levers to start the car, but all of these have failed either through inefficiency or from their complicated nature. It is an admitted fact that anything to be applied to a car for this or any other purpose must be perfectly simple and absolutely free from liability to get out of repair. This device has these qualities, besides being very efficient for the purpose.

There are many points in favor of improvements of this class which will suggest themselves to those practically acquainted with the management of street-car lines, and it is deserving of attention not only as a matter of money saving but from a humane point of view. Any one witnessing the efforts of horses in starting a heavily laden car can but wish that a device calculated to relieve the animals from these extraordinary strains might be put into practical use.

The inventor informs us that the car starter has been critically examined by competent engineers during its several months of trial, and they have spoken in the highest terms of its value and practicability. However, the device needs no special indorsement, as any one familiar enough with mechanics to understand its construction and operation will readily admit that it must be efficient.

For further information address Mr. Thomas H. Kemble, 617 North Sixteenth street, Philadelphia, Pa., or the Inventors' Institute, 733 Broadway, New York, where a model of the invention may be seen.

AMERICAN INDUSTRIES.—No. 54.

THE MANUFACTURE OF STEEL.

The Pittsburg Steel Works of Messrs. Anderson & Co. are among the oldest in the United States, having been established in 1845, more than a third of a century since, long before railroads became universal, and at a time when it was generally thought that fine steel must necessarily come from England. But the steel industry has outgrown almost every other manufacture, and the quality of the various products is fully equal, if not superior, to anything imported.

The Pittsburg Steel Works had a small beginning, but as time passed they gradually developed, adapting themselves to the numerous and constantly increasing wants of the country, until they now cover a larger area and produce steel for a greater variety of purposes than any other mill in Pittsburg. Its managers are men of energy, perseverance, courage, and practical ability, who have fostered the growth of inventions in the manufacture and application of steel, and whose efforts have been very fruitful in the development of industrial resources.

Wherever a particular kind of steel has been required for a particular purpose it has been characteristic of this firm to embody the new form of steel in their manufactures. As a consequence of this they have many specialties in their business, among which may be mentioned the five-plate safe cast steel, which is used exclusively by Hall's Safe and Lock Company, of Cincinnati, whose safes are largely used throughout the United States; agricultural steel, which is used in the large plow factories of the West; steel for hoes, for shovels, also for forks, harrow teeth and rake teeth; grain drill, reaper, and machinery steel, and, in fact, steel for every variety of agricultural implement. They have acquired a reputation in the Eastern States for a fine quality of steel used in the manufacture of table cutlery, which is equal to any of the Sheffield productions. They have also a large railroad trade in frog points, side bars, and heel plates for switches, and they manufacture steel for hammers, chisels, and drills, which is generally used in the quarries of New England. Most of the steel rods from which the wire was drawn for the Brooklyn Bridge was furnished by this firm.

To turn out all these products, Messrs. Anderson & Co. employ 575 men, whose wages amount to $400,000 yearly.

The general appearance of these extensive works is shown in the small perspective forming one of the views in our title page engraving, and the interior views convey an idea of some of the operations conducted here.

The plant consists, briefly stated, of five 24 pot Siemens furnaces, 3 sets of coke hole furnaces, 6 converting furnaces having a weekly capacity of 90 net tons, 3 single puddling furnaces, 16 hammers, a rake tooth shop, 10 trains of rolls, two of them being 20 inch plate rolls, one 16 inch bar, one universal train, one 16 inch spring, two 16 inch sheet, and one 8, one 9, and one 10 inch guide.

The wire rod mill was erected in 1877 on the Belgian system, with a capacity to turn out 20 tons of No. 5 crucible steel every ten hours. One hundred and fifty pots can be used at each heat in the steel works. These are run double turn, making three heats each turn, making them equal to 900 single pots daily. The annual output is 15,000 net tons, the product is cast and German plow steel, plate steel, and the best edge-tool steel. The cast steel consists of selected pieces broken and melted in the crucibles and poured into ingot moulds. It is afterward reduced to bars or sheets by hammering and rolling. One of the upper views in our engraving shows the crucible furnaces in the foreground, and the iron ingot moulds being filled with melted steel in the middle ground.

The open hearth steel works, added in 1879, contain one 15 gross ton and one 7 gross ton Siemens open hearth furnace, one blooming mill, and one plate mill. The 15 ton furnace, which is shown in our engraving, is the largest in this country.

The rod rolling mill, shown at the top of the engraving, turns out rods for wire manufacturing, and one of the smaller views shows one of the trains for rolling sheets of steel. Under the huge steam hammer shown immediately below an ingot of heated steel seems as plastic as clay.

