twenty-four ties, crossing and binding the struts, with secondary ties to assist in holding up the bottom, all made of steel. By these means, the Forth Bridge will be carried over two spans each of 1,710 feet (nearly a third of a mile), besides the half spans extending inland, where the ends of the cantilever girders, at and beyond the piers of support, are ballasted so as to counterbalance the weight of the suspended parts and of any trains passing over them. To allow for expansion or contraction of metal, the connecting central girders, resting on the cantilevers, each weighing about 800 tons, are only rigidly attached at one end, leaving the other end free. No one can fail to admire the mechanical ingenuity of the whole contrivance, which relies on the principle of "stable equilibrium," instead of a rigid union of all the parts of this immense and ponderous structure. It will scarcely, like the unfortunate Tay Bridge, be liable to be blown down by a gale of wind.

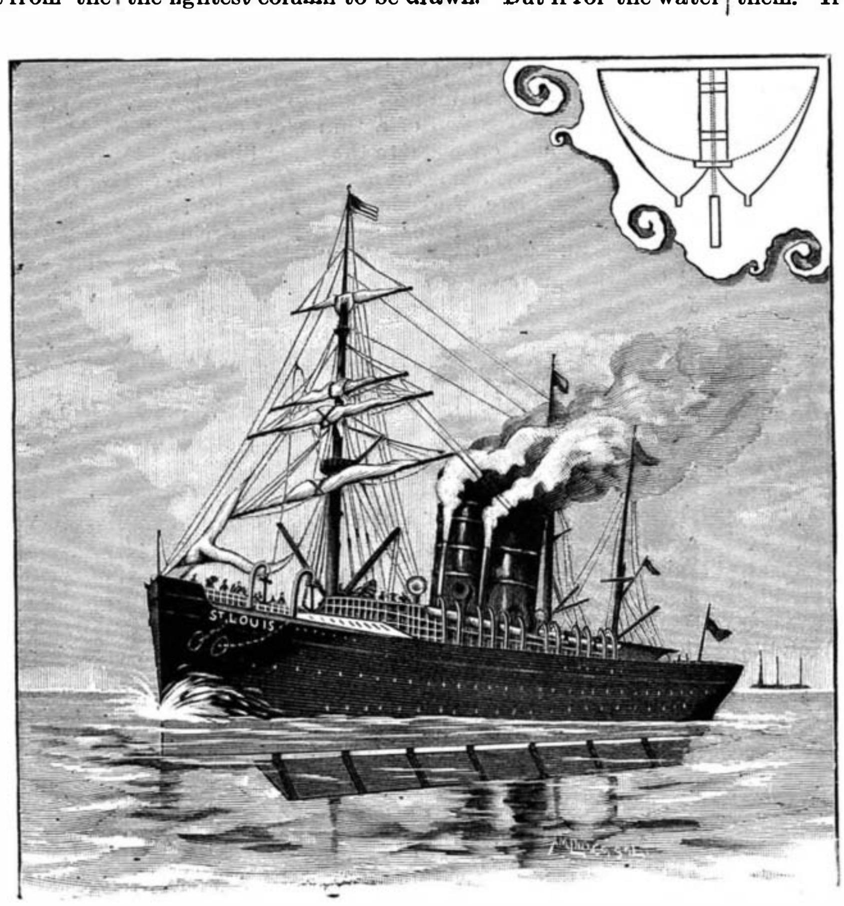
POURING WATER INTO A SIEVE.

Our engravings show a general view of the Forth Bridge so far as it is at present completed, and a more detailed view of one of the piers and the great double cantilevers resting upon it.

