expenditure of labor. The lights being interchangeable facilitates the removal of the structures when necessary, and also renders them more easy to repair. The invention, it will be seen, is a very simple thing, but it will, says the author, be found an improvement in the construction of garden frames and other horticultural appliances.

SPIDERS' WEBS AND SPINNERETS.

The exterior parts of the silk-producing organs of spiders are called spinnerets. They are four, six, or eight papillæ, or sometimes, instead of papillæ, flat plates, situate on the under side of the end of the abdomen, in a little depression adapted to their size and shape. As far as I am aware, no British spider has a less number than six. On the ends of each spinneret are little funnel-shaped tubes, *a* and *b*, Fig. 1, from which the silk is emitted, and which I call silk tubes, being ignorant of their proper name. The spinnerets lie in pairs, and are naturally divisible into two sets, an upper and a lower. There are two pairs in the upper set, one above the other, which I therefore name the first and second pairs, the one pair in the lower set being distinguished as the third pair. The spinnerets of the first pair have two joints, and their silk tubes are situated sometimes on the end of the second joint, and sometimes irregularly down its inner side. The second spinnerets have but one joint. They are smaller than the first, and have the silk tubes on and around the ends. The construction of the third pair differs a little from that of the other two. Like the first they have two joints, but the basal joint is always much larger than the terminal, which is very short. Their silk tubes are on a retractile plate at the end of the second or terminal joint, which, when not in use, is drawn inwards until the tips of the silk tubes are nearly level with the end of the spinneret. This plate has a thickened rim, and on the interior margin, where the rim is broadened for the purpose, are a few holes and two silk tubes of unusual size. The exact use of these I have been unable as yet to determine. The spinnerets of a spider are mobile, and their movements are effected by longitudinal muscles.

The first and second spinnerets always produce plain or non-adhesive threads; if the spider be of a species that spins viscid threads, these are always emitted by the third pair. There is one family of British spiders which has an extra and very remarkable pair of spinnerets in the lower set, which produce threads of a peculiar character; they are described further on.

Fig. 1. Fig. 3. Fig. 4.

Fig. 2.

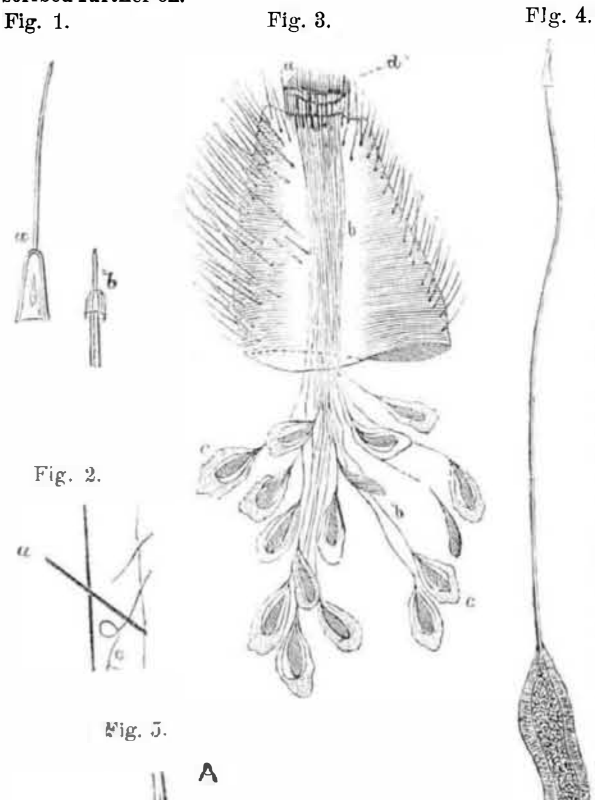
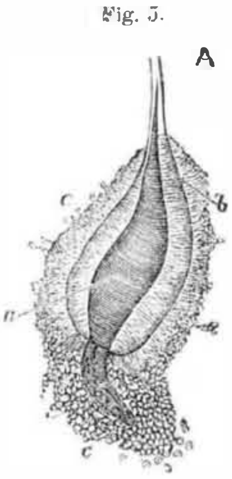


Fig. 5.



