AMERICAN LOCOMOTIVES.

The United States exported 25 locomotives during the fiscal year of 1870, and 60 during the year 1880—an increase of 140%. Several monster locomotives for freight service are in process of construction for the New York, Pennsylvania and Ohio railroad. They rest on six drivers and a four-wheeled truck, and will weigh 38 tons, empty. Train men are considerably troubled by these trains breaking in two when hauled by these powerful consolidated engines, and the only remedy seems to be in equipping freight cars with heaviest drawbars, shackles, and pins.

The following from Mr. R. M. Brereton, C. E., may be quoted as an authoritative English opinion of American built locomotives: "I argue that the greater duty done by the American motor is due to the better design and the better system of working the locomotives. The American builder excels in the system of framing and counterbalancing, and in the designs of crank axles, etc., so that the engine may run remarkably easy and without jar, round sharp curves, and work not only on the light roads, but also diminish the wear and tear on the solid roads, and at the same time increase the effective tractive force. The English engine is a very heavy affair, and in running it not only wears and tears itself very rapidly, but also the roadway, and it greatly, by its unsteadiness and jar, fatigues the drivers and firemen. I have ridden hundreds of miles on engines in India, in England, in France, and in the United States, and I have always found the American engine most easy and comfortable, but I never did the English or the Continental engines. It is almost impossible to give these engines their full hauling power, simply because the greater portion of the weight cannot be thrown off the driving wheels."

THE INFLUENCE OF A TUNING-FORK ON THE GARDEN SPIDER.

Having made some observations on the garden spider which are I believe new, I send a short account of them in the hope that they may be of interest to the readers of *Nature*.

Last autumn, while watching some spiders spinning their beautiful geometrical webs, it occurred to me to try what effect a tuning-fork would have upon them. On sounding an A fork and lightly touching with it any leaf or other support of the web or any portion of the web itself, I found that the spider, if at the center of the web, rapidly slew round so as to face the direction of the fork, feeling with its fore feet along which radial thread the vibration travels. Having become satisfied on this point, it next darts along that thread till it reaches either the fork itself or a junction of two or more threads, the right one of which it instantly determines as before. If the fork is not removed when the spider has arrived it seems to have the same charm as any fly; for the spider seizes it, embraces it, and runs about on the legs of the fork as often as it is made to sound, never seeming to learn by experience that other things may buzz besides its natural food.

If the spider is not at the centre of the web at the time that the fork is applied, it cannot tell which way to go until it has been to the centre to ascertain which radial thread is vibrating, unless of course it should happen to be on that particular thread or one stretched supporting thread in contact with the fork.

If when a spider has been enticed to the edge of the web, the fork is withdrawn and then gradually brought near, the spider is aware of its presence and of its direction, and reaches out as far as possible in the direction of the fork, but if a sounding fork is gradually brought near a spider that has not been disturbed, but which is waiting as usual in the middle of the web, then instead of reaching out towards the fork the spider instantly drops—at the end of a thread of course. If under these conditions the fork is made to touch any part of the web, the spider is aware of the fact and climbs the thread and reaches the fork with marvelous rapidity. The spider never leaves the centre of the web without a thread along which to travel back. If after enticing a spider out we cut this thread with a pair of scissors, the spider seems to be unable to get back without doing considerable damage to the web, generally gumming together the sticky parallel threads in groups of three and four.

By means of a tuning-fork a spider may be made to eat what it would otherwise avoid. I took a fly that had been drowned in paraffine and put it into a spider's web and then attracted the spider by touching the fly with a fork. When the spider had come to the conclusion that it was not suitable food and was leaving it, I touched the fly again. This had the same effect as before, and as often as the spider began to leave the fly I again touched it, and by this means compelled the spider to eat a large portion of the fly.

The few house-spiders that I have found do not seem to appreciate the tuning-fork, but retreat into their hiding-places as when frightened; yet the supposed fondness of spiders for music must surely have some connection with these observations, and when they come out to listen, is it not that they cannot tell which way to proceed?

The few observations that I have made are necessarily imperfect, but I send them, as they afford a method which might lead a naturalist to notice habits otherwise difficult to observe, and so to arrive at conclusions which I in my ignorance of natural history must leave to others.—*C. V. Boys, in Nature.*

THE ISTHMUS SHIP RAILWAY.

