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The editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

HISTORICAL.

UPON a certain summer's day in the year 1755, there might have been witnessed the advance of a small detachment of British and Colonial troops, not much over a thousand strong, through the dense forests that lined the banks of the Monongahela River a few miles above the point where it merges with the Allegheny. The objective point of the expedition was a small fort at the confluence of these rivers, which formed one of the most important links in that chain of military posts and trading stations, which the restless and far-seeing energy of the French colonial government had strung out between the mouths of the St. Lawrence and the Mississippi, by way of the Great Lakes, the Ohio, and the Mississippi Valley. In the van of this little army, bearing himself with a confidence born of much successful warfare in other lands under less difficult conditions, and heedless of the warnings of his young colonial aide-de-camp George Washington, who had command of the rear guard, was Gen. Braddock. Advancing in a close formation, which was better suited to the open spaces of Continental battlegrounds than to the all-but-impenetrable forests of the American frontier, the devoted band marched right into an ambush of the French regulars and their Indian allies, and was quickly cut to pieces. Braddock was killed, and Col. Washington, his military coat pierced more than once by the bullets of the French sharpshooters, barely succeeded in carrying the shattered remnants of the force back over the Alleghenies into Colonial territory. The political and military considerations that prompted that disastrous expedition were worthy of a better fate; and, indeed, subsequent history has proved that in endeavoring to capture Fort Du Quesne and break the bounds which the French were endeavoring to set to the westward development of the British colonies, our forefathers had taken a just view of the situation. To-day the objective point of the expedition forms the site of Pittsburg, one of the greatest centers of industrial activity in the world; while hidden among the back streets of the city, and rescued from destruction and preserved through the care and munificence of a local historical society, may still be found Fort Du Quesne, or rather its immediate successor Fort Pitt. A few miles up the river, at the town of Braddock and on the identical spot where the battle occurred, is to be found one of the greatest steel works in the world; while for many a mile along those very banks of the Monongahela where Braddock laboriously cut his way through the woods, is to be found the most wonderful aggregation of coking ovens, blast furnaces, and rolling mills in the world. Although just now we are concerned merely with the history of the development of these industries, we may be pardoned a reference to the fact that in St. Louis, five hundred miles to the westward of the Braddock battlefield, the great Republic which has sprung from that strip of colonies that fringed the Atlantic seaboard in 1755, is just now preparing to celebrate the one hundredth anniversary of its acquisition from France of the vast territories from which that country sought to bar the early colonials out.

In selecting a point of beginning for a brief survey of the rise and growth of the iron and steel industry in this country, we cannot do better than go to the records of Pennsylvania, from which we shall learn that in the year 1786 the Legislature lent a certain Mr. Humphries the sum of three hundred pounds for five years, to enable him to make steel "as good as in England." Progress must have been slow; for a quarter of a century later, or in the year 1810, the total production of pig iron in the United States was but 53,908 tons; and of this, less than one thousand tons was made into steel. In 1842 the total was only 215,000 tons; and in 1861, during the great civil war, it was still far below the million mark, being only 653,164 tons. In 1864 the total production had risen for the first time to a little over one million tons. Up to this time steel was looked upon as a very special product, the methods of production being costly and the total output relatively small. But in the year 1864 there was invented and demonstrated in the mother country what was, and will ever be, the greatest invention in the history of iron and steel—the Bessemer converter. By this device, it was made possible during an operation of an extremely simple and inexpensive character, and in a few minutes' time, to convert common cast iron into steel. Steel, from costing as high as six or seven cents a pound for the common grades, began steadily to decrease in cost, until in the closing year of the nineteenth century steel billets, in lots of a hundred thousand tons, came to be sold at the rate of "three pounds of steel for two cents." The entrance of the Bessemer converter marked the close of the Iron Age, and from this time on steel became the standard material of construction in all but a few limited classes of work. It was not long before the Bessemer process was introduced into this country, and this fact, coupled with the period of general commercial prosperity which followed upon the close of the civil war, stimulated the development of the iron and steel industry so greatly that by the year 1872 the total production of pig iron had increased to 2,548,713 tons. In 1880 the total had climbed to 3,835,191 tons, and in the following year it had risen to a little over 4,000,000 tons. By the close of this decade the production of pig iron had doubled, the total output in 1891 having reached the wonderful figure of 8,279,870 tons. During the last decade of the century there was another increase of about one hundred per cent, during which the total output of pig iron passed far beyond that of our nearest competitor, Great Britain, reaching in 1901 the enormous output of 15,878,354 tons; while for the following year the production climbed yet higher, reaching a total of 17,821,307 tons. Toward the close of the century there was introduced a method of steel manufacture which gave early promise of being a rival to the Bessemer converter, a promise which has been so far fulfilled, that it may be said without any exaggeration that the age of Bessemer steel is drawing to its close, and that open-hearth steel is destined ultimately to be the all-but-exclusive product of the industry. The open-hearth furnace has the advantage, especially in the United States, that whereas the Bessemer process requires for its successful working the use of ores that are comparatively free from phosphorus, ores that are high in phosphorus can be used successfully in the open-hearth furnace. Moreover, for reasons which are given later in the present issue, it is possible to produce a grade of steel in the open hearth that is so superior to Bessemer steel as to more than compensate for the additional cost of manufacture. The advantages of the process and product were quickly recognized by both ironmasters and engineers; and it is becoming increasingly common to see open-hearth steel called for in the specifications of the more important classes of construction.

