### A NOVEL DESIGN FOR A BRITISH CHANNEL TUNNEL.

We illustrated, on page 306 of our volume XXXI., a new method of building submarine structures, the invention of Jerome Wenmaekers, a Belgian engineer; and we refer our readers to the description there given, which fully shows the adaptability of the system to works of any extent, and

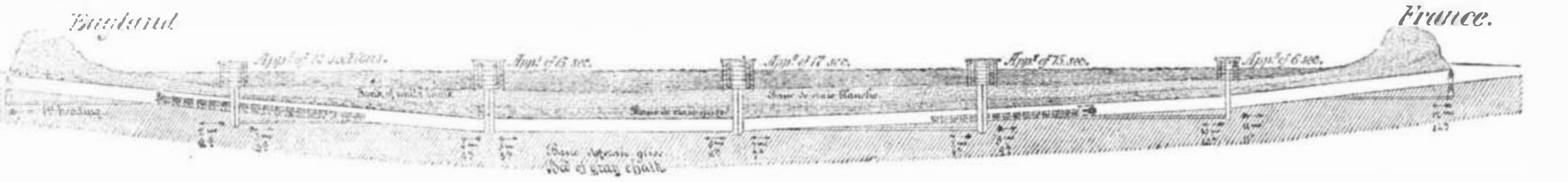


Fig. 1.—WENMAEKERS' BRITISH CHANNEL TUNNEL—LONGITUDINAL SECTION.

however difficult of execution. The inventor of the plan now publishes a detailed account of a tunnel under the British Channel, to be constructed on his plan, which shows many new features which are worthy of consideration.

He proposes to sink five caissons (as shown in our longitudinal section, Fig. 1), the deepest of which, in the center, will require seventeen sections, the depth of water being about 40 meters (about 130 feet). The erection of these structures, if practicable at this depth, would enable the tunneling to be done in twelve headings at once, and would give an easy means of hauling away and disposing of the *débris*, an important consideration in a tunnel of this length Moreover, a very large means of ventilating the tunnel would be afforded, and thus the great difficulty anticipated in working such a submarine railway would be obviated. M. Wenmaeker's idea is to insure solidity to the tunnel by perforating the white chalk which underlies the sand of the ocean bed, and to construct the work in the hard gray chalk still lower down. The magnitude of the proposed works may be seen by nspection of the plan, Fig. 3, which shows the diameter of the caisson to be 162·5 feet. This dimension would allow the work of hauling the loose earth to the surface of the water to be done on a very large scale and with great rapidity

