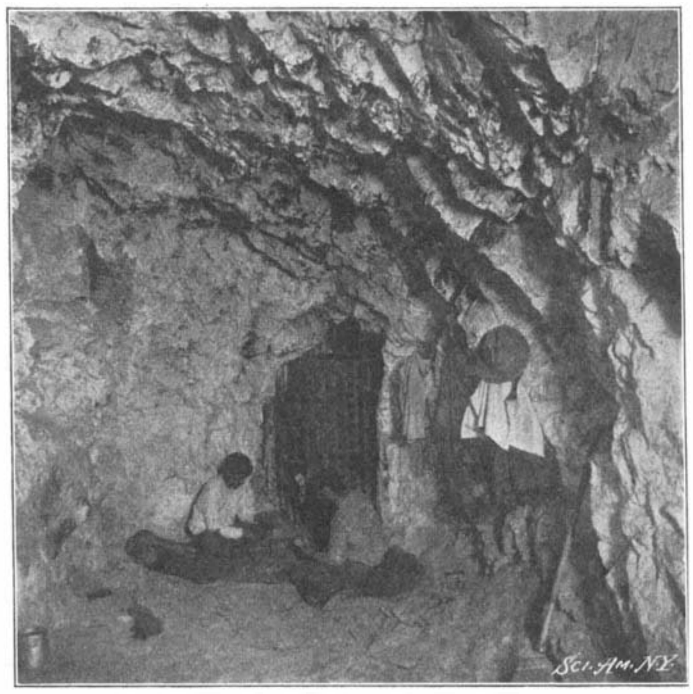
THE INVENTIONS OF DR. WILLIAM CHURCH.

(Continued from first page.)

effected by means of a cam (not shown), which, in the further advance of the wheel *I*, struck the friction roller at the upper end of the lever *O*, and caused the opposite end of that lever to draw forward the matrix bar by its connecting piece *P*.

The next operation was that of discharging the types from the mold, which was done by a cam (not shown) on the periphery of the wheel *I* coming into contact with the friction roller of a lever, connected by its shaft with the lever *R*, so that both moved together. By the movement of the first-mentioned lever, the lever *R* forced down the punch-bar *S*, connected with it by the link *m*, from the underside of which bar clearing punches protruded. By the descent of the punches into the groove of the mold-bar *B*, the types were projected downward and descended into a guide which was twisted one-quarter around, in order to bring the bodies of the type into proper position, so that they could arrange themselves side by side in the same manner as when placed in a line by a compositor. The last-mentioned cam having passed the friction roller of the lever *Q*, the weight V^1 descended and lifted the lever *R*, which raised the punches out of the molds to their former position. Another cam, on one of the spokes of the wheel *I*, now struck the roller at the lower end of the lever *O*, and pushed it back, thereby causing the connecting piece *P* to drive back the matrix bar *C* to its former position. The locking of the matrix-bar was now to be effected by still another cam (not shown) which came into contact with the under side of the friction roller of the lever *M*, which pushed it back again, and drew the previously mentioned wedges up into the slots of the loops. The next motion of the mechanism was the sliding of the mold bar back into its former position. This was done by the friction roller of the lever *L* (as the wheel *I* passed onward), descending from an enlarged part of the periphery of the wheel *I* to the reduced part of the periphery. The lever *L* connected with its short lever was pulled down by the weight and shifted the mold-bar back to its initial position. The wheel *I* having performed an entire revolution, brought the cam *c* again under the friction roller of the lever *J*, thereby raising the plunger and permitting another operation of the casting to begin. After the types descended in the twisted guides, they were pushed backward into the ranges of the box *U*, by means of the guide cams *V V*, fixed upon the shaft *H* of the hand wheel *G*. The friction roller at the end of the lever *W* acted between these cams. By the revolution of the shaft and the cam, the lever *W* was caused to oscillate so that the bar *X* connected with the punch projector bar was reciprocated. Thus, at every revolution the punches were forced through the twisted guides to drive the types one after the other in their exact position into the ranges of the box *U*.

