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(Illustrated articles are marked with an asterisk.)

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SCIENTIFIC AMERICAN SUPPLEMENT

No. 694.

For the Week Ending April 20, 1889.

Price 10 cents. For sale by all newsdealers.

Permeability of Cements.

At a recent meeting of the Engineers' Club of Philadelphia, Prof. L. M. Haupt presented some notes upon the permeability of cements and mortars, with a view of bringing out a discussion of this subject. He quoted from the recent report of the Board of Experts on the Washington Aqueduct tunnel. That report says:

"If all of the work could and would be faithfully fulfilled in accordance with the later specifications requiring backing by masonry laid in cement mortar, it would make the tunnel reasonably water-tight; yet it would not prevent all leakage absolutely, and it is difficult to foretell how much water would pass through.

"The head of the water in the tunnel varies from about 75 to 175 ft., and the pressure due to this head from 32 to 76 lb. per square inch. This is an internal pressure, tending to burst the tunnel outward—a direction of force which the tunnel lining is not well adapted to resist; and in an inelastic material like brick or cement, cracks are liable to be developed on the least yielding—which would be almost inevitable if any weak points were left in the filling. But even if it were all filled, it must be remembered that both brick and cement are permeable to water. Mr. James B. Francis made some recent experiments on the percolation of water through cement mortar, a record of which was presented to the American Society of Civil Engineers May 16, 1888. These experiments showed that about 17¼ gallons of water per square foot of surface passed through a thickness of nearly 16 in. of cement in 24 hours under a pressure of 77 lb. per square inch.

"Mr. Stauffer's experiments, made in the Dorchester Bay tunnel, serve to throw light on the leakage through brickwork. He constructed a bulkhead of brick, laid in cement, 4 ft. thick, in a tunnel 10 by 10 ft. He found that under a pressure of 72 lb. per square inch the water percolated through at the rate of 120,000 gallons per day, or 1,200 gallons per square foot.

"The experience on the Boston main drainage works proved that it was not practicable to build brick masonry that was water-tight under a pressure of 64 lb. per square inch.

"At the new Croton reservoir, New York, water under 36 ft. head was found to percolate through 26 in. of brickwork and 4 ft. of concrete."

Mr. Marichal said that the imperviousness of cements is a question of the greatest importance; yet it seems that no steps are taken by manufacturers to improve their products in that direction. The *fineness* is one of the most important considerations, and wherever percolation is prejudicial—as is the case in aqueducts subjected to pressure, in dams, and in works exposed to sea water—care should be taken to select a very finely ground cement. The manipulation of the mortar will also affect its imperviousness.

When asked whether it was possible to make cellars water-tight by means of cement, if the level of the water was, for instance, generally a couple of feet above the floor, Mr. Marichal answered that some years ago he succeeded in rendering perfectly water-tight, by means of cement, some cellars which used to contain about 6 ft. of water.

The Hastings Telescope.

Professor Charles S. Hastings, of Yale University, New Haven, Conn., has discovered a method of finding practicable combinations of three kinds of glasses to produce objectives without secondary aberration. Some of the results of his new method, as applied in making a telescope of small size, are described by him in a recent number of the *American Journal of Science* as follows:

The largest objective which could be made of the pieces in my possession was of 2¾ inches clear aperture. This, though smaller than desired, was sufficient to give a fairly satisfactory answer to the questions. Accordingly the glasses were worked accurately to the curvatures and thicknesses corresponding to the computations and mounted for use. The astonishing beauty of the images in the new telescope was its most surprising feature at first. The familiar purple was wholly wanting, or, at least, could only be recognized with the closest attention, with magnifying powers greater than forty to the inch aperture and on objects most suitable to its exhibition. But the moment that the instrument was applied to astronomical use it was also evident that its defining power was remarkable. The companions to Polaris and Rigel, instead of being objects which require somewhat careful looking, as is the case with my eye and an ordinary achromatic of the same aperture, were strikingly plain. More difficult, but certainly seen, was the fifth star in Σ Orionis. The binary star η Orionis was so well elongated that its position angle was estimated to within 5° of its true value. On the other hand, ξ Ursæ Maj., which I suppose to have at present a separation of 1".7, was divided only with difficulty on a fairly good evening, though it was supposed that it would be easy. Saturn showed all that I have seen with an admirable telescope of considerably greater apertures, including more than half of Ball's division, the ring C, a single belt, and five satellites, though Tethys and Dione have not been seen unless they had an elongation equal or greater than that of the end of the ring. Rhea has been seen in conjunction. By reference to the records of many observations which I have made with various telescopes, the power of the new telescope was estimated as equivalent to a 3½ inch objective of the ordinary construction. The powers used varied from 53 to 265 diameters, with 194 as the most satisfactory for Saturn and for double stars.

