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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.

SUPERVISION AND SAFETY OF THE BROOKLYN BRIDGE.

There are some engineering and architectural works which, if correctly designed and properly constructed, are safe for all time; there are others whose safety is directly proportional to the intelligence and care of the men (engineers or mechanics) appointed to supervise and keep them in repair. Prominent among the latter class of structures is the modern steel bridge, and particularly that type of it known as the stiffened suspension bridge, to which type the Brooklyn Bridge belongs. In the case of the great East River crossing, there are peculiarities in certain parts of the design and construction which demand a thorough knowledge of the theory of bridge construction on the part of its caretakers; for it is only a qualified engineer who would perceive just which are the points most liable to failure, and therefore calling for particularly close inspection. Such critical parts existed in the bridge from the very first, being inherent, as we have said, in the design; and their liability to overstrain has been greatly aggravated by the fact that, from the time construction was begun, various increments in the live loads have been allowed, until now much of the structural material of the bridge is being strained beyond the unit recognized as good practice by modern engineers, and some of it—as recent events have shown—beyond the breaking strength.

That actual breakage should have occurred, is to be attributed to lack of knowledge, or lack of care, or both. We are free to confess that recent utterances of the engineers in charge seem to indicate that they are not as familiar with the theoretical and practical aspects of the problem which is presented by the care and upkeep of this costly and overworked bridge, as the importance of the structure demands. For proof of this it is not necessary to go beyond the Chief Engineer's own report, in which he makes the astounding admission that the break in the suspender rods could not be detected until the broken ends were pulled up to view by the rising of the cable; while his assistant has asserted that the broken rods were sheared off by coming in contact with the upper edges of the floorbeam chords. What makes the Chief Engineer's statement the more disquieting is his admission that there had been previous breakages at this point of the bridge; for it is evident that even with practical evidence to back up theoretical indications of weakness, the bridge authorities either did not know how, or did not care, to use that simple method of inspection by a tap of the hammer, which is practised to-day on the tie-rods of every Howe truss on our Western railroads.

As a matter of fact, the whole atmosphere in and around the Engineer's office of the Brooklyn Bridge is particularly disquieting in view of the recent critical condition of the structure. There seems to have been too much of the "happy-go-lucky" about the management. Plans of parts seem to be difficult to find, and in some instances do not appear to exist. Is there on file in the Engineer's office a complete strain-sheet of the bridge under its present loading, showing the maximum stresses upon every member under the most unfavorable conditions of temperature and loading? Does this sheet show the actual tension in the outermost, diagonal over-floor stays, at maximum temperature and under maximum local concentration of load? When the trolleys were admitted upon the roadways, was any calculation made of the *dynamical* effect of the motor axles as they pound across the gap at the center of the main span? What is the tensional strain, under this hammering, at the center of the pair of channels which form the bottom chord of the floorbeams at this point? When the incident of the nine broken suspenders occurred, what was the increase of load thrown upon the suspenders, adjacent to the gap, which did not break? And what was the margin of resistance in these suspenders by which the process of snapping was prevented from running the full length of the truss and dropping the northern roadway into the river?

The Roeblings built a bridge which embodied the best engineering knowledge of twenty years ago, at a period when the theory and practice of bridge building, as we now know it, was not far removed from its infancy. In spite of its added loads the bridge is not an unsafe structure to-day—always provided (again we emphasize this point) that it is supervised by professional men who see to it that a most thorough system of inspection is unceasingly maintained.

THE NEW YORK CENTRAL RAILROAD TUNNEL NUISANCE.

On another page will be found the report of the grand jury's investigation of the two-mile tunnel, by which the New York Central Railroad reaches its terminal at Forty-second Street. We most heartily concur in the three recommendations of the grand jury, namely, that the wall dividing the two outer tunnels from the center tunnel be removed; that passenger coaches be protected from the sun when not in use; and that some other motive power than steam locomotives be used through the tunnel. The management of the New York Central road have only themselves to thank that this great public nuisance should have become the subject of action by the grand jury. Had the company shown the slightest indication of that anxiety to consider the comfort of their traveling patrons which, in recent press interviews, the leading officials of the road have claimed to experience, the present action of the grand jury, which is certainly not very creditable to this great and wealthy corporation, would never have been taken.