Capt. Eads is a good persuader. His remarkable scheme of a ship railway across the Isthmus of Tehuantepec is taking a tangible shape. The Mexican Government has made a very liberal concession, giving him the right to construct a railway on such line as he may select, the work to be commenced within two years and completed within 12 years. He is allowed to charge $5 per cubic meter of the displacement of each vessel transported; also $15 for each passenger on the ship, and 1% on the value of coins or precious stones carried. The Government also gives him a subsidy equal to 1,000,000 acres of public lands, and makes other liberal concessions. While this will go but a little way toward the estimated cost of $75,000,000, it will doubtless assist Capt. Eads in raising money in the United States. He desires to have our Government guarantee 6% dividends on $50,000,000 of the stock of the company in consideration of free transportation of Government ships, officers and soldiers, and the benefit which the proposed road will be to our commerce. This, however, will be difficult to obtain. The projected road is, if built, to be about 112 miles in length, while the proposed Panama canal will be 45 miles long; but the Tehuantepec route will save about 1,500 miles between New York and San Francisco over the Panama route, while the distance from the mouths of the Mississippi to California by Tehuantepec is 2,300 miles less than by Panama. The Panama canal and the ship railway are fairly in the lists as competitors, while the Nicaragua canal scheme is also being urged, and if all are completed, it will be all the better for the country.

MACHINERY FOR WASHING AND SCOURING WOOL.—This is an invention of combination of mechanism for dragging the wool from the washing contrivance up the incline to the squeezing rollers. One of the modifications consists of two sets of frames rammed with teeth, the rays of the teeth in one frame alternating with the rays of the teeth in the other frame, while another modification makes use of only one frame to drag up the wool, the other frame having a lifting movement to retain the wool. The frames are similar to a harrow in construction.

THE COLOR RELATION OF METALS.

In a paper on the color relation of metals, and notably on those of copper, nickel, cobalt, iron, manganese and chromium, lately read before the Chemical Society, Mr. T. Bayley records some remarkable relations between solutions of these metals. It appears that iron, cobalt and copper form a natural color group, for, if solutions of their sulphates are mixed together in the proportions of twenty parts of copper, seven of iron and six of cobalt, the resulting liquid is free from color, but is gray and partially opaque. It follows from this that a mixture of any two of these elements is complementary to the third, if the above portions are maintained. Thus, a solution of cobalt (pink) is complementary to a mixture of iron and copper (bluish green), a solution of iron (yellow) to a mixture of copper and cobalt (violet), and a solution of copper (blue) to a mixture of iron and cobalt (red). But, as Mr. Bayley shows, a solution of copper is exactly complementary to the red reflection from copper, and a polished plate of this metal, viewed through a solution of copper salt of a certain thickness, is silver white. As a further consequence, it follows that a mixture of iron (seven parts) and cobalt (six parts) is identical in color with a plate of copper. The resemblance is so striking that a silver or platinum vessel covered to the proper depth with such a solution is indistinguishable from copper. There is a curious fact regarding nickel also worthy of attention. This metal forms solutions which can be exactly simulated by a mixture of iron and copper solutions; but this mixture contains more iron than that which is complementary to cobalt. Nickel solutions are almost complementary to cobalt solutions, but they transmit an excess of yellow light. Now, the atomic weight of nickel is very nearly the mean of the atomic weight of iron or copper, but it is a little lower—that is, nearer to iron. There is thus a perfect analogy between the atomic weights and the color properties in this case. This analogy is even more general, for Mr. Bayley states that in the case of iron, cobalt and copper, the mean wave length of the light absorbed is proportional to the atomic weight. The specific chromatic power of the metals varies, being least for copper. The specific chromatic power increases with the affinity of the metal for oxygen. Chromium forms three kinds of salts—pink salts, identical in color with the cobalt salts; blue salts, identical in color with copper salts; and green salts, complementary to the red salts. Manganese, in like manner, forms more than one kind of salt. The red salts of manganese are identical in color with the cobalt salts and with the red chromium salts. The salts of chromium and manganese, according to the author, are with difficulty attainable in a state of chromatic purity. He thinks these properties of the metals lead up to some very interesting considerations.

TEMPERED GLASS.—Tempered glass can be tempered in great pieces, gifted with a power of resistance, of which its specific lightness, compared with heavy metals, would not have given the least presumption. It can now be employed, notably in carpentry, for posts, joists, ties and buttresses. It combines the advantages of strength and of incorruptibility, in contact with all atmospheric agents, as well as with chemical factors, and consequently is of perpetual duration. Besides these advantages another is the smallness in the price of acquisition. This material is now as cheap as iron of the same weight, and as a large sale is counted on, it will not be long before the reduction of price will be below the cost of wood. No doubt many industries will profit from this new progress in the fabrication of glass, and it will be greatly appreciated in the household. One will see the time when the metals and wood will be replaced by glass, in a great number of implements, utensils, and objects of diverse nature, such as stop-cocks, gutter-spouts, buckets, and even barrels.