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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.

THE LESSON OF THE EAST RIVER BRIDGE FIRE.

The recent East River Bridge fire will not be without its useful effect if it results in provision being made for fireproofing the completed structure. Of all the risks incidental to a great work of this kind, the very last that anyone seems to have considered was that of fire. It is easy to be wise after the event, but it is a matter for regret that, in preparing the temporary saddles for carrying the footbridge cables and supporting the strands of the main cable during erection, the Roebling Company did not build them of steel instead of timber. The cost would have been very little more, and the disaster which occurred would have been rendered impossible. At the same time, the accident teaches a very obvious lesson with regard to the future work on the bridge; for, if the existence of a structure costing from $20,000,000 to $22,000,000 is liable to be threatened by the use of combustible material in its construction, obviously the builders of the bridge should be careful to eliminate as far as possible all material that would cause a serious fire. As at present designed, the construction of the roadways, footways and railroad tracks calls for the inclusion of several million feet of timber. The existence of this material, high up in midair, where it is exposed to the full force of any wind that is blowing, will be an invitation to a disaster compared with which the fire of last week would be insignificant. Should the mass of timber in the roadway floorings, or in the railroad ties of the elevated and trolley tracks, once become thoroughly ignited, the fire would be liable under the influence of a strong breeze to sweep with great velocity and fierceness throughout the whole length of the bridge. To guard against fire two precautions should be taken: the amount of timber should be reduced to a minimum, while such as is used should be thoroughly fireproofed, and this protection should be further strengthened by the laying of ample water mains across the bridge with frequent hydrants. The use of fireproof wood would, of course, be costly; but viewed as an insurance upon the structure, it is an expense that would be justified by every consideration of prudence and economy.

PIPE GALLERIES FOR THE BROADWAY TUNNEL.

We understand that the City Controller at the last meeting of the Rapid Transit Commission moved that the Chief Engineer be instructed to prepare alternative plans, one of which will provide for pipe galleries along the Broadway line leading to the Brooklyn tunnel. It is the hope of the Controller that the city may be able to furnish the money necessary for the construction of these galleries. The announcement of this most important fact formed an insignificant paragraph in the daily press of the city that probably escaped the notice of a majority of its readers. Yet it is a fact that the question at issue has more to do with the comfort of the citizens of New York than many other municipal questions that receive, and will receive, far more attention. It cannot be denied that the water and gas mains and electric cables that underlie the streets of New York are the source of more interruption to traffic, more dirt and general confusion, than any other cause, unless it be the erection of new buildings. Whenever a main gets out of order, whenever the existing mains become too small for the needs of the city and have to be replaced by larger mains, whenever new connections, however small and insignificant, have to be made between a building and the street mains, the surface of the street is broken up, an unsightly and very obstructive excavation is made, and, as if the disturbers of public comfort rather gloried than otherwise in their work, when the excavation is closed the dirt is roughly thrown in, and it is usually weeks before the original granite or asphalt surface is restored. And this is going on every day of the year, and in a thousand different places at once.

With the construction of the Rapid Transit Subway it was realized by the engineers that there was a great opportunity presented for solving this problem by gathering all the city mains, conduits, cables, etc., together, and placing them in galleries constructed at the side of the Rapid Transit Tunnel. Plans were drawn for these galleries, and they were so arranged, with proper manhole openings at intervals, that whenever any repairs, laying of mains, making connections to buildings, etc., had to be done, the gallery could be entered at the proper manhole and the work done without any disturbance whatever of the city's streets. On some stretches of the Rapid Transit subway excavation was made for these galleries; but owing to a most disgraceful political move on the part of the Tammany politicians who were in power at that time, two or three heads of departments raised a series of obviously absurd and inadequate objections to the plan, with the result that the Rapid Transit Commission, rather than become involved in a legal controversy that might seriously delay the work, decided to go ahead with the tunnel and drop the subway scheme altogether. As a consequence, the city mains have been spread over the roof of the tunnel, a foot or so below the surface of the ground, and the city will continue to be exposed to the same interminable interruptions of traffic, which will be all the more exasperating because they could easily and cheaply have been avoided. In the construction of the subway down Broadway to the Brooklyn tunnel an opportunity is presented for putting in the pipe galleries and ridding this important and crowded thoroughfare of the street main nuisance. According to the City Controller, the erection of the galleries is now a question of finance; and we suggest that if this is the only consideration that stands in the way, it would be well to sacrifice some other and far less necessary city improvements in order to insure the carrying through of this greatly needed work. We commend the subject to that most enterprising body the Merchants' Association, which, we believe, in times past has itself directed attention to this important question. The subject is a pressing one, and unless favorable action be taken at an early date, an opportunity will be lost, as regards our most important thoroughfare, which will never return. For it would be a more difficult and costly matter (if not in some cases impossible) to build the subways after the structure of the tunnel has been completed.

