$$\text{the pillars, we have } \theta = \frac{2 \times 0{\cdot}00583 \times 8}{2 \times 330} = 0{\cdot}000141$$

The coefficient of elasticity being about 2,000,000 kg. per square centimeter = say 28,446,000 lb. per square inch, this θ corresponds to a change of tension of $0{\cdot}000141 \times 2000000 = 282$ kg. $= 619{\cdot}6$ lb., or to a change of $\frac{282}{2} = 141$ kg. $= 309{\cdot}8$ lb. greater and less than the stress at the middle position. Therefore the tensions in the horizontal spring at the vertex will vary between 670 + 141 and 670 —141; or 811 and 529 kg. per square centimeter or 11663 and 8676 lb. per square inch.

As the spring plates are not riveted together, and hence each one may bend separately, the difference in tensions in the uppermost and the lowermost fibers is only ¼ of that above calculated; the other ¾ of the 141 kg. being manifested as a difference of tensions, common to all constructions. There is, then, nothing risky in using springs or plates for hinges, as the materials will sustain the bending without damage, the more so as the maximum temperature changes occur only at long intervals, and the changes caused by load variations are but a small proportion of those caused by temperature changes.

The double vertical plates in the center withstand the shearing stresses caused by loads passing that point. The springs at the abutments have but slight angular motion—that due to flexure of the side span girder by load variations, temperature changes being here without influence.

Similar sprmg hinges have been applied to small cantilever bridges in Dresden, to prevent lifting of the girder ends on the four points of support.

(3) The vertex hinge has been put below the roadway surface to get the necessary horizontal stiffness by making the roadway framework a nearly straight girder with uninterrupted flanges, connected by the cross beams, which here form the wind bracing. All other suspension bridges have the vertex considerably above the roadway, to get necessary vertical stiffness. Thus in these others the transmission of stresses through the vertex distorts the connecting members and causes injurious horizontal motions of the whole girder.

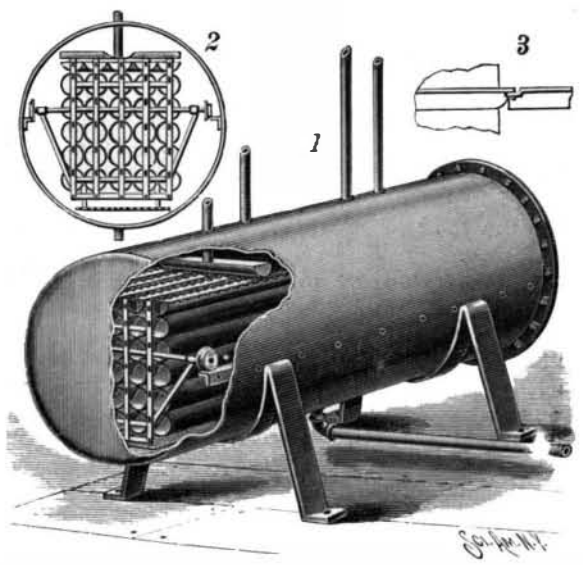
Besides this, there is difficulty in making the hinges as single links (as in the Thames and Monongahela bridges) with pins, for heavy stresses, as the narrowing of the free space between the girders must be avoided. On the contrary, the total breadth of the plates forming the two main springs at the vertex of the Loschwitz bridge is 2·8 m. = 8·5 ft., and besides these, there are also two horizontal plates under the roadway, connecting the hips of the cross beams; and a pair of vertical plates for carrying the vertical stresses caused by moving loads passing the center opening. Thus considerable additional stiffness in the roadway has been obtained. The diagonal cross beams take part of the lengthwise stresses; while they also resist shearing effects, such as those caused by the wind blowing unequally on the different halves of the girder. These connecting springs could only be applied by placing them below the roadway.

(4) Transverse beams crossing each other diagonally so as to make a horizontal lattice which stiffens the bridge against wmd and passing loads were recommended as far back as 1860, in the Hannover'sche Zeitschrift; and in 1861 in the Civil Engineer and Architect's Journal of January 1.

The value of this bracing, together with the position of the middle hinge at the level of the lower flanges, in the Loschwitz bridge, may be seen in the fact that its lateral motion during the passage of thirty-six men keeping step was but 0·45 mm. = $\frac{1}{55}$ inch.

