copper being given, it may be unhesitatingly recom­mended in point of safety, durability, and ultimate eco­nomy.

In the article Steam, we have already introduced our readers to the important experimental researches of the Commission of the Franklin Institute in America, concerning the structure, phenomena, and explosions of steam-boilers. We shall, in another place, present the results of their investigations of the causes of explosion. But there is a branch of the investigation undertaken by the committee, which is of importance to our present enquiry. It regards the strength of the materials of steam-boilers ; a subject not before satisfactorily ex­amined ; and relates more immediately to the effect of high temperatures on the cohesive attraction of the particles of metals ; an enquiry essential to our know­ledge of the manner in which the known strength of metal, when cold, may be altered when, in a boiler, it is subject to the action of a fierce fire. The sub­committee to whom this subject was intrusted, were men of great practical skill and eminent scientific attain­ments. Professor Walter R. Johnson, Benjamin Reeves, Esq., and Professor A. Dallas Bache, were the members to whom the enquiry Was committed; and it has been carried on with a degree of judgment in its arrange­ments, and of precision in the experiments, which war­rant our implicit confidence in the results, and deserve our sincere thanks for the valuable additions made to our knowledge of this important and difficult subject. The importance of the branch of enquiry committed to these gentlemen, may be judged of from the following state­ment of its principal branches.

1. What is the absolute tenacity of rolled boiler iron at ordinary temperatures, and how great the irregulari­ties to which it is liable ?

2. A similar determination for copper boiler plates.

3. What effect is produced on the tenacity of these boiler plates by change of temperature ?

4. What is the effect produced on the tenacity of iron by various processes of manufacture, such as wire-draw­ing, hammering, or rolling into bars or rods ?

5. What are the comparative tenacities of boilerplate made from different mixtures of crude iron and from refined irons ?

6. What is the comparative value of sheet iron manu­factured by the processes of puddling, blowing, and piling respectively ?

7. What is the effect of piling, into the same slab, iron of different degrees of fineness ?

8. What is the comparative tenacity of rolled iron in the longitudinal, diagonal, and transverse directions of the rolling respectively ?

9. What is the influence of frequently repeated heat­ing on the plates of a boiler ?

10. What relation exists between the force that will produce a permanent elongation in boiler plate, and that which will entirely overcome its tenacity ?

11. What amount of elongation may the several kinds of metallic plates undergo before fracture ?

12. What is the effect of rivets on the strength of a boiler ?

These are some of the many important subjects of experiment undertaken by the committee. They have discharged the duties devolved upon them in a manner which is highly honourable to themselves, and which reflects great credit on the institution and the country that has sent forth into the world so valuable a contribution to practical science. We regret that the limits of this article will not permit us to enter into the experimental details and subsidiary enquiries connected with the ex­tensive and laborious investigation ; details which are always ingenious and instructive, and will amply repay the minute study of the mechanical philosopher or engineer as a valuable body of experimental truth. But, although we cannot convey to our readers the pleasure we have enjoyed in the perusal of these interesting records, we should do them and our subject injustice did we omit to convey to them the general conclusions which have been obtained.

*Strength of Copper Boiler Plates* The experiments

upon this subject were very numerous. 32° being taken as the standard, it was found that the increments of heat always caused a diminution of strength. Thus, a stripe of copper, capable of carrying 10,000 lbs., was only capable of carrying 7,500 lbs. when heated to a tempe­rature of 500° ; while at 820° the same bar could support no more than a tension of 5,000 lbs, and at 1200° a visibly red heat in day-light no more than about a tenth part of the strength remains. By these experiments the law which connects the diminution of cohesion with the increase of temperature has been accurately deter­mined, and it appears conformable to the following simple expression,

σ=σ

when

Log. d' = 3/2 (Log. *t'*—Log. *t*) Log. *d*

by means of which the diminution of strength having been ascertained for one temperature, it may be found for every other according to the following rule. From the logarithm of (*t'*) the temperature (reckoned from 32°) of the diminution sought, subtract the logarithm of a given temperature, (*t*) and multiply three halves of the remainder by the logarithm of the known diminu­tion (d) of strength at the latter temperature, and the product is the logarithm of the required diminution at the temperature assigned.

The following table exhibits the close accordance of the experiments with this law.

Table of Diminution of Strength of Copper Boiler Plates when heated. Their standard strength at 32°, being 32,800 lbs. per square inch.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Temperature above 32®. | Diminution of Strength. |  | Temperature above 32®. | Diminution of Strength. |
| 1 | 90° | 0.0175 | 9 | 660° | 0.3425 |
| 2 | 180° | 0.0540 | 10 | 769° | 0.4398 |
| 3 | 270° | 0.0926 | 11 | 812° | 0.4944 |
| 4 | 360° | 0.1513 | 12 | 880° | 0.5581 |
| 5 | 450° | 0.2046 | 13 | 984° | 0.6691 |
| 6 | 460° | 0.2133 | 14 | 1000° | 0.6741 |
| 7 | 513° | 0.2446 | 15 | 1200° | 0.8861 |
| 8 | 529° | 0.2558 | 16 | 1300° | 1.0000 |

We are, therefore, warranted in admitting the con­clusion, that the square of the diminution of strength varies with the cube of the temperature.

Hence we learn, that between the temperature of freezing and boiling water copper loses 5 per cent of its strength ; that at 550° it loses about a quarter of its strength; at 850° the half of its strength; and at 1330° loses all its strength, becoming a viscid, granular, soft, incohesive, substance; although it does not actually melt until it attains nearly 2000°. These phenomena in copper are strikingly at variance with the phenomena exhibited by iron at the same temperatures.

In this substance the remarkable anomaly was dis­covered, that the additions of heat, instead of weakening the metal, as we should have expected, and as was found