Another method of determining the relative power of the telescope was by comparing the distances at which a table of logarithms could be read with it and a very perfect telescope of 2⅝ inches aperture made a number of years ago, and with which I have observed a great deal. Allowing for the 5 per cent increase in size in the new instrument, the mean of five tolerably accordant determinations indicated a gain of 23 per cent, or that the new objective was equivalent to a 3⅜ inch objective of the ordinary construction. This ratio of improvement is doubtless higher than would generally be admitted as possible by most opticians, but it must stand for the present as the best value attainable.

[In view of these surprising results, a new era of interest in the science of astronomy seems about to open. Glorious discoveries are likely to follow the application of the new system to large telescopes.—ED.]

A Fast Train.

Mr. Geo. J. Lunn gives the programme of one of the runs of the vestibule trains from Savannah to Jacksonville, on February 7 last, when the distance of 172 miles was done at the average rate of 52·4 miles per hour. Several runs aggregating 60 miles were made at the rate of 60 miles per hour or over, 12 miles at over 70 miles per hour, and one run of five miles was made at 75 miles per hour. This run was made by Savannah, Florida, and Western engine 80, built by the Rhode Island Locomotive Works, Providence, R. I. Cylinders, 18 in. by 24 in.; driving wheels, 72⅝ in. diameter; gauge of track, 4 ft. 9 in.; driving wheel base, 9 ft. 1 in.; fuel, coal; boiler, of steel, 62 in. diameter; number of tubes, 239, 2 in. diameter by 11 ft. long; fire box, 78 in. long, 34 in. wide, 66 in. high; weight on drivers, 71,300 lb.; weight of engine, 105,400 lb.; weight of tender, 76,420 lb.; total weight, 181,820 lb.; is thoroughly equipped with the Westinghouse brake for the whole train, steam brakes on the drivers, weight of the train without the engine being about 340,000 lb., a total, including the engine, of 521,820 lb.

The Chignecto Marine Railway Company.

The company formed to construct this application of the late Captain Eads' plan for passing ships over land by railroad, instead of by canal, issues a prospectus in the London papers of March 18 and 19, from which we learn that Sir John Fowler and Benjamin Baker, with Mr. H. G. C. Ketcham, of Fredericton, are to be the engineers.

The share capital is divided into £300,000 preferred shares and £100,000 common. The preferred shares to have 7 per cent cumulative, after which the common shares are to receive 7 per cent. The Dominion government guarantees an annual subsidy for 20 years, payable half yearly, of $170,602, as long as the capital does not earn 7 per cent, after which excess earnings are to be divided between the government and the share holders. The company is also authorized to issue £700,000 5 per cent bonds.

The railroad, which will be 17 miles long, is expected to save from 300 to 500 miles for vessels that would have passed through the Straits of Canso, and 700 miles for those that would have rounded Cape Breton, and the total sum to be estimated at 2d. per ton on cargo and 6d. per ton on hulls. The directors have contracted with Messrs. John G. Meiggs & Son, contractors in the Argentine Republic and elsewhere, to complete the work for the share and debenture capital; the contractors to pay interest on preferred shares during construction.

Trial Trip of the Ferry Boat Bergen.

The screw ferry boat Bergen, of the Hoboken Land and Improvement Co., which was illustrated and described in the SCIENTIFIC AMERICAN of December 8, 1888, had her trial trip on March 30. It consisted of a run down New York Bay and up the North River. The appearance of the boat, with her long cabins and comparatively unencumbered sweep of deck, is far superior to that of other boats of the side wheel type.

