

weight of the steel sector is sufficient both to turn the telescope on its polar axis and to propel the clock. The governor of the clock releases the cord at the proper speed to cause the image of the observed star to remain in the slit of the spectrograph.

The mounting of the telescope was designed in general by the writer, and in detail by the Parke & Lacy Company, of San Francisco. It was constructed in the shops of the Fulton Engine Works at Los Angeles. The optical parts of the telescope and spectro-

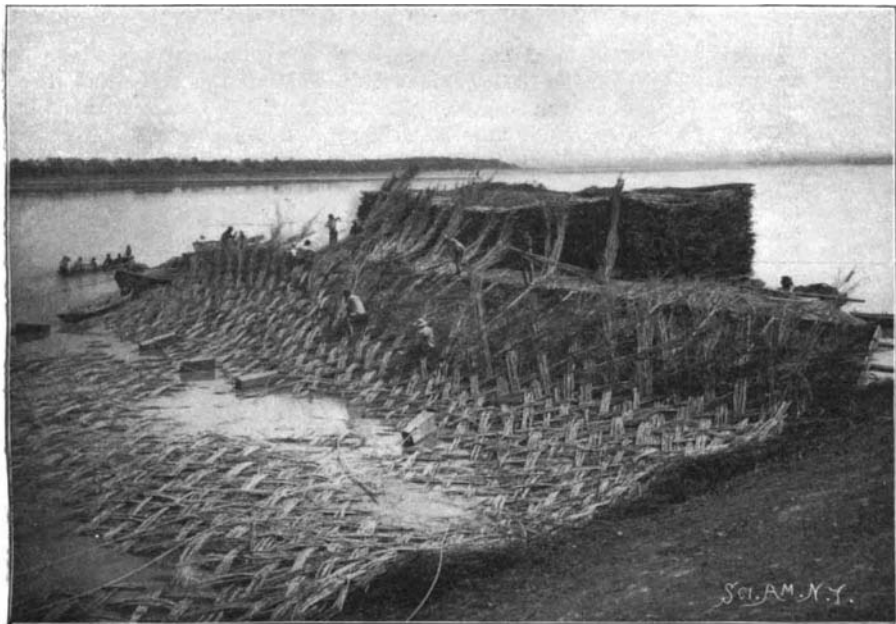
the brighter stars in the one-quarter of the sky surrounding the South Pole. The photographs will be sent to the Lick Observatory for measurement and discussion. It is confidently expected that a combination of the spectrographic results obtained at Mount Hamilton and at Santiago will lead to a very satisfactory solution of the perplexing problem of the motion of the solar system through space.

There is little doubt that, as in the Mount Hamilton observations, the discoveries made as by-products of

PROTECTING A RAILROAD FROM FLOOD CURRENTS.

BY DAY ALLEN WILLEY.

A piece of revetment has recently been built along the Missouri River in the vicinity of the town of Cambridge which has attracted much attention from engineers on account of the plan of construction, its comparatively low cost and the permanent protection which is afforded to the banks. It is perhaps unnecessary to say that the shore on either side of the Missouri for many miles is of such a formation that even slight



Weaving the Mat.



Sinking the Mat by Dumping Rock upon it.



Paving the Bank.



Government Dike to Prevent Scouring the Bank.



Hydraulic Grader at Work on the Bank.



Eastern End of the Mat Completed and Sunk.

PROTECTING A RAILROAD FROM FLOOD CURRENTS.

graph are from the well-known shops of the John A. Brashear Company. The spectrograph and clock were constructed by our instrument-makers. The instruments are to be contained in a 30-foot steel dome constructed by the Warner & Swasey Company, of Cleveland, Ohio.

The dome and instruments will be mounted on the summit of one of the low hills near Santiago, where they will remain for two or three years. It is planned to measure the velocities of three or four hundred of

the investigations will rival in scientific interest the results which comprise the main purpose of the work.

The expedition will be in charge of Acting Astronomer W. H. Wright, who has ably assisted in the observations made with the Mills spectrograph in the past five years. He will be accompanied by Assistant H. K. Palmer. The government of Chile has offered to further the purposes of the expedition in every possible manner.

currents frequently cut away much of the earth, while during periods of high water the current is so strong as to do considerable damage, often materially changing the river bed at bends and other points where the contour of the shore offers obstruction to the water.

