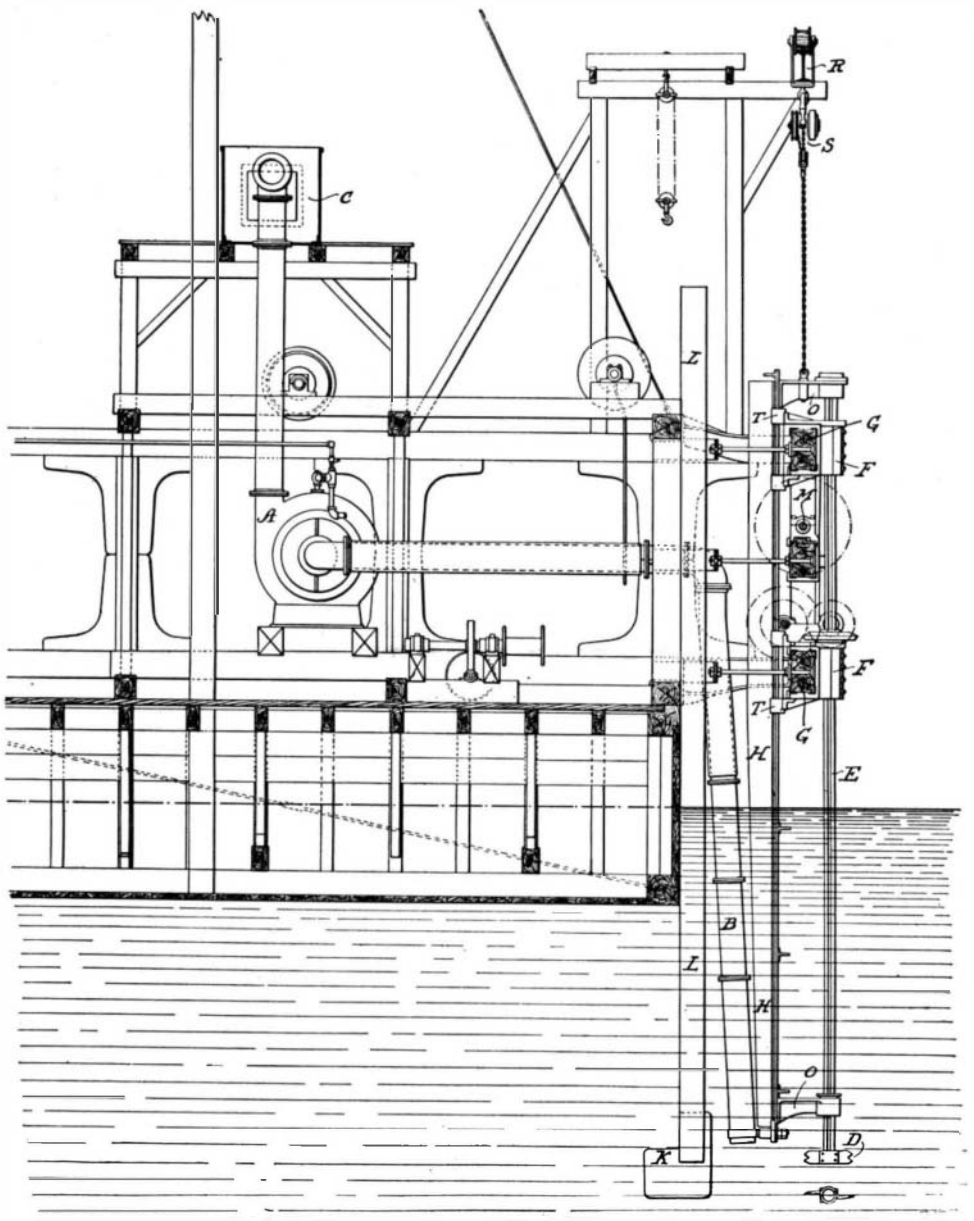

Fig. 2.—SECTION THROUGH FRONT END OF HYDRAULIC DREDGE.

