Neilson, a young gas engineer of Glasgow, was granted a patent in 1828, entitled: "Improved application of air to produce heat in fires, forges and furnaces, where bellows or other blowing apparatus are required." He found in experimenting with an ordinary smith's forge, that if the blast were heated, the iron in fire was brought to the same heat, using far less fuel than could be done with cold blast. After numerous attempts to obtain the consent of some of the ironmasters in the vicinity to make the experiment at a furnace (there being a very strong prejudice against any meddling with the furnace, as while a furnace was running properly, a small set-back meant, sometimes, weeks before furnace would be again on good iron), the first trial was made at the Clyde works, in 1829. At each tuyere or blast nozzle was placed a wrought iron box, or oven, heated by a fire underneath, whereby a blast temperature of 200° F. was attained. Even this small rise showed a decided improvement in fuel consumption and increased output. Boxes were short-lived, however, and were soon replaced by cast iron retorts, six feet by two feet nine inches, which were much more durable, and temperature of blast rose to 280° F. The first proper stove was erected in 1832 by Neilson, at the same works. Blast was passed through a series of Λ-shaped pipes placed in one large oven, which supplied all the tuyeres with hot blast at a temperature of about 600° F. The waste gases from furnace were next used to heat the blast. First arrangement was simply passing the hot gases over the pipes conveying the blast, whereby excess of heat was absorbed, but gases were not ignited. In the next type of stove they were ignited with an access of air for combustion, and from this on great improvements were made in forms and types of stoves, until a temperature of 800° to 1,000° F. could be attained; this is the limit of safety for an iron pipe stove, as above this temperature they are liable to crack or burn out. Cowper, in 1860, patented his stove, in which firebrick was used to absorb the heat from the burning gas. Whitwell patented another form about the same time, and from these two types have arisen many forms of brick stoves which are all improvements in construction. A modern furnace has a complement of three or four stoves, which can maintain the blast at any desired temperature up to 1,500° or 1,600° F.

Blowing apparatus has improved in like manner, from the old skin bags and bellows, bamboo tubes, water trompe, wooden and iron tubs worked by water power, noisy, clumsy-geared machines, through all these stages up to the beautiful vertical cross-compound condensing engine of to-day. Each modern furnace is supplied with a pair of blowing engines, capable of delivering up to 30,000 cubic feet of air—and sometimes more—a minute, able to force this amount through the large amount of fine stuff which generally gets into a furnace.

The blast furnace itself, although retaining much the same internal shape, has enlarged greatly in size. A century ago one 25 to 30 feet high, and the greatest diameter being 6 to 8 feet, producing 4 or 5 tons a day, would be considered large. Now at present a big furnace means one 80 to 100 feet high, and a diameter of 18 to 22 feet, turning out 300 tons a day or more. But it does not occupy any more ground space than the huge piles of masonry used in the older furnaces. They were generally built near a hillside, and a platform ran from the side of the hill or incline to the furnace top to dump in the raw materials. The first boilers and some of the first stoves utilizing the waste gases were placed on top of the furnace or on the hillside adjoining. The furnace top was afterwards entirely closed by bell and hopper, and gases drawn from under the bell through flues to the stoves and boilers placed on the ground level. The waste gases to-day supply all the heat for steam required, heating the blast, and sometimes to calcine some of the ores. Certain furnaces using raw coal collect the tar and ammonia from the gases also.

Immense strides have been taken the last few years in the replacing of other fuels by coke, and methods of washing, cleaning and coking the raw coal. Previous to 1850 the increased production each year was obtained not by greater efficiency of plant, but their increased number. At this time a stack 50 feet by 15 feet would be considered large, and a product of 20 to 25 tons a day good work. Sir Henry Bessemer's mechanical genius and work he did, in the 10 years experimenting, to make an economic success of his process for the conversion of cast iron into steel, has been the starting point which has so revolutionized the iron world that it is fast converting the age of iron into one of steel. Sir Henry is alive to-day, one of the few great inventors who have lived to see and derive the benefits from his invention. Besides many honors, he has received something over $5,000,000 in royalties, etc. One of the best things the Bessemer process did for the iron industry was to open the eyes of ironmasters to the value of chemistry in furnace work. This process required iron of a certain composition; this demanded care in selection of all raw materials and careful analyses of all supplies and product, so the careful preparation of all the ores and fuel was brought about. Where to-day three to four tons of raw material are required to make a ton of pig, five to six were formerly used. No up-to-date plant is equipped for work without a well fitted laboratory for speedy work, all supplies and output being bought and sold on analysis. Iron and steel works' chemists have during the last few years converted the use and manufacture of iron and steel from the old "hit-or-miss" methods to a science.

First actual Bessemer steel made in America was at Wyandotte, Mich., in 1864, and first rails were rolled at the North Chicago Rolling Mills, May 24th, 1865; the total production of steel rails in America, in 1867, was 2,550 net tons; 1890 was the largest year up to date, with a production of 2,091,978 tons. The perfection in detail of most modern steel plants is such that the iron is run direct from the blast furnace into ladles, thence direct to the converters; the resulting ingot never cools until it is in the finished rail. First market prices of Bessemer rails was about $130 per ton; they are selling to-day for $28, which was the amount of duty imposed on them in 1870 in the United States.

Germany and the United States have during the past twenty years shown most marked improvements in their iron manufactures, and, in fact, all departments of metallurgy. In 1875 there were over 680 furnaces in the United States, and the output for that year was 2,023,733 tons pig. Furnaces had increased in size up to 80 feet by 20 feet; one of these using a blast pressure of 6 to 8 lbs., and temperature of blast 800° to 900° F. Consuming less than 1½ tons of coke to make even a No. 3 iron was considered to be doing exceptional work. Managers were then only beginning to appreciate the value of chemistry and possibilities of the furnace. Some furnaces will now make more iron in a day than the maximum weekly output of twenty