We may repeat, in conclusion, that each opening of the Forth Bridge is one-third of a mile in clear span, which unprecedented width is spanned by a steel structure made up of two cantilevers or brackets, projecting 675 feet from the piers, and a central lever connecting the ends of the cantilevers. As shown in the engravings, the cantilevers project about 400 feet from the piers, and pieces are being added to the ends at a rate which will complete the bridge this year. It was reported that, during the recent storms which did so much damage to shipping, the Forth Bridge had suffered, but as a matter of fact not a plate or bolt was shaken, although, in its present condition, the structure has not one-half of its final strength.—*Illustrated London News.*

## ST. LOUIS TO BE A SEAPORT.

A company has been formed in St. Louis, under the title of the Mississippi River and Ocean Navigation Company, with a capital stock of five millions of dollars, having for its object to establish direct ocean steamer lines between St. Louis, the West Indies, South America, etc., thus avoiding the great expenses of transferring and reshipping goods at New Orleans. A large amount of valuable information and cogent reasons in favor of this new enterprise are given in a pamphlet issued by the company. The prospective trade to be commanded by such lines of vessels is set forth as very great and very profitable. In order to realize the project in a practical manner, the company proposes to build its steamers on the plans invented by Andrew H. Lucas and John F. Cahill, of which we herewith present an illustration. The ships are to have double hulls and dropkeels, so they may readily navigate shallow waters.




IMPROVED DOUBLE-HULLED AND DROP-KEELED STEAMSHIPS.

The cut shows the manner of application of the adjustable or drop keel. When in actual use, however, the cylinders are not to be exposed, as shown in the illustration, as the strain would be too severe on the uprights by means of which the drop keel is suspended and made to ascend or descend between the two hulls, as shown in Fig. 2. When in use, the upper part of the drop keel is held firmly in place by stout steel braces constructed along the entire length of the inner sides of the two hulls.

The mechanism for raising and lowering it will be mounted in connection with the engine shaft of the vessel. It will be understood that the series of pinions or screws for manipulating the drop keel are to be run together and at the same rate of speed, so that there will be no straining or cramping of the parts in the cylinders. The movable keel may be lowered at will any distance equal to the loaded immersion of the ship. From the bow to a point over the forward end of the drop keel the ship is to be built solid, with watertight compartments. Her engines are to be of the triple expansion type, and her motive power the twin screw. The inventor has devised an original system of propulsion, by means of which every pound of steam power may be utilized and a higher rate of speed reached than is attained by any of the marine engines now in use. If this system should be found practicable, an extraordinary rate of speed is certain, as the construction of the ship affords excellent facilities for the use of auxiliary twin screws placed near the stern of each of the hulls. The loaded draught of a vessel of 1,000 tons will not exceed seven feet. The additional immersion of the drop keel will give the ship all the strength and stability requisite for safety in stormy weather and high rolling seas. The cylinders pass upward through the decks and are securely fastened between steel bridges equally distributed along three-fourths of the ship's length, thus relieving the immersed movable keel of all undue strain.

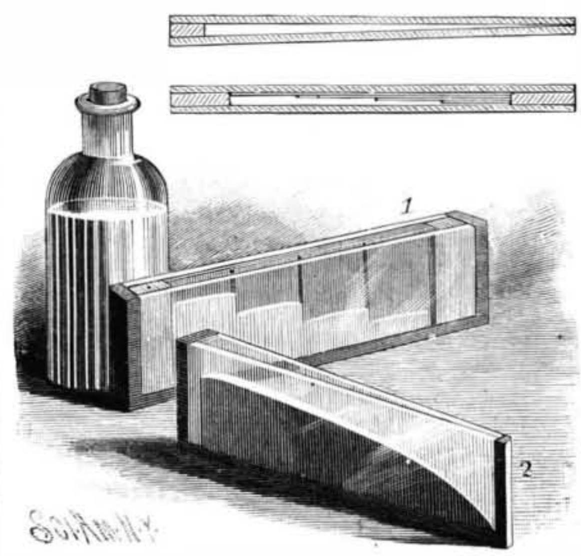
Each of the hulls is, likewise, provided with its own keel, so as to facilitate navigation.

## EXPERIMENTS IN CAPILLARY FORCE.

What may be termed the reaction of capillarity as manifested between solids and liquids is divisible into two classes. One of these is illustrated in the case of a liquid wetting a solid, typical examples of which are found in blotting paper, in the drying action of a towel, and in many experiments founded on this general basis. Where the liquid wets the solid, the forces of adhesion and cohesion are both developed, and a distinct type of phenomena comes into play. But where the liquid does not wet the solid, as in the case of mercury against wood or glass, an action dependent on cohesion alone, or very slightly modified by adhesion, is produced. In the illustrations accompanying this article several illustrations of what may be termed the capillarity of cohesion are shown.