SPIDERS' WEBS AND SPINNERETS.

In Fig. 1, *a* and *b* are silk tubes of first and third spinnerets of *tegenaria domestica*. Fig. 2 shows the web of the same × 150; *a*, first threads, *c*, third threads. Fig. 3 shows the under spinneret, with glands attached, ×38. *a* are the common silk tubes; *b b*, ducts; *c c*, glands; *d*, silk tube of unusual size. Fig. 4 represents the silk tube, duct, and gland of the first spinnerets, × 38. Fig. 5 represents the gland of third spinnerets; *a*, gland; *b*, bag or case; *c c*, coating of epithelial cells.

As may be supposed, I selected the commonest spiders for observation, and house spiders happened to come handiest. The web of a tegenaria, and I believe of every spider, contains three sorts of threads, not two only, as usually stated. Two of these are plain, and stretched taut from point to point (*a*, Fig. 2), and they differ in nothing but size, being spun by the first and second spinnerets, of which in all spiders the first is larger than the second, although in some instances it has a fewer number of silk tubes. The third thread (also shown on Fig. 2) is exceedingly elastic, and studded with viscid globules, or, if these be absent (as in the web selected for illustration), it is slack, irregular, and sometimes much curled.

The apparatus by means of which a spider forms its silk is a series of glands within the abdomen, near and attached to the spinnerets, and immediately beneath the liver and intestinal canal. The glands of the upper and lower sets of spinnerets differ somewhat in character and shape, as is noted below. Fig. 3 is a drawing of one of the third spinnerets of *tegenaria domestica*, with its glands, of which only a few are shown. These communicate with the silk tubes by ducts, *b*. They vary in size in different individuals, but in a large tegenaria $\frac{1}{10}$ of an inch is an average length. Each gland has its own duct and silk tube. On the first pair of spinnerets there are about 60 silk tubes; on the second pair, although the spinnerets are smaller, about 80. The silk tubes on these two pairs are alike; but they differ in shape from those of the third pair and are much larger (see Fig. 3, *a* and *b*). There are nearly 220 tubes on the third pair, thus making altogether about 360 on the six spinnerets.

The glands, likewise, which are proper to the first and second pairs of spinnerets differ from those belonging to the third. Fig. 4 represents one of them with its duct and silk tube, drawn to the same scale as Fig. 3, for the sake of comparison. It is a simple sac, closed at one end, and terminating at the other in the duct, which carries the secretion to the silk tube. On the surface of the gland is a coating of cells, probably epithelial, which are surrounded by a very delicate membrane. The points of difference in the silk glands of the third spinnerets are these: They are smaller (about one quarter the length), of a different shape, and chiefly, they are enveloped by a bag or case interposing between the actual gland and the epithelium (see A, Fig. 5, *b* and *c*), which bag is wanting in the other glands; while the epithelium is apparently without the membranous covering by which, in them, it is always surrounded. This case, continued as a tube, surrounds the duct for some distance, in all probability as far as the silk tubes, but I have not been able to trace it so far.

It has been argued that the drops of liquid silk coalesce as they emerge from the spinnerets, and so form a simple, homogeneous thread, but various observations have convinced me that such is not the case. The following also tends to contradict this theory, namely: When a garden spider has caught a fly, as every one knows, she very expeditiously binds it in a covering of silk. Until I saw the exact process, I often wondered how she could manage to accomplish this so quickly. She places the tips of her six spinnerets almost in a line, at the same time seeming to erect each separate silk tube, and thus puts forth, not a single thread, but a broad band of many detached threads, which is rapidly wound round the unfortunate fly. The examination of the web of a house spider, under a high magnifying power, will show that many of its main threads are frayed, like a rope worn by use; this could not occur if they were homogeneous.—*H. M. J. Underhill, in Science Gossip.*

Correspondence.

The Scientific Treatment of Criminals.