Her engines developed about 900 horse power, distributed as follows: High pressure cylinder, 298 H. P.; intermediate cylinder, 292; low pressure cylinder, 303. This was indicated at 140 lb. boiler pressure throttled down about 20 lb. She made 158-160 revolutions. A measured mile was run with and against the tide, giving an average time for the mile of 4 min. 19½ sec., or a rate of 13·85 miles per hour. The trip was a perfect success in every way, and augurs a successful issue to what is an experiment as yet untried in this vicinity. The marine engineering profession was well represented among the guests invited.

The Paris Exhibition.

[FROM OUR SPECIAL CORRESPONDENT.]

PARIS, March 15.

So far as the principal buildings are concerned, the machinery department will be one of the least decorated in the exhibition. This occurs because of its great size and the fact that it cannot be subdivided by partitions as other departments are, these subdivisions affording excellent scope for decoration. Nevertheless, the machinery department has a good deal of ornamentation and decoration, since both sides of the roof are used for this purpose.

The spaces between the roof girders form panels about 25 or 30 feet deep, which extend up to the glass part of the roof. On one side of the building these panels contain cornucopiæ and the arms of the various towns, departments, etc., in France, the paintings beneath showing their productions. The other side of the roof is similarly decorated, but devoted to foreign countries. Here, for example, is a description of two of these panels:

In the center and at the top, in large letters, is "America," and beneath it, in a raised oval frame or panel, is a portrait of General Washington, beneath which is a shield, on which is painted the United States flag. On each side is a cornucopia filled with fruits, etc. On the right hand side is the word "China," and beneath it a shield having the armorial bearings of the city of Pekin, beneath which is a spray of a tea plant. On the left is "Autriche," with a shield with the armorial bearings of Vienna, and beneath it ornamentation, among which is a spray of hop vine. On the left hand of this, and between the two next roof girders, is a crown, and beneath it "Londres" and the English standard, with cornucopiæ as before. On the right of the crown is Denmark, with the armorial bearings of Copenhagen, beneath which is painted decoration, whose most prominent feature is a horse's head. On the left side is "Italie" and Rome with its shield. The cornucopiæ are raised in zinc, but of course painted.

The English are said to be spreading themselves in the matter of decorations, and here is a description of their section of products of woods and forests. First of all, let me remark that in this section of the exhibition buildings the departments are divided by partitions that do not extend to the roof, so that when you stand at the door and look into a department, not only its own roof but those of neighboring departments are in view. This, from the great taste displayed in the coloring of the roof, gives a very fine *coup d'œil* as one enters. Looking straight down one of these departments, one sees that it is divided off by partitions that do not extend higher than the side partitions, so that the full length of that section of the roof is before the eye. The glass extends down about one-third of the depth of the roof and is painted a very pale blue. Below the glass are two rows of panels, extending from one roof girder to the next and one panel being beneath the other. The stringers of the roof are painted crimson, and the upper panel is of pine stained a deep rich yellow. At the point where the roof glass meets the panels there are suspended and looped up heavy, rich silk cord (crimson and white), with huge tassels to match, and strung upon the cord is ornamental bead work corresponding in color.

The side partitions have a maroon ground, with a dado at the top, the feature of the pattern being yellow and pale green. The partitions between the sections of this department are not completely decorated yet, but here is an idea of one of them. The open archway, through which one passes from section to section, has the letters indicating the character of the section and numbers to identify the section in the catalogue. The decorations on the archway are scarlet edges, white ground, and scroll green leaves gilded on their edges. The cases in this department are so far a plain black.

One of the most striking features of this part of the decorations is the charmingly subdued effect that is obtained, notwithstanding the employment of many positive and striking colors, for there is not a trace of the "Dutch" effect one so dreads where any of the reds and other strong colors are employed.

Some of the iron columns used in the buildings are similar in construction to the rectangular columns of parts of the New York elevated roads, but there is more open space between the ironwork. This space is, however, filled in with fancy tile work, one layer being composed of tiles about 8 inches deep and the next about 2 inches deep. These tiles are not all one plain color, but mottled, as it were, the reds running up or fading off rather into yellows and ochers of various shades.

In some cases, where the natural construction of the building is not considered to afford sufficient scope for ornamentation, a little art is brought into play. Thus I saw an artificial column formed by a square wooden framework, on which at intervals were nailed segments making a round collar on which laths were nailed, thus forming a round column, which will appear as a necessary part of the building, and which when ornamented or decorated will add greatly to the effect.

