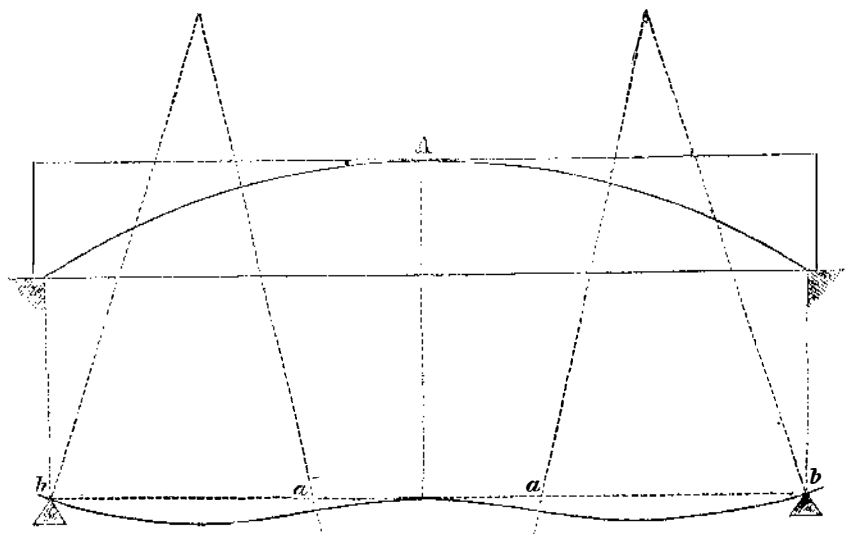
## CONSTRUCTION OF ROOFS.

MESSRS. EDITORS:—The frequency of accidents from the falling of bridges, roofs, &c., must be my apology for offering the following suggestions, and for wishing to call attention to what I conceive are errors of construction. I think there are many errors; but I will, at this time, confine my attention to combined systems, especially to such as consist of parts of unequal vertical depths, such as the roof of the Union Depot, at Troy, is said to have been. This is represented to have had a span of 150 feet, the vertical depth of the trusses being 30 feet, and these are said to have been strengthened and supported along their lower parts by iron girders. The depth of these girders is not given in the report before me; but it was probably much less than that of the trusses to which they were attached. This description is brief, and it may be erroneous in some respects; but this is not of much consequence, as I only allude to this description as it has been published, because it contains the objectionable combination to which I wish to call attention, and to show that it *may* have been the cause of thefailure of this roof, and how it may be a mistake to attribute it to construction as has been done.

In order to understand why it is objectionable to unite two systems of beams, girders, or trusses of *unequal* vertical depth for the purpose of making the capacity of such combined system equal in strength to that of both when separate, it becomes necessary to consider the well-known fact (and its effect on the combination) that the deflection of each part is necessarily proportional to its length and depth. Thus, a beam, girder, or truss of given length, strength and depth will deflect about three times as much as another of similar construction of like length, and strength and *three* times the depth of the first. Now, the objection to all such combinations is that the part having the least depth, and which is most flexible, will bend away from the load more readily than the other, and leave most of it to be borne by the part having the greatest depth, so that the combination must fail, under even the most favorable circumstances, with a load that is slightly greater than that which the part of greatest depth might bear singly. When the difference in the depth of the parts is considerable, the part of least depth may, from the very first, act by its weight as a load upon the other part. But, believing that it is only necessary to call attention to the fallacy of the theory on which all such combinations are based, to induce an abandonment of all such devices, I will here leave this part, and take up another of similar nature, such as is often called for, and can be made to answer well when *rightly* arranged. I mean the suspending of the middle parts of floor girders from roof trusses, when it is desired to have the story underneath free from obstructions. When, as is most generally the case, the depth of the trusses is three or four times as great as that of the floor girders, it will be found to be best and most economical to make the floor girders in half lengths; their outer ends resting in the walls, and their inner ends suspended from the middle of the roof trusses. The walls will then sustain one-half of the floor, and its load and the other half will be sustained by means of the suspenders at the middle of the roof trusses. With such an arrangement, with the girders in half lengths, the strain on the roof truss, from the floor and its load, will be much less than when the girders are made to span the entire width of the building in single lengths, and have their middle parts supported from the roof by means of suspenders, as in the case of half lengths. This difference will, in most cases, amount to full one-fourth, as I will show hereafter. These statements may seem paradoxical to many, but a thorough examination of this question, and the results of many and various practical tests made within twenty-three years past, are such as to leave no ground for doubt as to the correctness of these conclusions. The accompanying diagram will serve to make this question more plain.