For several miles the tracks of the Chicago & Alton Railway follow the river, in the vicinity of Cambridge, crossing it near the town of Glasgow by a steel bridge which is one of the longest structures of this kind in the West. It was completed in 1900 and is 2,435 feet

in length including viaduct approaches, deck spans, and a channel span which in itself is 338 feet in length. The bridge and approaches cost in all about \$500,000. Near one of its terminal points the shape of the bank recently suffered from floods to such an extent that the railroad company found some plan of protection was necessary. After a careful examination the chief engineer determined upon a plan which has been carried out in several portions of the country by the government engineers, and the work was begun with the approval of the Missouri River Commission. The plan consisted of first grading the banks, then making an artificial foundation for the stonework by weaving what is known as a "mattress." This was "ballasted," and the revetment was completed by covering the shore end of the mattress with smaller stone in layers which reached a certain distance up the banks. In grading, the hydraulic system was used, a pump being installed which furnished a pressure of 100 pounds to the square inch, throwing the water through a 4-inch pipe fitted with a nozzle of 1½ inches in diameter. This stream was found to be sufficient to cut away the top of the bank, throwing the surplus material into the river and leveling it to the desired grade. The force of the water was such that the bank beneath the water to be covered by the mattress was also graded. With a force of six men the engineers were able to grade 100 linear feet of bank in 10 hours.

In making the mattresses two barges, each 20 by 50 feet in size, were lashed end to end, and a platform and a set of ways constructed thereon. The weaving was done on the ways. When the top of the ways was reached, the mattress was held up by the men, and the mattress boat allowed to drop down stream until the work was again at the foot of the ways. The mattress is woven of brush, 1 to 2 inches in diameter at the butt, and 15 to 25 feet in length, the "stitch" being over and under. It is 12 inches thick and 86 feet wide, with a selvage on both the inshore and outstream edges, and is strengthened and held in place by a system of cables. The line of the inshore edge of the mattress follows a contour line, 3 feet above low water. Galvanized wire cables were run longitudinally, one cable under the mattress and one on top, and a single cable was run in the inshore selvage. Similar sets or pairs of cables were also run transversely, at intervals of 16 feet 8 inches, one cable under the mattress and one on top. The transverse cables were anchored to posts planted on the main bank, back from the top of the slope. These anchors are yellow pine timbers, 12 by 12 inches and 4 feet long. To prevent the finished mattress from sagging, it was straightened as fast as completed by pulling upon the cables with block and tackle.

In sinking the completed mattress, the mattress boat was floated down the stream with the current, the mattress itself being left to float on the surface. A barge loaded with bowlders weighing from 100 to 200 pounds each was then drifted upon the mattress, and the stones dropped upon it in such a way as to distribute their weight as equally as possible over all parts. The stone served as anchors to hold the submerged portion firmly in place on the bottom of the river.

One of the most difficult and interesting features of the revetment was the "paving," as it was termed, which extended from the top of the artificial grade to several feet beneath low water. The inshore edge of the mattress was covered with crushed stone from a point 3 feet below water to about 3 feet above, making a binding between it and the bank proper. Upon this was placed a layer of larger stone ranging from 8 inches to 12 inches in size, and extending as already stated to the top of the grade. It was wheeled in barrows to the graded banks and placed regularly in a sort of pavement. By following this plan much more resistance is offered to the action of the water than if the stone was merely thrown loosely upon the formation. A top dressing, however, was given the pavement, consisting of a layer of 2 inches of crushed stone, this filling the crevices and practically forming a solid embankment.

In spite of the apparently large amount of work required to carry out the various processes, the cost was less than \$7.50 a linear foot of revetment, including all expenses. The force of men required to weave the mattresses comprised but 33 in all, who completed 90 linear feet in 10 hours, while 30 men were employed to unload the stone barges and 32 men for paving and supplying the paving material. With the force of labor divided in this way, the various portions of the improvement kept pace with each other, so that while a section of the bank

was being graded, the mattress to cover it was being woven, etc.

The revetment which has been completed is 8,250 feet in length, and apparently will resist the action of the river even during the times of the highest water. It is considered superior to dikes and other formations for protection, for the reason that the submerged portions as well as the construction above the water are so bound together that the current can-



NOAH'S ARK OF THE HUICHOL INDIANS.

not work behind the bank where the improvement has been made—a frequent cause of injury to dikes, as indicated in the accompanying photograph. The plan followed in this instance leaves the formation of the shore at such an angle as to offer no direct resistance to the current, and it is believed will require little or no repairs for a period of years, although the formation of the shore at this point, as already intimated, is of loose material.