A RESULT OF IMPROVED RAPID TRANSIT.

The remarkable increase in travel shown in the annual report of the Manhattan Elevated system is another proof that it pays the great transportation companies of this city to spend large sums of money in the betterment of their tracks and rolling stock. Also, it may be noted that the statistics of travel on this road for the past eight or ten years prove with equal clearness that it does not pay a great railroad system to lag behind in the matter of improvements, trusting to its prestige and the great needs of the traveling public to maintain its volume of traffic. During the year ending September 30, 1902, the Manhattan Elevated system carried a total of 223,427,283 passengers as against 194,152,316 carried during the preceding year. This great increase is to be attributed to the change which the company has made during the past year from steam to electric traction, with its resulting advantages of improved cars, better lighting, higher speed, more frequent service, and generally increased comfort of travel. The electric equipment of the Manhattan system was a very costly undertaking; yet the results of the first year of travel under the improved conditions show that the outlay was more than justified. It may surprise the public to learn that this great increase serves merely to bring the total of railroad travel about up to the figure at which it stood in 1893, when over 221,000,000 passengers were carried. In the following year there was a marked decrease to 202,751,532 passengers, and to explain this we must remember that at that time the Metropolitan Street Railway Company, or its predecessor rather, commenced the substitution of cable traction for the old and slow horse cars. This improvement of the surface system immediately began to attract passengers from the Elevated road, which made no effort whatever to meet the competition. A still further decrease of travel occurred in the year 1898 to 1899, when the enterprising Metropolitan Street Railway Company began to open that vast system of electric railroads which now embraces the whole city, the cable system and many of the horse car lines being replaced by electric traction. The figures of travel on the Elevated railroad since 1894, stated in millions of passengers, are for 1895, 187 millions; 1896, 184 millions; 1897, 182 millions; 1898, 183 millions; and the low-water mark was reached in 1899, when the total fell to 174 million passengers; the passenger earnings being $8,704,000 as against a total of $11,000,000 earned in 1893. In 1900 there was an upward movement manifest, the total number of passengers being 184,000,000, and this increased, as we have seen, to over 223,000,000 in 1901. These figures are all the more significant when we remember that only one-half of the elevated system's lines are completely equipped with electric traction, and consequently the travel for the year 1902-3 will probably be very much greater than this. One of the most valuable advantages of the improved conditions is the fact that on account of the greater frequency of the train service and the increased length of the trains, this great increase in the passenger traffic is taken care of with less crowding than when there was a smaller volume of travel. With the opening of the Rapid Transit Subway at the close of next year, there will probably be a movement from the elevated to the subway trains, and we may look for a corresponding decrease of travel on the elevated system. So rapid, however, is the growth of New York city, that it will not be two or three years before both the elevated and subway systems, especially on the express trains to Harlem and the Bronx, will be taxed to their full capacity.

THE NEW AMERICAN LIGHTHOUSE SYSTEM.

BY GEORGE ETHELBERT WALSH.

In its efforts to protect the shipping interests of the country, which stretch over some thousands of miles of ocean and inland waterways, the United States Lighthouse Board has in recent years accomplished results of an unusual nature, and, in the practical and experimental work performed, reliable data have been collected that must throw some light upon lighthouse problems in other countries. From one of the poorest-lighted coasts, the American Atlantic seaboard has, within a quarter of a century, become one of the best in the world, and the new system of lighthouses and signal lights is far more comprehensive than anything heretofore attempted. The problem of lighting the immense stretches of coast bordering two oceans, the Great Lakes, the Gulf of Mexico, and the inland rivers and waterways, was a stupendous one to contemplate. There was, in fact, so little comprehension of the magnitude of the enterprise that for many decades no idea was entertained of attempting to establish a system of lights, beacons and buoys that would be amply adequate for all purposes. The early efforts in lighthouse construction were consequently directed chiefly, and almost solely, to the establishment of a disconnected and irregular system, which would protect the shipping world only in certain dangerous places.

In this early development of the work, the coasts were divided into zones with certain important dangerous points marked plainly for lighthouse protection. The Cape Hatteras region, and the scarcely less important Cape Cod district, early received special attention. Both of these capes were in the direct route of commerce, and the storms and shoals that made them dangerous to navigators had to be offset by adequate lights which would warn mariners of their proximity. The first attempts at lighthouse construction were consequently made at a few such dangerous points along the coast, and from these in either direction new lights were gradually erected. They formed the beginning of the new system which seeks to make all of our coast so well protected that navigators need have little apprehension in approaching the land from any direction at any point.

