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VIBRATIONS OF STEAM VESSELS.

Mr. A. F. Yarrow presented recently, before the Institute of Naval Architects, a very able paper, descriptive of a series of practical experiments which he has lately conducted, relating to the causes of vibration in screw-propelled vessels. The paper is illustrated with a number of diagrams. One of the instruments employed to show and record the vibrations consisted of a weighted drum hung in elastic slings and operated by clockwork, with paper and a pencil, the apparatus being so arranged that the pencil was made to shake by the vibration of the vessel, but the drum and paper remained at rest. In this way the pencil was made to mark the vibrations on the paper. The experiments were made on board of a fast torpedo boat in which the engines made 248 revolutions per minute. The author found that the vibration was not due, as has been heretofore commonly believed, to the action of the propeller in the water, but is caused by the unequal balancing of the machinery—of the cranks, piston rods, cams, etc. So great was the vibration of the experimental vessel that when held fast by cables in still water, the propeller being removed and the machinery set in motion, the vibration of the hull was communicated to the surface of the water, and the waves so produced photographed. Different parts of the hull of the vessel showed different degrees of vibration in the water; that is to say, the shake varies in intensity at different points in the length of the hull. There are places where it is excessive, and places, termed "nodes," where it does not exist. We give an illustration on next page, which is from a photograph. It shows the vibrating sections and the nodes, and the effect produced on the water. The vessel on which these experiments were tried was 130 feet in length, 13 feet 6 inches beam, 1,100 h. p., and had a speed of from 22 to 23 knots.

Mr. Yarrow shows that by the application of balancing or bob weights and devices to the machinery the vibration can be very greatly reduced. The vessel was tried under three conditions: First, without any balancing weights whatever, with engines as usually constructed; second, with balance weights on the cranks only; third, with balance weights on the cranks and with bob weights. The use of the weights effected a very great reduction in the vibration.

This subject of the vibration of small steamers reminds us of an experience we had a few years ago. We were invited to witness an experiment with a steam launch for which it was claimed a velocity of 30 miles an hour had been obtained. This launch was built at Amesbury, Mass., chiefly from English designs, and the builder pledged himself the boat had made the above time, and he would prove it to us by giving us a test of her speed. We duly attended, and the boat was put in motion. The builder said the way he had been accustomed to test the speed was by timing from on board, a watch being held in the hand and stakes on shore observed.

The boat was started with the builder at the engine, and when the highest speed was attained the watch was observed, but so terrific was the vibration that it was impossible to see the position of the pointers, and observance of the correct time by that method was out of the question. We subsequently ascertained by a stop watch and other means that the vessel could not, on that occasion, at her highest speed and shortest spurt, reach 20 miles per hour. Where unusual speeds are claimed by private owners or interested parties, the tests should be conducted by reliable persons who have no interest in the result, and the precise method of taking the speed should be fully explained.

World's Fair Notes.

An effort is being made to collect $25,000, with which to build at the exposition a headquarters for the Sunday schools of the United States. The scheme contemplates asking each school to contribute an amount equal to ten cents for each officer and teacher and one cent for each pupil.

As an illustration of the rapidity with which the work of erecting the exposition buildings is being pushed at Jackson Park, it may be stated that on March 1 sketches were made for a building to serve as permanent accommodations for the construction bureau, the Columbian guards, emergency hospital, central fire alarm service, etc. The contract was let on April 2, and on April 30 the building was finished and occupied. The structure measures 200 by 300 feet, is covered and ornamented with staff, and is substantially put up.

The scene which the exposition grounds now afford, with most of the buildings nearing completion and the construction being pushed forward by more than 6,000 workmen, is accounted so interesting and wonderful that from 1,000 to 5,000 visitors a day willingly pay the admission fee of 25 cents to witness it. Before the abolition of the free pass system, the visitors often numbered as high as 15,000 or 20,000. The work of construction was interfered with, so that it was thought best to charge an admission, and thus diminish the size of the crowd of sightseers and at the same time add to the financial resources of the exposition.