We may look with pardonable pride upon the growth of an industry for which there is no parallel in the history of the world; and the more so as this growth is a true index of the general material prosperity of the country at large. For it must be remembered that, great as is the total production of iron and steel, it has proved, during the last year or two, so far short of the home demand, that we have been obliged to call upon foreign manufacturers to supply the deficit.

SECRETS OF OUR SUPREMACY IN IRON AND STEEL.

In looking for the causes which underlie the supremacy of the United States in the steel and iron trade, honesty and gratitude alike demand that first place be given to the marvelous natural resources of the country, for which there is no parallel anywhere in the world. Not only has nature provided stores of iron ore, coal, and limestone in lavish abundance, but the supply itself is easy of recovery from its native beds, and advantageously placed for the transporting of its various elements to a common center; while the materials are of a quality that could scarcely be surpassed for economy of handling and treatment in mine, furnace, and mill. But although the fundamental secrets of our success are to be found in natural conditions, too much cannot be said in praise of the intelligence and skill with which the American ironmaster has risen to his opportunities. It is to the remarkable ingenuity shown in the production of labor-saving machinery that much of the cheapening of the cost of production is due; to say nothing of the broad administrative ability shown by the management of the great steel and iron works, in laying out the component parts of their establishments in such a way that the heavy tonnage which passes through these plants day by day shall proceed from the crude material to the finished product with the least possible amount of handling and trans-shipment. Lastly our iron and steel men, early in the history of the development of the industry, perceived and acted upon the fundamental economic fact that, for the cheap production of iron and steel, magnitude of operations and combinations of capital are essential.

First then, we must recognize the lavish hand with which Nature prepared the way for our industrial triumphs, by accumulating along the southern and western shores of Lake Superior those vast beds of iron ore, which are not only the most extensive in the world, but are so placed that the labor of excavating and loading for shipment is practically nothing. The ore, which is extremely rich, sixty per cent of it being iron, lies practically at the surface of the ground; and it is so loose and friable that all that is necessary for its recovery is to run in a train of cars, set a steam shovel at work, and load the material directly onto the cars. This work has actually been done at the rate of 5,800 tons in ten hours, and this with the labor of but eight men at a cost of five cents only per ton for labor. The supply is enormous, a single corporation having recently estimated its holdings at 500,000,000 tons, valued at as many million dollars. These vast and easily-recovered supplies, however, would have a limited value, were there not available a proportionate supply of coking coal; and this has been provided with an equally lavish hand in the famous Connellsville district, where a single coke company on entering into one of the great industrial combinations of the past few years, stated that it owned 40,000 acres of coal lands in this region, and 11,000 coke ovens. Within easy reach of the coal district there are also large quarries of limestone, the third of the three constituents in the charge of a blast furnace.

But the mere existence of these natural supplies of the raw materials of manufacture would not in itself be sufficient to account for the marvelous growth of the iron and steel industry in America. The raw materials must be brought together to some common center, and the transportation of this enormous tonnage, the frequent handling and trans-shipment that is necessary, must be done with the least possible amount of expense, if the American ironmaster is to start with anything like an even chance in competition with European manufacturers; for these are not under the necessity of transporting their materials over a thousand miles of distance, before they can smelt them in the blast furnace. Now, here it is that man has so ably co-operated with Nature. Acting on the well-established industrial principle that the greater the magnitude of the scale of operations, the less is the cost per ton of the finished product, the machinery and general plant for excavating, handling, and transporting the ore have been built on a colossal scale. At the mines, steam shovels capable of lifting five tons of ore at each stroke will load a 25-ton car in two and a half minutes, or at the rate of 600 tons an hour, and in accordance with the same policy cars have grown to 50 tons in capacity and locomotives to 130 tons in weight. When the ore trains reach Lake Superior special automatic, quick-acting machinery unloads the ore direct into special ore steamers built for this particular work. At the eastern terminal ports similar machinery unloads the ore from steamer to railroad, where again 50-ton cars and 130-ton engines haul the precious mineral in trains of 1,000 tons or more total weight, into the heart of the coal and coke region, where it is finally unloaded by special machinery, at the foot of the blast furnaces.

The ingenuity and resourcefulness shown in the matter of handling and transporting the huge tonnage necessary for the manufacture of over 17,000,000 tons of iron a year, was ably seconded when it came to the matter of recovering the iron in the blast furnaces, and fabricating it into the thousand and one forms in which the finished product is put upon the market. In no single branch of industry has more thought been given to labor saving than in the manufacture of iron and steel. In the first place, to reduce handling and transshipment to a minimum the processes are made as far as possible continuous. The erection of a typical modern steel works will call for a plot of ground which is rather a parallelogram than a square, and there are in the country to-day works that on a width of a quarter of a mile will extend for a mile and a quarter in length. At the upper end will be the stockyard, with its artificial mountains of ore and coke; next the blast furnaces; then the Bessemer converters, or the open-hearth furnaces, as the case may be. Then will come the soaking pits or furnaces for heating the cast ingots. Beyond them, in some cases, will stretch one vast building a thousand feet or more in length, with its blooming rolls and shears, roughing rolls, finishing rolls, and steel saws succeeding each other in orderly succession, until at the end of the building one can see the finished product being loaded onto the cars almost before the last trace of the furnace heat has gone out of it. Moreover, in its long journey through the mills, the material has been rolled and heated and rolled again, positively with no manual labor whatever; and in many of the mills that are notable for the great tonnage that they turn out in a single day, the continuous processes are carried on with such rapidity that the journey of a thousand feet or more through the mills is made on one single heat.

In any summary of the causes of our success in steel