To the Editor of the Scientific American:

Your remarks on the "Scientific Treatment of Criminals," on page 224 of your current volume, strike me as being, in the main, profound and sensible. You omit, however, to take account of one grave fact, which is a weighty factor in determining society's method of the treatment of criminals.

It is this: Each one of these "ill-regulated machines" is a generator of other and worse regulable machines, and generally the prolificness is in inverse ratio to the regulability. This is a state of facts which the modern theory of dealing with the criminal class takes no account of. We send a badly constructed locomotive to the repair shop, and if it can be tinkered up at all it may have some degree of utility. The case, I imagine, would be very different if each locomotive were the spawner and perpetuator of its own defects to all futurity. The mode of dealing would then be the summary breaking up in the shop for the sake of the old material. This is just what human society has done in all past time with its own failures, and to this process of "moral selection" we unquestionably mainly owe the advance which the race has made in moral evolution. It is only in the most recent times that the retrograde course has been adopted, chiefly for sentimental reasons under false theories. Having reached a plateau of comparative security, society kicks down the ladder by which its moral eminence has been in part attained, and ignores the horrid depths from whence it commenced its ascent toward the light.

It is highly questionable whether, sentiment aside, the profit to society from the maintenance of costly prisons and reformatories is greater than the old, simple, and inexpensive methods. For cases other than the most incurable and hopeless failures, however, there seems to be no reason for abandoning the reformatory and punitive modes of treatment, simply on account of a better philosophical hypothesis. The presentation, by society, of powerful motives of action has been, next to selection, a most efficient agent in moral evolution. Now, on the mechanical theory, or any other, it is certain that these motives act, namely, fear of punishment, hope of reward, love of approbation. This is a mere matter of observation. Where, then, does human responsibility to society cease? To be alarmed on this score is to imitate the consternation of the old lady, who, when told that red flames 10,000 miles high had been discovered in the sun, exclaimed: "Now we shall all be burned up alive!" The truth is that the machine is just what it always has been, complex beyond calculation, full of numberless antagonistic springs and coördinating devices, adapted to be played upon by the minutest objective and even subjective phenomena, and capable, to a certain small extent, of a choice of motives. In this lies its responsibility. It is clear that some of the motives by which the components of society have in the past been powerfully influenced and molded may become less potent or disappear. Such transformations are continually going on as society progresses; but there can be no fear that, while the machinery remains constituted as it is, that portion of it which is so wonderfully susceptible to the influence of motives, namely, the imagination and the passions, will, as in the past, be also the prolific generator of new motives sufficient to control the action of all for the general good. H. H.

Washington, D. C.

Small Boat Engine.

To the Editor of the Scientific American:

I have taken an interest in the small engine question, and I wish to say that I have a small engine in a boat 17 feet long and 5 feet wide. It is an upright engine; the cylinder is 2 x 3 inches, and drives a propeller 18 inches in diameter. The boiler is a common upright one with 22 tubes. I can run for four hours with one fire; in a whole day's run, it consumes about 4 buckets of coal. The boat's general rate of speed in still water is about 6½ miles per hour.

Barrytown, N. Y. J. ASPINWALL.

[In descriptions of engines, further particulars would be useful—such as dimensions of boiler, pressure of steam, pitch of screw, and revolutions of engine per minute.—EDS.]

Ice Lenses of Unlimited Size.

To the Editor of the Scientific American:

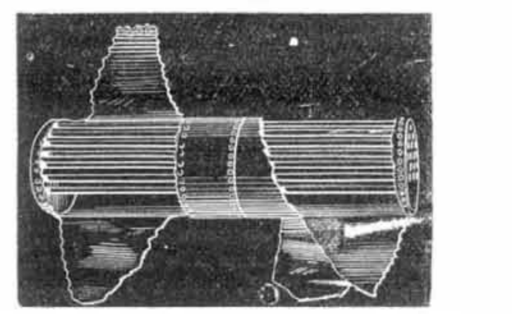
If you had lived in Minnesota and seen our ice, you would not think me foolish in suggesting the possibility of freezing filtered water so as to make a perfectly achromatic lens of unlimited size, to be used in a telescope during the winter months; but as you are used to New York ice, I shall only expect you to think that I am somewhat visionary in this last thought. C. RIDGWAY SNYDER.