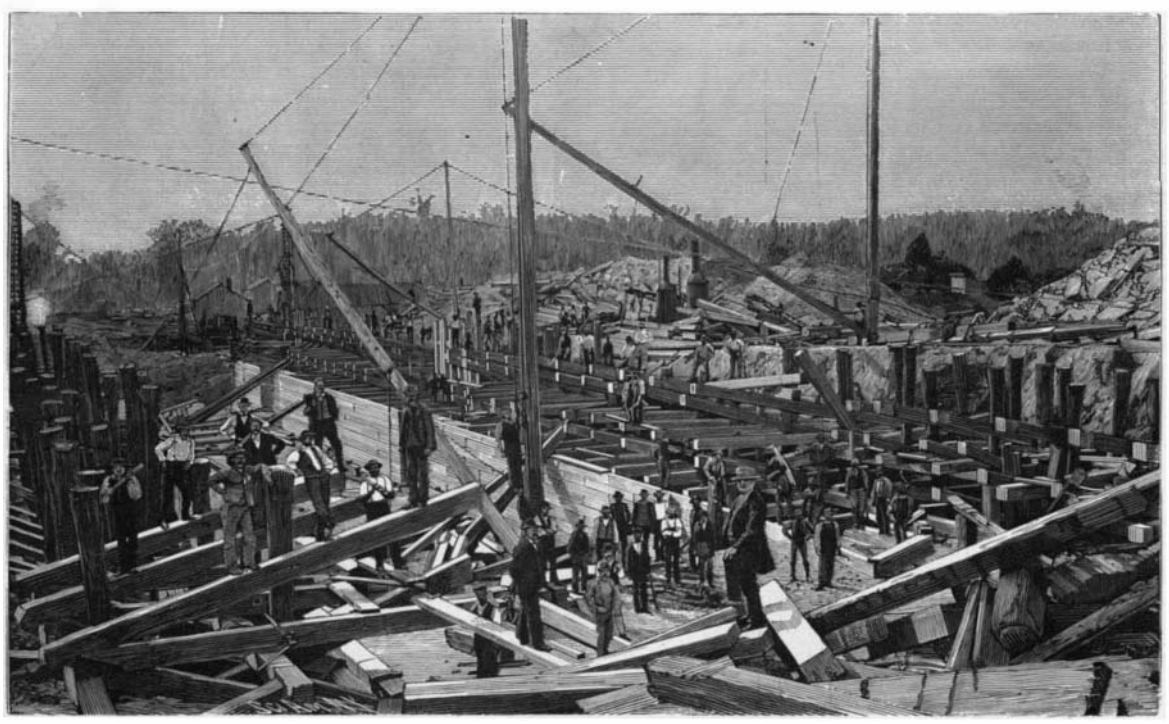

Fig. 3.—CONSTRUCTION OF LOCKS, DISMAL SWAMP CANAL.

Although the old canal was supposed to provide a depth of six feet throughout, its available depth was scarcely half that amount. The level varied with the rainfall, and the bottom of the canal was so obstructed with sandbars and accumulations of wreckage—sunken logs from timber rafts, etc.—that boats having a draught of more than two or three feet were unable to pass through. The report of a government survey made by Assistant Engineer Frederick W. Post, in 1880, speaks of Deep Creek Level and Turner's Cut as "constituting the worst features of the work, having been constructed through low sand ridges, and the high banks formed from the excavated material being left without protection of any kind." The sand had fallen or drifted back into the canal, forming sandbars which extended more than half way across the cut. A study of the accompanying profile shows the irregularity of the bottom, especially at Turner's Cut. The canal also suffered during the war, and its final practical abandonment was caused by the construction of the Albemarle and Chesapeake Canal, which accommodates boats of a greater tonnage. The report referred to states that the canal was not at that time navigable by a boat of more than 3½ feet draught or whose beam was over 16½ feet, or its length greater than 108 feet.

Another survey made by the same engineer in 1896 found the canal in such a condition that boats drawing over two feet of water were unable to pass through. Fresh shoals had formed in several places, and the losses due to percolation and the prevalence of an unusually dry season had brought navigation practically to a standstill, the weekly traffic amounting to three or four lighters and an occasional raft of lumber.

The plan of improvement recommended in 1896 was practically the same as that of 1880, and contemplated abolishing the Northwest Lock at Wallaceton and the formation of a summit level extending from Deep Creek to Culpeper Locks, at an elevation of 16·20 feet above mean low water in the southern branch of Elizabeth River. The South Level length was to be lowered 3 feet and Gilmerton and Turner's Cut were to be maintained at their present location and elevation. Four masonry locks were to be built, one each at Gilmerton, Deep Creek, Culpeper and South Mills, each lock being 40 feet by 220 feet. The canal was to be 10 feet deep and 80 feet on the bottom, with slopes of 1 to 1 and 1½ to 1, according to the material of excavation. The estimated cost of this work was $1,711,380.

