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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

ANCHORING DOWN THE FLOOR OF THE GATUN LOCKS.

The magnitude of the problems confronting the engineers who are building the huge locks at Panama, by far the largest work of the kind yet attempted, is shown by the nature of recent experiments which have been carried on at the site of the lock foundations. The object of these experiments is to determine the best way to anchor down the floor of the locks, and prevent it from being lifted bodily by the pressure of the water.

Now, to the average reader the statement that the floor of this huge concrete structure has to be anchored down to the mother rock below, will come very much as a surprise; for it has a uniform thickness of thirteen feet. Moreover, since the locks, when in operation, will be filled with not less than forty-five feet of water, one would imagine that the pressures on the floor would be altogether downward. Yet, as a matter of fact, provision has to be made for maximum upward bending stresses upon the floor, which will occur, not when the locks are full, but when they are unwatered for inspection. This upward thrust might become so great that the weight of the thirteen-foot thickness of concrete, plus its own strength to resist bending and breaking stresses, would not suffice to prevent its being thrust up from below and wrecked.

Now, since the floor of a single lock would weigh over one hundred thousand tons, it can be understood that this upward pressure tending to burst in the floor when the lock is empty, must be of enormous proportions. The question will naturally be asked, What is the character of a force which is capable of lifting up and breaking apart a mass of concrete one thousand feet long, one hundred and ten feet wide, and weighing one hundred and four thousand tons?

The answer is, that water seeping through the surrounding ground, and possibly following along the sides of the lock from the Gatun Lake, and collecting below the floor of the lock, might expose the latter, when the lock was emptied, to a hydraulic pressure equivalent to that exerted by a column of water eighty-seven feet in height; that being the vertical distance or "head" from the under side of the floor of the lock to the level of the water of the Gatun Lake. Those of our readers who are familiar with the principles of hydraulics, will understand that should such a seepage occur, and a film of water gather beneath the lock when it was empty, and should there be a clear connection between this film of water and the body of water in the lake, a hydrostatic pressure acting vertically against the under side of the floor of the lock would be established.

The engineers have guarded against such seepage of water by sinking a deep curtain wall through the ground beneath the entrance to the locks, extending this wall down the full length of the locks against the outside wall, and sinking it everywhere to the impervious underlying rock. The possibility of seepage past this wall is very remote; but such is the extraordinary care which has been taken to render the Panama Canal absolutely secure against disaster, that it has been decided to consider the floor of the locks as liable to this seepage and this upward pressure, and take special steps for anchoring the floor down to the rock below. Experiments have been made to determine the effect of anchoring steel bars in the rock underlying the floor, for the purpose of ascertaining to what extent they could be trusted to hold the floor down against upward pressure. A number of old French steel rails were sunk in the rock to depths of from five to fifteen feet, and secured therein by concrete. In the test on a rail put down five feet, the rock began to crack under a pull of 98,250 pounds, and finally gave way under a pull of 136,800 pounds. The second rail anchored ten feet deep resisted all efforts to pull it up, the apparatus breaking under a pull of 237,750 pounds.

The Board of Engineers having the investigation in hand found that the maximum thrust to be resisted above the intermediate gate sill is that due to eighty-seven feet of water. This thrust would occur in case the lock and forebay should be pumped dry for examination, and a full head should develop under the entire area of the floor. It has been decided that this can be resisted by a floor thirteen feet in thickness, anchored down to the rock below by rails spaced six feet apart over the whole floor of the lock, each rail having a resistance of 128,000 pounds. The depth of the anchoring rails in the rock will be increased to fifteen feet in the middle part of the lock floor.

FAR-SIGHTED POLICY OF IMPROVEMENT.

When the early railroads of the United States were projected, the scarcity of capital made it necessary to build them on the cheapest possible plan. In locating the new lines, care was taken to interfere with the natural configuration of the ground as little as possible. Deep cuts were avoided. When the engineer encountered a bluff, he located his line around instead of through the obstruction; and if his survey was being made along the flanking hills of a tortuous valley, he made the line conform closely to the configuration of the ground, using many and sharp curves, in the effort to avoid costly work of excavation with pick, shovel, and dynamite.

Sharp curvature and steep grades, however, though they may secure for the railroad company a line that represents but little first cost, involve a very heavy cost of operation. The resistance of sharp curves and grades of two per cent and over limits the number of cars that the individual locomotive can pull. To move a given tonnage of freight or number of passengers over a crooked and hilly road, may call for two or even three times the number of locomotives and train hands that are necessary to haul the same traffic over a road that is fairly straight and reasonably level.

As the years went by, it began to be evident to the railroad companies that it would pay to spend a considerable sum of money in straightening out curves and reducing grades; since the interest on the capital thus invested would be more than offset by the reduced expenses of operating the improved road. Consequently, the railroads, as soon as their finances would permit, began to eliminate the worst features of these hastily and cheaply constructed pioneer roads. The work of revision has been carried on more or less steadily throughout the seventy-five years that our railroad system has been in existence; and during the past two decades, the sums of money that have been spent in relocating and rebuilding the lines have been enormous. The Union Pacific Railroad expended a few years ago between thirty and forty millions of dollars in cutting down grades and straightening the line on its Rocky Mountain division; and more recently the Pennsylvania Railroad has laid out an even greater sum on its crossing over the Alleghany Mountains.