The construction of the exposition buildings is progressing in the most satisfactory manner, and there is no reason for doubt that all will be completed in time for dedication. The rough carpentry work is practically finished on all of the large structures except Machinery Hall and the Manufacturers' building, and on these it is in an advanced stage. Six or seven of the buildings have the exterior appearance almost of finished structures, and look like imposing marble palaces. The erection of a number of the State buildings is now progressing. Landscape gardening and other work of beautifying the grounds is being pushed by a large force of men, and sodding, walk making, and the planting of thousands of trees, shrubs, etc., is in progress.

The Ammonia Motor.

The Standard Fireless Engine Company had a run of their ammonia motor, Sunday, April 24, on Jackson Park, the World's Fair site, for the benefit of those who could not come week days. On this occasion 36 persons rode around the grounds on the motor. In our issue of January 23, we gave a description of this novel motor and its operations; but since that time improvements have been made which have decreased the cost of running the motor from 1⅜ cents per mile, as stated in that issue, to less than one cent per mile, while adding to the smoothness of the running. The distance traversed on the construction tracks was 14 miles with two thirds of a charge. Among these present were several street railroad men and capitalists, some ladies of note and representatives of the press. This motor is a portion of an exhibit for the World's Fair of 1893, when the company will have a select location for operation in the front of the grounds terminating opposite the Administration Building.

Rapid Railroad Building.

In an article in a recent number of the *Engineering Magazine*, Mr. J. S. Coleman describes the process of track laying on the Texas and Pacific Railway, where as much as three miles of track were laid in one day, which is stated to be a record performance for a single force of tracklayers working from one end. The main difficulty in such performances is said to be the supply of the material. In this instance the sleepers had to be transported a distance of nearly 800 miles, and delays were therefore frequent, consequently reducing the rate of progress considerably. The arrangement of forces for laying was as follows: A tie squad in advance of all others who laid the ties. These ties were loaded in wagons and hauled by teams along the roadbed, and set and spaced under the care of the engineer who accompanied the squad. In the most rapid work this gang numbered 125. Behind the tie-setters and spacers came the iron gang, who brought with them the truck into which the rails were loaded; as they advanced, the rails were taken out of the car by twos and dropped into place on the ties. The ends were then brought snug with the last rails laid and placed at the proper gauge. The car was then advanced over these rails and the process repeated until it was empty, when it was tipped off the line to make way for a second truck and gang, who continued the work. Close behind this gang came the "strappers," who make the joints between the rails, and the first spikers who simply spiked the centers and ends of the rails to the ties, which held them securely enough for the loaded iron trucks to pass over them. These were followed by the main force of spikers who finished the work, so that the material trains could deliver the ties and rails as near the working point as possible. The "lining," "surfacing," and "black filling" was done by three separate squads of men in the order named, who left the work ready for inspection.

Eye Measurements.

A good mechanical eye is an almost essential requisite in a good mechanic, says the *Manufacturers' Gazette*. No one can ever attain distinction as a mechanic unless he is able to detect ordinary imperfections at sight, so that he can see if things are out of plumb, out of level, out of square, and out of proper shape, and unless he can also detect disproportioned or ill-shaped patterns. This is a great mechanical attainment, and one which can be readily attained by any ordinary person. Of course there are defective eyes, as there are other defective organs; the speech, for instance, is sometimes defective, but the eye is susceptible of the same training as any organ. The muscles, the voice, the sense of hearing, all require training. Consider how the artist must train the organ of sight in order to detect the slightest imperfection in shade, color, proportion, shape, expression, etc. Not one blacksmith in five ever attains the art of hammering square, yet it is very essential in his occupation. It is simply because he allows himself to get into careless habits; a little training and care is all that is necessary for success.

Sutro's Great Mining Tunnel.