Minneapolis, Minn.

Remarkable Boiler Explosion.

To the Editor of the Scientific American:

A fatal boiler explosion occurred in this city at 9 A. M., on October 2, in the factory of the Dubuque Cabinet maker's Association. The engineer and another man were instantly killed, and a third severely scalded. The cause of the explosion cannot be ascertained. The boiler was new (not much over a year in use); it was 15 feet long by 4 feet diameter, with 38 four inch flues. It burst in a queer way, both heads remained on the flues, but the shell of the boiler



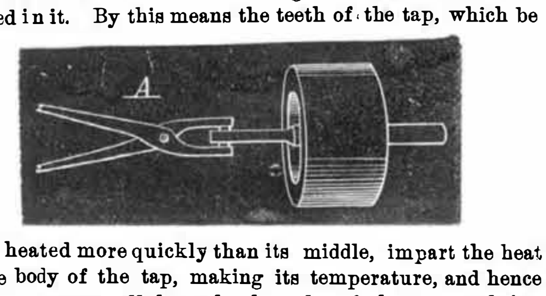
burst along the rivet holes nearly all around both heads, leaving a wreck as shown in the engraving.

Dubuque, Iowa. M. A. KELLER.

Hardening and Tempering Tools.

To the Editor of the Scientific American:

Upon the above subject permit me, in conclusion, to say that, since I withdraw the tube from the fire before inserting the tap, the products of combustion do not interfere with my operation of tempering; and since the tube is shorter than the tap, some part of the latter is at all times exposed to the air, as here illustrated, at A, it being obvious that the tap must be moved endwise through the tube as well as revolved in it. By this means the teeth of the tap, which be



come heated more quickly than its middle, impart the heat to the body of the tap, making its temperature, and hence its temper, even all through, the color of the temper being plainly, at all times, discernible; and perfect access of the air is permitted. The sand bath process I have objected to from the first, for reasons then stated, to which Mr. Hawkins has given his endorsement.

In tempering dies, I do not permit them to lie more than a few seconds on either face, excepting at the end of the operation, when I lay the back edge (the one furthest from the teeth) for several seconds on the hot iron, making the back a little softer than the teeth, and thus strengthening the die. JOSHUA ROSE.

New York city.

To the Editor of the Scientific American:

Enclosed find a tap, or rather the pieces of a broken tap, a quarter inch in diameter, with twenty threads to the inch, with a very deep wire thread (round top and round bottom This tap has tapped over two hundred thousand hot forged nuts. It broke in tapping a nut which was too small in the hole, otherwise it was good for several thousands more. It ran constantly at 480 revolutions per minute for 48 days. This tap I believe to have been well made and properly tempered; and if any of your readers can improve on it, I should be glad to hear from them. It was made from W. Jessop & Sons' best English steel, swaged at as low a heat as possible, the screw end being a sixteenth of an inch larger than the size, in order to true up to size; the shank was forged and swaged as near the finished size as possible, and it was then heated slowly to a cherry red and imbedded in lime until cold; it was then centered and straightened. The shank was filed bright in the lathe, then reversed and the screw end turned straight and parallel for about two diameters, or half an inch from the end of the thread; and from that to the point, the tap is given the amount of taper that will allow a nut of the proper size to go on the tap flush with the end. The lathe is then set to chase a straight parallel thread; the tap, when chased, is passed through a hardened steel gage, and is then ready for the milling machine. It is milled with three deep half round grooves; it is afterwards filed with a little clearance on the top of the thread, then passed through the same steel gage as before (but this time in the reverse way, namely, shank end first), and unwound through the gage. This is done to remove the fine burr made by the milling and filing, which is very necessary; though sometimes the burr is scarcely perceptible, yet it would make a material difference in the size of the nut. The tempering is done thus: Heat the tap slowly to a cherry red, and dip endways and straight into clean cold water; and when perfectly cold, clean off the oxide or thin scale, with soft brick or an emery stick, until bright. The cleaner you make your tap, the higher and brighter will be your color. Then draw the temper to a purple bordering on a blue, by placing the tap shank on a piece of heated iron, and drawing the shank as soft as possible, drawing the temper towards the point. When the shank is soft, roll the tap backwards and forwards over the hot iron, until you have an even temper and color all over the body of the tap; then drop it into oil to cool. The taps are kept sharp by grinding the top of the thread where the nut starts; for the scale in the nuts soon wears a step on the tap and the starting point must be kept sharp or the tap would have to be forced into the nut. This is all the grinding or sharpening given these taps, and, in my judgment, is all they require. I am using taps all of which run at a high rate of speed, and the average amount of work got out of quarter inch taps is ninety thousand nuts. I have sent a quarter inch tap, as a small tap is a more delicate test of quality. Large taps never break if properly made and used, and they last a long time before they wear out; whereas a small tap, if not carefully and properly made, would either snap off or burr up, perhaps with the first nut. I also mentioned machine taps because you can never judge the results or gage the work done by hand taps. One particular point in making a taper tap is to be sure and have the thread parallel, giving the taper only to the outside or top of thread. By so doing each tooth does its share of the work, and the cut is regular.