The discomfort due to heat and noxious gases is greatest in the side-tunnels, and the remedy suggested of cutting away the dividing walls and substituting for them steel columns and girders, would afford a very marked relief, by permitting the heat and gases to escape through the open wells which exist above the inside express tracks. If the company has a fraction of that solicitude for the public comfort of which they recently have made such loud protestations, the recommendation that during the hot weather passenger trains, when not in use, should be stored in sheds, to prevent their being heated by the rays of the sun, will meet with an instant response. As to the change of motive power, that also has to come; and it will be as well for the New York Central Company to realize at once that the public is determined that it shall come, and with as little delay as possible. The officials of the road have recently stated that they have been expending unlimited time and thought upon this problem, and regret to find that all of the alternative plans present insuperable difficulties, etc., etc. As a matter of fact, the public is beginning to realize that the most insuperable obstacle is the very large expense to which the company will be put by this alteration of its tunnels and this change of motive power. For the officials of the road to say that a change of motive power is mechanically impossible, is to trifle both with the subject and with the hundreds of thousands of passengers who are put to unnecessary discomfort and suffering by the present conditions. If the railroad company had the disposition to make the change, we venture to say that the electrical companies who are now equipping the Manhattan Elevated Railways would be perfectly willing to draw up a feasible scheme and put in bids for equipping the line from Mott Haven with the third-rail system, and providing the thirty or forty electrical locomotives necessary to bring the trains through the tunnel and handle them in the terminal yard. It is true, a third rail would involve some very complicated work at the numerous crossings and switches in the yard; but there is no reason to believe that these difficulties are beyond the ability of a good electrical engineer. The only objection to such an installation would be the three or four minutes delay in changing from steam to electric locomotive at Mott Haven. But this would be offset, as far as the operation of the road is concerned, by the convenience of having the steam locomotives disengaged at the round house, and saved from the round trip into and out of the terminal yard at Forty-second Street.

There can be no mistaking the genuineness of this last outburst of indignation against a railroad company of which the public has been such a liberal patron, and to which the city of New York has extended in the past such liberal concessions. We should have thought that with the construction of the Hudson River Bridge and the entrance of competing roads into Manhattan Island a probability, the New York Central would have been prompted by mere instincts of self-protection to remove a nuisance which is a standing disgrace to an otherwise admirable system.

DIVERGENT OPINIONS ON BATTLESHIP DESIGN.

Broadly speaking, and without the least disparagement of the ability and good judgment of the gentlemen composing the minority in the Naval Board on Construction, it must be admitted that there is what we might call an *a priori* presumption in favor of the superior excellence of the new type of battleship recommended to the Department, based on the significant fact that the three technical members of the Board are united in favor of the majority design. Rear Admiral Bowles is expertly qualified on the question of the structural arrangement of the hull and disposition of the armor; Rear Admiral Melville is similarly qualified to determine questions of motive power, coal supply, etc., while Rear Admiral O'Neil, by virtue of his office, is entitled to be called the most qualified expert on questions of armament. Regarding the merits of the two designs, as shown elsewhere in our issue, it is admitted that each has virtues which so strongly recommend it, as to prevent any offhand decision as to which is the all-round better ship. The Bradford design, with its four 12-inch, twelve 8-inch and twelve 6-inch guns, is in respect of its offensive qualities an enormously powerful vessel, and on paper it stands far ahead of any of the vessels built or building for any navy in the world. We presume that the Admiral has fully worked out the details of weights, displacement, coal endurance, etc., for this ship; but we are free to confess that even with her 17,200 tons displacement, she looks scarcely able to carry such an enormous battery with the great weight of emplacements, ammunition hoists, and ammunition, necessary to adequately mount and serve it, and at the same time find room for engines that will drive her at 19 knots, and for the large supply of coal which she must carry to bring her up to modern requirements as to sea speed and radius of action. An undue proportionment of weight to guns and armor must be accompanied by a reduction in the weights allotted to other essential elements of the ship; and the mounting of twelve 8-inch guns and the six heavy turrets in which they are installed, cannot have been accomplished, we fear, in this design without some sacrifice in other directions. We say this with due appreciation of the fact that 300 tons of extra displacement is allotted to cover these weights.