Within the parallelogram, A, is represented the outlines of an arch, and of a triangular roof truss, from either of which the middle part of a floor girder is supposed to be suspended. The compound curved line, *b b*, is meant to represent the form such girder will take when heavily and uniformly loaded; its ends bearing in walls at *b b*, and its middle suspended from the middle of the truss above.

Now, it is quite clear that all that part of the load between the points of opposite flexure at *a a*, must be sustained wholly by the suspender connecting it to the center of the roof truss. It also appears plain that in order to determine how much of the other parts is to be sustained by this suspender, and how much by the bearing at the ends, the end parts of the girder having downward flexures, between *b a* and *a b*, must be considered as separate beams, with their outer bearings at *b b*, and their inner ends as *terminating* and having their *bearings* at *a a*. It is clear that the pressure will be alike at all of these four points, and each equal to the weight of one-half of the load situated between *b a* or *a b*. By adding those parts of the load that bear on the points *a* and *a*, to that part bearing *between* these two points, their sum will be the weight due to the suspender or center of the truss.

The same result may be obtained very nearly, when the load is uniform, by dividing it into 32 equal parts, and assigning $5\frac{1}{2}$ of these parts to each of the end supports, which will be 11 for the two ends, and 21 parts to the middle support. Thus, $E5\frac{1}{2}+Md21+E5\frac{1}{2}=32$, where the girder is in one length; or, $8+16+8=32$, when said girder is in two lengths. As the difference is 5 parts, and as this is concentrated at the middle, its effect is equal to twice this weight uniformly diffused over the truss. A right understanding of this question in all its relations becomes important indeed. Many of the recent failures of floors, roofs, and bridges may without doubt be charged to a want of such knowledge and a right application of it. BENJAMIN SEVERSON

Baltimore, Md., Jan. 6, 1860.

THE OLD FRANKLIN PRESS.—The old press at which Franklin worked in Boston, on the New England *Courant*, in 1720, has been preserved more than a century in the office of the Newport *Mercury*, which was established by James Franklin, brother of the philosopher, who then owned and used the press. It has recently been sold, and is now the property of J. B. Murray, Esq., banker, Mr. Murray was, previous to the recent purchase, owner of a press at which Franklin worked, in Watt's printing-house, near Lincoln's Inn Fields, London, in 1725-6. The old press Mr. Murray procured in London, in 1841, and deposited it for safe keeping in the United States Patent Office, at Washington, in 1842, where it still remains. The only presses identified with the name o. Benjamin Franklin are now under one ownership, and will probably be kept together during his lifetime.

## THE GREAT WASHINGTON AQUEDUCT BRIDGE.

MESSRS. EDITORS:—Among the public works now in course of completion at Washington, one of the most remarkable, though least known, is the Washington Aqueduct Bridge over Rock Creek, at the western end of Pennsylvania avenue, now nearly completed from my own designs and under my direction. As a great national work of art, indicative of the astonishing progress of the American people in civil-engineering, I trust you will deem it to be a subject of sufficient importance and general interest to deserve a place in the columns of the SCIENTIFIC AMERICAN.

The bridge is a cast iron arch of 20 feet rise and 200 feet clear span between the abutments. The arch consists of two ribs, each of which is composed of 17 cast iron pipes of 48 inches internal diameter, and 12 feet 8 inches in length. They have flanged ends pierced with holes for screw bolts, by which the pipes are firmly connected together. After being cast, they were placed in a lathe, and the ends and flanges were accurately turned or faced off. They are put together in the form of a circular arc, the faced ends abutting against each other, and 40 screw bolts firmly secure each joint. Such is the accuracy obtained by the present use of machinery in engineering, that these joints are water-tight, under the aqueduct pressure of 120 feet head, by mere application of the dressed surfaces of cast iron, no packing or cement being used in the joints.

Upon these two arched ribs, which are firmly connected with each other by cast iron tubular crossbraces and heavy wrought diagonal ties, is erected a framework of heavy rolled iron "H" beams (from the works of the Phœnix Iron Company of Philadelphia), supporting two continuous horizontal iron girders, of 204 feet 6 inches in length. Upon these girders rest crossbeams of timber, supporting the roadway of the bridge, which embraces two city railroad and carriage tracks and two paths for foot passengers.