Pittsburgh, Pa. T. J. B.

The Engines at the American Institute Fair.

To the Editor of the Scientific American:

In your issue of October 17, a correspondent who signs his name "Esor," makes some remarks upon the engines at the Fair which seem to display a hypercritical spirit, and have the further disadvantage of being in one or two instances incorrect in point of fact. For example: He says that "the Wright engine has its eccentric straps a quarter of an inch apart, and are not locked together by the bolts at all, but merely hang on the shaft; they are the only ones in the Fair possessing this defect." When I saw the bolts this morning, there was a head on one end and a nut on the other, and the eccentric straps were held together by them. "Esor" must intend to convey some other impression than that naturally attaching to his expressions. As to the straps being open a quarter of an inch, he is correct; but it is not a defect to have them so, but standard engineering practice, not necessarily faulty because disapproved of by your correspondent. He further says that a small rod on this engine (meaning probably the Wright engine though he has just referred to one or two others previously) "is about ten inches long and connects one end of the rocker arm to the arm of the shaft working the cut-off, the movement of each end of the rod being part of the circumference of a circle, the plane of one circle being at right angles to the plane of the other, and said rod having the bore of its brasses at each end trumpet-shaped from the center to each face of the brass, so that the rod has a right-about-face and 'slantindicular' movement, in all directions, merely hanging on its journals, since its faces will be free, and unconfined by flanges, collars, or other guides common to a respectable connecting rod."

In point of fact, and in few words, this rod has a ball and socket joint; how it can be "trumpet-shaped" under such circumstances is more than I, or any one whom I have asked, can discover. It is an old device, not new or claimed to be, by the makers of the engine. As regards the "thump" of the engine, your correspondent, before pointing out such a thing, might have reflected that it is not possible or desirable to go to the expense of putting down as heavy foundations for an engine at a Fair as they would be if intended to be permanent. The slight pound is caused by the springing and settling of the supports, and is in no way attributable to the connecting rod brasses.

Intelligent criticism is always in order and desirable, especially in mechanical matters; but the crudity of your correspondent's remarks can only be accounted for by a want of familiarity with the subject he discusses.

42 Cliff Street, N. Y. EGBERT P. WATSON.

[We were glad to observe, on our last visit to the Fair, that the exhibitors of the engine, acting on the hints of "Esor," had re-adjusted the machine and stopped the pounding. This is practical. But the charges of "hypercritical spirit", "crudity", "ignorance of the subject", etc., raised by the above correspondent, appear to be a waste of adjectives.—EDS.]

The South American Boxer.