Having disposed and arranged the several types into narrow boxes or slips, each slip containing a great number of types of the same letters, was placed in the upper part of the composing machine in boxes *A A*. From these boxes the types were removed by a mechanism operated through the movement of a keyboard, very much as in the modern typewriter or linotype machine. But since Dr. Church knew nothing of typewriters, he quaintly tells us that this composing machine of his is operated "in a manner somewhat similar to the jacks and keys of a harpsichord." The heads of the vertical key-levers or "jacks" slide in slits formed in a plate. The number of jacks is equal to the number of boxes of type. When one of the keys was depressed by the finger, the end of the corresponding jack was caused to advance and push forward the undermost type of the corresponding file. By the descent of the key the bar *c* was forced down, thereby depressing the arms *d*, and raising a lever, by which a clock train, situated back of the machine and therefore not shown, was set in operation. This clock train gave oscillating motion to two rods, *Q Q*, rising up to a cross lever which was fixed upon a shaft *s*. At the front end of the shaft the arm *t* was fixed, forming nearly a right angle with



INTERIOR OF AN ARIZONA CAVE-JAIL.

the cross lever. Our illustration shows the action of this arm *t* upon the shaft *v*. To the right of the arm *t* is fixed a corresponding arm *u*. Both arms were operated together by cross rods *w*. The clock train, on the depression of a key, caused the ends of the cross lever to vibrate, which caused the arms *t* and *u* to swing from side to side. To the lower ends of these arms small rods *x x* were attached, which at every vibration of the arms carried attached collectors *y y* toward the middle of the race *z* and back again.