It is a well known fact that if water is poured between two plates of glass held a slight distance apart, but nearer at one end than at the other, the fluid will rise the highest between the plates where they are the closest. The liquid will thus form a curve, in general sense a hyperbola concave upward. The water is attached to the glass by adhesion, travels upward, and by cohesion draws the liquid column after it, naturally to the greatest height, where there is the least liquid or the lightest column to be drawn. But if for the water we substitute mercury—a fluid which does not wet glass—the force of adhesion does not appear, cohesion draws the mercury strongly together and pulls it down to the greatest distance, where there is the least mercury to be acted on. This place is, of course, where the glass is closest, so that if mercury is poured between two plates of glass nearer at one end than at the other, it will rise to the greatest distance where the plates are farthest apart, and will descend in a curve convex upward. This curve will be directed toward the part of the glass plates which are nearest together. It is the reverse of the water curve.

In Fig. 2 of the drawings is shown such a trough, containing mercury. The upper sectional figure shows its construction. It is made of two pieces of glass cemented together by means of a little sealing wax, two of their edges being in contact, and two held apart by a slip of glass or cardboard. A piece of paper may be cemented over the bottom with gum tragacanth as a cementing material, or the opening may be closed with sealing wax or otherwise, as desired. This forms a wedge-shaped trough. When mercury is poured into such a receptacle, it takes a very peculiar shape, shown in Fig. 2. In Fig. 1 of the same illustration a variation on this is shown. Here the tank is constructed of plates of glass parallel one to the other; but before being put together, a series of strips of paper are pasted on one of them, each slip being about one-fourth of an inch or more shorter than the one beneath it. In this way the open space is divided into a series of step-like divisions of varying width, each division, however, having practically parallel sides. If mercury is poured into this trough, it will arrange itself into a series of steps, as shown in Fig. 1.




MERCURY TROUGHS.

In the next illustration, the same idea is carried out and applied to water. A cup is made of No. 50 gauze. The seams are joined by soldering, and the bottom has its edges bent upward, and is also soldered in place. It is then heated, when perfectly dry, and thoroughly coated with paraffine. This fills the meshes. When sufficiently coated, it is again heated, and the paraffine is expelled from the meshes by sharply blowing against them. If now the cup is held as shown and water is poured into it very gently and along one of its sides, there is no difficulty in filling it to the depth of three inches or more with water. This illustrates water held in a sieve. If a finger of the hand holding the cup is wet, the water as it rises to the level of the moistened part will at once rush out. If, when the cup is full, the wet finger is rubbed on the bottom, this will be sufficient to cause the water to escape. The cup will float upon water for an indefinite period, but if inverted and placed like a diving bell, will at once sink.

The water in this experiment practically forms a film or membrane, not touching the wire gauze and holding the body of the water together. The figure on the upper part of the cup is an attempt to show how the water rests upon the wires. The little film is bowed down between every two wires, forming a species of sac.

The experimenter must remember to have his hand perfectly dry. It is very curious, as the water rises, to feel its chilling effect through the wire gauze without the hand being at all moistened.

## Crowley's Brain.

Crowley was a chimpanzee. He was an interesting feature at our zoological museum, and his human traits offered much amusement to visitors. Crowley's portrait, and a description of his antics, was published in the SCIENTIFIC AMERICAN of October 23, 1886. He died a few months ago, and his brain has been examined by Dr. Spitzka, who finds that it weighs less than one-third that of a human brain, but in the course of the examination he made an important discovery. At the floor of the fourth ventricle in intelligent persons there are what are called auditory streaks, which are supposed to have something to do with hearing and the power to distinguish the different words of a language, and in the brain of this chimpanzee were found faint white streaks in this area—a fact more remarkable when it is borne in mind that in deaf mutes these auditory streaks are not to be found.