The cornice of the bridge is decorated with *modillions* of cast iron, and a light wrought iron railing surmounts the whole.

The abutments, founded upon solid rock, are built in the most substantial and durable manner, of a fine gray sandstone, obtained in large blocks from the government quarries at Seneca, upon the Chesapeake and Ohio Canal, 24 miles from the city of Washington. The strength of this stone is 17,000 pounds per square inch.

This bridge is particularly remarkable for the double duty which the arch performs. While it supports a roadway, forming a beautiful and much-needed communication, by which the traffic between the cities of Washington and Georgetown is carried over, the water of the Washington Aqueduct is conveyed into the city of Washington through the pipes of which the arch is composed. To guard against all danger of freezing, the pipes are lined with staves and resinous pine timber, three inches in thickness, leaving a clear water-way in each rib of three and a half feet in diameter.

The flanges and bolts by which the pipes are connected at the joints are covered with decorative moldings, encircled with foliage of cast iron. The arch ribs spring from ornamental bases, which distribute the pressure over huge blocks of granite set in the skew back of the abutments. The intersections of the beams in the framework of the spandrils are covered with ornamental bosses, also of cast iron. The whole is a model of lightness and elegance, being 200 feet in clear span and 45 feet in hight from the water to the top of the parapet.

The abutments contain vaults, in which are the connecting pipes and stop-cocks for regulating the flow and discharge of water; and in the western abutments on the Georgetown side, one of the vaults serves as an engine-room and contains a water-pressure engine—the first, it is believed, erected in this country.

This engine, drawing its supply from the cast iron street mains of the Washington Aqueduct, pumps 10,000 gallons of water per hour into a reservoir on the hights of Georgetown, a mile distant, and 204 feet above the machine. This reservoir supplies that portion of Georgetown which is above the level of the great store and distributing reservoirs of the Washington Aqueduct. In a recent experiment, the engine, using 10,862·2 gallons of water per hour, under an effective pressure of 99·86 feet as power, pumped 10,410.4 gallons of water against an effective head or resistance of 90.245 feet. This gave an useful effect of ·866 of the power employed; the loss

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being absorbed in friction, in producing motion of the parts of the engine and of the water and in leakage, the latter alone being about 2½ per cent of the water used. By the formula given by Weisbach for the efficiency of the engine alone, the efficiency of the engine and pump being considered equal, 12½ of the total loss of effect being due to the motor, the efficiency of the motor here used is 933, a very high result. The engine and pumps were built by H. B. Worthington, of New York city, under his patent of 1855.

The masonry of this bridge has been executed by Messrs. Carman & Dobbins, of Philadelphia, contractors; the iron work by Messrs. A. & W. Denmead & Sons, of Baltimore. The style of the work is creditable to those engaged upon it.

The Washington Aqueduct has other works not less remarkable than the one described; among them, the great granite arch, by which the masonry aqueduct, nine feet in diameter, crosses the Cabin John Creek, at a hight of 101 feet above the bed of the stream. The arch is built of huge granite, is 20 feet wide, 57 feet 3 inches rise, and, being 250 feet in clear span, is the largest stone arch in the world. Had either of these bridges been constructed in Great Britain, the public press would have teemed with illustrations and descriptions of them, and every reading man, woman and child in Europe and America would have been as familiar with their history as with that of the Menai Bridge or the *Great Eastern*; while in Washington they are quietly executed, and few but those who have bestowed upon them the thought and toil necessary to their design and construction, seem to know of the existence of such national achievements of science and skill.

M. C. MEIGS.

Washington, Jan. 27, 1860.