A change from steam to electric power on the



GOD HOUSES OF THE HUICHOL INDIANS.

Georgetown & Portsmouth Railroad has resulted in throwing upon the market a lot of second-hand rolling stock. It was first thought that this rather expensive equipment would be converted into junk, for the reason that the railroad is of narrow gage. A bargain has, however, been made with a large contracting company, interested in the construction and operation of roads in China, for the purchase of engines and cars, both passenger and freight. The rolling stock is to be shipped to China to be used on a road of similar gage now under construction.



THE GRANDMOTHER GROWTH OF THE HUICHOL INDIANS.

THE SYMBOLISM OF THE HUICHOL INDIANS.

BY WALTER L. BEASLEY.

Carl Lumholtz, the well-known Norwegian explorer, who has made three expeditions, occupying five years of research, among the natives of northwest Mexico, in the interest of the American Museum of Natural History, has brought back much valuable information and many strange and interesting ethnological objects. These have recently been installed in the new west wing of the institution, and form a most striking and comprehensive exhibit, illustrating the peculiar symbolism and culture of practically an unknown race of people, who are at present living in the same state of barbarism as when Cortez first put his foot on Mexican soil. Mr. Lumholtz is the first white man to visit and study the tribe. He succeeded in making friends with the leading shamans and tribal officials, from whom he obtained a great number of traditions and legends associated with the various symbolic and archeological objects collected. Of extraordinary interest among the specimens secured is the representation of an ark, together with the Huichol version of the same. There has been no Bible or priest among them for centuries, and they have forcibly resisted the intrusion of missionaries in recent years. Their old beliefs, customs and ceremonies all remain in their ancient vigor. Just how and when the Bible story found its way among the Huichols and became embodied in their mythology is unknown. Before explaining the ark and its symbolic significance, a brief outline of the Huichols is herewith given. The tribe number at present about 4,000, and they live in a rugged country, difficult of access, in the northwestern part of the State of Jalisco, among the Sierra Madre range. The territory is estimated to be about 40 miles long by 25 wide. All of their settlements—save one on a high mesa—lie on the east border of the Chapalagana River, which traverses their country from north to south. The Huichols are of medium height, with skin of light reddish brown. The dress of the men consists mainly of a shirt made of a cheap quality of cotton cloth. The women wear a skirt and short tunic of the same material, and cowhide sandals. The women weave tunics and girdles from wool, and are quite clever at embroidery, with which they adorn their dresses. They live in circular houses made of loose stones and mud, and covered with thatched roofs. They dwell in small ranches; only the officers of the tribe stay in the pueblos. The Huichols offer to their innumerable

gods many remarkable symbolical objects, being the embodiments of prayers. These votive images are found in the god houses and sacred caves. All ceremonial objects lose their potency after five years, after which time they are thrown out and renewed. The gods are implored naturally for material benefits only. The moving principle in their religion is a desire of producing rain, thereby enabling them to successfully raise corn, beans and squashes, their principal food. One of the most unique and remarkable of the symbolic objects obtained from the Huichols is an ark, which was kept in one of the god houses, and deposited occasionally upon the waters of a small lake as one of the extreme measures of getting rain. To the Huichol mind what has once been associated with an effect has the power of reproducing that effect, and therefore the Ark, once connected with water, is thought to have the power of causing the water to rise and descend again, or in other words to produce rain. The following is the myth of the Deluge and the Ark of the Huichols as related by a famous shaman to Mr. Lumholtz:

Once upon a time, long, long ago, before the white man (the Spaniards) came to the country, a Huichol was at work felling trees in the preparation of his field for planting, but each day he found that the trees he had cut down on the previous day had grown up again. He worried over this and grew tired of working, but still he came on the fifth day to try once more, bent upon finding out how it happened. Soon there arose from the ground in the middle of the clearing an old woman with a staff in her hand. The woman was Taka'tsi Nakawe. This name means our Grandmother Growth. She is the mother of the gods. All the earth belongs to her, and she lives in the under world. All vegetation is her product, and she is the special goddess of corn, squashes and beans. She pointed with her staff toward the south, north, east and west, and finally toward below, when all the trees which the young man had cut down immediately stood up. Then he understood how it was that his clearing was always covered with trees. She told him he was working in vain. "A great flood is coming," she said; "it is not more than five days