### On Certain Surfaces Feebly Sensitive to Light.*

BY J. W. OSBORNE.

The specimens which accompany this statement are suggestive, inasmuch as they tend to illustrate the widely extended range of photo-chemical action and the part it plays in everyday phenomena. In thinking and speaking of substances sensitive to light, photographers and others are apt to remember only the haloid salts of silver, chromic acid under restraint acting on organic matter, asphaltum, and a few salts of iron and platinum, which short catalogue does, in fact, include all the sensitive bodies used in practical photography.

But as every one knows, this list may be indefinitely extended (if the degree of sensitiveness be disregarded), and the accompanying specimens serve to show such extension in certain directions. Broadly, the results should not be regarded as new, though in the manner of their preparation and presentation some novelty may be claimed for them.

On sheets Nos. 1 and 2, three samples of colored commercial paper will be found which are bleached by light, and which give, therefore, a negative when exposed under a negative. On sheets 2 and 3, exposed papers colored for the purpose with eosine and methyl violet are exhibited, which likewise establish the fact that these colors under the luminous influence give rise to colorless compounds. But, though a great number of colors used in the arts are bleached by light more or less rapidly, this is by no means a universal rule. On sheet No. 1, a small piece of commercial orange paper is shown, part of which has been darkened by exposure. Specimens of paper colored with picric acid will also be found on sheet No. 4, in which the darkening to a brown is very marked.

The duration of the exposures required to produce these photographic effects is very considerable when the change is carried to its maximum, varying from twenty to thirty-five or forty hours in direct light, which was the only kind of exposure employed in these experiments. Such substances are perhaps from four hundred to eight hundred times less sensitive than chloride of silver paper. Indications of photo-chemical action are, however, visible in much less time. On sheet No. 2, a piece of eosine paper exposed under two strips of black lace shows a faint positive after half an hour. Also on sheet No. 3 a piece of methyl violet paper similarly exposed shows the gradually increasing strength of the positive (by contrast) after one, two, and three hours.

The fact that printing and writing papers become brown by age is familiar to most persons, but that this change is essentially photographic is not a common belief. On sheet No. 5 will be found pieces of newspaper taken from the New York *Tribune*, the Baltimore *Sun*, and the Washington *Evening Star*, on which photographic images have been impressed by simple exposure under a dense negative. These papers were subjected to no preparatory treatment, establishing the fact that the newspapers we read daily are (probably all) printed on papers sensitive to light and adapted for the production of positive pictures. On sheets Nos. 6, 7, 8 and 9, such pictures will be found on *Evening Star* paper, made by direct exposure to the sun's rays, under collodion negatives. A fact of some significance is that some of the experiments on *Evening Star* paper were made on sheets which had been very carefully washed before exposure. The washing was done by causing a rapid film of water to flow over and under the paper at the same time, for two and a half hours. The paper was then dried and exposed. This treatment did not seem to affect the sensitiveness of the paper to light, and the presumption would seem to be justifiable that the sensitive compounds present are not soluble in water.

The time required to produce the maximum effect is about fifty hours, but this must often be exceeded if any part of the negative is in the least obscured by cloudiness. The color produced by exposures on such papers is peculiar. When the paper is clean and in good condition, as in Nos. 6, 7, 8, and 9, a very pure golden bronzy color is produced, which can be appreciated only in strong white light. I will not now discuss the nature of the resulting brown yellow compound, except to say generally that it is not easily acted on by the chemical reagents, and that it undergoes a very peculiar darkening by the application of heat alone, as by ironing the paper bearing such a photograph with a moderately hot flat iron. On sheet No. 8, a piece of paper is mounted with two tints on it longitudinally, half of which (divided across the tints) was heated in the way described, and which is, in consequence, much darkened. The print above it on the same sheet was also so developed or intensified.