Some of the machines are, I am informed, to be shown at work at stated times, and this will greatly add to the interest in the exhibition, and enable a much more thorough examination of the merits of the exhibits. American screw-cutting machinery in operation would certainly bring the exhibitor considerable orders. Not that there are not American bolt cutters here, for I have seen them at Elders', on the Clyde, and in other large shops, but they are not generally known, and much inferior machines are in general use. I am of decided opinion that in all branches of thread cutting they are behind here. Not long ago, indeed, a member of one of the largest pipe manufacturing firms of Great Britain came out to New York to inquire into American methods, and in consultation told me that they had been unable to make their pipe threads and fittings taper, and to discover how it was done was the object of his visit. I referred him to some back numbers of the SCIENTIFIC AMERICAN, to a paper read before the American Society of Mechanical Engineers, and to some trade literature got up, I believe, by Mr. M. D. Luehrs, of Cleveland, Ohio, and to whom many of us are under obligations for information on screw-cutting matters. Most of the American bolt cutters I find here are the productions of Wm. Sellers & Co., of Philadelphia, and this undoubtedly arises from the judges' report at the Centennial Exhibition, Wm. Anderson, an eminent English engineer (formerly of the Woolwich Dockyard), being one of the judges.

American sandpapering machines there is undoubtedly a good field for here, especially to some of the ship building yards; and as I have seen the mortising machines of J. A. Fay & Co., of Cincinnati, here, I have been surprised at not finding their sandpapering machines, especially as I have seen as many as ten men sandpapering by hand at one time. Of course it is only a matter of time when such machines will either be imported here or copied.

One thing I am pretty well convinced of already, and that is that you can find a great many more American machines, or copies of them, in either France or England than you can find of foreign machines or copies of them in the United States (some American machines have been more successful here than in the United States); one of the most recent examples in point being the Worthington steam pump, which has become very popular in England since the English government ordered them for the Soudan. It is an open secret now, I believe, that when those pumps were ordered, the Worthingtons tried in vain to persuade the English engineers to have compound condensing pumps, and that it was afterward discovered that in consequence of this advice not having been followed, the pumps themselves would have about consumed all the water the pipes would convey by the time it reached the last pump.

I find a good many firms here using the emery wheels of the Tanite Company, of Stroudsburg, Pa., and machines using them in a novel manner are to be exhibited. I also find wooden wheels, leather covered and coated with very coarse emery, being used where, it seems to me, solid wheels would be better, that is, if a proper cementing material can be found for such very coarse emery when used on such comparatively small wheels as 6 inches diameter.

In the matter of drilling machines, the French and English manufacturers do not approach the American. They do not, indeed, seem to understand the advantages of the American form of construction, such, for example, as the quick return motion of the spindle; and this recalls to my mind the fact that an English engineer of very high standing stated, in his articles on American machines at the Centennial Exhibition at Philadelphia, that he was of opinion that these motions would be short-lived. As a matter of fact, however, the tendency has been and is to widen the range of feed and to provide all machines of any size, or rather all machines having an automatic feed, with a quick return motion. "You Americans," said an English engineer I met in the machinery department, "seem to us to be in a chronic state of change. Why, it is not long ago that I used to read in your papers about the clumsy, heavy English lathes, when all at once you turn about face and put more iron into some of your lathes than we English would ever think of. During the last year or two you have run off into a groove in quick return planing machine beds, shooting them back as if out of a catapult; but just you wait a little while and see, when the rack and pinion teeth get worn, what a nice little thump you'll have every time the table reverses. It's all very well while you have your cut gearing a dead fit, but two or three years will tell the tale."

