to be the case with copper, actually increased its strength, so that iron plate at 550° above the freezing point was 16 per cent stronger than when cold. After this point the strength began to diminish rapidly, so that this point appears to be the temperature of maximum strength. It was assumed as the standard strength, on both sides of which the strength was found to be dimi­nished both by heat and cold. The strength diminishes rapidly with increments of temperature, after passing the maximum at 570° : thus,

At 32° to 80° the tenacity was = 56,000 lbs. or 1-7th below its maximum. -At 570° — = 65,500 lbs., the maximum.

At 720° — = 55,000 lbs., the same nearly as at 32°.

At 1030o — = 32,000 lbs., nearly 1/2 of the maximum.

At 1240º — = 22,000 lbs., nearly 1/5 of the maximum.

At 1317° — = 9,000 lbs., nearly 1-7th of the maximum.

At 3000° iron becomes a fluid.

The following is a table of a series of these experi­ments.

Table of Experiments on Iron Boiler-Plate at High Temperatures; the Mean Maximum Tenacity being at 550° = 65,000 lbs.

|  |  |  |  |
| --- | --- | --- | --- |
| Temperature observed. | Diminution of Tenacity observed. | Temperature observed. | Diminution of  Tenacity observed. |
| 550° | 0.0000 | 824 | 0.2010 |
| 570° | 0.0869 | 932 | 0.3324 |
| 596° | 0.0899 | 947° | 0.3593 |
| 600° | 0.0964 | 1030° | 0.4478 |
| 630 | 0.1047 | 1111 | 0.5514 |
| 562 | 0.1155 | 1155 | 0.6000 |
| 722 | 0.1436 | 1159 | 0.6011 |
| 732 | 0.1491 | 1187 | 0.6352 |
| 734 | 0.1535 | 1237 | 0.6622 |
| 766 | 0.1589 | 1245 | 0.6715 |
| 770 | 0.1627 | 1317 | 0.7001 |

The law of variation of the strength of iron and of copper by temperature may be easily illustrated by the following curves, of which the horizontal ordinates are temperatures, and the vertical abscissas are diminutions of strength.

The temperatures are measured from the origin A towards T. The total strength being = AX = 1000, the diminutions of strength are represented by the fractions of A X measured from A towards X. These curves represent to the eye very distinctly the characteristics of the metals. The line for copper, rising from zero at A, shows, by continual recession from its maximum AA, the continual and regular diminution of strength by

increased temperature according to the law already stated. The line representing the iron, on the contrary, having its origin 15 per cent above A, descends and shows an increase of strength until it reaches a maximum about 500°, whence it suddenly rises, showing a very rapid diminution of strength up to 1000°, when again it changes, turns outwards having a point of inflection be­yond which it may be carried to a great distance, while at last it becomes liquid between 2000° and 3000°.

The next branch of the enquiry was, how the strength of iron is affected by the mode of its manufacture, and by the different states in which it is used, as in bars, in wire, or in plates, produced by hammering, drawing, or rolling. The following are the results of several ex­periments on the tenacity of different kinds of iron, at ordinary temperatures.

0.333 . . 84,186 lbs.

Iron Wire, diameter 0.190 . . ∙ 73,888

0.156 . . 89,162

Russian Bar Iron, ..... 76,069 English Cable Iron, hammer-hardened, . 71,000

English Cable Iron, .... 59,105 Lancaster Co. U.S. . . . . 58,661

Centre Co., US., ..... 58,400 Swedish Bar, 58,184

Salisbury Com., U.S., .... 58,009

Tenessee Bar, U.S., . ... 52,099

Slit Rods, 50,000

Missouri Bar Iron, .... 47,909

No. 1. Pig iron, of the white fracture, produces the most cohesive bars.

No. 2. Pig iron, of a lively gray fracture, produces bars inferior to No. 1 by 11/2 per cent.

No. 3. Pig iron of a dead gray fracture, produces bars inferior to No. 1 by 2 to 3 per cent.

No. 4. Pig iron, of a mottled fracture, produces bars inferior to No. 1 by 5 per cent.

A mixture of all the kinds produces bars inferior to No. 1 by 5 to 10 per cent.

The difference between the strength of boiler-plate, cut lengthways and across, was found to be about 6 per cent in favour of the longitudinal over the crosscut.

Stripes cut longitudinally sustained 63,947 lbs. Stripes cut transversely sustained 60,176 lbs. Stripes cut diagonally sustained 53,925 lbs.

The specific gravity of iron boiler plate was found to range from 7.7922 to 7.6013., and to be at a mean value 7.7344.

The effect of repeated piling and welding was found to be a great increase on the strength of iron. The iron given in the preceding table, from the Centre Company’s manu­factory, whose strength when rolled amounts to 58,400, was found to be so much improved by piling four bars and welding twice, as to support a mean of 59,247 lbs., and to be so homogeneous that the highest did not differ from the lowest results by more than 3.4 per cent in the different specimens. Simple welding twice without piling, gave a result of 58,787 lbs.

It has been thought that by welding together dif­ferent kinds of iron of different degrees of fineness, and then rolling it out, a valuable boiler-plate might be obtained. This was tried, and the highest result gave only 40,600 lbs.

The weakening effect of riveting is thns calculated from these experiments, being a diminution on the whole of 1/2 of the original strength.

Strength of the stripe without riveting. . . 9290. Strength of the remaining metal, deduct­

ing rivet-holes, + 5662.

Diminution of strength by rivet-holes, . ∙ —3628.

Strengthening effect of rivets, . . . + 679.