The Bowles design is marked by great simplicity and by the total elimination of one caliber of gun, reducing the number carried to three, namely, 12-inch, 7-inch, and 3-inch, as against the four sizes, 12-inch, 8-inch, 6-inch, and 3-inch, carried in the Bradford design. While it is true, as urged by Admiral Bradford in his minority report, that the Bowles design introduces yet another altogether new type of ship into the navy, we take it that it is the expectation of Admiral Bowles that the type, if adopted, will be so satisfactory that it will remain, with possible modifications, a permanent type for future ships. As regards the new 7-inch guns which it is proposed to use we consider that developments in guns and armor during the past few years point to this caliber, or perhaps, preferably, a caliber of 7½ inches, as the most desirable for what we might call the intermediate battery of battleships. The commonly accepted practice in our navy has been to install four heavy guns for penetrating the main turrets and the armor belt of an enemy; an equal or larger number of 8-inch guns for use against the lighter armor of the casemates and smaller turrets; a secondary battery of 6-inch guns, also for use against the lighter armor of the ship, and a large number of 14-pounders and 6-pounders for the purpose of attacking the unprotected portions of the ship with a storm of smaller shells. The wonderful improvement in armor, however, due to the introduction of the Krupp process, has discounted the efficiency of all guns, great and small. The 6-inch gun is no longer able to penetrate 6-inch armor at ordinary fighting ranges, nor is the 8-inch gun serviceable against the heavier belt and turret armor. At the same time the 8-inch is over-heavy for use against the more lightly armored portions of a vessel—facts which would indicate that the time has come for the introduction of a weapon of intermediate caliber, such as 7 or 7½-inch—one that would combine some of the penetrative power of the 8-inch with the rapidity of fire, light weight, and handiness of the 6-inch gun.

We have noticed in the development of foreign naval ordnance during the past year or two indications of the recognition of this necessity. The French seem disposed to throw out the 5.5 rapid-fire in favor of the 6.4 and 7.6 semi-rapid-fire gun; while England has been building a 7.5 rapid-fire gun which has already made its appearance in one of her later battleship designs. As modified by the recent extraordinary improvements in armor, we think that the desiderata in the arming of a battleship are as follows: A main battery of four heavy guns for attacking the waterline belt and main turrets; an intermediate battery of 7-inch or 7½-inch rapid-fire guns for attack on casemates and the more lightly armored turrets of the enemy's intermediate battery; and thirdly, a numerous battery of 3-inch, 12- or 14-pounder guns, whose province it would be to smother the enemy with a storm of projectiles, and effect that general demoralization of the enemy's aim, which results from the concussion and indescribable din, to say nothing of the wreckage, of a storm of bursting shell. It seems to us that these conditions are excellently realized in the battery of the majority design of the Board on Construction. At the same time it is undeniable that Rear Admiral Bradford makes out a strong case in his minority report for the *tactical* advantages to be gained by mounting a numerous 8-inch battery in double- and single-decked turrets. The Bradford design has the advantage of possessing an overwhelming power of attack; although it gains this by the adoption of principles of construction that expose the vessel to the risk of a sudden disablement of a large portion of its main armament. The Bowles design, on the other hand, though less formidable for offense, is relatively simpler, less liable to quick disablement by a few well-placed shell, and with its larger secondary battery of 3-pounder guns, and the more rapid fire of its intermediate battery of 7-inch guns, would, in a given time, deliver many more aimed shots than the minority type of vessel.

However, after every argument has been made, one cannot but feel how purely theoretical is the whole question of battleship design. Only the test of a grueling fight between ships of opposite type could determine their respective merits. The Spanish-American war should have furnished the naval constructor with much of the proved data for which he is ever looking; but unfortunately the one-sided character of the engagements rendered the technical lessons of the war altogether meager and disappointing.

VARIOUS USES OF PAPER.

BY GEORGE E. WALSH.

Paper manufacturers have developed their industry in two ways in recent years, and the results justify all the labor and experiment carried on through the application of science and chemistry. The application of machinery to cheapen the process of converting the raw material into different grades of paper has enormously stimulated paper production in this country, and the various processes employed have often been described.

But a no less important expansion of the paper industry has been in increasing the manifold uses to which paper can be put. Here, too, science has been the chief agent, and it has wrought remarkable changes and improvements. Chemistry has been laboring in this field for two decades, and from the laboratory have come discoveries that have made possible the numerous side-products of the paper trade that are now manufactured on a large scale.

One of the things in the paper industry that seemed almost incredible a number of years ago was the manufacture of car wheels. It seemed incomprehensible to the lay mind that wheels made of compressed paper would stand the strain better than wheels made of steel. But the manufacture of paper wheels is no longer a novelty, and they are made in a great variety of sizes and shapes for use on roller skates up to heavy car wheels. After the car wheels made of paper were announced somebody applied paper to the construction of hollow telegraph poles, which were designed to take the place of those which had heretofore disgraced our streets and highways. But paper telegraph poles have never proved of any great value except to illustrate to the skeptical what can be done with paper.