Although special diagonal bracing may be strong enough statically, the greater changes of length by tension and compression in such special bracings, which are, of course, weaker than the cross beams, increases the lateral flexure and hence the oscillation period. The matter of oscillation of bridges is more appreciated of late years than formerly, the conviction gaining ground rapidly that horizontal vibrations are as injurious to durability as vertical ones are.

(5) Loaded levers to counteract the push of an arch were applied to the street girder of the bridge over the Elbe at Riesa. The chains or cables of suspension bridges are usually anchored to the natural rock or confined in walled abutments; but there is seldom any precaution taken to permit easy access to all parts of the anchorage system, which last has often been rapidly destroyed by rust. The anchors of the Loschwitz bridge are accessible in every part, so that their coat of coal tar can be readily inspected, and, when necessary, renewed. The anchors bear, in addition to their regular load, the roadway, which covers them, and which is of slag blocks on Monier plate, their ends being inserted into the walls. They cannot give way by any increase of the bridge load within the limits of the bridge strength.



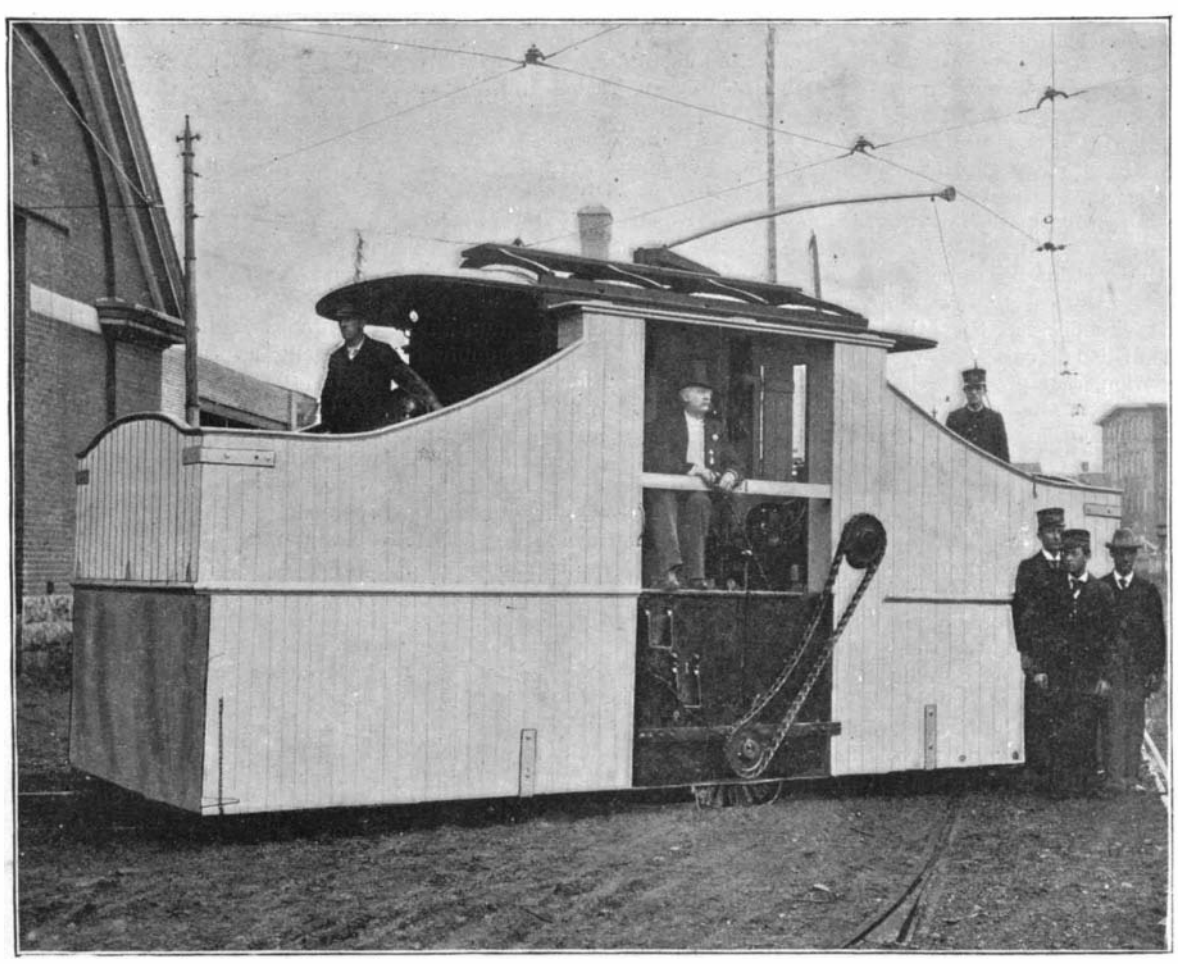
MUNDAY'S FEED WATER HEATER.

