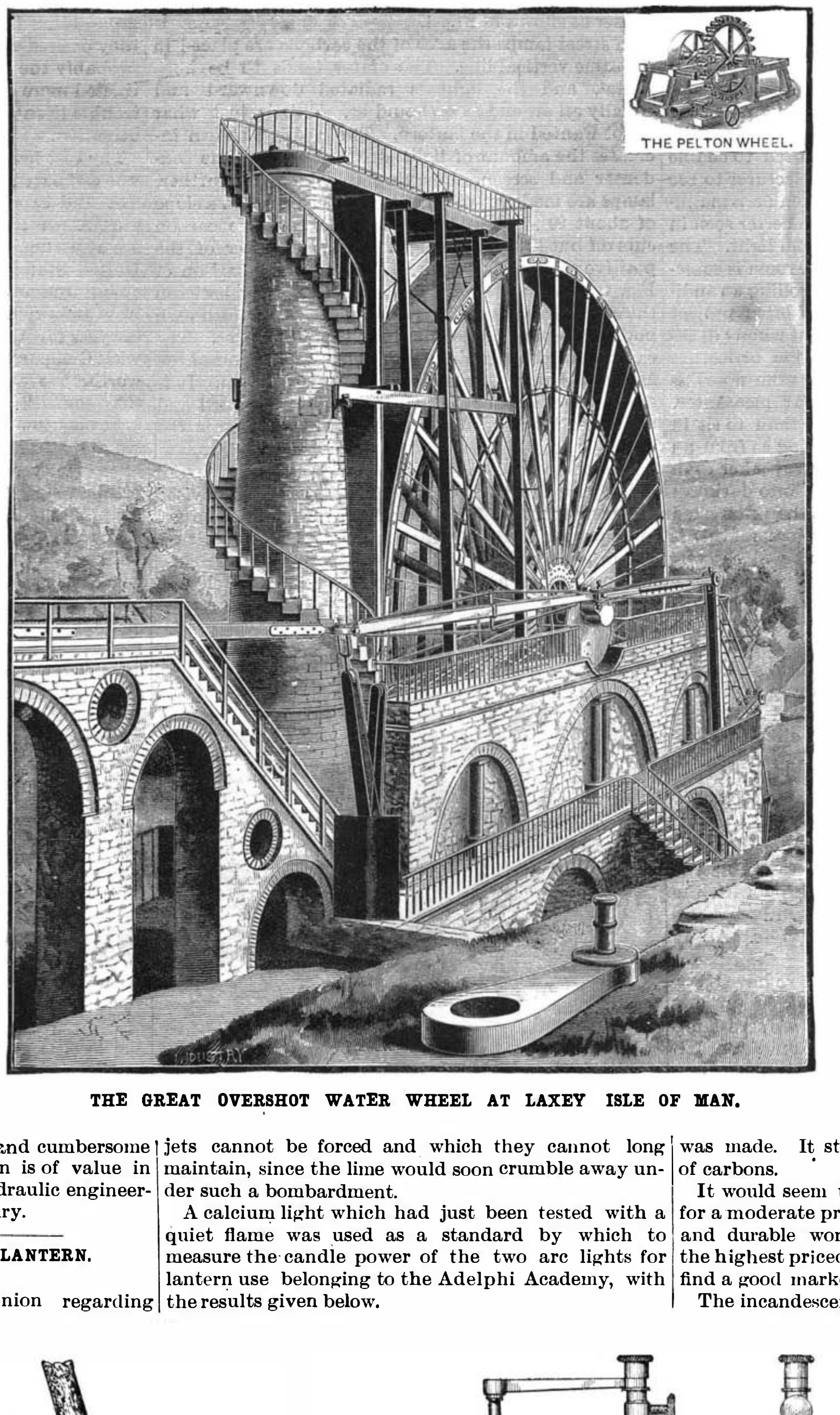
THE LARGEST AND THE SMALLEST WATER WHEEL.