Sheets Nos. 10, 11, and 12 have mounted upon them pieces of white pine, of different qualities, upon which photographs have been produced by exposures under stencil negatives, made by cutting openings in tin foil, and pressing it into close contact with the surface of the wood by means of a plate of glass properly clamped thereto. The exposure required to produce these photographic images varies from thirty to fifty or sixty hours. On sheet No. 13 a piece of poplar is shown, the picture on which was produced in twenty hours, for it seems probable that of all the woods in common use, poplar is the most sensitive and gives the darkest color when fully exposed. In making these experiments it is important to obtain a fresh surface on the wood, to effect which, in the case of an old piece, a good deal of the outside has often to be removed by the plane, for the penetration of the light is often considerable.

It seems probable that this darkening of wood (which is very commonly though rather vaguely attributed to the action of the air) is related to the photographic effect obtainable on printing papers. These are now hardly to be had without an admixture of wood pulp, and the present inquiry (inasmuch as it proves the phenomena to be strictly photographic) may have a practical bearing if it points to means which will keep printing papers white indefinitely.

On sheet No. 1, the bleaching action of light upon a dried leaf is exhibited, and on No. 5 a piece of parchment is mounted, which has also, though substantially white, become a little whiter where the light has acted. As far as it goes, this would tend to show that the "yellowing of parchment by age" is not a photo-chemical process. This parchment had a very long exposure.

As connected with this general subject, I would call to mind the investigations of Mr. Thomas Gaffield, of Boston, who established conclusively more than twenty years ago the slow effect of light on colorless glass, in gradually giving it color, sometimes pinkish and sometimes yellow, the former being apparently due to a reoxidation of the reduced manganese employed to counteract the iron. These changes often required years for their completion.

Experiments only just completed tend to show that pure cellulose in the form of the finest filtering paper is not sensitive to light, at least a constant exposure in a horizontal position to diffused and direct sunlight failed in two weeks to produce any perceptible change in color. On the other hand, the same filtering paper colored with picric acid and similarly exposed for the same time, about one hundred and forty hours of diffused and direct sunlight, gave a coloration as before, when sized and calendered paper of the best quality was the kind treated with the acid. On sheet No. 14 two pieces of the above filtering paper prepared with picric acid and exposed horizontally, as stated, will be found, but one of them has been washed in hot water till all the soluble matter has been removed. This treatment of the exposed print tends to raise the contrast by letting the darkened parts appear as on white paper. It also shows the insolubility of the darkened portions in hot water, the production of which was effected by light alone.

Simultaneously with the above exposures, another was made of the same duration and in the same way. This was the presentation of a thin stratum of commercial picric acid on glass to the same illumination as that already mentioned, under a stencil tin foil negative and a plate of glass covering the same. The picric acid was darkened as before very decidedly, though it would be difficult to exhibit the results in a satisfactory way at a meeting of the society.

In concluding this paper, and to account for its incompleteness in certain ways, I may be permitted to explain that the investigation, the results of which are here given, was not undertaken with a practical purpose in view, but simply to determine the limits within which bodies may be properly described as sensitive or non-sensitive.

* Presented before the Society of Amateur Photographers of New York.

### The Trials of an Architect.

A writer in the *Ohio Valley Manufacturer*, who is evidently an architect, depicts some of the trials one of his profession has to endure from his client.

He enters an architect's office and starts the conversation by stating his wants, desires, etc., in regard to the future house. His greatest want invariably is to get the house for about one-half what it will surely cost him.

His next want is to design the house from within, and in this he has an able second in the person of his wife or daughter, as the case may be, and oftentimes several persons more. He proceeds by jumps of one room at a time, without any general or definite idea of the whole. He wants the hall like Mr. Some-one-else's hall, the dining room like that of some other house, and so on, utterly regardless of anything else but to have them just so, and nine times out of ten, when he gets it that way, it is not what he wants at all, it is but a taking fancy of the moment, and he allows it to mislead him without thinking it seriously, for when completed, Mr. Some-one-else's hall and Mr. Some-other-house's dining room are entirely of a different plan and feeling from each other, and so on through the house. They are all designed by different minds upon different principles, probably the hall from a seaside cottage and the dining room from some city house, but no matter, he pays his money and he must have it. Thus the architect receives his idea of the future house, from basement to roof, and he makes his plan accordingly.