Now it is quite true that we did suddenly begin to put more iron into the framework of our lathes and planers, but not one jot of their handiness was sacrificed, whereas the English lathes, and the French ones too (so far as I have as yet seen the latter), are the perfection of clumsiness; but as I shall probably go into this part of the subject somewhat in detail in connection with the exhibits, I withhold any further remarks at present, more than to say that while I have seen the English form of lathe, and some of them of English make, in several large shops in the United States, as at R. Hoe's, at the Betts Machine Works, Wilmington, only one firm that I know of consider them superior to the American lathe, and I am pretty sure that time will modify that opinion. While on this subject I cannot refrain from mentioning a piece of botch work I saw in an English shop a short time back. A piece of 4 inch shaft, about 6 feet long, had a keyway chipped in it for about half its length, and the man was trying to save filing by putting it in the lathe and using the slide rest as a traveling tool carrier or ram. He fastened a tool in the required (sideways) position, jammed the shaft tight between the centers, and putting on a feed with the cross feed screw, moved the slide rest along, carrying the cut along the keyway. But the tool cut deepening, he could not move the slide rest, so he first got a man to help him and then he got a piece of tube as a lever to move the slide rest with. A more mechanically murderous piece of work I never saw, and the result was just what I expected, for out came a tooth from the pinion, and a moment after out came another from the rack. If such a thing as that had occurred in an American shop, the man would soon have found the outside of the door; but as it was, they coolly went to another lathe of the same pattern and that was not being used, took out its pinion, put it in place of the broken one, and started on anew with the tube lever, one of them remarking, "Something has got to go. I don't know whether it will be the tool or the pinion." To make matters worse, there was an unused planing machine standing idle in the shop.

JOSHUA ROSE.

Expansion of Timber due to the Absorption of Water.

BY PROF. DE VOLSON WOOD.

It is stated by some writers upon the properties of building materials that timber shrinks but little in the direction of its fibers from being thoroughly dried, or expands but little in the same direction from the absorption of moisture; but the amount of these changes was not given in any work that I examined. Desiring to get some definite knowledge upon this subject, I caused to be prepared some pieces of pine, oak, and chestnut. The pieces selected were from lumber fairly seasoned, and were afterward kept in a dry room for three weeks before any measurements were made. The pieces were straight-grained, free from knots or other defects.

In order to secure accurate measurements brass pins were driven near the edges and ends, opposite to each other, and a fine mark made in each. The measurements were made to the nearest half-hundredth of an inch. The pieces were about five-eighths of an inch thick, thirty-six inches long, and five and one-eighth inches wide.

After the first measurements were made, the pieces were put into a vessel of water and allowed to remain there thirty-seven days, at the end of which time they were measured again. The measurements were made on one side only. The following are the mean of the results:

Specimen.	Pine.	Oak.	Chestnut.
Initial length, inches	35·505	35·572	35·582
Final length, "	35·622	35·602	35·640
Elongation, "	0·017	0·030	0·058
Per cent of elongation	0·05	0·085	0·16
TRANSVERSE MEASUREMENTS.			
Initial width, inches	4·470	4·464	4·481
Final " "	4·586	4·620	4·645
Expansion, "	0·116	0·156	0·164
Per cent of expansion	2·6	3·5	3·6
Rate of lateral expansion / Rate of elongation =	53	41	23½

It will be seen that the chestnut expanded laterally and longitudinally more than the oak or pine, that the rate of longitudinal expansion was about three times that of the pine, and the lateral expansion was about one and four-tenths that of the pine. The expansion in the direction of the fibers was larger than I anticipated, especially in the oak and chestnut.

The Use of the Telephone on Railways.

A novel application of the telephone has been made on the railway between Saint Valerie-sur-Somme and Cayeux (France), with a view to facilitate communication between a train broken down on the line and the nearest station. *Industries* says the stations on this line are already in telephonic communication by means of an overhead wire, and in the guard's van of an experimental train was fitted up a telephone, with battery of ten Leclanche cells and call bell. One pole of the battery is put to earth by being connected to the framework of the guard's van, and the other is joined in the usual way to the telephone, the other terminal of the latter being connected with a wire, by which connection with the existing telephone line can be made at any point. To facilitate this operation the wire is inclosed in a light steel tube, long enough to reach the overhead wire from the roof of the van, and provided at the end with a hook for attachment. Upon ringing up, the stations in front and rear of the train receive the signal, and conversation can be carried on with both simultaneously. The object of this arrangement is to enable the guard of a train, delayed or broken down on the line between two stations, to call for assistance. The apparatus carried in the guard's van is self-contained, inclosed in a box, and weighs only about 25 pounds.