The overshot water wheel shown in the accompanying illustration has the reputation of having been the most costly to build as well as that of being the largest water wheel ever constructed. It is at Laxey, on the Isle of Man, where it is used to pump water in working a lead and silver mine. The wheel is 72 ft. 6 in. in diameter, 6 ft. in breadth, has a crank stroke of 10 ft., and develops about 150 h. p. The power operates a system of pumps raising 250 gallons of water per minute, the lift being 1,200 ft. The power is transmitted several hundred feet to the pumps by means of wooden trussed rods, supported at regular intervals, the supports resting on small wheels, running on iron ways, to lessen the friction. The water to turn the great wheel is brought from a distance in an underground conduit, it being carried up the masonry tower by pressure. This great wheel was constructed some forty years ago, and has been running continuously ever since.

In the upper right hand corner of the same picture is represented another water wheel, drawn to the same scale, and which will afford as much power under similar conditions of head and water supply. This small wheel is the well known Pelton, having peculiar cup-shaped buckets on the periphery of the wheel, into which the water is so directed from one or more nozzles that nearly the full value of its weight for the height of its head or fall is transformed into the inertia of the wheel. The power represented by the force of the water is thus converted into mechanical movement, almost entirely without friction, "the buckets simply taking the energy out of the stream and leaving the water inert under the wheel." The Pelton wheel is extremely simple in construction, and is in size and appearance apparently but little more than a mere toy, in comparison with the ponderous piece of machinery shown as the great Laxey wheel, with its massive column, arches and stone foundation. Probably the cost of putting in position a Pelton wheel to afford the same power as this great overshot wheel would not be one-fiftieth of that of the earlier and cumbersome construction. Such an object lesson is of value in showing the wonderful progress in hydraulic engineering practice during the last half century.



THE GREAT OVERSHOT WATER WHEEL AT LAXEY ISLE OF MAN.

ELECTRIC LIGHT FOR MAGIC LANTERN.

PROF. W. C. PECKHAM.

There is great diversity of opinion regarding the candle power of both the calcium and electric arc lights. Makers and dealers in the calcium light claim as high as 900 candle power for it as actually used in the lantern. I have made numerous measurements in the laboratory of the Adelphi Academy upon both. The method employed was that of the Bunsen grease spot photometer, with a sight box by the American Meter Co. The standard of light was the Sugg London standard Argand gas burner and a Methven screen, by the same company. These have been compared with standard candles and are correct, or what is called so. The following table is compiled from my notes, each jet being tested three times. 1. A noiseless flame. 2. A medium flame making as much noise as would be allowable in the lantern. 3. A roaring flame, taking all the gas it will use.

CALCIUM LIGHTS.

Jet.	1	2	3		Jet.	1	2	3	
A......	304	304	413	candles.	D......	264	304	353	candles.
B......	130	205	413	"	E......	180	...	304	
C......	264	304	491	"					

Column 3 gives the maximum beyond which these jets cannot be forced and which they cannot long maintain, since the lime would soon crumble away under such a bombardment.

A calcium light which had just been tested with a quiet flame was used as a standard by which to measure the candle power of the two arc lights for lantern use belonging to the Adelphi Academy, with the results given below.