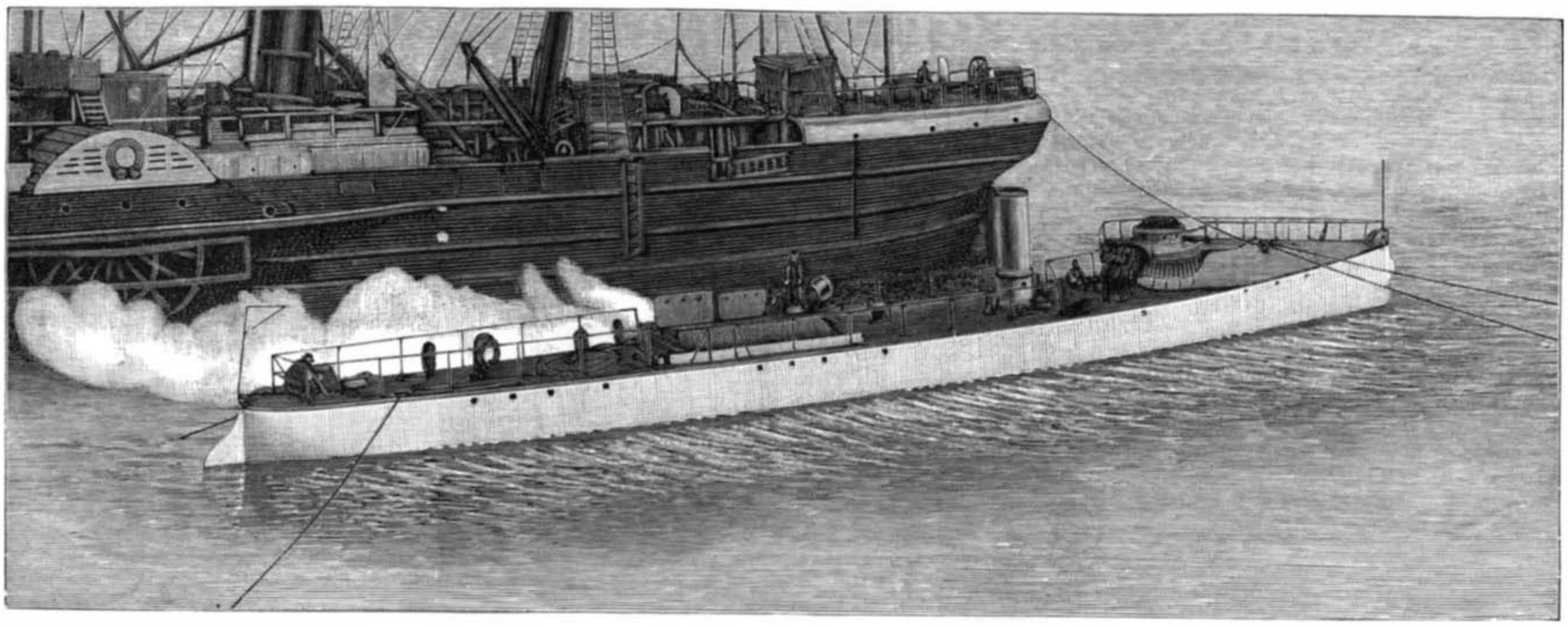
Adolph Sutro recently delivered an interesting lecture before the mining students at the University of California. In speaking of the development of the Comstock, he said:

New obstacles now developed themselves, one of which was the rapid increase of heat. As a usual thing, the increase of heat in nearly all parts of the globe amounts to one degree of Fahrenheit for every 60 feet of descent. On the Comstock the increase was more rapid, and when the mines had reached a depth of 2,000 feet, it was a common occurrence to find the thermometer in the lower drifts rise to 110 degrees and over. Such a temperature, in an atmosphere saturated with moisture, is almost unbearable, and it would often take three men to one pick; that is to say, one man would work ten minutes or thereabout, and then retire to the cooling station, while the second man took his place, to again retire in order to make room for the third man, and so the rotation went on during eight working hours. The miners received $4 per day. In this mode of working, a day's labor amounted to $12.