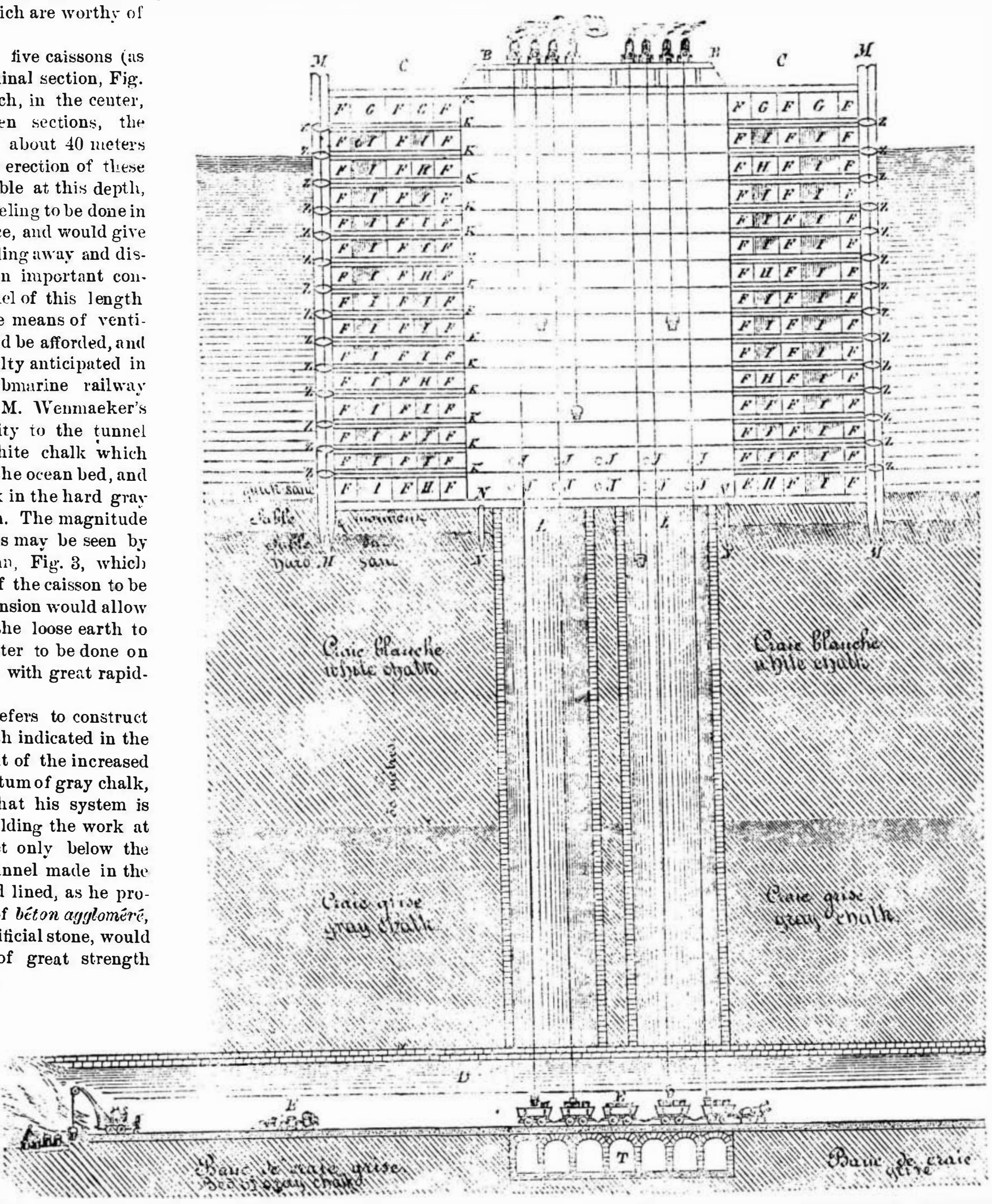


Fig. 2.—SECTION OF THE PROPOSED CAISSONS FOR THE BRITISH CHANNEL TUNNEL.

M. Wenmaekers prefers to construct the tunnel at the depth indicated in the engravings, on account of the increased solidity of the substratum of gray chalk, although he claims that his system is equally useful for building the work at a depth of 6 or 8 feet only below the bed of the sea. A tunnel made in the durable stratum, and lined, as he proposes, with masonry of *béton aggloméré*, or other well tried artificial stone, would doubtless be a work of great strength and permanent value.

The distance between each two caissons would be about three miles and a half, and between those nearest the shores and the entrances to the tunnel, respectively, rather less Tunnels of such lengths are trifling works compared to those of Mont Cenis and St. Gothard. It is proposed to take a route between the nearest points, namely, St. Margaret's, about three miles east of Dover, and a point about the same distance west of Calais, half way between that city and Cape Grisnez.