The present reconstruc-

tion of the canal is being carried out under Mr. J. C. Wrenshall, the chief engineer of the Lake Drummond Canal and Water Company. The government plans have been modified by abolishing the Culpeper Lock, as well as that at Wallaceton, and forming one level, 22·15 miles in length, from Deep Creek to South Locks. New timber locks are being constructed at each end, the chambers being 40 feet in width by 125 feet long. The depth throughout is to be 10 feet; but the width is reduced from 80 feet on the bottom, as suggested in the government report, to a bottom width of 40 feet and a surface width of 60 feet or more, according to the slope allowable by the nature of the material.

The new level will be 7½ feet lower than the old summit level—a change which will present a twofold advantage: It will serve to drain a large area of cultivatable and cultivated land in the swamp and, because of the increased drainage, it will increase the water supply for compensating the losses through lockage. It is expected that the drainage of the adjacent lands will be a benefit second only to that conferred by the improved navigation of the canal. The Gilmerton Level and Turner's Cut will be abandoned and the locks will discharge directly into the rivers at each end of the canal. The feeder canal from Lake Drummond has been deepened and widened, and at about 200 yards from the shore of the lake a new lock 20 feet wide by 100 feet long has been completed. The contractor for the deepening of the canal is P. McManus, of Philadelphia, to whom we are indebted for several views showing the special plant employed in carrying out the work. Others of our views were furnished by Mr. G. B. Overton, of South Mills, who has also furnished us with useful data regarding this interesting project.

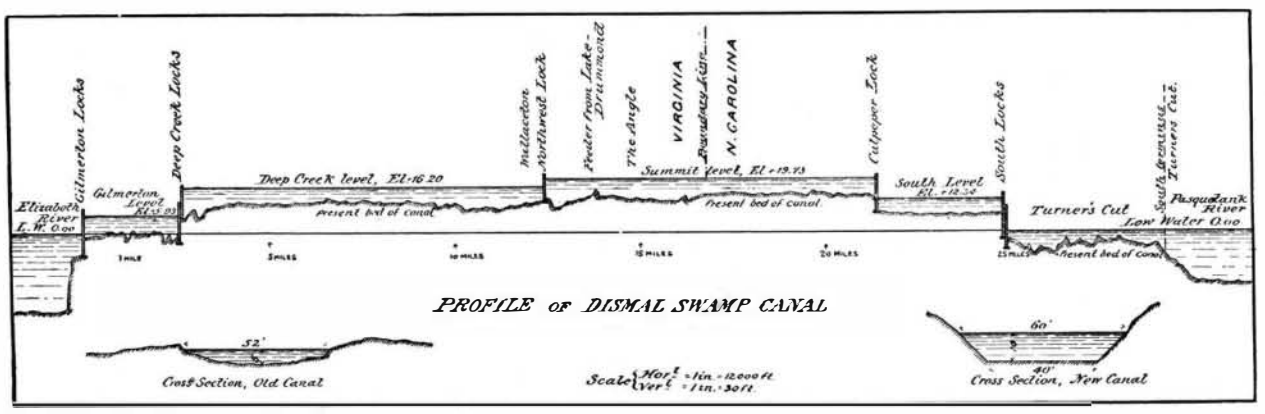

Fig. 4.—PROFILE OF THE OLD CANAL.

The conditions at the letting of the contract were such that the contractors were obliged to build an entire dredging plant in the middle of the canal, the difficulties of transportation being such as to render it impossible to bring the plant to the work in bulk. Selecting a position on the old Summit level, not far from Lake Drummond as a starting point, Mr. McManus built four large hydraulic dredges and three dipper dredges. It was necessary to build these boats in the middle of the canal, moreover, as a provision against a season of drought, and the plan proved afterward to be correct, since for a period of three months during last summer the old canal was entirely drained, and the only water available to float the dredges was what remained in the portion which had already been dug. Our two illustrations show the method adopted in the work of widening and deepening. The dipper dredges first removed the surface material, tearing up roots and matted vegetable growth to a depth of about 5 feet. Behind these followed the hydraulic dredges, which worked upon the looser material underlying the bed of the canal. The nature of the material to be excavated varied, but consisted chiefly of hard clay mixed with sand. The deepest excavation was, of course, in the old Summit level, where it extended to a depth of 17½ feet below the normal surface of the water. It is interesting to note that at this depth a large number of fossils and oyster shells, together with coral and other calcareous matter, were brought up by the dredges. The specimens belong to a deposit of the Miocene age, and include oyster shells weighing as much as 5 pounds apiece and fully 12 inches in length. The level of the water in the finished canal will be 7½ feet below the old level, and the Deep Creek level will be similarly lowered about 4 feet, making a continuous level, as before stated, from Deep Creek to the South Mills, a distance of 22½ miles. The total yardage to be moved is estimated to be about 3,600,000 cubic yards, and the total cost of the improvement, completed, is estimated at about $1,000,000.