(6) The bridge brake consists of clamps which oppose to the sliding or vibratory motion of various parts of a bridge a certain amount of sliding friction, regulatable by springs, by bolts and nuts or otherwise, and thus absorbing much of the vibration or other injurious motion. It is most successfully applied in the bridge here described.

At a trial of the stiffness of this bridge a load of steam and horse road rollers, vehicles, etc., amounting to 150 tons, caused a center deflection of but 9 millimeters, = ⅜ inch, and a company of soldiers marching over it in step caused scarcely perceptible vibration.

AN ELECTRIC SELF-LOADING CAR FOR STREET CLEANING.

Among the many novel applications of electricity one of the latest is that shown in the accompanying illustration, where it is utilized, through the medium of an electric car, for sweeping up and carrying off the street refuse. The car is 8 feet wide by 25 feet long and 11 feet high. It is carried on two axles, and is fitted with the usual equipment of a trolley car. The brakes and the motor are placed above the wheels. The motor is connected by chain and sprocket gear to the driving wheels and to the brush, the brush making five revolutions to one of the car wheels. The brush runs in a cylindrical case which is open at the top and the bottom, and it is arranged to work both ways, a reversible steel deflector being arranged above the brush. The car consists of an upper platform, in the center of which is a shelter or cab containing the motor, and a lower closed section into which the street rubbish is thrown. Its lower floor is formed in parallel sections, which are hinged transversely to the car, and by the operation of a lever can be opened for dumping out the refuse. The broom, which ordinarily, as shown in the illustration, is the full width of the car, can be extended to cover nearly the full width of the street if so desired.



ELECTRIC SELF-LOADING CAR FOR STREET SWEEPING.

In operation these cars are used in connection with manual labor, the sweepings of the gutters and sides of the street being thrown toward the center, where they are picked up by the car, which thus sweeps its own section of the road, and also takes the place of the refuse carts.

The car is the invention of A. Jackson Reynolds, of Montreal, who states that when sweeping it travels at the rate of six to eight miles an hour, and that it carries refuse, snow, etc., out of the city at a cost of $2.50 per mile. For removing snow a car specially wide and long is constructed; and it is claimed that by running the car continuously during a snow storm there is no difficulty in keeping a street open. A self-loading car is now being built which will be one of the largest street cars in the world, being 8½ feet wide and 45 feet in length. It will have a capacity for cleaning 25 miles of street without stopping.

AN IMPROVED FEED WATER HEATER.

The illustration represents a heater in which troughs connected with the supply pipes distribute the water over tubes in thin streams or a thin sheet, within the shell of the heater, with whose upper portion steam inlet pipes are connected. The improvement has been patented by George T. Munday, Brenham, Texas. On opposite sides of the interior of the shell are secured angle irons forming tracks, on which the tubes are removably supported by means of a supporting frame at each end. as shown in Fig. 1, and in the sectional view, Fig. 2, a transverse shaft of the frame carrying rollers which travel on the tracks. The tubes are open at their ends, to permit the free circulation through them of steam admitted to the heater, and extended above the tubes are troughs supported by the end frames, the edges of the troughs being serrated to cause the breaking up and fine distribution of water flowing from them, each feed pipe discharging into transverse troughs. Below the tubes is a wire cloth screen, also supported by the movable frame, designed to receive falling scale, and in the bottom of the shell is an outlet blow-off pipe. When the tubes and troughs are to be removed from the heater, for cleaning and the removal of scale, the head of the shell is taken off and extensions of the angle iron tracks, as shown in Fig. 3, are connected with the ends of the tracks within the heater, the outer ends of the track extensions being supported in any desired manner, when the whole interior mechanism may be readily drawn out. It is designed with this heater to heat the water as nearly as possible to the temperature corresponding with the boiler pressure, and effect the rapid formation of scale, which may be removed with but little trouble.