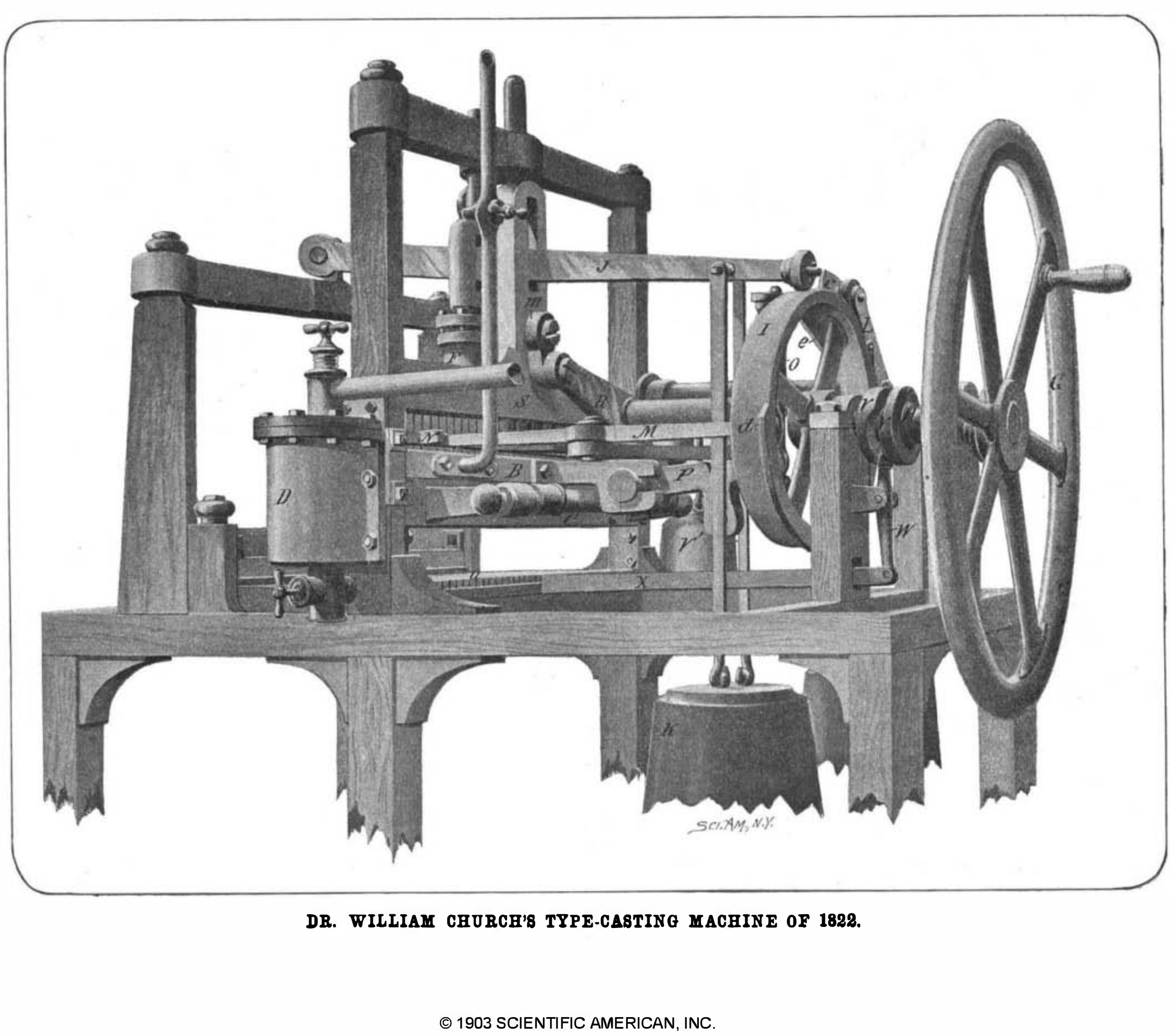
It is now necessary to refer to the situation of the type which has been pushed forward by a key lever into the race *z*. The collectors in advancing brought the type into the center under the beak of the lever c^1, at which instant the clock train caused the back part of the lever c^1 to be lifted and the type to be placed under its beak and to be pushed down the aperture d^1 into the curved channel e^1 which "acts as a composing stick," Dr. Church tells us. In this mechanical composing-stick the types accumulated and were progressively collected into words and sentences, and these were then taken and adjusted into lines by hand or collected into pages by means of a box which was placed at the side of the machine at the end of the "composing stick" e^1.

The third portion of Mr. Church's invention is a press for printing and delivering the sheets in a pile. The inking rollers were mounted in a frame, and were supplied from a distributing table with a lateral movement. At each movement of the frame ink was transferred by the rearmost inking roller from an endless band connected with a trough, and having a ratchet movement consequent on that of the roller frame. The roller frame was driven to and fro over the form by means of a belt connected with the shaft of a crank wheel. Having proceeded nearly over the form the roller frame was locked by means of a slider with the frisket frame and carried it under the platen. The impression was given by the rising of the type by a knee lever or descent of the platen. The printed sheet was then removed by nippers on endless bands passing over and under the platen and discharged. The register points were attached to the frisket "in a manner similar to that by which they are attached to the tympan of an ordinary press." The frisket was furnished with wedges which dropped into corresponding recesses in the platen or in the table and thus insured perfect register.