To the Editor of the Scientific American:

The boxer of South America is so called by English and American settlers on account of its pugilistic propensities. It is of the grasshopper family, light-made, long limbed, and of a beautiful green color, and is an inhabitant of the south temperate zone. Those which I saw were brought in by *gauchers* (herdsmen) from the camp (country) and given to the *major domo* (foreman) of the *salerado* (salting establishment) at Port Roman, situated on the east side of the Uruguay river, about forty miles above Independencia and in about latitude 34° S. They were brought in to show as curiosities. The major domo, with whom I was well acquainted, placed one of these little fighters on a table and said to me: Tease him, and see what he will do. So I put my forefinger against him and pushed him lightly back; he was then in his natural position, on all fours. He faced around toward me and moved back about an inch. I then touched him lightly again, and he retreated again, as before; and we observed a sort of nervous movement in the hands, or rather the lower extremities of the fore legs, which we will call hands. I followed him up again; but this time, instead of retreating, he raised himself up, his body being nearly perpendicular, and drew his feet up, placing himself like a Turk in sitting posture, at the same time clinching his fists and putting himself on guard as a boxer would do.

I then made a pass at him with my finger, which he turned off as well as Yankee Sullivan could have done; and as long as I continued teasing him in this way, he warded off and gave blows as regularly as any pugilist could do. Soon after I ceased teasing him, he came down on all fours again and walked off leisurely across the table. The major domo told me that he had seen plenty of them, and that they all showed fight when teased, the same as this one had done.

Stratford, Conn. TRUMAN HOTCHKISS.

Vesicatory Potato Bugs.

To the Editor of the Scientific American:

Your correspondent, Mr. I. B. Hodgkin, is correct as to blistering with potato bugs.

In childhood, in the country, I frequently ran bare-legged among potato vines, and nearly always was blistered on my ankles by contact with these same bugs. I am not sure that crushing the insect was necessary; contact sometimes seemed to raise a blister. Generally a sac larger than a buck-shot occurred, which (unless attended to) caused an irritating sore.

It was a well known fact; but the bug was rarely used in blistering, in consequence of the acridity of the poison, and consequent difficulty in healing. The Colorado bug, common this season, should rather be called a grub; it will be recognized by most persons who have seen it as similar in form and movement to the blood sucker of the brooks (leech), but different in color and not active. The common impression is that it is in some way poisonous. It is as tough as rubber; a sharp knife will scarcely cut it. Most people hereabout know what it is like to their cost. R. H. A.

Baltimore, Md.

[For the Scientific American.]

SOME NEW GALVANIC BATTERIES.

Several new forms of the galvanic battery have lately been brought to our notice, a short description of which will interest our readers.

I. A copper pot is filled with dilute sulphuric acid, inside of which is placed the ordinary porous cup, filled with a strong solution of sal ammoniac in water, in which is placed the amalgamated zinc. The action of this battery seems to be as follows: The sulphuric acid, entering through the porous vessel, decomposes the chloride of ammonium, setting free the hydrochloric acid, which, in turn, attacks the already oxydized zinc, forming water and chloride of zinc.

II. In a jar, of about six inches diameter by ten inches hight, is placed a carbon plate, within a bag of unoiled leather; the bag is surrounded by peroxide of manganese, closely packed; the jar is then filled with a strong solution of sal ammoniac to which a few drops of hydrochloric acid are added; a plate of amalgamated zinc, of the same dimensions as the carbon plate, is placed in juxtaposition with the carbon. The action in this closely resembles that of the well known Leclanché cell. Constancy of action and large electromotive force are claimed for it.

III. A copper pot or cylinder is taken, inside of which is placed a porous cup filled with a strong solution of sal ammoniac in water and a plate of zinc (amalgamated). The outer vessel is filled with rain water, in which is placed a quantity of lucifer matches surrounding the porous cup. This form of battery is simple yet powerful. The matches seem to furnish a supply of ozone which is really its motive power. L. B.

LABOR is the duty man owes to society; rest is the duty he owes to his person; recreation is the duty he owes to his mind.

Charles M. Keller.