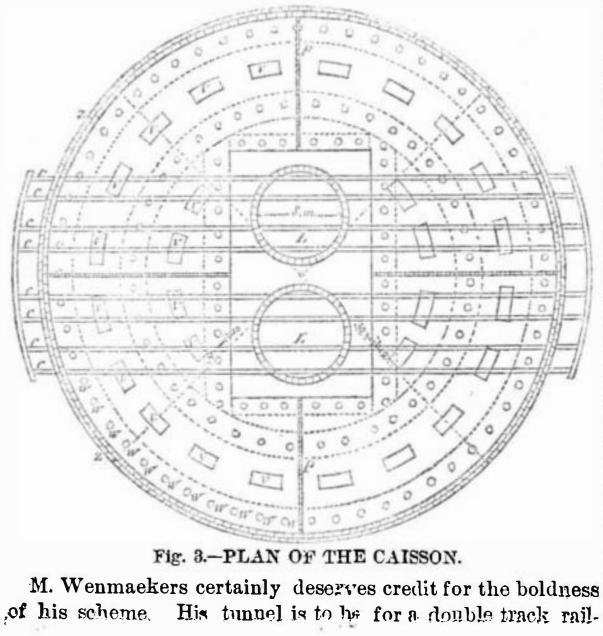

Fig. 3.—PLAN OF THE CAISSON.

M. Wenmaekers certainly deserves credit for the boldness of his scheme. His tunnel is to be for a double track railway, being 26 feet wide and 13 feet high; and he has carried out his design into detail, proposing to use perforating machines (Fig. 4) capable of excavating a bore 9 feet 9 inches in diameter. The use of a compressed air chamber, of the full diameter of the tunnel, is shown in Fig. 5. He is, moreover, sanguine as to the commercial success of the work, estimating its cost at $24,000,000, including the necessary junction railways on both shores. He anticipates a gross revenue of $6,000,000, and believes that the working expenses can be kept down to $1,000,000, leaving a profit of nearly 21 per cent on the expended capital.

There is reason to believe that the work of constructing a channel tunnel will be seriously taken in hand. The corporation most likely to be benefited by its construction is the Northern Railroad of France, a line which is largely owned by the Paris branch of the Rothschild family. A joint commission to investigate the whole subject has been appointed by the English and French governments and the capitalists interested, and M. Wenmaekers' plans have already been submitted for their consideration.

### Fluorescence of Bodies in Castor Oil.

Charles Horner states that certain natural organic coloring matters, which exhibited no fluorescence when in aqueous or alcoholic solution, were observed to fluoresce brightly when dissolved in castor oil; while other substances, possessing naturally a faint fluorescence, were found to have this property considerably augmented.

In this solvent, cudbear exhibited a brilliant orange-colored light, and extracts of logwood and camwood a powerful apple-green fluorescence. The well known fluorescent light of turmeric solutions was increased in brilliancy at least threefold, and is described as a vivid emerald green fluorescence, comparable only with the appearance presented by the best uranium glass under similar circumstances. It is suggested, therefore, that, in studying the phenomena of fluorescence, advantage should be taken, when possible, of the solvent property of castor oil.

### Compounding Marine Steam Engines.

A somewhat novel experiment in the way of applying the compound principle to existing oscillating paddle engines has been carried out in the case of the Royal Mail Company's steamship Eider, and the attempt, which it is believed has not previously been made, seems to have proved a great success. The Eider is a paddle steamer of 1,564 tuns, builder's measurement, and 310 horse power, built specially for the intercolonial service of the Royal Mail Company in the West Indies, and has been engaged in that capacity for several years. She was recently sent home to Southampton to be refitted and have her engines compounded; and this work having been completed, she will shortly sail again for her old station. The Eider's engines have oscillating cylinders, which were originally 66½ inches in diameter and 6 feet 6 inches stroke, working at 30 lbs. pressure, and consuming about 35 tuns of coal per day. In order to adapt the compound principle to these engines, and do so with as little alteration and expense as possible, Mr. J. Bowers (the company's superintending engineer at Southampton) decided to retain the whole of the existing engines, with the exception of the cylinders, pistons, and slide valves. As the new cylinders had to oscillate between the old columns supporting the entablature, it was found impossible to make the low pressure cylinder of a larger diameter than 72 inches, and the high pressure cylinder was therefore made 42 inches diameter, both, of course, having the old stroke of 6 feet 6 inches. The contract for the new compound cylinders, new high pressure boilers, steam pipes, etc., was given to Messrs. Day, Summers & Co., of the Northern Iron-works, at Southampton, who have carried out their engagement to the entire satisfaction of the company's superintendents. The Eider was taken to Stokes Bay a day or two since, and the results of two runs on the measured mile were as follows: First run, 4 minutes 30 seconds, equal to 13·333 knots per hour; second run, 4 minutes 46 seconds, equal to 12·587 knots, giving a mean speed of 12·96 knots per hour; revolutions of engines, 20¼ per minute; steam, 65 lbs.; vacuum, 27¼ inches; indicated horse power, 1,251. The space saved in the Eider by the diminished size of the boilers and coal bunkers enables her to carry between 200 and 300 tuns more cargo than heretofore, and the consumption of coal will be reduced from 35 to 22 tuns per day. The improvement in the general arrangements of the ship, in consequence of the decreased space required for the machinery, have added much to the comfort, and improved the appearance, of the Eider