PROF. WM. H. BREWER contributes to the Yale Scientific Monthly an account of observations during the past 45 years on earth tremors at Niagara Falls. The heaviest vibrations were on either side of and near the Horseshoe Fall. They disappeared in places in the soft shales below the limestone, although they were evident in the harder limestone and sandstones that occur amid these. Passmg down along the gorge, the vibrations decreased in intensity, becoming too faint to be perceived between the suspension bridges, but increasing again on nearing the rapids. Persons living near the falls believe that crystals are more common in the rocks there than elsewhere, the texture having been affected by the jar of the cataract, but Prof. Brewer finds no evidence of this.

Inventions.

Mr. Horace L. Arnold, in the American Wheelman, is correct in saying that a great deal has been written to exactly define what constitutes invention. Some very skillful and ingenious minds say there is no such thing as invention, and others advocate the view that the simplest and most obvious combination of old and well known elements is an invention. One view makes nothing whatever an invention, and the other makes anything an invention and the proper subject of a patent in case it has not been "anticipated" by exactly the same combination.

The courts are constantly called upon to decide whether the "subject matter" covered by the claims of a patent is an invention or the mere handicraft of a skilled workman, and sometimes the courts decide that what seem to be really intricate inventions are not inventions at all, or that extremely simple things are real inventions and fit subjects for patents.

The point of view seems to be this: If the alleged inventor has done no more than a mechanic skilled in the art might do in the way of meeting the demands of the situation, he is not an inventor, he has not made an invention, and should not have a patent. But if what the alleged inventor has done was a stepping out of the beaten path, and required original thought, which may be defined as either finding new and better answers to old questions, or the first sufficient answer to a new question, then the result of his thought is invention, and the fit subject for a patent.

For illustration, take a cycle frame of the now universally adopted "diamond" pattern, made of tubing. The use of tubing could never have been the subject of a patent, because any skilled mechanic knows that a large hollow thing is stronger and stiffer than a small solid piece of the same weight. But had the "diamond" frame been brought out complete, all at once, by one designer in its present form, that arrangement of frame members would have been an invention, and might have been made the subject matter of one of the most valuable patents ever issued. In fact, the "diamond" design for a cycle frame was of slow growth, and the outcome of successive approximations. Even so, it seems quite likely that had the man who was first to combine these preceding approximations, and produce exactly the now universally used form of the diamond frame, applied for a patent, he would have had it issued to him and it might have been sustained by the courts, and every cycle made might now pay a royalty to the lucky Coventry man who, it is said, was the first one to show the diamond frame.

I have said that the courts are continually called upon to decide what constitutes an invention, and some of these decisions are evidence of very clear thinking on the part of the judges presiding. Often several judges sit together on a case, and they are not always unanimous in conclusions; the decision goes with the majority, one of whom writes all the considerations and premises and influencing circumstances which lead the majority of the judges to their decision, and this goes on file and into print as the opinion of the court in the matter. Sometimes where the decision is not unanimous a dissenting judge writes a little dissenting opinion, and that is printed, too; but the dissenting opinion does not carry weight, although where all the judges concur the decision has a better front.

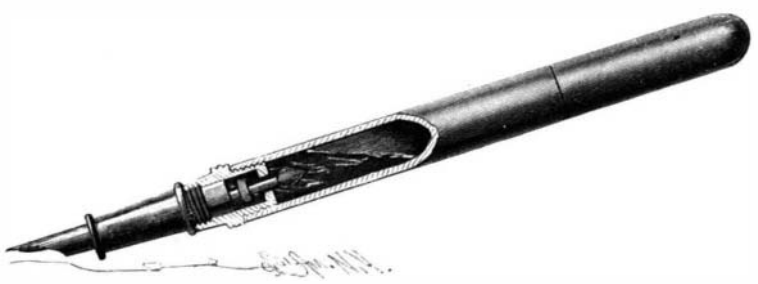
In a very recent decision it was decided that the direction in which a little hole drilled in cast iron was inclined was a matter of invention, and properly the subject of a patent, even in the face of the fact of previous unintentional use. The invention related to those gas fireplace logs which have asbestos moss on them and look, when in use, as if they were being burned, although the fire is really that of burning gas only. It is desirable that the gas flame should lie close to the cast iron fire logs, and that there should not be a little explosion when the gas is turned off. If the little holes through which the gas comes out of the hollow cast iron fire log to be burned are drilled at a sharp angle to the surface of the log, then the flame does lie close, and there is no explosion at the time of starting or stopping the fire. Yet, as the logs are half round and were laid on a driller table to have several rows of holes drilled in them, it had always been the practice to drill part of the holes inclined and part at nearly right angles to the surface of the fire log. The invention claimed lay in drilling all the holes at about the same acute angle to the face of the fire log, with the outer opening of the drilled hole higher than the inner opening, which avoids the explosion and makes the flame lie close to the log, and gives more heating effect for the same amount of gas burned.