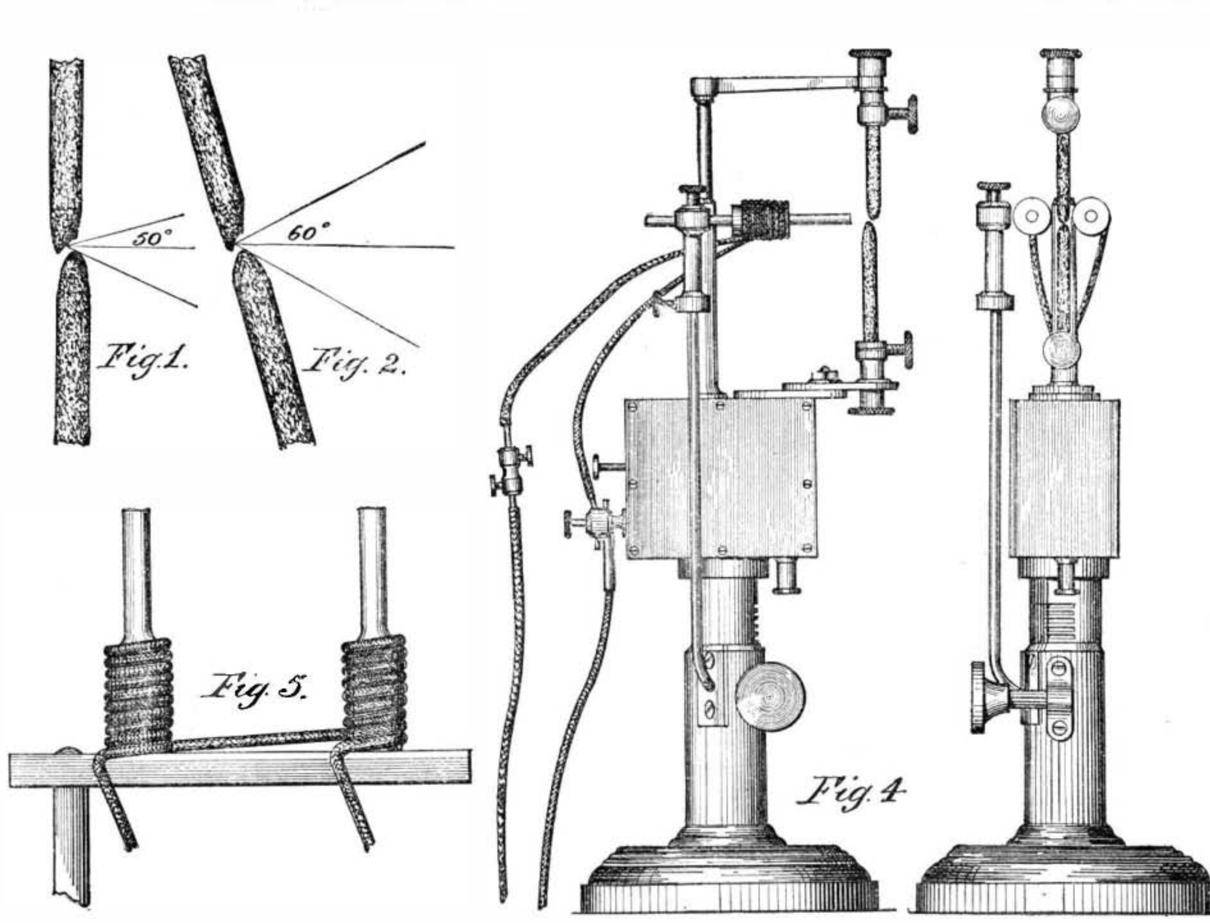
A small lamp made by the United States Electric Lighting Co., requiring about 8 amperes at 110 volts, gave 355 candles. A Clark lamp of full capacity with a current of about 15 amperes gave 1,378 candles, and with a full current of 20 amperes on gave 1,758 candles. These figures show that candle power is much overestimated in all cases. The last lamp measured is what is called a 2,000 candle power lamp. It gives in the condition in which it would be used 1,300 candles, and this is a magnificent output when compared with the 300 candles of the calcium lights.

In many places current can now be had from lighting and power circuits, while many educational institutions have their own plant, which could easily be employed for this purpose, but as yet no arc lamp of moderate price equal to the work has been put upon the market. Not to mention the old regulators, like the Foucault, with clockwork which requires frequent winding, there are several lamps costing about one hundred dollars made for this use, but that price for the lamp alone is prohibitory to many. English writers recommend the Brockie-Pell lamp most highly. The Clark lamp, spoken of above, is a favorite here. It, however, is hung down into the lantern, resting on the top of it. Its regulating magnets and mechanism are heavy, rendering the whole somewhat topheavy. To adjust the light one must reach above the top of the lantern, and if the lamp is to be removed from the lantern, a special stand must be provided for it. The lamp I have used for nearly two years was made by the United States Electric Lighting Company. It is simple in construction, rising by a rack and pinion by hand, as the lower carbon is consumed to bring the arc into focus again. Its fault is that it does not "take up" quickly when the current varies through varying resistance in the arc. With a little experience its regulation by hand, to overcome this defect, is not difficult.