### Female Voters.

The Supreme Court of the United States has lately decided, in the case of Miner *vs.* Hoppersatt, that women, although they are citizens, are not therefore voters. Women are citizens of the United States, and of the State where they reside. The court unanimously held that the Constitution of the

Fig. 4.—PERFORATING MACHINE.

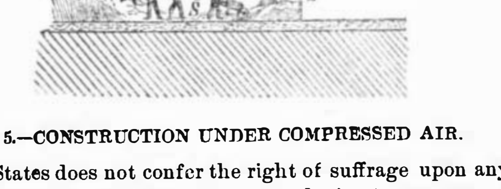

Fig. 5.—CONSTRUCTION UNDER COMPRESSED AIR.

United States does not confer the right of suffrage upon any one. The right of suffrage is not made, in terms, one of the privileges of a citizen. The elective officers of the United States are chosen directly or indirectly by the voters of the

States. The United States has no voters. No one can vote for Federal officers without being competent to vote for State officers. It follows from this decision that women cannot become voters until they are authorized by the States in which they live.

## Correspondence.

### The Grasshopper.

*To the Editor of the Scientific American:*

I have received the most valuable of all books, the *Science Record*, for 1875. I notice an article on page 456, on the habits of the grasshopper, by Professor Humiston. I differ from his description of their method of depositing their eggs. He says: "The tail of the female locust consists of a hard, bony, cone-shaped substance, capable of being thrust into ground from ½ to 1 inch in depth. Just above this, on the body of the insect and attached to it, is the egg cell; the grasshopper is able to push its conical tail down into the ground and leave it there, with the cell containing the eggs."

I wish to state that the grasshopper does not push her tail into the ground, nor does she leave it there. The cone part, as he describes it, is a hard, forked, bony terminus, both above and below the anus. It is capable of being moved, and the female uses it as a drill. She does not leave the tail (as he calls it) with the eggs; but deposits the eggs, with draws the tail, and goes about her business. His view as the hatching in spring tme are correct.

Leroy, Kan. J. G. SHOEMAKER.

### An Improvement Wanted in Street Railways.

*To the Editor of the Scientific American:*

One of the greatest needs of street railroads is some simple and economical invention to keep the rails, where they meet, in a level condition; or in other words, to prevent the end of the forward rail from sinking below the end of the near rail. The device at present used is an iron plate placed under the junction of the two rails; but this does not entirely prevent the evil.

I invite the attention of inventive minds to this subject.

SAM. L. PHILLIPS, President.

Office of the Third Avenue Railroad Company, New York city.

### Is Candy Injurious to the Teeth?

[From a paper by Dr. John T. Copman, read before the New York Odontological Society.]

Most certainly it is. For outward proof of it I will refer you to any candy-making village in our country, as the village of Neponset, Mass., where the shocking condition of the teeth, of the youth brought up in proximity to large candy manufactories, shows plainly the cause. But this is perhaps negative proof, and we should seek for proof positive, because other causes than those of the use of candy may be the reason, in this instance, of the disease.

But by far the most injurious consequence in the use of candy is in its indirect action through the system, first by its constituents, second by its disturbing action.