At first sight it would seem that this was a very thin invention; it was shown, however, that it was of commercial value, as making a better and more economical fire log, and it was held that the previous accidental drilling of angular holes lacking uniformity of angular direction was merely slovenly work, while the drilling of the holes all at about the same angle to produce certain valuable results, and the gaining of these valuable results by this intentional uniform angularity of the gas jet holes, was invention, and to be considered the more meritorious because of its extreme simplicity.

In general terms, if a new and valuable result is gained, no matter how simple and slight the changes made to gain the novel effect, the courts sustain the patent. It is hard to avoid the conclusion that there was original reasoning used to gain a new effect from very slightly modified well known means, and when, as is often the case, the new effect gained by such a slight change in old means is commercially valuable, the patent is almost always sustained.

THE "CLIMAX" FOUNTAIN PEN.

The illustration represents a new fountain pen which forms the subject of two recently issued patents. The pen is designed to write to the last drop of ink, without any liability to leak, and the flow of ink can be easily and instantly regulated to suit the writer or stopped entirely, enabling the pen to be carried point down in the pocket with absolute safety. The chief feature of the pen is that, by means of a nozzle revolving in a plug, the ink duct can be instantly shut or opened, the flow of ink increased or diminished, and all superfluous ink withdrawn from the nib of the pen and stored in cells or basins, where it remains perfectly air bound as long as the pen is out of use. The picture represents a small size of the pen, which is being introduced by the Climax Fountain Pen Company, of No. 130 Broadway, Brooklyn, N. Y. As may be seen in the broken away section, when the nozzle is turned downward into the plug the ink duct is opened, and the ink is forced into the nib by air pressure; but when the nozzle is turned upward the ink duct is closed, and a reversed suction takes place by which the ink is withdrawn from the nib of both the pen and feeder. The feeder is so constructed that, when the flow is regulated, blotting and leaking are impossible, as hardly a drop of ink can be forced out, even by violent shaking. The inside shaft of the feeder has an automatically sliding valve keeping the ink always in fine flowing condition, and the pen, when necessary, may be washed without removing any single part, simply by holding it, point up, under the open faucet. Patents have been granted for this improvement in the United States and Canada, and other patents are applied for in England, Germany, France and Austria.



THE "CLIMAX" FOUNTAIN PEN.

Thomas Jefferson as Meteorologist.*

The following items are extracted from notes furnished to the editor by the gentlemen named below. Further interesting remarks on this subject will be found in articles by Mr. Alexander McAdie, published in the Popular Science Monthly, vol. xlv, p. 331, and in Weather Bureau Bulletin No. 11.

Monticello (in Italian "Little Mountain"), the home of Thomas Jefferson, is on the summit of Monticello Mountain, on the south side of the Ravenna River, in Albemarle County, and three miles southeast of Charlottesville, Va. This mountain, which towers up more than five hundred feet above the general level, commands a magnificent view of all the country to the north and east. The birthplace of Thomas Jefferson, called Shadwell, named after the parish in London where his mother was born, is a couple of miles away.

The general appearance of the Monticello mansion has undergone no alteration or change since Mr. Jefferson's death. The central portion consists of two stories, with a dome surmounting the center; the wings are of one story and attic.