Fig. 4 shows the appearance of the lamp and its interior mechanism, the sides being removed for that purpose when the photograph was made. It stands 20 inches high, with full length of carbons.

It would seem that a focusing lamp might be made for a moderate price which would, with plain, strong, and durable workmanship, be as good practically as the highest priced lamp, and that such a lamp would find a good market.

The incandescent lamp has been used in the lantern by some. In its ordinary form with a long loop of filament the light is too widely distributed. A special form has been made for the lantern of 100 candle power. The carbon filament was coiled into a close spiral of about a half inch in diameter, which is about the size of the white spot on the lime. This lamp is very easy to use, since its resistance would be fitted to the circuit upon which it was to be put, and it would run with the other lamps upon the same circuit and with no more attention. The operator has nothing whatever to do but to turn the key when the light is wanted. Where its light is sufficient nothing better can be desired, nothing cheaper be found. The lamp itself costs very little, and a support for it in the lantern can be made by any one. It is infinitely better than any



ELECTRIC LIGHT FOR THE MAGIC LANTERN.

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oil lamp. I have known them to be used in small lecture rooms in preference to the calcium or the arc light. But it is the arc light alone which can take the place of the calcium light for all uses. It leaves nothing to be desired. I cannot agree with the remark of Mr. Lewis Wright in his recent book on "Optical Projection": "Such a powerful light is quite useless for exhibitions unless the disk shown exceeds 30 feet in diameter." My experience is that the better lighted a picture is, the less the eyes of the observer are taxed. With the calcium light the deepest darkness is necessary in other parts of the hall to save the picture from indistinctness, and the reading lamp of the lecturer often blurs one side of it. When the arc light is used the illumination is so abundant that enough lamps, gas or incandescent electric, may be left lighted to enable the audience to see the lecturer and the lecturer to see his audience, so that notes may be taken or a manuscript read, while still the picture can be better seen in all its details than with any other artificial light. The ability to have other lights in the lecture room is sometimes an important consideration in controlling an audience of students. It is useful always. I often project a slide of a diagram or a machine without wholly darkening the room, and go on with recitation or lecture upon it, while the class attend, copy, or take notes as required. In a popular lecture it is far pleasanter. Nothing is more weird for an audience than to sit in deep darkness and listen to a voice coming as from an abyss beyond; nothing more unreal for a speaker than to stand upon a platform and to speak into darkness in which there may be supposed to be interested listeners. With the arc light in the lantern all this is changed, and speaker and hearer may be *en rapport* with each other in a fairly lighted room.

If the operator is on an arc light circuit, his lamp is put directly in series with the others on the same circuit, but the high potential used on such circuits makes such an arrangement rather a ticklish one to work with. The low potential generally used with incandescent lights is more safely handled and there are now many arc lamps used on such circuits. The potential is never above 110-120 volts. At this pressure the wires may be handled as safely as those from a battery. Of course they must not come in contact with each other; for a short circuit will produce a great heat.

If the arc lamp is to be used on an incandescent circuit, additional resistance is required to enable the low resistance arc lamp to burn in multiple with the high resistance incandescent lamps. Arc lamps use from 8 to 15 amperes of current at 115 volts. Apply Ohm's law to this, $C = \frac{E}{R}$ or $R = \frac{E}{C}$, and we have $\frac{115}{8} =$ 15 nearly, and $\frac{115}{15} = 8$ nearly. So an 8 ampere lamp requires 15 ohms and a 15 ampere lamp 8 ohms approximately of resistance to control the current.