In Hansard's "Typographia," published in 1825, some interesting criticisms are to be found on Church's method of casting and composing type. After disclosing the operation of Church's machines, the writer remarks: "Well—suppose all this done, the performer also perfect in his knowledge of the keys and beginning to play his lesson—how long would he proceed with his tune without meeting with some unlucky note in his ballad, without having to call for some performers to play in concert? One to help the instrument to space out its lines; set its heads (italics I suppose would be provided for by another row of keys and pipes to answer those of the swell organ); then another to set smaller type for notes; a word or two of Greek or Hebrew, or, perhaps, side notes to the word; to space out heads, gage and tie up the pages; to emboss, correct, etc. To effect this saving of three parts in four of a compositor's labor, would take one key player, two helpers, one reader, one engineer, and one artist to keep such a machine in repair; and then if a simple key or trigger out of the 153 wanted for the boxes or a pair of cases should get out of tune, the whole foundry and composing machinery must all be brought to a dead stop." Hansard also refers to the "invention of one M. Henri Didot of Paris, made patent in this country by Louis John Pouchée, for casting type at the rate of 24,000 per hour." Hansard states that there is a complete identity in the machinery of M. Didot and Dr. Church; "and this, according to the law of patents, will put the exclusive right of the latter to any part of his patents to some jeopardy if ever contested. But an English expired patent anticipated them all; at least that this idea of casting type in multiplex molds is not entirely novel will be seen by referring to an expired patent of William Nicholson, granted to him in 1790." In this Hansard is wrong. The Scientific American has taken the trouble to look up this patent of Mr. Nicholson of 1790, and does not find that it involves the setting of type by machinery as in the Church patent. We are, therefore, probably correct in assuming that Dr. Church's invention is about the first patented type-casting and type-composing machine.

A CAVE USED AS A JAIL.

One of the strongest jails in the country is located in Graham County, Arizona, in the town of Clifton. This com-



DR. WILLIAM CHURCH'S TYPE-CASTING MACHINE OF 1822.

munity is situated in a valley on one side of which rises a hill composed principally of quartz rock. When the county authorities desired to have a place for confining prisoners, it was decided to make an excavation in the hillside, which was done by blowing out the rock with explosives. The opening was made merely large enough for one man to pass through without difficulty, while the interior was excavated like a coal mine, and divided by natural partitions into four cells. No effort was made to finish the interior of the cells, the roof and sides being left in the jagged condition caused by the blasting. To admit air and light, several holes were made in the hillside, also by means of explosives, and the openings secured by bars of steel about an inch in diameter, driven into holes in the rock and cemented.

The entrance was fastened by means of a door also composed of steel bars; but as a means of further protection and to provide accommodation for the sheriff and his officers, an artificial wing or vestibule was constructed of rough masonry, the stone which had been blasted out of the excavation being used for this purpose. The vestibule is divided into two sections, so that, in order to reach the jail proper, one must go through three barred gates. While the cells are but four in number, each is large enough to hold several inmates, and this novel jail can accommodate a score of persons at one time if desired. Although the walls, sides, and roof are composed of rock, the interior is dry, and the inmates suffer far less discomfort than many of those who are placed in artificial structures. The thinnest part of the wall of this jail is over six feet in thickness, so the jail, besides being fireproof, is certainly secure.

In order to prevent the substitution of inferior goods in an original bottle, an inventor who has recently secured a patent on his scheme. proposes to embed a dime or other coin in the body of the bottle, which, he claims, will be sufficient inducement to secure the destruction of the vessel when it has been emptied.

TRANSPORTING LUMBER ACROSS DEEP GORGES.