It is with the deepest regret that we announce the death of Charles M. Keller, the eminent patent lawyer, which occurred at his country seat at Milburn, N. J., on Thursday morning, October 14. For a year past Mr. Keller was in delicate health, and it was very evident to his friends that he needed rest from the arduous labors of his profession. Early last spring he was directed by his physician, and implored by his friends, to withdraw for a time from active work, and to devote himself to the restoration of his health. To these entreaties he gave no heed, insisting that his duties to his clients and to his cases were paramount to all others. At last, the feared result came; and about ten days before his death he was assailed by the complication of diseases which ended his life. He died in harness, working and consulting, on the last day before his attack, upon a difficult argument. And almost his last words were an expression of pleasure at the decision of an important case in his favor.

Mr. Keller was born in France, but came to this country with his parents at an early age. His father was employed in the old Patent Office; and at the early age of twelve years, young Keller began his career in the Office. He had a remarkable talent for mechanics, which he developed by assiduous and extensive study. His value was appreciated, and for many years he was an examiner under the organization of the Office prior to the act of 1836. In 1834, he conceived the idea of reconstructing the system of patents, and drew the act which was passed in 1836, and which is the foundation of the Patent Law of today.

A few years afterwards, Mr. Keller determined to leave the Office and to commence the practice of the law. For two years he studied, after office hours, until he deemed himself equipped for his new profession. So wide was his reputation that, before he opened his office, he was besieged with retainers, and with his first case he stepped to a foremost place at the patent bar. Since that day he has been engaged, on one side or the other, of most of the important patent litigations which have occupied the courts; and his practice was attended with singular success.

Mr. Keller's life was that of a purely professional man. He was fond of social pleasures, and was a charming and genial companion; but his thoughts day and night were on his cases, at which he labored with wonderful assiduity. No one has ever equaled him in his skill and perspicuity in explaining machinery in court, or in describing and claiming it in patents. To this talent he added excellent attainments in the law. His knowledge of equity, of pleading, and of the theory of the law of contracts was thorough and complete; and his method of preparing his cases for argument was so good that some twenty years since, the Supreme Court of South Carolina, in adopting a rule to regulate the form of briefs to be used before that court, printed with their rule a brief of Mr. Keller's as a model.

All friends of the mechanic arts will deplore the great loss they have sustained by his death. He was wise and prudent, learned and modest in consultation, earnest in argument, and always truthful, sincere, and just. His memory will long be cherished as that of one of the Fathers of the Patent Law.

Transformation of Sandstone to Marble.

J. Corvin, an engineer residing at Dresden, Germany, has invented a method of giving the ordinary sandstone, found in abundance in many localities, the exterior appearance of marble. He accomplishes this by impregnating the well dried stone with soluble silica and alumina. The thus prepared sandstone becomes much lighter in color, some kinds being intensely white and translucent, while it is capable of the highest polish, equal to that on the purest marble. He has even succeeded in imitating marbles of every color by adding mineral colors to the liquid used for impregnation. The famous quarries near Pirna, in Saxony, produce a sandstone especially adapted to this process, and Mr. Corvin now makes colored stones from this sandstone, adapted to the most elegant architectural structures. The price is considerably below that of marble; and the new material has the important advantage that it is much more fireproof than marble, which, when exposed to the fire, rapidly burns into quicklime and crumbles to dust.

Distilling Sea Water.

The author of a book lately published in England, entitled "Two Years in Peru," thus describes a simple contrivance recently devised by an English resident of that country for procuring fresh water from sea water through the direct action of the sun's rays:

"The apparatus consists of a box of pine wood, 1 inch thick, and which is about 14 feet long, 2 feet wide, and an average depth of 6 inches. The upper part of this box is closed with ordinary glass, which has an inclination of 1½ inches.

"At the lower edge of the glass, there is a semi-circular channel, destined to receive the fresh water which is condensed on the interior surface of the glass. The salt water is let into the box to about 1 inch in depth. It is then exposed to the rays of the sun, the heat of which is sufficient to raise it to 160° or 180° Fah. A very active evaporation then begins, and it is proved that 10½ square feet of glass will condense daily two gallons of pure water."

The author says he saw the apparatus in successful operation at Callao. There are many places on the coast of Peru, as in various other parts of the world, where fresh water is only to be got by distillation, and in such localities the device cannot fail to be exceedingly useful.