## A WONDERFUL NATURAL PHENOMENON.

MESSRS. EDITORS:—Science recognizes no unexplained phenomenon as being too trivial for investigation. The science of galvanism was deduced from investigating the cause of the twitching in a dismembered limb of a frog; Newton would know why an apple fell from a tree, and he stumbled upon the discovery of gravitation. Among the hills and valleys of the East and upon the plains of the West, I have observed a phenomenon which must be due to a force pervading our globe. The object of this communication is to solicit inquiry into that force. Whenever the ground freezes hard, careful observation will discover minute fissures in the exposed earth, running N. N. W. and S. S. E., nearly. These fissures are more or less in width, and parallel with each other, yet not continuous; being broken into lines of various lengths. It looks as if the ground had been lightly swept with a brush or raked with a comb, and had afterwards frozen, obscuring yet not obliterating their traces. It is best observed in plowed lands, and by the roadside, in lands of friable nature. These lines ever preserve an invariable course—in the shade at the bottom of gulleys or ravines or climbing embankments, they turn neither to the right nor to the left; thus excluding the supposition that either the sun or the wind is the cause of the phenomenon. It is evidently due to some cause which prevails over the crystallization of water, and perhaps it is determined by the molecular constitution of solids. It is stated that suspension bridges become unsafe by a re-arrangement of their atomic particles; may not this phenomenon be due to the same cause? I suggest the agency of *electricity* as the moving cause of the phenomenon above described. It is known that a change of temperature will give rise to electrical disturbance. May not the change attendant upon congelation develop electricity sufficient to account for the phenomenon of those earth-fissures, and the aurora borealis? If an electric coil be placed above and around a magnet in the direction of its length, there will be a deflection of the magnet to the right or left, dependent upon the direction of the current. If these lines be due to electric currents, they probably indicate the direction of those currents, and the deflection of the magnet to the North is a consequence of its developed antipathies.

An elimination of this subject, then, is not without practical and scientific interest. May not those electrical currents ever be inducing changes in the atomic constitution of all objects? Animals killed by electricity quickly putrify. May not the rapid decomposition of frozen vegetables be due to the agency of electrical change and re-arrangements of atoms, developed during congelation? May not the rapid decomposition of organic matters during warm weather be decomposition by electricity developed by a change of temperature? Observations and explanations of the phenomenon above alluded to, together with ahswers to other queries herein propounded, are requested through the columns of the SCIENTIFIC AMERICAN.

MEDICUS.

Hopkinsville, Ky., Jan. 21, 1860.

[Probably most of our readers have observed the cracks in frozen mud caused by the freezing, and if it is really true—which we strongly doubt—that these cracks extend invariably in the same direction, N. N. W. and S. S. E., it is certainly a very curious fact. Will our readers please observe this phenomenon in different parts of the country and let us know the truth in regard to it?—EDS.

## TRICKS OF THE WINE TRADE.

The United States are represented to be the largest consumers of champagne, and the consumption per annum is estimated at a million baskets. The whole champagne district, says the *Pennsylvanian*, is about 20,000 acres, and the amount of wine manufactured for exportation is 10,000,000 bottles, or about 800,000 baskets. Of this, Russia consumes 160,000, Great Britain and her possessions 165,000, France 162,000, Germany 146,000, and the United States 220,000. The Custom House in New York, through which passes a large amount of the champagne imported into this country, reports 175,028 baskets per annum. Therefore, 780,000 baskets of the wine drank in this country for imported champagne is counterfeit—an amount equal to the whole supply of the champagne district for the world. We have no doubt of the fact that a large amount of spurious, villainous stuff, called "champagne," is annually consumed by our people; but it should not be forgotten that a good deal of genuine, sparkling Catawba is made and sold here.

POSITION IN SLEEPING.—It is better to go to sleep on the right side, for then the stomach is very much in the position of a bottle turned upside down, and the contents are aided in passing out by gravitation. If one goes to sleep on the left side, the operation of emptying the stomach of its contents is more like drawing water from a well. After going to sleep let the body take its own position. If you sleep on your back, especially soon after a heavy meal, the weight of the digestive organs, and that of the food, resting on the great vein of the body, near the back bone, compresses it, and arrests the flow of blood more or less. If the arrest is partial, the sleep is disturbed, and there are unpleasant dreams. If the meal has been recent or hearty, the arrest is more decided, and the various sensations, such as falling over a precipice, or the pursuit of a wild beast, or other impending danger, and the desperate effort to get rid of it, arouses us; that sends on the stagnating blood, and we awake in a fright, or trembling, or perspiration, or feelings of exhaustion, according to the degree of stagnation, and the length or strength of the effort made to escape the danger. Eating a large, or what is called "a hearty meal," before going to bed, should always be avoided; it is the frequent cause of nightmare, and sometimes the cause of sudden death.