I visited Nevada for the first time in the early spring of 1860, and, traveling over the country, saw at a glance what an advantage to the mines a tunnel would be driven into the mountain from the valley of the Carson.

Actual work on the tunnel was commenced in 1869, and it is my special object to allude to its construction and some of the obstacles encountered.

At first all the work was performed by hand labor, and the progress was slow; but as more ample means were procured, drilling machinery driven by compressed air was introduced and the advance was more rapid, amounting to an average of 300 feet per month.



VIBRATIONS PRODUCED BY THE MACHINERY OF STEAM VESSELS.

Ten, twelve or fifteen holes would be drilled in the face on each side, going toward the center, so when all these holes were charged with dynamite and exploded by electricity a wedge-shaped mass of rock would be blown out from the center to a depth of 6 or 8 feet, and afterward more holes were drilled on the side and similarly exploded, making an advance for the whole width of the tunnel of 6 or 8 feet or thereabout.

After the tunnel had penetrated some thousands of feet, the air became worse and worse, and the heat commenced to increase. It was therefore necessary to have (besides the air derived from the drills) additional air thrown in by means of blowers placed at the mouth of the tunnel.

Here I will note a curious fact, which I have never seen explained, and which is worthy of close investigation by means of experiments. We found that the compressed air used for driving the machine drills, after having been compressed and expanded, and discharged from the drills, was not wholesome to breathe, and the men and mules would all crowd around the end of the blower pipe to get fresh air suitable to be inhaled by the lungs.

Whether the air in being compressed has parted with some of its oxygen or become vitiated from some other cause, I do not know, and I hope that this subject will at some future day be carefully examined into.

Speaking of mules reminds me of some of the peculiarities of these intelligent animals, which were extensively utilized in the underground workings. We soon found that horses would not do, for if anything touched a horse's ears, it would throw its head upward, and so be apt to injure itself, while a mule, if anything touched its ears, very wisely dodged.

We had as many as 200 mules employed in the transportation of debris from the works and otherwise. Going along through the tunnel a torch would be fastened to the mule's head, but coming out of the darkness into the sunlight their eyes became dazed, and returning into the darkness from the bright sunlight the mules could not see anything and stumbled about, so a remedy was found, and that was to bandage up one eye before coming to daylight, which bandage was removed after the mule had re-entered the tunnel, thus enabling it to see perfectly with that eye.

In driving the tunnel all the length of four miles many obstacles were encountered. As regards the surveys, it was not an easy matter to keep a perfectly straight line, for sometimes observations had to be made at short distances on account of the mist, and the slightest variation in centers would throw it to one side or the other.

After the tunnel, however, was completed and the connection made with the shafts at the Comstock lode, the foul and moist air was driven out within the first 24 hours, and for the first time daylight was seen from its farther end, appearing as a small, tiny star of the fifth magnitude.

If the tunnel had been driven a few miles more daylight would have been lost altogether, though the opening at the mouth was quite large.

In this connection, speaking of surveying, we had another curious experience.

Under the act of Congress the Sutro Tunnel Company was given a right to all the mines discovered for a width of 2,000 feet on each side of the tunnel for its whole length. When the time came to survey this grant, application was made to the General Land Office at Washington for the survey of those 4,000 feet. The law provided that 2,000 feet should be projected at the tunnel level, but the Land Office at Washington proposed to run the lines on the surface to that width, to which we objected, for a line measured 1,500 feet or 2,000 feet under ground would have a greater width projected up to the surface, being a portion of the radius of a circle commencing at the center of the earth; it would have given us several feet more on the surface, which might have been of great value in that country of bonanzas.

The Land Office, however, refused to make that projection, and so we had to accept the 4,000 feet as measured on the surface.

In driving the tunnel we encountered all sorts of ground, nearly always rock, some as hard as flint, and some of ordinary hardness. In very hard rock, the drills striking against it would illuminate the face of the tunnel with a thousand sparks, and give the men and the machinery quite a ghastly appearance.