The lower right hand view shows several of the immense shears employed in cutting agricultural steel into the hundreds of shapes in which it is required.

THE MILL IN OPERATION.

To a person unaccustomed to the scene, a sudden introduction to the whirr, clatter, and roar of a vast establishment like that under notice is confusing. Trip hammers pound, trains of rolls whirl out the flaming iron or steel, engines puff and rattle, furnaces glow with white heat, and the heated iron or steel flashes as it is drawn out. Immense shears clip great sheets of iron as easily as ordinary shears would paper. Vast grindstones smooth and polish the plow colters, and up and down, intense activity, wondrous power, and seeming confusion are apparent amid the most deafening noise. But there is no confusion. The mill is departmentized. Each set of hammers, or train of rolls, or set of shears, or engines, is under a superintendent or manager, who is responsible for the quality of the work. Rigid accountability follows every department of the work—the standard in this mill being as near absolute perfection as it is possible to reach. It seems amazing that administrative capacity should be so developed as to follow the broken scraps of steel or pigs of iron, from the weighing room, through all the stages of manipulation, till they come out in the form of the most perfect steel now manufactured in any part of the globe, and yet avoid confusion, loss of time, waste of material, or loss in any form. Yet it is done here in the quietest manner and without display of any kind. It is confusing to think of the accuracy in technical knowledge essential to the management of such works. The tensile strength, resistive force, enduring power of the product is to be considered; the combination of material, the chemical properties involved and to be produced. The changes of the rude lumps of pig iron from one quality to another, till it is beautiful finished steel, are perplexing to the uninstructed mind. And then the business aspects of the affair! They involve the closest study of economy, the successful dealing with many men, the survey of the world, its wants, demands, present and prospective, in the line of steel. The proprietor of the works under mention looks upon the broad world as a market. Every section of this country, South America, and Europe, afford the market. It broadens one's conception of the importance of our great manufacturing establishments when we realize how vast is the scope of their trade, and how closely they must study the competitive forces arrayed against them.

THE SIEMENS FURNACES.

In appearance, these furnaces resemble coke ovens, flattened at the top. The pots, containing the metal to be melted and manipulated, are let down through long, narrow slits, at the top, and are thence taken out when ready. The fuel used is gas, manufactured for the purpose, and mixed with air, and introduced under the furnaces by means of huge pipes. The heat generated rises to 3,000° Fahrenheit —the most terrible intensity of heat known to be artificially produced. The men who take out the pots of melted metal stand over these slits, at the top of the furnace, exposed for the moment to the intense heat, and with long iron pincers grasp the pots of melted metal, lift them out and pour the metal into receptacles to cool. These men have cloths wrapped around their limbs, and thoroughly saturate them with water before going to the furnaces, thus preventing the burning of clothes or body. In a moment they turn away, smoking from the intense heat.

THE SIEMENS PROCESS.

It may be of interest to our readers to know of the process by which steel is manufactured under this patent. This process was introduced in this country by Mr. Anderson. Cast steel is made from blister steel, broken into fragments, and carefully selected as to temper, placed in crucibles of plumbago, lowered into the smelting furnaces, and exposed to the heat of 3,000°. The most exact skill is required in this part of the process. When the contents of the crucible are ready for pouring they are poured into an iron flask, or mould, forming ingots of various sizes. Four hours are required to transform blister steel into cast steel. The Siemens furnace consists of two distinct parts, the producer, in which the fuel is converted into gas, and the furnace proper, including the regenerators. The furnace proper is composed of one heating and four regenerating chambers. The latter are placed beneath the heating chamber in such a manner as to leave space between for the passage of air and gas. The gas enters at the bottom of one of the chambers, the air enters the neighboring chamber, and the two, mingling at one end of the furnace, produce an intense and uniform flame. This heat is utilized entirely, passing the regenerators, and being used in various ways. Thus, by the reversal of the current of heated gas, it is thoroughly used, producing a continuous heat of 3,000°. The action of the furnace is so perfect that the gases which enter the stack through the waste flue to be cast into the air do not exceed 300° Fahrenheit. This is the process which has been in use here since 1868, when this firm first introduced it into this country.

This vast business in all its extensive ramifications requires executive ability of a high order. The established success which the works have achieved is largely owing to the untiring industry, indomitable perseverance, and persistent energy of Robert J. Anderson, who twelve years ago, in connection with other partners, purchased the business from Jones, Boyd & Co., the senior member of which firm opened the business in 1845. The business has thus changed hands only once in thirty years. The best evidence of successful management is found in the fact that all through the last several years of financial depression these works have never stopped except for repairs, having run double turn, and sometimes the whole twenty-four hours of the day. They are now turning out agricultural steels, and bid fair to have a future as successful as the past. Progressive in their ideas, fully up to the wants of the age, having all the elements of success, they cannot fail to obtain it.

