absorption. Examination of a piece of spongy iron will show that it is of honey-combed structure, consisting of particles of metal seemingly cohering only very slightly, leaving space between. Iron in this condition is pure or impure, according to the richness of the ore used. If the ore used in producing it contains few impurities and these only of the less injurious sorts, so will the spongy iron be almost perfectly pure. The chief impurities contained in the spongy iron are phosphorus, sulphur, silicon and manganese. Of these debasing elements absorbed by the metal the worst are phosphorus and sulphur. These two are very low in our ores. The spongy iron, active as we have seen, takes up about 88 per cent. of the phosphorus contained in the ore and which is derived from the phosphoric acid present. The presence of phosphorus in the metal is very injurious, as we shall see further on. The sulphur taken up or absorbed by the mass of spongy iron is derived chiefly from the presence of the iron pyrites in the fuel; it is also derived from the bi-sulphide of iron, which is an impurity found in very small quantities in our ores. The sulphur can, as a debasing element, be largely prevented from absorption by certain methods, of which the chief feature is the use of lime in excess. Silicon and manganese do not rank so highly as debasing elements, still they are debasing, and have to be got rid of as much as possible. *Of the two, silicon is generally considered the* worst in its effects. The silica is derived from various impurities present in the ore and coke; these are chiefly clay and quartz and present generally in the form of silicates, and they are fused or melted with such great difficulty, even under the high temperature present in the blast furnace, that they are considered practically to be unfusible, hence the employment of limestone. This limestone, by entering into combination with the earthly impurities, changes them into substances which are capable of being smelted or made fusible to a considerable extent; the lime combining, as we have seen, with the clay and quartz, forming the silicate of lime and silicate of alumina, and this being fused into a species of lime glass, otherwise known as slag. About half the manganese contained in the ore unites with the iron, and the remainder goes off with the slag.

Another element taken up by the iron is carbon. This, however, is done in such a particular way that it has given rise to a term which indicates its characteristic, viz., carbon deposition, showing that it is not so much a process of absorption of the carbon by the spongy iron, as that it is mechanically placed or deposited upon the surface of the granules of the iron. Carbon unites with the iron from 2 up to 5 per cent.

Considerable diversity of opinion exists as to the exact position in the furnaces at which fusion of the ore takes place. Chemists know that certain combinations must, in certain circumstances, produce certain results, but it does not follow that they can trace or define the exact position of this fusion. The very condition of the furnace shows that there must be points at which we can only guess at what is going on. It is when the absorbing or combining process is completed that the process of complete fusion commences, it being completed at what is known as the "zone of fusion." The narrowing or decreasing of the area of the furnace just here is rendered necessary by the decreasing bulk of iron now in a state of fusion; it serves also to intensify the temperature at the lowest point, or that at which the crucible of the furnace is situated, at the point where the furnace is at its narrowest, called the "white heat zone." When the melted iron in its downward course passes through at what is called the "white heat zone," the fusion or reduction is complete. The mass of metal thus assumes the lowest position; the slag being lighter or of less gravity, floats, so to speak, on the top of the metal. This slag is taken from the furnace every two and a half hours, and run into a large "slag ladle," and from thence dumped into the field. When the reduction is completed, which takes six hours, the metal is ready to be withdrawn from the furnace, which is done by opening the tap hole, when it flows into a long channel or sewer formed in the sand, which constitutes the floor. Branching off from the main channel are minor ones or molds, into which the molten metal flows. These molds or channels are called pigs, hence the term by which the bars of cast iron are known is familiar to every one as pig iron; the length of these pigs is about four feet, and the breadth from three to four and one half inches. When making iron for the steel and forge works, the furnace turns out on an average 82 tons of iron every twenty-four hours. This, when cooled, is loaded and shipped direct to the N. S. Steel and Forge Co. in Trenton. These works were erected in 1882, and consist of 2 Siemens-Martin melting furnaces, 20 tons capacity each; 3 gas heating furnaces, 5 reverberatory heating furnaces, 26-inch reversing cogging mill with trains of live rolls, heavy vertical hot billet shears with live rolls, 1 20-inch plate mill, 1 16-inch bar mill, 1 12-inch bar mill, 1 9-inch guide mill, 12 pairs shears (40 tons and smaller), 1 5-ton steam hammer with 15-ton hydraulic crane, 5 smaller ones; machine shop, 175 feet by 75 feet, with 30-ton travelling crane commanding whole shop, equipped with 24-inch slotter, 6 drills (1 a 9-foot radial, 5 spindle), 9 lathes, one of which will swing 8 feet 10 inches in the gap, will take 37 feet between centres; small and large planers, shapers, etc. Power is supplied by some 50 steam and 10 hydraulic cylinders; entire works are lighted by arc and incandescent light; output, 100 tons of steel per day. This company has supplied over 97,000 axles to Canadian railways. The pig iron used in making steel, prior to the erection of the Ferrona furnace, was imported from Great Britain, but as the Ferrona iron is specially adapted for steel making on account of the small percentage of sulphur and phosphorus, the N. S. Steel and Forge Co. are able to use it in large quantities.

Before describing the conversion of pig iron into steel, it might be well first to note what steel really is. On the one side we have pig iron, a hard and comparatively brittle substance, containing carbon from two up to as high as five per cent. On the other, wrought or malleable iron containing very small quantities of carbon. From between these two bodies, therefore, we obtain steel. It is a body or substance intermediate, distinct in itself, yet possessing the characteristics of both. The distinguishing property of steel containing carbon over 0.35 per cent. is the power of being hardened at pleasure by being plunged while hot into water, oil or other medium by which it is rapidly cooled, being intermediate in position between wrought and pig iron. Steel is both fusible and malleable, but requires a higher temperature for fusion than pig iron, and a greater compressing power owing to its lower welding temperature than wrought iron. Those varieties that are richest in carbon are the hardest and most fusible,