The effect of use and long exposure on the strength of boiler iron was found to be a great diminution of its strength, none of the specimens coming up to 50,000 lbs.

The effect produced by the accidental overheating of a boiler, was found to be the permanent reduction of its strength from 64,000 or 65,000 lbs., to 45,000 lbs. per square inch, being about 1/3d of the original strength.

The permanent extension produced on iron plate by weights much less than are required finally to overcome its cohesion, was a subject of careful examination. The extension began to take place in general when 3/5ths of the breaking weight were applied, and sometimes when only 2/3ths had been applied. The total extension varied be­tween 1/10th and 1/16th of the total length, and was greater in the longitudinal than the transverse direction of the bar.

The following diagram of a fracture is highly instruc­tive. The elongation transversely is 1/10th of the original dimension, and the curve, is 1/7th longer than the chord. The longitudinal direction of the fibres is in the line of the shortest dimension. It is evident that the diminution of the thickness, previously to fracture, must have greatly weakened the plates of the boiler. This boiler plate was taken from that part of the boiler immediately over the fire, and had burst where sediment had collected, and excluded the water from contact with the boiler, so as to allow it to get overheated.

It is evident that the diminution of area at the point of fracture, which accompanies this stretching of the plate before fracture, must weaken the plate very greatly when it is exposed to strains that stretch it much beyond its initial length, this strain being about half the ‘breaking strain due to the original thickness. This constriction or thinning out of the plate is observed to take place much more in thickness than in breadth, and to amount in iron to about 161/2 per cent of the whole area. It is remarkable, that the constriction was found less in heat­ed than in cold specimens of iron, a result the reverse of that which we should have anticipated. The fractures at high temperatures were found to take place suddenly, and the surfaces of fracture presented appearances alto­gether different from those exhibited at low temper­atures ; the peculiarity of the fracture at high temper­atures being, that the section is smooth and flat instead of jagged, fibrous, and irregular, and that it takes place directly across the plate, and tapering off at an angle of 45°, so that the separate fragments resemble “ the edges of two mortising chisels.” One result which we deduce from the American investigation is, that boiler iron can­not safely be trusted with a greater pressure than ’th of its standard maximum cohesion. Such are some of the valuable facts elicited by this transatlantic investigation. The experiments should be repeated in this country upon the different species of our own iron ; and we have no doubt the subject will be taken up by some of those gentlemen who have prosecuted valuable researches on the strength of metals; into which, however, they have not yet introduced the element of high temperature.

The increase of the strength of iron, with the increase of its temperature up to 570°, is a remarkable anomaly which should incite us to examine other metals, and metallic alloys, in a similar manner, for the purpose either of resolving this phenomenon into some general law of corpuscular force, or of setting it aside as a cha­racteristic and distinctive property of that singular metal. To the practical man, this discovery is of importance, insomuch as it has shown him a quality in iron, as a material for boilers, which may weigh strongly with him when he hesitates in choosing.

The comparative value of copper and iron boilers is materially affected by this enquiry. The great advan­tages of copper are its durability, its high conducting power, and the value of the old materials. It is by no means so strong as iron, being, when cold, 3/5ths of the strength of iron, and at 500° only about 3/8ths of the strength of iron. But thin iron decays so rapidly, that its strength to-day is no criterion of its strength to­morrow : it decays so rapidly, especially with the salt water of steam vessels, that its very strength at first is necessarily followed with subsequent danger ; for an iron boiler having once borne a great pressure with impunity, will afterwards, when the rapid but unseen decay has insiduously eaten through the metal, be again subjected to the same ordeal by which it had been for­merly proved ; and although under apparently the same circumstances, it may yield to the strain, and produce the distressing consequences of a violent explosion. It is time alone, then, that is the great enemy of iron boilers, while the integrity of the copper will continue unimpaired for a quarter of a century. On the whole, we find that the following general result should limit our faith in the materials of boilers :—

Standard strength of boiler plate, . . 55.000.

Strength after riveting, . . . . 2/3.

Strength after heating and cooling in use, . 2/3. Strain of permanent extension, . . . 2/5.

Greatest practical strength = 2/3 of 2/5 + 2/3 = 8/45 = 1/6 nearly.

The greatest practical strength being 1/6th of the abso­lute cohesion, and the greatest practical strength, to prevent explosion, being four times more than any boiler should be ordinarily worked at, we have -2/45 or 1/22 of the standard strength of boiler iron, as its ordinary working pressure ; 2,500. lbs. of extension on each square inch of cohesive action may, therefore, be assigned as the safe working strain of iron boilers.

To a steam-engine boiler there are many appendages, contrived for the purpose of facilitating the regulation of the quantity of fuel or of water, the intensity of com­bustion, the elasticity of the steam. One of the most simple and essential of these is a water-gauge. Water-gauges are of three kinds, glass-gauges, stopcock­gauges, and float-gauges.

The glass-gauge is of two kinds, plane and tubular. A plane glass-gauge consists simply of a small window in a boiler, of very thick glass, inserted at the place up to which the water should rise in the boiler. The tubular glass-gauge is a small pipe of glass about half an inch in the internal diameter, and an inch and a quarter in thick­ness. It is placed on the outside of the boiler, and com­municates at the top and bottom by stopcocks with the interior of the boiler ; the higher stopcock enters the boiler among the steam, a little above the upper sur­face of the water, and the lower stopcock enters a little below the surface of the water, so that the water, stand­ing in the glass tube on the same level with the water in the boiler, shows itself in the glass tube to the attend­