The latest, and in some respects the most striking enterprise of this character, is a cut-off which is being made by the Delaware, Lackawanna & Western Railroad, by which it will shorten a forty-mile stretch of its line between New York and Buffalo by eleven miles; reducing the grades from sixty feet to the mile to a maximum of less than thirty feet, and reducing the total length of the curves from thirteen miles to less than five miles. Yet, although the total length of the cut-off will be only twenty-eight and one-half miles, its construction will cost $13,000,000, which is equal to an average of about $450,000 per mile.

The principal object of this cut-off is to enable the railroad to haul its heavy coal traffic by a short and easy route across the divide between the Delaware and the Passaic and Raritan rivers. The present line runs to the south of a direct line, making a detour of forty miles, in which, as mentioned above, the grades reach sixty feet to the mile, and there are over thirteen miles of curvature. The new line extends from Lake Hopatcong north to Andover and to the Delaware River in an approximately straight line. In order to eliminate curvature and grades, it became necessary to make some of the deepest cuts and the loftiest and longest embankments in existence. One cut through the solid granite is over one hundred and fifty feet deep at the point of greatest maximum depth, and is over a half a mile in length. Out of this cut alone must be blasted over half a million cubic yards of rock. Beyond the cut is being built the greatest railroad fill in this country, if not in the world. It will be over three miles in length, and from seventy-five to one hundred and ten feet in height. Into the embankment, when it is completed, there will have entered over six and one-half million cubic yards of material. This is about one and one-half times as much material as was taken out of the two huge excavations in New York city for the new Pennsylvania and New York Terminal stations.

THE WRIGHT AEROPLANE INFRINGEMENT SUIT.

A suit in equity has been brought by Orville and Wilbur Wright against the Aeronautic Society of New York, to prevent further exhibition and use of the Curtiss aeroplane owned by the Society, on the ground that the machine is an infringement of the Wright patents. If the suit is brought to a final hearing, it will result in the first complete review of the state of aeroplane art in patent law, and will settle once and for all who should be legally acknowledged as the inventor of the balancing devices which are now employed in many aeroplanes.

Although we have not complete data before us, it is safe to say that the Wrights will undoubtedly base their chief claims for infringement on their method of warping the planes. Whether or not this method is new with them must, of course, be determined by a court. To understand just what warping the wings means, we must first understand something of the principles of an aeroplane's flight. An aeroplane may be defined as a surface propelled horizontally in such a manner that the resulting pressure of air from beneath prevents its falling. Such a plane runs on the air like a skater over thin ice, to employ a simile invented by the late Prof. Samuel P. Langley. The most familiar example of an aeroplane is the kite of our boyhood. We all remember how we kept it elevated even in a light breeze by running with it against the wind. The cord may be regarded as the resultant of two forces acting at right angles—the one the pressure of the wind, the other the weight of the kite. Substitute the pull or the thrust of a propeller for the horizontal component (pressure) and an areoplane flying machine is created. If this were all, the problem of artificial flight would have been solved long ago. There remains the extremely difficult art of balancing the plane so that it will skate on an even keel. Even birds find it hard to maintain this stability. In the constant effort to steady himself, a hawk sways from side to side as he soars, like an acrobat on a tight rope. Occasionally a bird will catch the wind on the top of a wing, with the result that he will capsize and fall some distance before he recovers himself. If the living aeroplanes of nature find the feat of balancing so difficult, it is no wonder that men have been killed in endeavoring to discover their secret.

A sailing canoe in a stiff breeze affords a striking example of what this task of balancing an aeroplane really means. As the pressure of the wind on the sail heels the canoe over, the canoeist must climb out on the outrigger, so that his weight will counterbalance the wind pressure and so that the moment of gravity will counterbalance the moment of air pressure. In a canoe the feat is comparatively easy; in an aeroplane it may demand constant and flashlike shifting of the body, because of the incessant variations of the wind. Otto Lilienthal, a pioneer experimenter with the aeroplane, met a tragic death after he had succeeded in making over two thousand short flights in a gliding machine of his own invention, simply because he was not quick enough in so throwing his weight that the centers of air pressure and gravity coincided. Pilcher, an Englishman, came to a similar violent end for a similar reason. Octave Chanute in the United States continued the work of the ill-fated Lilienthal. Realizing the inherent danger of a glider in which the operator must adapt himself to the changing center of air pressure with acrobatic agility, Octave Chanute devised an apparatus in which the center of air pressure was mechanically controlled, so that there was no longer the perilous necessity of indulging in aerial gymnastics. In his machine, the tips of the planes, when struck by a gust of wind, would fold slightly backward, thus considerably curtailing the tendency of the center of air pressure to shift. The Wright brothers warp the ends of the planes for the same purpose. In his earlier machines Curtiss, instead of warping the ends of the planes, employed wing tips, which were moved up or down. The effect was the same. In the new Curtiss machine acquired by the Aeronautic Society and involved in the present infringement suit, no attempt whatever is made either to provide the main planes with movable tips or to warp them. Instead, the balancing planes are carried between the main supporting planes. These intermediate balancing planes are rotated about horizontal axes, in order to balance the entire machine. The court will therefore be called upon to decide whether or not these intermediate planes of Curtiss, entirely unconnected with the main supporting planes, are the mechanical equivalents of the Wright brothers' plane-warping devices. If they are, the court will further have to pass upon the question whether Chanute's wing tips were an anticipation of the Wright brothers' plane-warping invention.