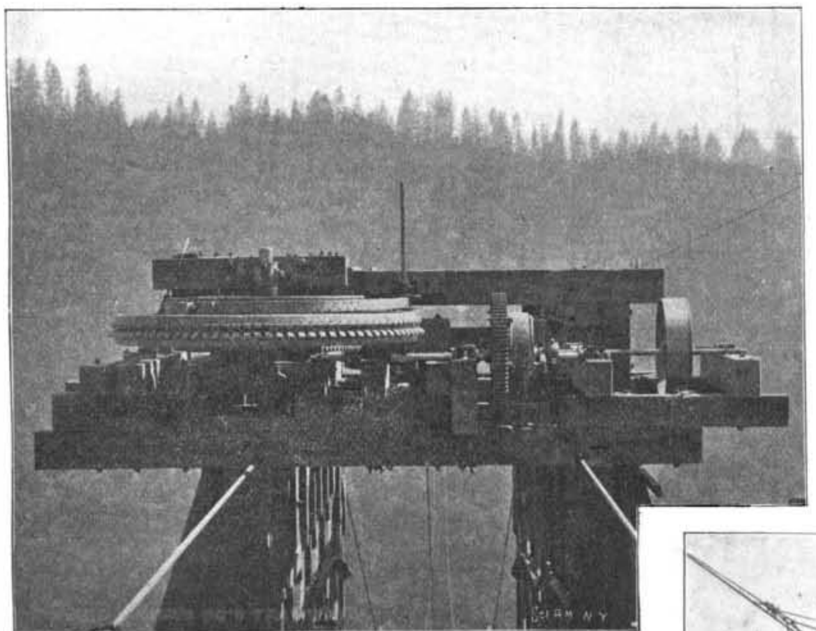
In the higher altitudes of the Sierra Nevadas in California are some of the most magnificent forests of sugar pine to be found on the western continent. The difficulty of marketing the product is intensified by the many natural obstructions which are characteristic of this region. The timber lands are intersected by deep and precipitous cañons or gorges over which the timber has to be carried before the railroad is reached, an operation expensive and extremely liable to accident. An instance is the case of the Eldorado Lumber Company, a San Francisco corporation owning an immense tract including thousands of acres of splendid timber on the South Fork of the American River in Placer County. This river is the largest affluent of the Sacramento. Years ago the lands were owned by a company which expended a million dollars in building dams on the river and constructing railroads to connect with the main lines at Placerville, but floods carried away the dams and obstructed the railroad.

After many years of disaster, the original company succumbed and the present organization succeeded to all its rights and privileges. Some of the most valuable of the timber lands on the tract are separated by a deep gorge of the American, having in this instance a breadth of only 2,650 feet at a height of 1,000 feet above the river bed. Formerly lumber had been transported over this depression by a cable tramway extending up the sides of the mountain and crossing the river by a suspension bridge. This plan, successful for a time, was slow and expensive as well as dangerous in the extreme, and it was determined to abandon it for a less objectionable plan, if engineering talent could be found that could suggest one. Mr. Edward J. Parsons, C. E., of the California Wire Works, devised the method of overcoming the difficulty, which was adopted and has now been installed. All difficulties attending the transportation of lumber in carload lots have been surmounted. Two cables each 3,000 feet long and 1 7-16 inches in diameter were thrown across the cañon. Each weighs 14½ tons. The cables are constructed with a solid wire core ½ inch in diameter, around which 57 wires, each 0.154 inch in diameter, are twisted in opposite layers of 13, 19 and 25 strands respectively. The cables have an ultimate strength of 125 tons and are anchored in solid rock. Two tunnels were driven for over twenty feet into the solid granite and at the end the cables are fastened into heavy castings and anchored into tons of solid concrete. Connecting rods are threaded throughout their entire length, so as to regulate the slack and restore the equilibrium of the cables when disturbed, thus maintaining at all times a constant level. Though the velocity of the wind in exposed places in the high Sierras is often great, yet the cables are but little affected.