TAKING COLD.—A "cold" is not necessarily the result of low or high temperature. A person may go directly from a hot bath into a cold one, or into snow even, and not take cold. On the contrary, he may take cold by pouring a couple of tablespoonfuls of water upon some part of his dress, or by standing in a door, or before a stove, or sitting near a window or other opening, where one part of the body is colder than another. Let it be kept in mind that uniformity of temperature over the whole body is the first thing to be looked after. It is the unequal heat upon the different parts of the body that produces colds, by disturbing the uniform circulation of the blood, which in turn induces congestion of some part. If you must keep a partially wet garment on, it would be as well perhaps to wet the whole of it uniformly. The feet are a great source of colds on account of the variable temperature they are subjected to. Keep these always dry and warm, and avoid draughts of air, hot or cold, wet spots on the garments, and other direct causes of unequal temperature, and keep the system braced up by plenty of sleep, and the eschewing of debilitating foods and drinks, and you will be proof against a cold and its results.

## A COLUMN OF VARIETIES.

Peter Bayne, who succeeded Hugh Miller in the editorial chair of that able paper, the *Edinburgh Witness*, has been selected as the editor of the new London daily, the *Dial*. The founders of this new sheet aim to place it in the front rank of the metropolitan journals. Mr. Bayne is widely and favorably known in this country, through his essays and his work entitled "The Christian Life."……The engines of the *Great Eastern* steamship work with an expenditure of about four pounds of coal per horse-power per hour……The Lancaster and Carlisle Railroad, in England, has been leased for 900 years……The English government is pushing the increase of its navy with such vigor, in order to keep ahead of the French, that, at the Portsmouth dock-yard alone, steamships are being launched at about the rate of one a month……The number of patents issued in the year 1848, was: in Great Britain, 1,890; in the United States, 3,710; and in France, 5,820. Thus, the United States issued about twice as many as Great Britain, and France more than both Great Britain and the United States combined. The numbers issued in the following countries, were: Belgium, 1,406; Austria, 703; Sardinia, 171; Saxony, 107; Sweden, 64; Prussia, 49……Common pitch is a good cement for the seams of an aquarium. It will not color the water, and contains no elemeut injurious to fishes……The common opinion is that we should take good care of children at all seasons of the year; but it is well enough in the winter to *let them slide*……It is reported that some very fine specimens of cotton grown in Queensland have been sent to Sydney, and it seems probable that cotton will become a staple production of this new colony after its separation from New South Wales……Herr Hochstatter, of Hesse Darmstadt, has invented a species of paper, the explosive power of which, and other projective capabilities, are said to surpass those of gunpowder. He has been invited to Woolwich to try the efficiency of his new discovery……The British government is drawing largely on the white oak forests of Virginia. Above 300 men are now employed in getting timber in the mountains near Rowlesburg, on the Cheat river, which is to be used for gun-carriages. The contractor has orders which it will take two years to complete. The Cheat river oak is said to be the best yet imported into England, and far surpassing the Canada oak, which it is fast superseding……An English journal says that, after years of mechanical labor and many mechanical tests, James White, of Wickham Market, has completed, and has now in constant operation, a self-winding clock, which determines the time with unfailing accuracy, continuing a constant motion by itself, never requiring to be wound up, and which will perpetuate its movements so long as its component parts exist……The power delivered by an engine is considered to be its theoretical power less the friction of its own parts. Morin ascertained that after the friction of an engine, working at its proper speed without load, had been determined, 7½ per cent of the remaining power was expended in overcoming the additional friction of the engine caused by the load brought upon it. A steam engine working without load has been moved with an effective pressure of three-fourths of a pound per square inch of the pistons. ……In 1854, an officer at Sevastopol was knocked down, not by a cannon-ball itself, but by the wind of it, as the ball passed close to him. The commotion produced was so intense that the tongue of the officer contracted instantly, and he could not articulate a word. Subsequently he was relieved by electricity……The human frame can withstand, without injury, a few minutes' exposure in an atmosphere heated to 325°. The principal effect, beyond increased perspiration, is a very considerable quickening of the pulse. The same temperature would cook a beefsteak in a very few minutes……Of the total power developed on the pistons of marine screw engines, it is estimated that but from 60 to 70 per cent are expended in the propulsion of the vessel. The proportion with paddle engines is, perhaps, no greater; sometimes only 43 per cent is utilized……Trevithick's locomotive, in 1804, was the result of a wager of 1,000 guineas, made by Samuel Homfray, of the Pen-y-darren Works, that he would convey a load of iron for a distance of nine miles along a cast iron tram-road……The *Great Eastern* has the largest screw propeller ever made, the diameter being 24 feet.

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