By long research I have discovered that the effect of the use of cane sugar, in small or in large quantity, is to produce a more or less constipated state of the alimentary canal, more particularly the refined sugar of the present day.

If, then, the balance of intestinal action is normally correct, the presence of sugar always disturbs it.

There is a point that may be stated here, and that is the action of sugar on an exposed nerve. We eat bread, meat, vegetables, and our "exposed nerve" makes no complaint; but the moment a little sugar is dissolved in the tooth, the tissue sets up a cry. What does it mean? Does it mean that it dislikes it—that it is discordant to the system? Does it mean that it is injurious to the fleshy or to the bony substances, or both? I have as yet not solved the problem. Who will do it? By an analogy we must conclude that cane sugar is injurious, and yet there may be other reasons and other causes for the pain produced in the tooth.

Besides the sugar contained in the candies of the present day and the coloring matters (mostly made of tincture of cochineal, which is harmless) are occasionally other material, such as pigments of green and yellow, which are poisonous.

We have a large number of essential oils, or medicaments, every one of which has a peculiar medical effect on the system, toning it up or down, binding up its parieties or loosening them, and to these medical effects much of the injury of the confectionery of the present time is due.

A small catalogue of these essential oils and flavors may be interesting:

Group No. 1.—Peppermint, checkerberry, sassafras, lemon, clove, anise, cassia or cinnamon, vanilla, rose, caraway, coriander, cayenne.

Group No. 2.—Jargonelle pear, strawberry, pineapple, banana, peach, almond.

Group No. 3.—Boneset, licorice, horehound, ginger, cardamom, chocolate, butter, cocoanut, cordial, brandy, gum arabic, acids.

In purchasing a pound of mixed candies, you may perchance get all of these flavors in one lot.

Now I do not pretend to say that one is likely to be poisoned by such a compound, but I do say that, when a mother gives a three year old child an ounce of peppermint drops to eat, she should know the effect of them when eaten—that she ought to know she is giving the child a medicament as well as an ounce of sugar; she ought to think and be taught that the effect of the oil of peppermint is definite, and that an ounce of peppermint drops will, if they are strong—and of course they are supposed to be good only as they are strong—contract the walls of the stomach and the small intestines, producing in a young child sometimes a spasm and inflammation, shown by a thirst for water, and a general disturbance of healthy action.

Such is, I believe, the general action of the essential oils of confectionery in group No. 1. The oil of cassia or cinnamon is very irritating. The oil of cloves is considered by many as destructive or poisonous. As a rule, the essential oils retard digestive action in the same manner that they preserve from decay meats and fruits, by retarding fermentation, or making compounds with digestible or decaying substances.

The pear and similar flavors in group No. 2 are imitations; they are chemical flavors, and are decidedly unhealthy. The composition of them I have found to be as follows:

The jargonelle pear flavor is made of the acetate of amylic ether, which is prepared by distilling a mixture of fusel oil, acetate of potash, and concentrated sulphuric acid.

The pineapple is made from butyric ether dissolved in another portion of alcohol. Butyric acid is made from decaying cheese, grape sugar and chalk, fermented together.

Various mixtures of the ethers, with addition of various agents, such as acetic acid, camphor, orris, vanilla, the volatile oils, etc., result in imitations of strawberry, raspberry, apricot, currant, etc.

The tonka bean is used very much in place of the vanilla pod, to imitate the vanilla flavor.

The common oil of almond (bitter) always contains a considerable amount of prussic acid; this oil is said to be substituted sometimes by the oil of mirbane or nitro-benzole, eight or nine drops of which is said to have produced death.

The peach and almond flavors are also imitations, made from prussic acid in some form, and are very poisonous.

The third group contains medicinal flavors: licorice, boneset, or horehound, ginger, cardamom, all of which have a different action from the first group, being relaxants and diuretives, and will have that effect in greater or less degree.

There are varieties of which we will not here speak; but we must condemn the spirituous drops sold at the street corners, as decidedly impolitic and demoralizing to the little ones who may be tempted to buy them.