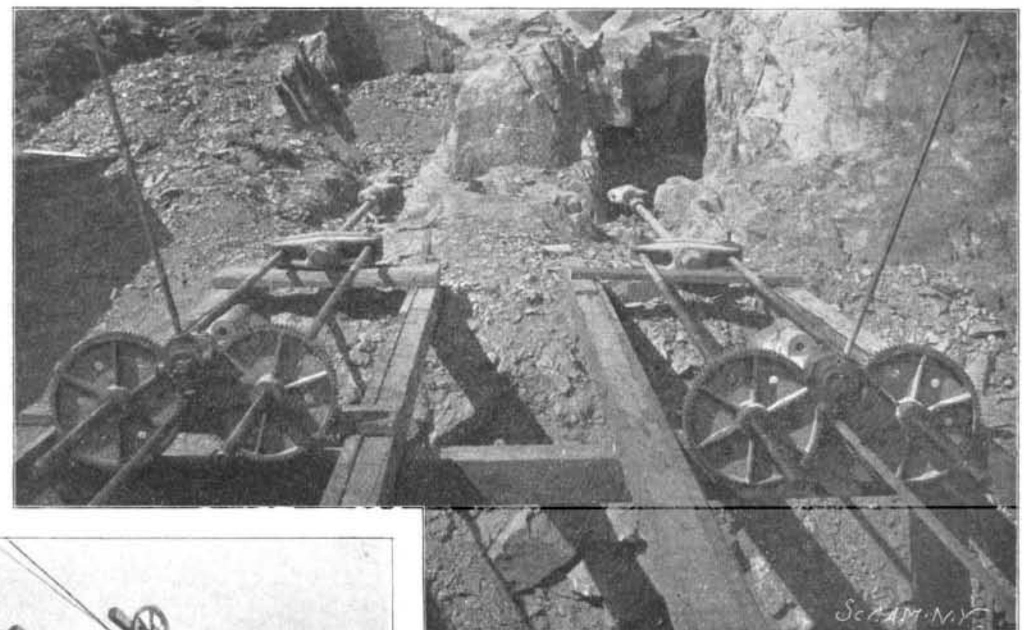
The engine, clutch wheel and connections are placed at the north end of the cable and the cage is operated from this point by an endless wire cable passing around a sheave at the south terminal which is 35 feet lower than the engine. The transmission cable is held and operated by horizontally placed wheels. In case of accident to the cables these clutches would enable the car to be drawn to the nearest or either terminal.

The skeleton cage in which the car of lumber is transported is of steel and it travels on the cables by eight deeply grooved wheels. The rails upon which the car of lumber rests connect with the roadbed at either terminal.

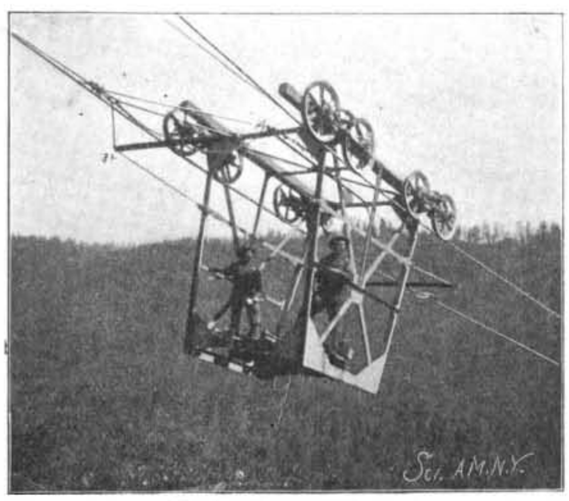
Clutches hold the car wheel securely in position. The cost of the improvement was less than $12,000, and the success of the enterprise is assured.