Representatives of this firm are located as follows: A. B. Parker, No. 21 Astor House, New York; Wm. F. Potts, Son & Co., Philadelphia, Pa.; Carolan, Cory & Co., San Francisco, Cal.; Augustus Wessel, Cincinnati, Ohio; Tronell, Handy & Greer, Baltimore, Md., and Miles & Cotton, 170 Lake St., Chicago, Ill.

ASTRONOMICAL OBSERVATIONS AT HIGH ELEVATIONS.

The progress of modern optics is now furnishing observers with telescopes of a power which exceeds the capacities of our lower atmospheres for their constant employment. The obstacles to definition due to this atmosphere have grown to be so nearly a barrier to any rapid progress that attention has lately been given to the conditions of vision which it is very commonly supposed will be found to be best on mountain summits. There is no exact information on this subject, however, and Prof. S. P. Langley was therefore led to make some observations on Mount Etna during a visit there in 1878, and the result of which he records in the July number of the *American Journal of Science and Arts*. His object was to gather some sort of quantitative estimate of the degree of transparency and definition, to take the place of vague statement, and to give a kind of standard for comparison with sites in our own territory. The station chosen was "Casa del Bosco," at an elevation of about 4,200 feet. The observations were directed to the sole end of determining the character of vision, as tested at night on stars and nebulæ, and by day upon the sun. After a limited number of comparisons, he infers that at this station about nine-tenths of the light of a zenith star reaches us, and that only one-tenth is absorbed by our atmosphere. The gain on Etna over a lower station, as tried by the tests of a double star observer, was more in clearness of the atmosphere than in that freedom from tremor which accompanies good definition. The latter was indeed upon the whole better than below, but not conspicuously so.

Prof. Langley concludes, as the result of his researches, that the balance of advantages for astronomical observations is most likely to be found in a dry atmosphere, and certainly at a great elevation. Such elevations have undoubtedly the advantage of diminishing the atmospheric absorption of the more refrangible rays, an absorption so important that it probably cuts off from us the larger portion of the ultra violet spectrum. The gain for observations of precision will be, though positive, not in itself probably such as to justify the difficulty and expense of such a site; but for the study of the nebulæ and stellar photometry the gain is very essential indeed, while for almost every problem in solar physics it may be said without reserve that, for rapid progress, such observations have now become not merely desirable, but indispensable. The summit of a lofty mountain, however, is not a desirable station. At an altitude of 10,000 or 11,000 feet the observer may still enjoy all the conditions of health that fit him for labor, but beyond this unfavorable conditions increase very fast.

Quoting from his own experience of a stay of ten days upon Pike's Peak, at an altitude of between 14,000 and 15,000 feet, Prof. Langley says that at this height the attenuated atmosphere makes a long stay impossible for some, while even for the healthiest the conditions of life begin to be such as to render continuous hard work scarcely possible. At the same time the mountain condenses about itself continuous clouds, so that, except during a brief period in the autumn, the opportunities for observation are far rarer than on the plains. A dry climate and a table land at an elevation of something like 10,000 feet, sheltered on the side of the prevalent winds by a mountain range, which precipitates their moisture in clouds that rarely advance beyond the observer's horizon, appear to be the most promising conditions in our present knowledge. Upon the whole, though the ideal station, where atmospheric tremor does not exist, and the observer pursues his studies in an ever-transparent sky, is not to be found on any part of the earth's surface yet examined, we find, says Prof. Langley, within our own territory, in the dry and elevated table-lands of Colorado or New Mexico, every condition which experience points out as favorable.

Our Leading Cities.

Cities.	1880.	1870.	1860.
New York	1,208,471	942,252	813,669
Philadelphia	843,000	674,022	565,529
Brooklyn	554,693	395,099	266,661
Chicago	502.940	298.977	109.260
St. Louis	395,000	310,864	212.418
Boston	352,345	250,526	177,841
Baltimore	350,000	267,354	212,418
San Francisco	280,000	1 9,473	56,802
Cincinnati	246,153	216,239	161,044
New Orleans	215,239	191,418	168,675
Washington	160,000	109,204	61,112
Cleveland	156,946	92,829	43,417
Newark	136,983	105,059	71,941
Milwaukee	130,000	71,440	45.246
Detroit	119,000	79,577	45,619
Louisville	112,000	100,753	68,033
Jersey City	105,000	81,744	29,226
Providence	104,500	68,904	50,666