But the injurious effects of candies do not stop here. The pure essential oils are costly and are increasing in price yearly; substitutes must be found, adulterations are practised, and among the most common is the adulteration of the oil of peppermint with spirits of turpentine, a thing to be utterly condemned, especially as its action is, with exceptional persons or in exceptional cases, that of a violent and dangerous poison, and in all cases it is an irritating oil, producing congestion of the veins and coagulation of the blood (a useful styptic in cases of excessive bleeding, by the way); and yet I am informed it is used by the confectioner himself, and only with a rule to put in as much as he can disguise or cover up.

The use of laudanum in licorice cough drops should be condemned. Many a child has been injured by them without the knowledge of what was going wrong.

The lemon drops are supposed to be made of citric acid, and flavored with oil of lemon; but why citric acid, when oil of vitriol is so much cheaper? I have reason to believe that tartaric acid is most generally used.

But why cry down candy, the pleasant pacifier, that which fills the sweet tooth of the rising generation? Almost every one likes candy—a little now and then—almonds, sugar-plums, gum drops (now made to a great extent of glue). I do not cry it down, but must raise my voice against its excessive use, and ask whence comes the tendency, the appetite, for so much sweet? It seems to me to be occasioned by the great and increasing use of sugar in the family at home.

That which in the past was a luxury is now supposed to be a necessity. We have toned up our appetites until our viands are tasteless unless they are sweet with cane sugar. We daily spoil the flavor that God has placed in our food, by adding our own product to it.

If we wish to eradicate from our youth the very strong tendency toward high seasoning or high sweetening, we must begin at home, and tone down instead of toning up, and teach ourselves and our children to love the inherent flavors of the grains, the fruits, and vegetables; and as we and our children cultivate a love for them, so will their tastes grow, until this excessive sweetness will bear disgust, and their appetites will turn away from what cloys and sickens, and disturbs the normal condition of the human body.

I should refer to an article used to adulterate sugar, called *terra alba*—a white earthy substance—quite harmless, being sulphate of gypsum (anhydrous calcic sulphate)—profitable to increase the weight without being suspected by the buyer. It is said to be used in large quantities. It can be easily found by dissolving the candy in water; if any sediment remains, it is likely to be *terra alba*, or perhaps chalk, which is also used.

### Hollow Structures.

Nature teaches us one of the grandest lessons in her economization of structures and materials. The stems of water plants are hollow and of various sections, as cylindrical, angular, or furrowed. Many of them, as all know from the revealings of the microscope, are of cellular or tubular construction. Examining the stem of a young dicotyledon cut across, we find the inner portion full of radiating cells of fibro-vascular bundles, of wedge-shaped section, the pith occupying the center. If we minutely examine these vascular bundles we shall find a layer of cells traversing the bundles; on the inside of this, toward the center of stem, the cells form the proper wood of the fibro-vascular bundle, and on the outer side, toward the circumference, the cells are closer and more compact. The layer between these portions is called the *cambium* layer, and the stem of the oak and other *exogens* is strengthened by continual increase of woody fiber outside this layer, or the *liber* of the stem. We might go on illustrating, from a variety of plants, the remarkable adaptation of stems to their habitats and conditions of growing; some triangular in section, as in various water grasses, sedges, etc., exposing only an angle to the flow of the stream; others square and round in section, of beautiful symmetry, and which man has imitated in the art of construction, and in casting his metal into cylinders and shafts.

Not only in stems of plants and grasses, but in the bones of animals, we find the same hollow structure developed. In the case of birds, where lightness is most necessary, the substance of the hollow bones is remarkably thin. Take a feather. What a wonderful union of strength and lightness is there in it! We find this hollowness particularly evident in that end of the feather at which the muscles act, or at the short end of the lever.