Then he is confronted with one of the meanest tasks that can be imposed upon a designer who takes pride in his work at all, namely, to design an exterior to fit the plan as laid out, a scheme as ridiculous in principle as to make the window frames to fit some old sash that may be on hand.

The whole house has been designed without reference to the exterior, and hence the public is confronted with a flat, featureless building which is an eyesore to the beholder; or else the building is covered with an excess of meaningless ornamentation put on to hide the defects of a plan designed without due and proper thought, but to please Mr. Must-have-it.

Moral: Leave the full designs and surroundings to the more experienced and better judgment of the architect.

### Uses of Cotton Seed.

The cotton seed which of late years has been put to such profitable uses is steadily increasing in popularity. Heretofore the seed after being taken from the cotton boll was thrown away, but now it is about all put to use and readily sold. From this valuable seed is extracted the much used cotton seed oil, and from the residuum are obtained cotton seed meal, cotton seed bran, and cotton seed hull ashes.

The seed after being taken from the cotton gin goes through a "linter machine," which takes off the short staple cotton which the gin does not remove. This short staple cotton is sold mostly to concerns who use it for cotton batting. It is also used for other purposes. After all the fiber is taken off, the bare seed is cracked and the kernel is separated from the hull. The kernel is then ground and put under severe heat or cooked. In the heated state the most oil can be extracted, and it is therefore put into a large iron caldron and is subjected to a heavy pressure. When thoroughly pressed, the residue or meal is in the form of cake.

#### USES OF OIL.

Cotton seed oil is used for numerous purposes, and is displacing other popular oils, owing to its cheapness and healthfulness, as it is purely a vegetable oil. This variety of oil is used very largely by lard manufacturers, who adulterate their lard with it. Although most people would prefer pure lard, it is claimed that the cotton seed oil adulterated with the hog fat lard improves the quality of the stock. The hog lard contains more than twice as much water as the seed extract, and consequently one pound of adulterated cotton seed oil lard goes much further than the pure stock. Large quantities of the seed oil are yearly shipped from this country to the countries on the Mediterranean where olive oil is produced. It is used almost wholly there to adulterate the olive oil, which is then sold both here and in Europe as olive oil from the Mediterranean countries.

Most of the sardines are now packed in this new oil, and it proves to be successful. Bakers also buy barrels of the liquid, which they advantageously use in substitution for the more costly lards and greases. Chemists and druggists use considerable also. The white or refined stock is used to quite an extent in the Pennsylvania coal mines for lamp oil. Although the cost is much higher than that of petroleum, the safety of the variety is preferable to the more explosive kerosene. The crude stock is used extensively in the manufacture of soap, as is also the foots or residue left after the oil is made.

#### THE MEAL.

As above stated, after the oil has been abstracted from the kernel, the caked meal is left as a residue. About 150 mills which utilize the cotton seed use both products, the oil and residue or meal. Most of the residue is sent to England in cake form, where the farmers crack it and feed their cattle with it. A large amount has been satisfactorily used in the West, and now it is being sold in this market, it is claimed, quite successfully. This meal is claimed to excel all others as a feed for cattle. That used in this country is not in the cake form, but ground, and now brings from \$26 to \$26.50 per ton. Last year the prices ranged from \$23.50 to \$24 per ton, the advance being caused by an unprecedented foreign demand. Cotton seed meal is not only claimed to be better, but also cheaper than other meals.

In St. Louis there is situated a mill which makes cotton seed bran from the hulls, and claims that it is superior to other coarse feed and costs much less, bringing about \$21.50 per ton. Most of the mills burn the hulls of the seed for fuel and sell it for fertilizing purposes. These ashes are bought by farmers in conjunction with the meal and mixed by them for fertilizer. This mixture is said to contain an abundance of potash and phosphoric acid, which have very powerful fertilizing properties. The ashes are worth from \$30 to \$32 per ton. This fertilizer is not exported, but used here, in this country mostly in the Connecticut valley, by the raisers of tobacco. The supply is limited, and dealers say they could have sold twice as much if they had it.—*Commercial Bulletin.*