iron. It is alſo heavier, increaſing in weight, according to Chaptal, one hundred and ſeventieth part. M. Rin- man has given as the remit of ſeveral accurate experi­ments on different kinds of ſteel the following specific gravity 7,795, while he makes ductile iron 7,700, and crude iron 7,251.

All iron is convertible into ſteel by exposing it to a certain degree oſ heat for a certain time along with a quantity of charcoal. Chemiſts differ in opinion con­cerning the nature and effects of this proceſs. Some ſay that ſteel is produced by abſorbing a quantity of caloric or heat in a latent ſtate, as the older chemiſts had ſaid it; was formed by abſorbing phlogiston. Lavoiſier ſeems to have aſcribed the qualities of ſteel to a slight degree of oxidation, others to a combination with plumbago or black lead, and others to a union with carbone. In agreeing with thoſe who ſay the forma­tion of ſteel is owing to carbone, we do not differ effen- tially from thoſe who attribute it to plumbago ; for the art of chemiſtry has now found that theſe ſubſtances are very nearly allied. Plumbago is a true charcoal combined with a little iron. The brilliant charcoal of certain vegetable ſubſtances, more eſpecially when formed by diſtillation in cloſe veſſels, posseſſes all the characters of plumbago.@@ The charcoal of animal ſubſtances poffeſſes characters ſtill more peculiarly reſembling it. Like it they are difficult to incinerate, they leave the ſame impreſſion on the hands and upon paper; they likewise contain iron, and become converted into carbonic acid by combuſtion. When animal ſubſtances are diſtilled by a ſtrong fire, a very fine powder sublimes, which attaches itſelf to the inner part ot the neck of the retort, and this ſubſtance may be made into excellent black lead pencils.

There are two ways oſ making ſteel, namely, by fu- ſion and by cementation. The firſt way is uſed to con­vert iron into ſteel immediately from the ore, or from crude or caſt-iron. By the ſecond way, bar-iron is expoſed to a long continued heat ſurrounded by charcoal. Each of theſe ways has advantages peculiar to itſelf ; but the ſame cauſes in fact predominate in both, for both kinds of ſteel are produced by heat and charcoal. The only difference between the two methods is this ; in making ſteel by fuſion the charcoal is not ſo equally defended from the acceſs of air as in the other way.

Swedenborgius has given the following deſcription oſ the method uſed in Dalecarlia for making ſteel from caſt-iron. The ore from which the crude iron to be converted into ſteel is obtained is of a good kind. It is black, friable, and compoſed of many ſmall grains, and it produces very tough iron. The converſion into ſteel is made upon a forge-hearth, ſomething ſmaller than common. The sides and bottom are made of caſt-iron. The tuyere is placed, with very little inclination, on one of the ſide-plates. The breadth of the fire-place is fourteen inches ; its length is greater. The lower part of the tuyere is fix inches and a half above the bottom. In the interior part of the fire-place there is an oblong opening for the flowing of the superfluous scoriæ. The workmen firſt put scoriæ on the bottom, then charcoal and powder of charcoal, and upon theſe the caſt-iron run or cut into ſmall pieces. They cover the iron with more charcoal, and excite the fire. When the pieces of iron are of a red white, and before they begin to melt, they ſtop the bellows, and carry the maſs under a large hammer, where they break it into pieces of three or four pounds each. The pieces are again brought to the hearth, and laid within reach of the workman, who plunges ſome of them into the fire, and covers them with coal. The bellows are made to blow ſlowly till the iron is liquefied. Then the fire is increaſed ; and when the fuſion has been long enough continued, the scoriæ are allowed to flow out ; and at that time the iron hardens. The workman adds more of the pieces of crude iron, which he treats in the ſame manner ; and ſo on a third and a fourth time, till he obtains a maſs of ſteel of about a hundred pounds, which is generally done in about four hours. This maſs is raiſed and carried to the hammer, where it is forged, and cut in­to four pieces, which are farther beat into ſquare bars four or five feet long. When the ſteel is thus forged, it is thrown into water that it may be eaſily broken ; for it is yet crude and coarſe-grained. The ſteel is then carried to another hearth ſimilar to the former, and there broken in pieces. Theſe pieces are laid regularly in the fire-place, firſt two parallel, upon which ſeven or eight others are placed acroſs ; then a third row acroſs the ſecond, in ſuch a manner that there is ſpace left be­tween thoſe of the ſame row. The whole is then covered with charcoal, and the fire is excited. In about half or three quarters of an hour the pieces are made hot enough, and are then taken from the fire, one by one, to the hammer, to be forged into little bars from half a foot to two feet long, and while hot are thrown into water to be hardened. Of theſe pieces sixteen or twenty are put together ſo as to make a bundle, which is heated and welded, and afterwards forged into bars four inches thick, which are then broken into pieces of convenient length for uſe.

The method of converting iron into ſteel by cemen­tation is a very simple proceſs. It consists ſolely in ex- posing it for a certain time to a ſtrong degree of heat, while cloſely covered with charcoal and defended from the external air. The furnaces employed for convert­ing iron into ſteel (ſays a manufacturer of this metal) are of different sizes ; ſome capable of converting only three or four tons weight, while others are capacious enough to contain from ſeven to eight or ten tons. The outſides of theſe furnaces riſe up in the form of a cone, or ſugar-loaf, to the height of a very conſiderable number of feet. In the inside, oppoſite to each other, are placed two very long cheſts, made either of ſtone, or of bricks capable of bearing the ſtrongeſt fire ; which is placed between the two cheſts. The bars of iron, after the bottom is furniſhed with a neceſſary quantity of charcoal duſt, are laid in st*ratum ſuper stratum,* with intermediate beds of the charcoal duſt, to ſuch a height of the cheſts as only to admit of a good bed at top ; which is then all covered over, to prevent the admiſſion of the common air ; which, could it procure an entrance, would greatly injure the operation. The iron being thus situated, the fire is lighted ; which is ſome time before it can be raiſed to a ſufficient degree of heat to produce any conſiderable effect. After which it is con­tinued for ſo many days as the operator may judge pro­per ; only now and then drawing out what they call a proof bar. This is done by openings fit for the pur- poſe at the ends of the cheſt, which are easily and with expedition stopped up again, without occaſioning any injury to the contents left behind. When the opera­

@@@[mu] Chaptal's Chemistry, vol. ii. p. 347.