Leaves show a similar adaptation of matter. Some leaves exhibit deep furrows or ribs which support the membrane or tissue, and give it a stiffness to withstand the pressure of the wind. Others have their surfaces indented or voluted, or formed of two or more convex lobes, thus giving rigidity to them. Again, shells and other organic forms possess cellular and corrugated parts in which the material is distributed to the best advantage. We have not been slow lately to avail ourselves of these lessons. Our tubular and cellular bridges, our iron vessels, our columns, and shafts of machinery, our iron roofs and walls, are instances of the employment of hollow and corrugated forms, and the extent to which they are applicable and may yet be employed is almost co-equal with the whole field of inventive genius.

But our primary object here is to call attention to some of the mechanical principles involved in these structures, and to indicate how the same principles may be applied to the uses of art. We have shown on what elements the strength of cast iron beams depends, namely, in putting all the metal into the shape of flanges on the extreme side of the neutral plane of the beam. Thus the inverted T shape answers this best in cast iron, as we have seen. Now, keeping this form in view, let us first examine the strength of a hollow cylinder. Here we find the material thrown at a distance from the central or neutral axis, and thus fulfilling the great principle of making the moments of resistance of the fibers the greatest possible. Thus let us take a solid cylinder of a given diameter. If we cut away or hollow it we shall find, although we are taking away a quantity of the material, we do not proportionately diminish its transverse strength; but if we place the material that we take out round its external surface, we greatly increase the strength.

The experiments of Mr. Hodgkinson upon columns of cast iron were conclusive in proving that the hollow cylinder was the strongest form of section under compressive force. These were conducted upon hollow tapering columns, upon cross sections, as used in the connecting rods of steam engines, and upon forms in which the metal was cast in the shape of the letter H. All these forms proved considerably weaker than the hollow cylinder of equal weight of metal. As the relative merits of these forms of casting metal are of constant use we append their proportionate strengths: Hollow cylindrical pillar, 100; H shaped pillar, 75; + shaped pillar, 44. The examples were all of the same weight and length, with rounded ends.

General Morin's rule for the thickness of cast iron pillars may be relied upon, as it is based upon the founder's experience of the minimum thickness.

| | | | | |
|---|---|---|---|---|
| Height, feet, | 7 to 10, | 10 to 13, | 13 to 20, | 20 to 27; minimum |
| thickness, inch, | 0·5 | 0·6 | 0·8 | 1·0 |

Another rule is to make the thickness in no case less than 1-12 of the diameter. Cellular or tubular girders exemplify to a still greater degree the value of hollow construction. The Conway bridge, in North Wales, designed by Mr. Robert Stephenson, is an instance of the application. The two tubes of this bridge are each 25 feet high in center, and 14 feet wide externally, 420 feet long, and weigh 1,300 tuns. The material is chiefly disposed in the top and bottom parts or flanges, and these are also composed of small tubes or cells to give additional stiffness. The sides are of plate iron riveted together, and each tube is really an immense beam, of slight diminution toward the ends. An iron ship is really a tubular or cellular beam, approaching a rectangle in section, and undergoing various strains. The waves are the points of support, sometimes near, and often wide apart: while occasionally the whole vessel is lifted and supported by one wave, like a pivot. Under these continually varying conditions, the deck and bottom of the vessel are subject to alternate compressive and tensile strains, and in very long vessels, like the Great Eastern, in a heavy sea, these strains are very formidable; and hence the value of adequate stringers under the decks, and diagonal braces, to stiffen the ship lengthwise and laterally, and bulkheads to prevent transverse or the rocking motion which a vessel often has when laboring in a heavy sea. Every deck and vertical division in a ship enables the ship builder to make his structure cellular, and gives him admirable opportunities of tieing and bracing together the sides.—*English Mechanic.*

### Free Lunch Suspended.

In consequence of the increase of postage and the necessity of prepayment, we are obliged to decline sending odd numbers or specimen copies of the SCIENTIFIC AMERICAN free, as has been our custom for a quarter of a century.

Hereafter persons desiring specimens or any special numbers of the paper will please to remit, for each copy ordered, ten cents.