But the rapidly increasing commerce on both the Atlantic and Pacific seaboard has made in recent years a more comprehensive system of lighthouses imperative. Likewise the shipping interests of the Great Lakes, the Gulf of Mexico, and the great inland rivers, have multiplied in importance, and the need for better protection from dangers to navigation has been general. For a quarter of a century now the American lighthouse system has expanded and developed, until it has reached a point in its evolution where it is without question one of the best in the world. The enormous coast line of the United States is now actually connected at every point with these modern "aids to navigation," and the seaman who knows his chart well has little difficulty in finding his way on the stormiest nights.

The full extent of the lighthouse service can best be appreciated by simply stating that there are some 9,000 warning lights and signals stretched along the American coasts, forming a perfect link so that the navigator need never be beyond the sight of one of the beacons. Of this grand total—including lighthouses of different classes, buoys, beacons, and danger signals—over 3,000 are lighted, giving forth their signals at night time. One thousand of these lights are located on the Atlantic coast, 1,500 are scattered along the rivers and inland waterways, 500 on the Great Lakes, and 200 on the Pacific coast. These so-called lighted "aids" include a great variety of modern inventions, from the tall flashlight lighthouse, with its base of steel and stone, and costly lamp operated by electric power, to the modern gas and electric-lighted buoys, beacons and lightships. There is such a variety of different lights included in this list that detailed description of them would fill volumes. The advances made in lighthouse and buoy construction represent some of the marvels of modern engineering science.

From time immemorial lighthouse construction has been one of the most intricate and difficult of engineering problems. The destructive effects of the sea and storms upon the foundations of these buildings early proved disastrous, and in the history of the science many unfortunate failures have been recorded. The need of a lighthouse at critical points has generally been almost in direct proportion to the difficulties of constructing such a building. Shifting sands have always formed insecure foundations for high buildings, and when these were aggravated by heavy seas and universal storms and winds the problem was intensified. Even the construction of a tall lighthouse on the sandy beach some distance back from the sea was not always a matter of easy engineering work. The encroachment of the sea upon the land in many places slowly undermined the foundations until they had to be strengthened or abandoned. One of the most effectual ways to protect the lighthouses on our sandy coasts adopted in recent years has been to build dykes of piles and brush far out into the sea for the purpose of making the ocean build up rather than tear down the beach. The tides and currents of the ocean, eddying in at particular points on the coast, would slowly wash away the beach and destroy it; but by constructing the dykes in the water these same destructive currents contributed to build up the land. When the tide laden with fine, loose sand strikes the brush anchored between the rows of piles, it either deposits the sand in passing through the obstruction, or collects it in a heap just where the angle is formed by being forced to one side by the brush. Slowly but surely land is thus formed. Half a dozen lighthouses along the Southern coast have been saved from total destruction in this way. Several of them, which a dozen years ago stood perilously near the edge of the water, now stand five hundred yards back from the tumbling ocean.

Even the best modern engineering has not yet been able to make the shifting sands a secure and permanent foundation for heavy structures. The difficulty of digging down into the sand for a secure foundation is sometimes attended by unexpected developments and obstructions that render the work almost of no avail. Forty and fifty feet below the sands nothing but soft, shifting quicksands have frequently been discovered, and the site of the new structure has had to be abandoned as a result. The difficulty of finding the right sort of foundation on the low sandy coast of our Southern States has consequently made lighthouse building more intricate in detail than along the rocky New England shore. Some of the most perplexing engineering problems have been solved in that part of the country.

One of the most noted advances in modern times has been the abandonment of the old towers of stone or brick and the adoption of the steel tubular structures in their places. The latter are built more easily on a solid, rocky foundation than the old huge piles of masonry. The steel skeleton is bolted into the solid rock or anchored there by means of long spindle-like legs, which sink many feet down into the firm foundation. These huge cylindrical towers of steel withstand the pressure of wind far better than the stone and brick structures, and their strength is so great that there is practically no danger of their ever being seriously injured by the elements. Even where the lighthouses are built in the water to mark shoals or dangerous reefs, the steel tubular style of structure is adopted. The foundation work of the structure is built up above the water with stone or concrete, and to this the steel tower is bolted. The latter looks more like a giant smokestack than anything else, and it stands as a permanent beacon of the sea to warn mariners of their danger.

