commonly employed in our mechanics, and other ſtructures where they are exposed to this kind of ſtrain. Theſe muſt be deduced ſolely from experiment. Therefore they muſt be conſidered as no more than general values, or as the averages of many particular trials. The irregularities are very great, becauſe none of the ſubſtances are constant in their texture and firmneſs. Metals differ by a thouſand circumſtances unknown to us, according to their purity, to the heat with which they were melted, to the moulds in which they were caſt, and the treatment they have after­wards received, by forging, wire-drawing, tempering, &c.

It is a very curious and inexplicable fact, that by forging a metal, or by frequently drawing it through a ſmooth bole in a ſteel plate, its coheſion is greatly increaſed. This operation undoubtedly deranges the natural situation of the particles. They are ſqueezed cloſer together in one direc­tion ; but it is not in the direction in which they refill the fracture. In this direction they are rather ſeparated to a greater diſtance. The general density, however, is augment­ed in all of them except lead, which grows rather rarer by wire-drawing : but its coheſion may be more than tripled by this operation. Gold, ſilver, and braſs, have their cohesion nearly tripled ; copper and iron have it more than doubled. In this operation they alſo grow much harder. It is proper to heat them to redneſs after drawing a little. This is called *nealing* or *annealing.* It ſoftens the metal again, and renders it ſusceptible of another drawing without the riſk of cracking in the operation.

We do not pretend to give any explanation of this re­markable and very important fact, which has ſomething reſembling it in woods and other fibrous bodies, as will be mentioned afterwards.

The varieties in the coheſion of ſtones and other minerals, and of vegetable and animal ſubſtances, are hardly ſuſceptible of any deſeription or claſſification.

We ſhall take for the meaſure of coheſion the number of pounds avoirdupois which are juſt sufficient to tear aſunder a rod or bundle of one inch ſquare. From this it will be easy to compute the ſtrength correſponding to any other dimension.

|  |  |  |  |
| --- | --- | --- | --- |
|  | 1st, Metals. | lbs. | |
| Gold, caſt |  |  | 20,000 |
|  |  |  | 24,000 |
| Silver, caſt |  |  | 40,000 |
|  |  |  | 43,000 |
|  | Japan |  | 1\9,500 |
|  | Barbary |  | 22,000 |
| Copper, caſt | Hungary |  | 31,000 |
|  | Anglesea |  | 34,000 |
|  | Sweden |  | 37,000 |
| Iron, caſt |  |  | 42,000 |
| Ordinary |  | 59,000 |
|  |  | 68,000 |
| Iron, bar | Stirian  Beſt Swediſh and Russian |  | 75,000  84,000 |
|  | Horſe-nails |  | 71,000 @@(a) |
| Steel, bar | Soft |  | 120,000 |
| Razor temper |  | 150,000 |
|  | Malacca |  | 3,100 |
|  | Banca |  | 3,600 |
| Tin, caſt | Block |  | 3,800 |
|  | Engliſh block |  | 5,200 |
|  | grain |  | 6,500 |

|  |  |  |
| --- | --- | --- |
|  |  | lbs. |
| Lead, caſt |  | 860 |
| Regulus of antimony |  | 1,000 |
| Zinc |  | 2,600 |
| Biſmuth |  | 2,900 |

It is very remarkable that almoſt all the mixtures of me­tals are more tenacious than the metals themſelves. The change of tenacity depends much on the proportion of the ingredients, and the proportion which produces the most tenacious mixture is different in the different metals. We have ſelected the following from the experiments of Muſchenbroek. The proportion of ingredients here ſelected is that which produces the greateſt strength.

|  |  |
| --- | --- |
| Two parts of gold with one of ſilver | 28,000 |
| Five parts of gold with one of copper | 5c,00o |
| Five parts of ſilver with one of copper | 48,500 |
| Four parts of ſilver with one of tin | 41,000 |
| Six parts of copper with one of tin | 41,000 |
| Five parts of Japan copper with one of Banca tin | 57,000 |
|
| Six parts of Chili copper with one of Malacca tin | 60,000 |
|
| Six parts of Swediſh copper with one of Malac­ca tin | *64*,000 |
|
| Braſs conſiſts of copper and zinc in an un­known proportion ; its ſtrength is | 51,000 |
|
| Three parts of block-tin with one part of lead | 10,200 |
| Eight parts of block-tin with one part of zinc | 10,000 |
| Four parts of Malacca tin with one part of re­gulus of antimony | 12,000 |
|
| Eight parts of lead with one of zinc | 4,500 |
| Four parts of tin with one of lead and one of zinc | 13,000 |
|

Theſe numbers are of conſiderable uſe in the arts. The mixtures of copper and tin are particularly intereſting in the fabric of great guns. We see that, by mixing copper whoſe greateſt ſtrength does not exceed 37,000 with tin which does not exceed 6,000, we produce a metal whoſe tenacity is almoſt double, at the same time that it is harder and more easily wrought. It is, however, more sensible, which is a great inconvenience. We alſo ſee that a very ſmall addition of zinc almoſt doubles the tenacity of tin, and increaſes the tenacity of lead five times ; and a ſmall ad­dition of lead doubles the tenacity of tin. Theſe are eco­nomical mixtures. This is a very valuable information to the plumbers for augmenting the ſtrength of water­pipes.

By having recourſe to theſe tables, the engineer can pro­portion the thickneſs of his pipes (of whatever metal) to the pressures to which they are expoſed.

2d, Woods.

We may premiſe to this part of the table the following general obſervations :

I. The wood immediately ſurrounding the pith or heart of the tree is the weakeſt, and its inferiority is ſo much more remarkable as the tree is older. In this aſſertion, however, we ſpeak with ſome hesitation. Muſchenoroek’s *detail* of experiments is decidedly in the affirmative. Mr Buffon, on the other hand, ſays, that his experience has taught him that the heart of a sound tree is the ſtrongeſt ; but he gives no inſtances. We are certain, from many ob-

@@@(a) This was an experiment by Muschenbroek, to examine the vulgar notion that iron forged from old horſe-nails was stronger than all others, and ſhows its falsity.