A part of this is offered by the arc itself. The adjusting coils of the lamp furnish something more, differing in different lamps, but not enough to make up the resistance to the amount required to choke off an excessive current through the lamp.

There are two ways of arranging the apparatus.

1. The common way is to place a rheostat in the main circuit whose resistance can be varied at will, and thus more or less current be sent through the lamp. This is the method when the current comes from a central station at a constant pressure.

2. Where there is a separate or isolated plant, as in not a few educational institutions, a coil of No. 12 German silver wire (so that it will carry the required current without heating, with a resistance of three or four ohms) may be put permanently in series with the lamp. The remaining adjustment will be made by the field rheostat of the dynamo. For this purpose the field wires should be brought to the lantern table, and a field rheostat be connected to them within reach of the operator. By varying the field resistance he can change the voltage of the current and thus adapt it to the lamp.

The only defect of the arc light for lantern use is the "blinking" caused by the change of the position of the bright spot on the positive carbon. This bright spot emits by far the greater part of the light. To see it, place a deep red and a blue glass together and look through both. The bright spot still looks white, but the rest of the carbons looks dark red. This spot is seen frequently to move, sometimes to swing around, sometimes to jump across to the opposite side of the carbon. This motion is attributed to impurities, principally silicon, in the carbon. The best carbons, the Carré French carbons, are not free from this defect.

The blinking does not make much difference for street use. The light flickers and hisses and we endure it, but in the lantern, if the arc goes to the back side of the carbons, the picture is blurred or obliterated entirely. This motion of the arc is fatal to the use of the light for projecting microscopic objects. The light entirely leaves the focus of the objective, and comes back when it gets ready. Several microscopic societies have abandoned the arc light in disgust on this account, though when the arc is in its proper position, the illumination is superb.

The remedy for blinking has been to place the center of the negative carbon in front of the positive by a distance equal to its radius. This serves two purposes. The distance from the tip of the negative carbon to the front side of the positive carbon is the shortest and easiest path for the arc, and so the arc will remain in front of the carbons, unless something makes it move. A second object which is gained is to form the crater in the positive carbon so that it slopes toward the condenser as shown in Fig. 1.

In street lamps the axes of the carbons are placed in the same vertical line. The crater tends to be horizontal, and the light is radiated downward and equally all around as it should be. This is just what is not wanted in the lantern. The position shown increases the amount of light sent out toward the condenser and screen. Carrying this idea still further, lamps are made in which the carbons are set on a slope of about 20°, in which position the negative carbon cuts off but little of the light from the crater of the positive carbon, as is seen in Fig. 2. A comparison of Fig. 1 with Fig. 2 shows an angle of opening between the carbons 10° larger in the inclined carbons, although both figures are made from the same negative. The carbons in the focusing lamp used on the tower of the Madison Square Garden are set in this position. It is more convenient for me to tilt my lamp forward and make the lower carbon negative, which answers the same purpose.

According to my observation, this is but a partial remedy for the defect of blinking, and I have devised and constructed a special regulator for holding the arc in its proper position, which so far as I know is new and original and which has proved successful.