Not only is additional strength and security obtained through the adoption of the steel tubular lighthouses, but the cost of construction is greatly reduced. Modern lighthouses cost far more than they did in former days, but that is due to the fact that they are built on a larger and more enduring scale, and the lights are of far greater power and intensity. A modern American lighthouse frequently costs $125,000, and often one-third of this is spent in the electric light and apparatus alone. In the old system the lights represented a comparatively small proportion of the expense. The finest French mirrors and lenses used were considered costly, but not in comparison to the electric lights and equipments. The gain obtained in the power of the light more than counterbalances the extra cost. There are a score or two of lighthouses in existence whose lights throw a beam of 100,000 candle power. The tendency is to increase the power of the lights, for by so doing the great link of lighthouses is made more secure and more trustworthy.

To maintain the lighthouse service a corps of over 4,000 men is constantly employed, and a fleet of more than fifty vessels. These latter are required to make periodical visits to the different lighthouses, light ships, and buoys, carrying supplies to the men and inspecting the lights in the interests of the department. The lighthouse keepers receive on an average $600 a year for their services. With the salaries of the crew, coal and provisions, it costs the government about $6,000 a year to maintain a first-class lightship, and about $500 a year for each of the 5,000 buoys scattered along the coast. At present the sum of nearly $750,000 is required to pay the lighthouse service men who watch the lights, tend the buoys, and live their solitary existence on the lightships. The service is altogether well handled, and as efficient as it is possible to make it, while the keepers and crews are as enthusiastic in their work as any body of men in the world.

THE PHYSIOLOGY OF CERTAIN COLORS.

BY JAMES WEIR, JR., M.D.

Havelock Ellis, several months ago, had an article on "The Psychology of Red" in Popular Science Monthly, in which he showed that red has an unmistakable effect on the psychical organism. Incidentally, he also demonstrated the fact that color has likewise a physical effect both upon plants and upon animals. He does not, however, discuss the physiological causes for each effect. It is the purpose, therefore, of this brief paper to bring out the probable action of color on the basic principles of life as far as we know them.

Thousands of years ago, it was noticed that plants reared in darkness were colorless and of weak and fragile habit. It was also observed that men who passed their lives in darkness or semi-darkness were not as robust as those who lived in the light of day. So the general conclusion was reached very early in the history of the world, that the light of the sun directly influenced both animal and plant life.

Recently, it has been determined that the rays of the sun exert dynamic, chemic, and physiologic effects on the *vis vitæ* of plants and animals. The three forces through which the rays of the sun act, viz., the dynamic, the chemic, and the physiologic, are, to a certain extent, intercorrelated; therefore, they must be studied together.

It will hardly be necessary to point out the fact that white light or daylight is a combination of all of the primary colors, violet, indigo, blue, green, yellow, orange, and red. It is highly important to my thesis, however, to demonstrate that certain of these colors exert a selective or elective influence on the physiology of animate organisms, and, individually, affect such organisms in some degree.

Flammarion's beautiful experiments at the climatological station at Juvisy, have shown beyond question of doubt, the widely different effects of the red and violet rays on plants. The plants chosen were of the genus *Mimosa* or "Sensitive Plant," and were subjected to the same environments with the exception that some were reared beneath dark blue glass, and others beneath red glass.

In four months, the plants grown under the red glass had attained extraordinary development, while those subjected to the violet rays had made no progress whatever. Similar effects were noted in the case of strawberries, and numerous other vines, plants, and shrubs.

The plants grown beneath blue glass did not die, but seemed to remain in a dormant condition without growth or further development.

Zacharawietz, of Vaucluse, has also shown that plants are strongly affected along the lines of rapid growth and development by red and orange rays. As early as 1883 I demonstrated and published the fact that typhoid fever germs would not live when subjected to the blue or violet rays.

Ward, Finsen, Berghold and others have shown that the blue, violet and ultra-violet rays are fatal to bacteria and that the other colors are not, while Finsen has made successful use of this knowledge in the treatment of zymotic skin diseases, such as smallpox, measles, and scarlatina. It would appear from these observations that the red and orange rays have a distinctly favorable physiological action on plants, while the blue, violet, and ultra-violet rays are as distinctly deleterious.

When we come to observe the action of the violet rays on animal life, we see that such action is, apparently, markedly different from that to be observed in vegetable life. But, as Davenport has pointed out, this difference is more apparent than real; for these effects on animal and plant physiology are due to the same chemical metabolic changes, but, "while plants succumb to the influence of the violet rays, animals, being more highly organized, are able to take advantage of them and flourish."