Our illustrations show the general construction of the two systems of dredges employed. The dipper dredge has a 2 yard bucket and 60-foot boom; its capacity varies between 1,000 and 1,800 cubic yards per ten hours, according to the nature of the material which it is handling. The illustration, Fig. 1, shows another dipper dredge of about the same capacity at work in Lake Drummond. This machine is provided with "land spuds." These were rendered necessary, because the specifications required that the present width of the feeder should be maintained; consequently, the width of the boat was limited to 20 feet to enable it to pass through the lock at the lake and, to give it sufficient buoyancy and prevent it from capsizing, the lateral "spuds" had to be employed. The construction of the hydraulic dredge, which, under favorable circumstances, can remove about 2,500 cubic yards in ten hours, is shown in our front page engraving and the smaller line engraving. Although its capacity under ordinary circumstances is 2,500 yards, the obstructions in the way of floating débris which were met with when digging the canal have limited its capacity to about 1,000 cubic yards per day. The dredge is manipulated by means of side lines and head lines, the head lines being worked by pulley drums and friction clutches and the side lines by winches operated by hand. There is also a spud at the rear to keep the boat from traveling too fast, which is kept down continuously upon the bottom. The shafts and pumps are all run by a 100 horse power engine, which is belted to the cutting shaft and to the pumps. The vertical cutting shafts, E, Fig. 2, of which there are two, are capable of both vertical and horizontal motion. They give a cut 24 feet wide and as deep as the knives will go, or 18 feet. Each shaft carries about fifty knife arms on it, and as the dredge is drawn forward against the cut these revolve toward each other and cut loose the material. The shafts, E, are carried by brackets, O, which extend forward from a stout wooden frame, H. This frame is hoisted by chain and pulleys, S, which are suspended from a traveling carriage running upon an I-beam, R. The knives and frame are themselves carried and slide vertically in a strong double Y-frame or yoke, F F, clearly shown in the front view of the dredge, and the Y-frame slides horizontally on heavy transverse timbers, G G, which extend across the front end of the boat. The travel of the knife shafts in the Y-frame and of the Y-frame on the transverse timbers thus gives the cutting

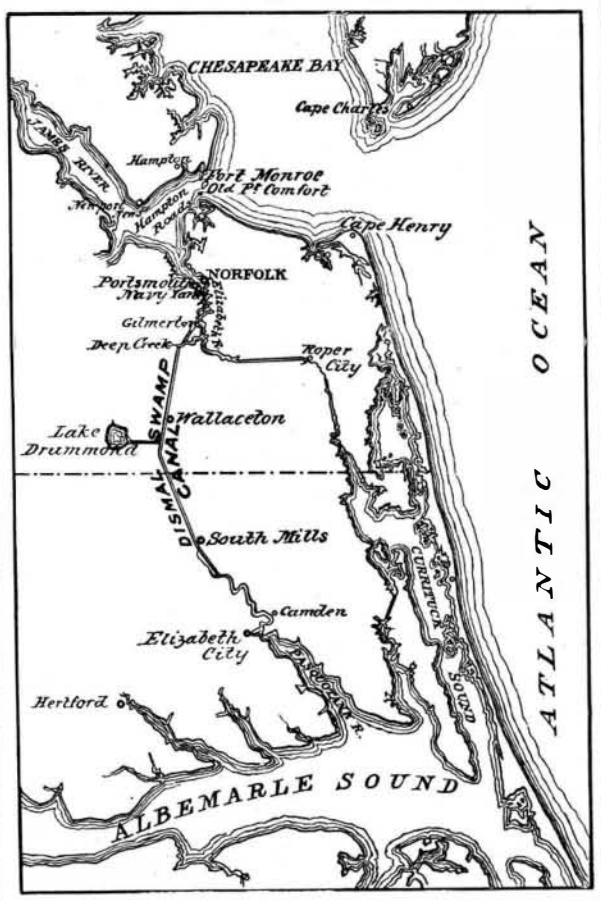

Fig. 5.—LOCATION OF DISMAL SWAMP CANAL.

knives a play over a cut 18 feet deep by 24 feet wide. The Y-frame is moved by a loose worm, M, on the center horizontal shaft, and the proper rotary motion is transmitted from the lower horizontal shaft to the cutting shafts by loose bevel gears.