There have in recent years been made of paper, water and sewer mains which promise to be of value. These are hardened and treated chemically so that they are more impervious to water than some of the iron and earthenware mains. It remains to be proved by actual test whether they can outlast some of the latter. The announcement was made a few years ago that paper window panes had actually been made and used, but these were much like the oyster-shell window panes of the Filipino huts. They may admit a certain amount of light to brighten up the interior, but they could never be looked through with any degree of satisfaction. Still, a semi-opaque glass is often needed for the ceilings of public buildings, where the light admitted must be dimmed and diffused in passing through the substance. Paper window panes have been used in this way with more or less success.

We are not only the greatest producers of paper in the world, but we have adapted it to more practical uses than any other nation. Our machinery for making paper, and for converting it into useful articles of commerce, surpasses that of any two European nations, and even in France and Germany, where the refinement of paper finishing has for years reached the high-water mark, our machinery is largely used. In fact, it might be said with considerable truth that our paper machinery has outstripped our paper production, and great as the latter is, the former eclipses it in extent and variety.

By means of improved machinery and new chemical processes wood pulp can be drawn out into the thinnest imaginable sheets. In this spinning and squeezing the paper does not lose its toughness. Thus thin paper napkins and table cloths are produced and printed with fancy borders and patterns. Some of these articles are almost as tough as linen in resisting the attempt to tear them. Of course, they will not stand wetting and soon lose their toughness when moistened. But otherwise they make serviceable substitutes for table linen. Likewise the paper vests and paper underclothing and lining of winter suits are prepared for practical use, and they accomplish nearly all that is claimed for them. The paper vests and lining are made so thin that their weight is practically nothing, and yet they keep out the wind and cold. They are chemically treated, so that they will last a long time. They are also manufactured so that they do not make the rustling sound usually characteristic of paper, and they are pliable enough not to stand out or bulge the cloth in any way.

Waterproofing, and more recently fireproofing, of paper have occupied the attention of chemists and practical paper makers. Paper made waterproof and as fine as the ordinary napkins and table cloths would prove a boon to many lines of industries, especially at restaurants and hotels. It is said that public eating houses are waiting anxiously for durable paper napkins and table cloths. Waterproof paper is made to-day, but not in such a way as to be valuable for table use. Waterproof paper sheets are frequently glued to cloth, and in this way the latter is rendered impervious to moisture. This waterproof paper is good, however, only for limited lines of articles.

Lately the paper pulp mills have been experimenting with fireproof paper. In fireproofing wood it has been found necessary to inject into it under great pressure non-inflammable chemicals, and thus either drive out or neutralize the inflammable material of the wood. It has been found that these fireproofing substances can be introduced into the paper pulp much easier than they can be injected into wood. Many attempts have been made to mix the right chemicals in the paper pulp to render the paper made therefrom fireproof. Not a little success has been attained in these experiments. In fact, the experiments in producing fireproof paper paved the way for making fireproof wood. The wood pulp that is compressed into molds for general household uses, such as for wainscoting, dadoes, ceilings and moldings, can be made fireproof in the same way as the paper. The fireproofing material is introduced and mixed with the wood pulp when the latter is in a soft, pliable condition, and when hardened through hydraulic pressure the chemicals remain in the wood.

This is one of the most interesting lines of experiments yet attempted by the wood pulp mills. It opens up a world of new possibilities. Should they succeed in producing perfect fireproof wood pulp there would be nothing to prevent them from furnishing our builders and marine architects with nearly all the interior wood trimmings in pressed material. The demand for such fireproof wood pulp products would be extensive. Our Navy Department is demanding such material for their battleships and cruisers, and the builders of the great skyscrapers in our cities are just as anxiously looking around for the same thing. If fireproof wood pulp could be produced satisfactorily it would enter into our daily lives in innumerable ways.

When we consider the great number of household articles already made of wood pulp, it can readily be understood that a fireproofing process for paper and wood would be immediately of great value to all. The interior trimmings of railroad cars, ferryboats, ocean and river steamers, public halls and hotels are nearly all made of hard wood treated with oil, so that it is more inflammable than in the natural state. All this trimming of wood forms a daily menace to thousands of people, and should a fire occur it would sweep irresistibly through these handsome steamship saloons and parlor cars. The whole trade is merely waiting for the proper fireproof wood to make revolutionary changes in its methods.

There are innumerable smaller trades built up in recent years as the result of improvements in manufacturing paper. Thus in the electric light business compressed paper, chemically prepared, is of great value, and it is employed for insulating purposes on a large scale. Paper is in increasing demand for packing perishable goods. Butter, cheese and similar products packed in waterproof oiled paper will keep twice as long as when wrapped in any other substance. This packing paper is rendered absolutely air-tight. Druggists use large quantities of it for wrapping around the corks of their bottles, and even in sealing up boxes of medicine which need to be kept from the air as much as possible. In this way results are obtained which cannot be approached by any other cheap material. Filter papers are also articles of considerable commercial value. Thousands of tons of fine filtering paper are used every year in the drug trade.