At many points great bodies of accumulated and often hot waters were struck, which came out through the crevices with such force as to throw the men down. At still other points great bodies of clay were encountered, especially when approaching the Comstock lode. This clay, after being cut through, would swell, and timbers 16 inches square would break in two like mere reeds. The pressure in some places was so great that a cap 16 inches square, placed on posts of the same dimension, would be found to be pressed through by the posts within 24 hours, showing an almost inconceivable force. In one place the track did swell up every day, and had to be cut down thirteen times before it remained level.

The heat in the face, though very high, could be endured on account of the fresh air constantly being blown in, but a few hundred feet back of the face the air would be insufferably hot, and so much deprived of oxygen that a candle could not be kept lighted.

In the dry atmosphere of Nevada, electricity accumulates very rapidly in the human body, and I could, first walking over the carpet, on almost any day, with my fingers light the gas. This was the cause of several accidents. We had a special house for the storage of electric exploders, and two men in charge of this house were terribly injured at different times through touching the wires of these exploders with their naked fingers, which caused several thousands of them to explode together. One man was killed outright, being penetrated with thousands of pieces of the copper which forms the exploder caps, while the other poor man lost his eyesight. This last accident occurred notwithstanding the precautions which had been taken to make the men, before entering the exploder house, wet their shoes, while on the floor of the house was placed an iron plate connecting by means of wires with the water flowing below to carry off the electricity.

Then followed a graphic account of the various theories on the origin and formation of the Comstock lode, and the difficulties of mining at great depths, and how they had been overcome.

The lecture concluded with a display of excellent lantern slides illustrating the lecture, which Mr. Sutro had prepared in London and which were thrown on a screen by Prof. Christy.

Transportation by Water in the United States.

In *Census Bulletin* 179 are presented statistics showing the condition of the industry of transportation by water in the United States in all its branches, except that of canals, for the year ended December 31, 1889.

The text and tables have been prepared by Mr. Thomas J. Vivian, in charge of statistics of transportation, under the general direction of Prof. Henry C. Adams, expert special agent, and the work exhibits rare ability.

This is the first census that has undertaken to gather, compile, and publish full statistics concerning all classes of transportation by water, and the totals given in this bulletin are indications of the importance of the industry and the success made in reporting it.

Among these totals are those which show that the transportation fleet of the United States at the beginning of 1890, with the exception noted above, numbered no fewer than 25,540 vessels of all classes, of which 6,067 were steamers, 8,912 were sailing vessels, and 10,561 were barges or unrigged vessels, whose gross tonnage was 7,633,676 tons, and whose estimated value stood at $215,069,296. Other totals show that during the preceding year the freight movement by the whole operating American mercantile fleec amounted to 172,110,423 tons of all commodities. Others show that the number of persons of all classes employed to make up the ordinary or complementary crews of all operating vessels of the United States, exclusive of pleasure craft on the Atlantic coast and Gulf of Mexico, numbered 106,436, and that the total amount paid out in wages was no less than $36,867,305. There are other totals of an equally interesting nature, but enough figures have been quoted to show how vast this industry of transportation by water has become. It is, moreover, almost wholly conducted in vessels of American construction.

A Big Saw for Work on Metal Plates.

Carnegie, Phipps & Co., who have the government contract for a portion of the armor plates of the new navy, are to add to the finishing plant of the armor department at their Homestead mill, near Pittsburg, a gigantic saw, weighing 110 tons, that will cut a nickel steel armor plate as an ordinary saw does a plank. The armor plates range in weight from 8 to 38 tons, and are sometimes 29 feet long and 20 inches thick. The saw has a blade 7½ feet in diameter, geared from above and revolving horizontally. With it an angular slab of cold nickel steel, weighing perhaps a dozen tons, is taken off like the slab of a pine log. The saw is the first of its kind used in this country and cost $35,000.