The fact that a magnet strongly repels an electric

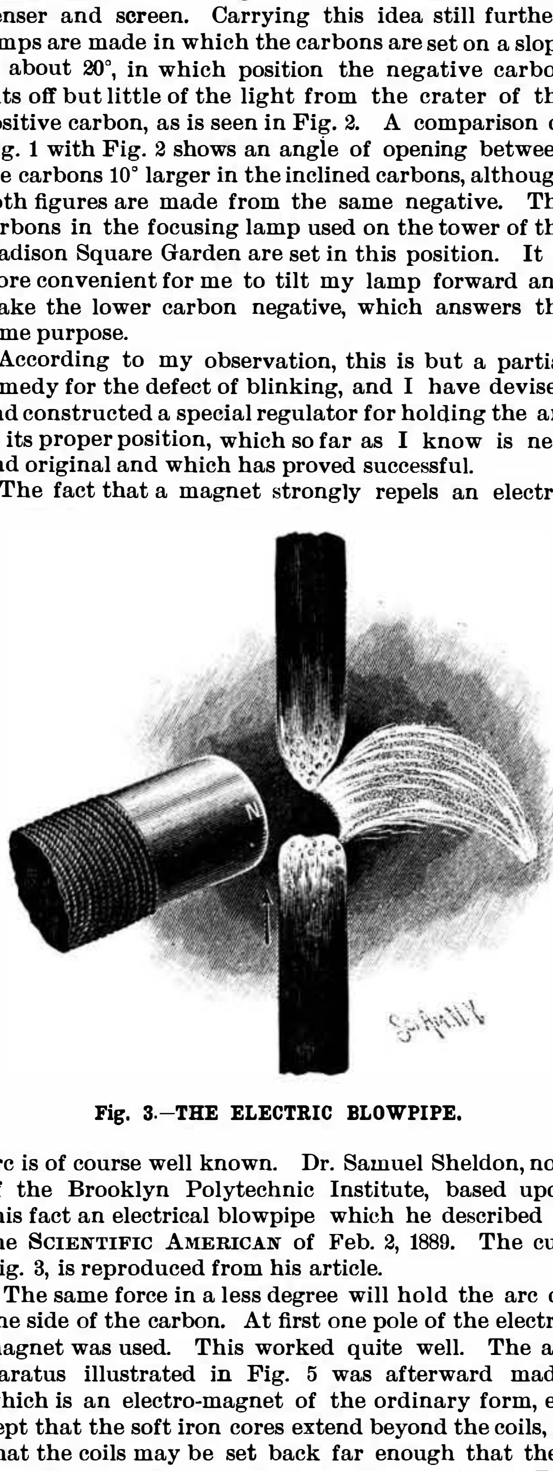

Fig. 3.—THE ELECTRIC BLOWPIPE.

arc is of course well known. Dr. Samuel Sheldon, now of the Brooklyn Polytechnic Institute, based upon this fact an electrical blowpipe which he described in the SCIENTIFIC AMERICAN of Feb. 2, 1889. The cut, Fig. 3, is reproduced from his article.

The same force in a less degree will hold the arc on one side of the carbon. At first one pole of the electromagnet was used. This worked quite well. The apparatus illustrated in Fig. 5 was afterward made, which is an electro-magnet of the ordinary form, except that the soft iron cores extend beyond the coils, so that the coils may be set back far enough that their insulation may not be destroyed by the heat. The cores are of ¼ inch rod, 2½ inches long, and set 2 inches apart. Eight to twelve turns of No. 12 wire on each core will produce a field strong enough when the poles are set about a half inch behind the carbons. The mode of attachment to the lamp is plain from Fig. 4. It will be seen that the rod which carries the regulator is attached to the base of the lamp and that the magnets can be moved forward and backward. If too near, they drive the arc out with a hissing noise. The regulator is adjusted once for all as high as the focus of the condenser, and as the carbons consume, the rack and pinion brings the arc up to its place again, with reference both to the regulator and condenser. The regulator is in series with the lamp, and the whole current goes through it. It might be in parallel, but nothing would be gained by that arrangement.

I have had it in use for more than a year with the best results. Any one can easily make one and test its working. It is confidently expected that it will enable the arc lamp to come into use for lantern projections wherever the heavy current can be had.

Torpedo Boat for Australia.

The first-class seagoing torpedo boat lately constructed for the Victorian government by Messrs. Yarrow & Co. left London for Melbourne, December 12. This vessel is 130 ft. in length by 13 ft. 6 in. beam, and on trial was found to have a speed of 22¾ knots during a run of three hours' duration in a fully equipped condition, with all weights on board.

The Law's Delay, its Heavy Costs, its Uncertainty.

During the past eighteen years the *Review* has published hundreds of columns relating to the suit of the Webster Loom Company *vs.* A. & E. S. Higgins. It now remains only to close the account, as the famous litigation may be assumed to be practically ended. On a motion being made for final argument by Mr. Walter Griffin, delay was asked for by the plaintiffs on the ground that their counsel had thrown up the case and they desired to substitute new attorneys. This means probably the final termination of a case which has attracted more attention and cost more money, time and trouble than any in the history of American patent litigation.