SCIENCE NOTES

The Olympic Theater at Vincenza has been reopened with the Œdipus of Sophocles. We illustrated this wonderful building in the SCIENTIFIC AMERICAN for July 16, 1898.

The Baldwin-Ziegler expedition sailed on the exploring ship "America" from Vardoe July 31, the vessel's course being shaped for Cape Flora, where Mr. Baldwin hopes to join the "Frithjof" and "Belgica." Mr. Baldwin intends to push as far north as possible to establish winter quarters. He has 426 dogs and 16 ponies with him.

The Arctic expeditions of 1901 include the Baldwin-Ziegler expedition, the Russian expedition under Admiral Makaroff, the Canadian expedition, the German expedition, the joint expedition by the Duke of Abruzzi and Nansen, Peary's Greenland expedition, the Stein Ellesmere Land expedition, a Russian expedition in the Kara Sea, to work to the eastward along the Siberian coast, and an expedition to Franz-Josef Land.

Count de la Vaulx, the aeronaut who will attempt to cross the Mediterranean in a balloon in the middle of August, has arrived in Toulon to superintend the preparatory arrangements. Many prominent persons have contributed to the cost of the experiment. An immense balloon shed opening toward the sea will first be constructed. A carrier pigeon post will be established along the coast from Barcelona to Nice, and at Corsican and Algerian ports, with which the aeronaut will communicate.

The New York Police Department has adopted a button invented by a woman, Mrs. Dudley F. Phelps. She has been working on the invention for many years. The button requires no sewing of any kind and can be taken off, cleaned and put back again without tearing the cloth. When she designed the button she had in mind particularly the requirements of uniforms. Two small prongs pierce the material of the uniform and on these fits the top like a glove fastener, which makes the whole thing perfectly secure.

A London firm of photographic apparatus makers, during the sojourn of the Moorish ambassadors, constructed a camera for the Sultan of Morocco at a cost of $10,500. The instrument is of the quarter plate size (3¼ x 4¼) and differs in no respect as regards the fittings from the ordinary camera made by this firm for general purposes. The metal work of the camera is constructed of gold, including the screws, and also the holders for retaining the plates. The instrument occupied the services of ten men for four months, the polishing of the base boards alone requiring eight weeks to accomplish. About 150 ounces of gold have been utilized and the instrument weighs 13 pounds instead of 5 pounds, the weight of the same camera for ordinary use. It is a combination hand and stand camera with double extension racking out from the center and rising front. It has but one lens, a Zeiss working at *f* 6.3. It gives two different foci, and it is stated that the powerful actinic light of Morocco will render the open aperture sufficiently rapid for the focal plane shutter, permitting an exposure of 1-1000th part of a second being given. The iris diaphragm, stopping down to *f* 45, will enable the lens to be employed for interior or sharply defined photography. Another camera was also made by the same firm—half plate in size—but in this instance silver is employed instead of gold for embellishing it. The cost of the second camera was $4,500. The Sultan of Morocco is stated to be an expert amateur photographer.

H. Becquerel has confirmed, by an unpleasant experience, the fact first noted by Walkoff and Giesel, that the rays of radium have an energetic and peculiar action on the skin. Having carried in his waistcoat pocket for several periods, equal in all to about six hours, a cardboard box enclosing a small sealed tube containing a few decigrammes of intensely active radiferous barium chloride, in ten days' time a red mark corresponding to this tube was apparent on the skin; inflammation followed, the skin peeled off and left a suppurating sore, which did not heal for a month. A second burn subsequently appeared in a place corresponding to the opposite corner of the pocket where the tube had been carried on another occasion. P. Curie has had the same experience after exposing his arm for a longer period to a less active specimen. The reddening of the skin at first apparent gradually assumed the character of a burn; after desquamation a persistent suppurating sore was left which was not healed fifty-six days after the exposure. In addition to these severe "burns" the experimenters find that their hands, exposed to the rays in the course of their investigations, have a tendency to desquamate, the tips of the fingers which have held tubes or capsules containing very active radiferous material often become hard and painful; in one case the inflammation lasted for fifteen days and ended by the loss of the skin; and the painful sensation has not yet disappeared, after the lapse of two months.—Comptes Rendus.