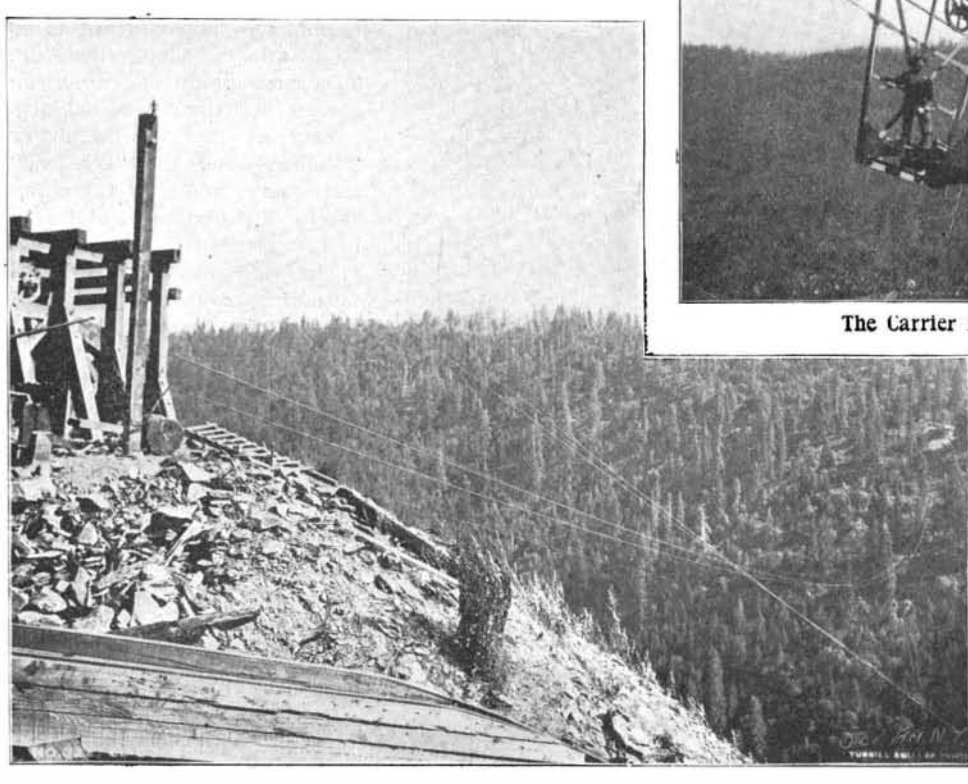
The Large Sheave.



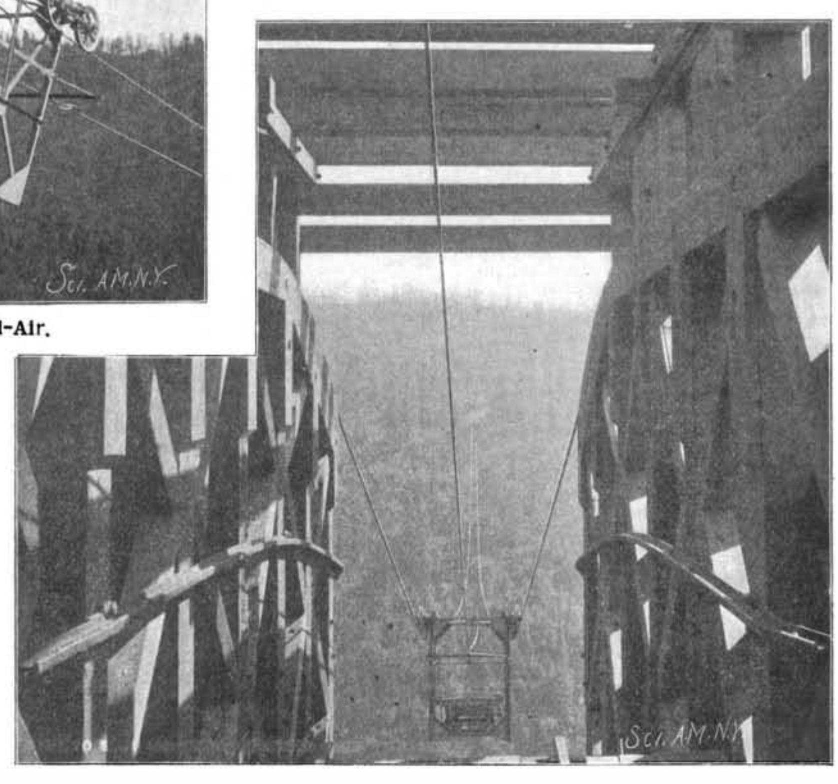
Anchorage and Tightening Devices.



The Carrier in Mid-Air.



Head House and Cables.



View of Tramway Looking Through the Head House.

TRANSPORTING LUMBER ACROSS DEEP GORGES

Much interest is manifested in the offer of a $3,000 cash prize by the World's Fair authorities to any person who shall successfully transmit without wires electrical energy amounting to one-tenth of a horse power 1,000 feet. This achievement, if performed, would mark a new step in the development of electrical science. Many experiments have been made in the direction suggested.