In 1883, while studying tinctumutation or the color-changing function in certain animals, I reared a large number of newts, or salamanders, from the eggs. The eggs were placed in shallow vessels which were covered by colored glasses, blue, orange, green, and red.

The eggs under the blue glass hatched out first; under the orange, second; under the red, third; and under the green, last of all. The young larvæ under the red glass were much more active, at first, than those under the other glasses, and attained full maturity several days earlier. The larvæ under the blue glass, however, grew to be much larger and in the end were much stronger and more agile. Under the green glass, the larvæ were sluggish, and of slow growth. I noticed, moreover, that whereas there were no monstrosities or deformed animals under any of the other glasses, there were many under the green and the orange glasses.

The animals under the blue glass were distinctly darker than those under the other glasses, and, under the microscope, the chromatophores, or color-bearing cells, were seen to be much more numerous.

The violet, and ultra-violet rays have a pronounced chemical as well as physical effect on the human body. They have, also, in all probability, a dynamic effect, which is shown by the feeling of well-being or otherwise. The "summer girl" who, in the early days of her vacation, cannot stand the sun, will, in the middle of summer, welcome the embraces of Phœbus Apollo and will revel in his kisses! She says that she has become accustomed to the rays of the sun and that she no longer feels them because it has become her "habit to walk abroad without hat, parasol, or umbrella." Thus she gives credit to the wrong agent; for her feeling of well-being is not due to habit, but to the thin brown veil of tan which the violet rays with ever-busy brush have spread out on the surface of her body wherever it has been exposed to them. The violet rays thus erect a barrier against themselves, for they cannot pass the tan. Nature always takes care of her children, that is, if they will give her time, and do not, in their ignorance, attempt to hasten her!

It is true that, primarily, the violet rays are superficial in their effect; yet they are, nevertheless, sometimes destructive in a high degree. Ask the boy who awakes in the night after an afternoon in the river, and "moans, and moans, and moans" on account of the intolerable fire between his shoulder blades, what *he* thinks of the ultra-violet rays; or, ask the blind and helpless traveler who stumbles across the weary waste of Arctic snows what *he* thinks of them? Both sunburn and snow-blindness are due to the violet and ultra-violet rays.

Yet, the violet rays are absolutely necessary in the up-building of the normal, healthy man. Their action must be, I take it, primarily through stimulation of the vaso-motor nerves, i. e., the nerves which control blood-vessel action. The first effect is dynamic in character; there is dilatation of the blood vessels with a consequent increased flow of blood. The second effect is chemical in nature; the increased flow of blood incites the blood-producing organs to manufacture new blood-cells, consequently the plasma of these cells differs chemically from the plasma of the old cells. There is, also, increased oxidation and oxygenation due to increased flow of blood through the lungs. The third effect is purely physiological. Owing to the increased flow of new blood cells to the tissues, cell growth is excited and new tissue is formed. Of course, waste is going on all the time; the violet rays merely act as a tonic in stimulating the organs of the animal economy toward repairment of waste by renewing and building up tissue. These beneficial rays are present in diffused daylight, hence the direct rays of the sun are not absolutely necessary in order to produce their good effects on the animal organism. Direct sunlight is, however, an exceedingly efficacious tonic when used moderately and understandingly; there can be intemperance, however, in the use of every good that Nature has given us.

TWO NEW WARSHIPS FOR CHILE.

Remarkable progress has been displayed by Messrs. Armstrong, Whitworth & Co., of Newcastle-on-Tyne, and Messrs. Vickers Sons & Maxim, of Barrow-in-Furness, the famous British armament manufacturers, who are each building a first-class battleship for the Chilean navy. On February 26 last, as both the new ships were to be as nearly alike as possible and brought up to date, Sir Edward Reed, the English M. P., who is naval architect and engineer of the Chilean government, brought the two firms into close communication in respect of everything of first-class importance in these two battleships, including the design of the two ships and of their machinery, armor, guns, etc. The result of the co-operative action of the builders in this instance is that already the Armstrong Company have worked 3,000 tons of materials, and the Vickers Company approximately the same quantity into the hulls of their respective ships, and have made corresponding progress with the armor, guns, etc. The work of construction was hurried forward by the recent threatenings of a rupture between Chile and Argentina, and the two firms contracted to build and arm the ships ready for sea within eighteen months from the date of signing the order; but the new treaty between the two countries has retarded building to a certain extent, though the two firms, in view of the progress that has been made, are yet hopeful of completing the work within the specified time. If the work is fulfilled within the eighteen months, it will constitute a record for speed in the building of a first-class modern battleship.