The cost has been something enormous. Years ago it was estimated that each side had expended $200,000 in fees and expenses. All the defendants, Elias S. Higgins, Alvin Higgins and N. D. Higgins, are dead, as are also Judge Bradley, who wrote the decision of the United States Supreme Court in favor of Webster's claim; Judge Hoar, of Massachusetts; Judge Nixon, of New Jersey; Roscoe Conkling and Geo. Gifford, the lawyers for A. & E. S. Higgins; Parker, the New Brunswick Company's lawyer; Davis, Wm. and John Duckworth, the experts; and E. N. Dickerson, the plaintiffs' counsel.

At one time the damages were calculated at $28,750,000, but after Mr. Wm. G. Smith's examination, which lasted two years, covered 6,294 questions and filled 2,384 printed pages, this claim was withdrawn and the claim for profits reduced to about $1,500,000. The Webster Loom Company's patents have expired; they never built a loom; all the defendants, as has been said, are dead, but the case has survived. And yet such is the judicial respect for previous decisions that the error made by Judge Nixon in the New Brunswick case in 1874 was not examined on its merits until sixteen years later, when the decision was pronounced radically erroneous. The master in chancery decided that the Webster Loom Company could receive only nominal damages. Judge Shipman reversed this decision. The defendants appealed, and Judge Wallace reversed his own decision of 1884. Then Judge Shipman wrote a second decision, agreeing with Judge Wallace. Beautiful uncertainty is the essence of law.

And yet in 1887 Mr. Griffin discovered that since 1856 the Roxbury Carpet Company had been using Johnson's wire motion, which the master decided to be better than Webster's. So there was really never any foundation for the action.—*Carpet Trade Review.*

Causes of Carpet Sprouting.

The surface of a Brussels carpet is composed of loops of worsted yarns packed closely together. When any one loop is formed, the particular worsted thread of which the loop is a portion sinks beneath the linen or cotton cross thread (weft) and remains with other threads in the body of the fabric until it is required to form another loop on the surface. These surface loops are held in position by the cross threads (weft), the closeness of the fabric and the intermingling of the various strands of worsted. Not being tied or knotted down, should any loop be caught or pulled by a sharp point in brush, broom, boot, paw or claw, then the worsted underneath will be drawn above the surface and the loose ends and tag will form a well developed case of sprouting.

The trouble is especially liable to occur in first-class goods in which the yarn is fine, soft and highly dressed, and in carpets in which the ground is not well covered. In grounds well covered the threads cross each other frequently and are thereby held down more firmly.

There is but one remedy, and that is to clip off at once all the loose ends. With careful, close clipping the threads by degrees get flattened down and the trouble ceases.

In every case of complaint from a customer the dealer should be especially careful to place the matter in the hands of an experienced employe, whose special business should be not only to see to the remedy, but also to ascertain the cause of the trouble. He should keep a sharp lookout for dogs and cats, whose paws or claws may have started the threads. The casters of all articles of furniture in the room should be examined, and likewise all legs of tables, chairs, etc., not provided with casters. A rough caster or a jagged end of wood has caused many a case of sprouting. Nails in boot heels have likewise much to answer for in this direction. Parrots, given the freedom of a room, are apt to use both beaks and claws on a carpet with disastrous effect. But the worst enemy of carpets is the common broom in the hands of a maid more muscular than intelligent. If possible, the housewife should avoid sweeping a new Brussels carpet for some months; that is, until the loops get trodden down somewhat. If sweeping is regarded as absolutely necessary, the only proper thing to use is a good carpet sweeper run over the carpet with the utmost possible care.—*Carpet Trade Review.*

A MYSTERIOUS ringing of electric bells in a Swiss house was traced to a large spider, which had one foot on the bell wire and another on an electric light wire.

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