Mr. Jefferson was one of the pioneer meteorologists of this country. He kept daily records of the temperature and other important weather conditions during the greater part of his life; he induced others in different parts of the country to make records simultaneously with his own observations; he collected and charted the results, and drew from them his own conclusions with regard to the character and movement of storms, etc. These conclusions were remarkably accurate, considering the meager data at his command for such investigations. Photographs and engravings of Monticello show on the roof a part of his instrumental equipment, viz., the wind vane, the construction of which is very similar to the modern vane. The vertical rod supporting the vane projects down to the ceiling of the portico, to the lower end of which is attached an arrow that indicates by its position on a lettered dial the direction of the wind at any moment, and this can be seen from within the house. Mr. Jefferson made and recorded his weather observations several times each day, and these were not neglected even during the performance of his most important and engrossing public duties. In Paris, during a time when his right arm was disabled, in consequence of a fall, his weather records were made with his left hand. Even during the exciting debate in Congress on the document which he had written, one of the noblest in the annals of the world—the Declaration of Independence—when he was writhing under the bitter criticisms with which it was attacked in some of its parts, his observations of temperature were continued. The record in his pocket memorandum book contains the following entries:

PHILADELPHIA, 1776.

	H.	Min.	Deg.
July 1	9	0 A. M.	81½
	7	0 P. M.	82
2	6	0 A. M.	78
	9	40 A. M.	78
	9	0 P. M.	74
3	5	30 A. M.	71½
	1	30 P. M.	76
	8	30 P. M.	74
4	6	0 A. M.	68
	9	0 A. M.	72¼
	1	0 P. M.	76
	9	0 P. M.	73½

For his temperature readings Mr. Jefferson used a pocket thermometer.

*By Fred. J. Randolph and Fred. L. Francis, of the Weather Bureau, in the Monthly Weather Review.

Work Spent in Pressing Pedals.

In a recent communication to the Paris Académie des Sciences, says Engineering, M. Bouny gives particulars of a series of experiments made to determine the power exerted in propelling a bicycle at different speeds. The method adopted was to take an autographic record of the total force exerted on the pedal throughout a complete revolution. To this end a disk was mounted on the bicycle crank concentric with the pedal pin. The pedal itself was mounted on stiff springs, and points fixed to it traced curves on the disk already mentioned. If no pressure was exerted on the pedal, these latter curves were simple concentric circles; when, however, the rider began to work, the springs on which the pedal was mounted yielded proportionately to the pressure applied, and the curves then drawn showed by their deviation from the circular form the value of the force applied at any part of a revolution. One of the pointers in question measured the force applied in a direction perpendicular to the plane of the pedal, while the other showed the pressure applied parallel to this plane. The latter is by no means an insignificant quantity, as all good riders shove their pedal forward as well as down. The angle the pedal made at any moment with the crank was also automatically recorded.

An examination of the diagrams thus obtained showed, in the first place, that there was no absolute dead point, such as occurs with an ordinary connecting rod and crank motion, and, secondly, that there is always some pressure on the pedal during the rise, the negative work due to which has to be subtracted from that done during the down stroke to obtain the net amount used in propulsion. The experiments were made at speeds ranging from 10⅝ to 21¼ miles per hour, the machine being run on a wooden racing track. The results, reduced to even English measures by means of a formula of interpolation, were as follows:

Speed. Miles per Hour.	Work done per Semi-revolution. Ft. lb.
10	18·58
10⅝	20·96
12·5	33·98
15·0	47·50
17·5	56·75
20·0	63·62
21¼	66·08

It will be seen from the above figures that the average pressure of the foot required on the pedal increases rapidly with the speed, being at twenty miles an hour nearly three and one-half times as much as at ten miles per hour. Unfortunately, the gear used is not noted by M. Bouny, and so it is impossible to deduce from the above figures the average tractive resistance of the machine at the different speeds. Probably at the higher speeds named a large proportion of the total work done was expended in overcoming atmospheric resistance, and the run of the figures might be changed considerably if the trials were conducted on a roughish road instead of on a smooth track.

IMPROVED hygiene and sanitation have reduced the death rate in the German army from 6·9 per thousand in 1870 to 2·4 in 1894. During the Franco-German war the French lost 23,400 men from smallpox, while the Germans, who had strictly enforced vaccination for thirty years, lost only 300 men from this disease. Since 1873 only two soldiers have died from smallpox in the German army.