The mouths of the suction pipes are placed behind the cutting knives, and the loose material and water are drawn up and discharged into a transverse trough, C, which is located about 18 feet above the surface of the water. The material is then discharged by gravity at points 60 feet distant from the canal on either side.

Our illustration (Fig. 3) shows very clearly the construction of one of the locks. The floor is carried upon piles which are driven on 4-foot centers to a depth of from 15 to 25 feet. These are capped with 12 × 12 timbers laid transversely to the axis of the lock, and upon these is the solid floor of 12 × 12 sticks. The walls are built up of the same size material, and they are supported by three rows of piling driven on 8-foot centers, to which they are braced with horizontal and inclined 12 × 12 inch struts.

Work was commenced February 15, 1896, and it is expected that the new canal will be ready for operation some time during the summer of the present year.

Petrified Forest Protection.

Land Commissioner Hermann is at work on a special report to the Secretary of the Interior, recommending that a forest reserve be made out of the petrified forest of Arizona.

Recent reports received by the Interior Department about the condition of this forest indicate that it is rapidly being used up for commercial purposes, and, unless the government steps in to stop the despoilment, the whole forest, which is one of the greatest natural curiosities in the world, will disappear. There is now building in Denver a hotel, all the walls of which are to be faced with the silicified wood taken from the forest, and all the tables for the hotel are also to be made of it. At this rate of consumption it would not be long before all the petrified wood would be used up. Commissioner Hermann thinks that there is immediate necessity for action on the part of the department. In his opinion, the best way in which the forest can be preserved is to make it a forest reserve.

The forest is located near Holbrook, in Apache County, Ariz. The largest and finest specimens of silicified wood in the world are taken from it. Whole trunks of trees and stumps with portions of the roots are found there, converted into stone as dense and hard as the finest agate. Every cell and every fiber of the former wood is preserved in stone. A forest of trees appears to have been entombed in the rocks and to have been preserved by a slow process of replacement by silica from solutions premeating the bed. Subsequently the surrounding sediments were washed away, but the enduring fossils of the trees remained.

Tons upon tons of specimens have been taken away by collectors and dealers. A company has been formed in South Dakota for cutting and polishing the stone for architectural and decorative work. Sections of these trees, four feet in diameter and large enough for the tops of tables, have been cut and polished. Many specimens were shown at the Paris Exposition, where they were greatly admired for the perfect preservation of every detail of structure of the wood, for the very high polish, and for the exquisite interblending of colors in the mass, due to the presence of various oxides in the original silicifying solutions. No other country in the world, it is claimed, can send to the lapidary such magnificent raw material of this nature as the petrified forests of Arizona afford. Not even the imperial works at Ekaterinburg, in Russia, with their wealth of kalkansto jasper, massive malachite, and other superb ornamental stones, can rival the beauty of the agatized wood of Arizona.

Commissioner Hermann is confident that Secretary Bliss will agree with him, when the facts are brought to his attention, of the wisdom of making some provision to protect this wonderful curiosity from despoilment.

Movement of Fishes' Eyes.

M. Nishikawa, in the current number of the Japan Zoological Annotations, describes a newly discovered mode by which the eye of the lower side of a flat fish travels round to the upper side during metamorphosis. According to the observations of Agassiz, the eye of the eventually blind side of the majority of flat fishes travels round the dorsal edge of the head until it attains its final position, and it is not until the rotation is completed that the dorsal fin grows forward beyond the level of the eyes. An exception in this respect is Plagusia, in which the dorsal fin grows forward to the snout, while the eyes are still symmetrical, and the left eye attains its final position on the left side of the fin by penetrating through the soft tissues at the base of the fin. In the fish observed by M. Nishikawa the dorsal fin also grows forward before the rotation of the right eye; but this anterior extension does not unite with the head until after the rotation is completed. Its neutral margin is contiguous with the dorsal surface of the head posteriorly where there is a distinct hole, bounded by the head and the anterior extension of the fin, for the passage of the right eye, which travels round the dorsal side of the head without sinking into its tissues. It is thus clear that the mode by which the change is effected in this fish is intermediate between that observed in ordinary flat fishes and that which is exhibited by Plagusia.