THE PROCESSES OF STEEL MANUFACTURE.

The manufacture of steel by a process as simple as possible, at the lowest cost and of the best quality, has called forth, especially of late years, the exercise of much inventive ability on the part of both chemists and engineers, both at home and abroad. There has resulted such a variety of differing methods that some systematic classification of the processes has become very necessary. In the *Mittheilungen des Hannoverischen Gewerbe-Vereines*, Professor Heeren publishes the complete classification, a translation of which is given below, and which will be found both instructive and of value for purposes of reference. As steel occupies nearly the middle place between cast and wrought iron in its proportion of carbon, it may be prepared either by decarburizing pig iron, or, on the contrary, by causing wrought iron to absorb carbon. The processes to accomplish these ends may be arranged under five principal heads: A, Fabrication of steel by decarburization of crude or pig iron; B, by carburization of wrought iron; C, by mixing a wrought iron poor in carbon with a pig iron rich in same; D, by mixing pig iron with ore (the pig yields carbon which reduces the ore and transforms the reduced iron into steel); E, directly by means of ore; F, cast steel. Subdividing these systems, we have the following methods under each heading.

A.—METHODS BY DECARBURIZING THE CRUDE IRON.

1. Steel obtained by a long heating of the crude iron in an oxidizing atmosphere, the metal not being brought to fusion. (*a*) Tunner's method in sand, where the deoxidation is produced by means of the oxygen in the air. (*b*) Jullien's method, in forge scales or spathic ore. This produces malleable iron. (*c*) Herzeeles' method in steam; (*d*) Thomas' method in carbonic acid. The last two processes have not been employed to any great extent.

2. Natural steel: In this method, employed since the earliest times, the crude iron is melted in a refining furnace with wood charcoal, and decarburized by the ferrous oxide of the scoria. The product is purified by a repeated refining.

3. Puddling: This process is the same as the preceding, from a chemical point of view, but is practised in a reverberatory furnace heated with coal. It is necessary to purify the product by repeated refining or by transforming it into cast steel.

The construction of puddling furnaces has undergone many changes. We may distinguish (*a*) the ordinary puddling furnace with fixed hearth and heated by coal, (*b*) the same heated by lignite or peat, (*c*) the puddling furnaces of Schafhäutl and others, with mechanical rabbles designed to diminish the labor so fatiguing to the workman. These, however, have been entirely superseded by new systems. (*d*) The Danks furnace, the hearth of which is formed of a hollow cylinder placed horizontally, and turning about its axis. It gives a product of excellent quality, and is economical. The interior lining, however, is difficult to maintain. (*e*) The Ehrenwerth furnace has a horizontal circular hearth turning about a vertical axis. (*f*) The Pernot furnace also has a circular sole, which, however, is not horizontal, but slightly inclined, so that during its rotation the iron and scoria run to the lowest point and are thus in a state of continual motion; while the elevated parts of the hearth, together with the iron and scoriæ thereto adherent, are submitted to the oxidizing action of the air. Professor Heeren thinks this furnace to be the best, because it realizes the advantages of mechanical puddling without needing any special lining.

4. The Bessemer process: A current of air, finely divided, is passed through the liquid crude iron. The carbon, silicon, and a part of the iron burn, and the temperature is so highly elevated that the iron, decarburized in part or transformed into steel, remains molten. It is then run into molds.

5. Bérard's modification of the above: Air and gases are alternately introduced into the retort with different advantages.

6. Peters' process: The liquefied crude iron in a reverberatory furnace falls in the form of rain in a vertical chamber in which the furnace gases also pass, and in which air is blown so as to decarburize the metal to the desired degree.

B.—METHODS BY CARBURIZATION OF WROUGHT IRON.

1. Indian or Wootz steel: Wrought iron of extraordinary purity, obtained by treating a very pure ore in small chamber furnaces by the direct method, is hammered, made into bars, cut into short pieces, and placed in small crucibles with a few green leaves. The crucibles are hermetically sealed and heated for a long time at a high temperature. The iron is transformed into steel by uniting with it this carbon contained in the leaves, and the steel even partially melts. These half melted masses furnish the famous sword blades and plates of Persia and Damascus.

2. There are several other processes resembling the Indian, which, however, are not carried on on a large scale. There are (*a*) the Mushet process, in which wrought iron obtained by the ordinary refining method is melted with powdered wood charcoal. (*b*) The Vickers' process, analogous to the preceding, with the addition of oxide of manganese. (*c*) The Stourbridge, Brooman, Thomas, and Binks processes, based on identical principles.

3. English cemented steel: Wrought iron of the best possible quality is, in the shape of bars, packed in clay boxes, together with wood charcoal coarsely pulverized. The heating continues for two or three weeks. Without melting, the iron is changed into steel, which by remelting is transformed into cast steel.

4. Parry's cupola steel: Fragments of wrought iron, melted in the cupola with a large consumption of coke or wood charcoal, may be transformed into steel or even into cast iron according to the length of the operation. This system offers an advantageous method of utilizing scrap, and requires no special apparatus.

5. Chenot's process: In this the ore is reduced by heating it progressively with coal. A non-melted iron sponge is obtained, which is ground and separated as well as possible from the gangues by the aid of a magnet. Lastly, it is mixed with carboniferous substances, and melted under pressure. The principal disadvantage of this process is the difficulty of separating the gangues without losing the steel.

6. Casehardening has for its object the transformation of the surfaces of wrought iron objects into steel. It is done in two ways. (*a*) The pieces are placed in small sheet iron boxes and surrounded with chips of wood. The boxes are hermetically closed and heated in a forge fire, for 15 or 30 minutes, to an intense red heat. They are then removed quickly, opened, and their contents thrown into cold water, whereby the exterior steel shell is rendered as hard as glass. (*b*) The pieces are heated to a whitish red and moistened with ferrocyanide of potassium, which acts, by its cyanogen, on the iron, and transforms the surface into steel.

C.—METHODS BY FUSION OF A MIXTURE OF CAST AND WROUGHT IRON.

The two materials may be, both or only one of them, used in a melted state.

1. Bessemer steel, prepared by the ordinary method. The crude and wrought iron here are both liquid, while, as we have previously said, cast iron may be directly transformed into steel. The method most followed, and which leads most surely to the end in view, consists in completely decarburizing the crude iron in the converter, and in adding to the melted metallic iron a rigorously determined quantity of liquid crude iron. The carbon of the latter affects the previously decarburized iron, and makes a steel containing a given proportion of carbon.

2. Crucible steel is obtained by melting in crucibles a mixture of crude and wrought iron. The former liquefies first, and slowly melts the latter.

3. Martin's steel is similarly made, by replacing the crucible with a reverberatory furnace. The crude iron is liquefied under a thin layer of scoria on the concave hearth of a reverberatory furnace, heated to an intense red-white heat by a Siemens regenerator. Scraps of steel and wrought iron of all kinds in desired quantity are added, and the steel is run into molds of cast iron.

D.—METHODS BY A MIXTURE OF CAST IRON AND ORE.

Uchatius steel: The cast iron is granulated by running it into water while molten, and the grains are melted with spathic ore, peroxide of manganese, and wrought iron in crucibles. The ferrous oxide of the spathic ore is reduced by the carbon of the cast iron, and the surplus of carbon unites with the wrought iron to make steel.

E.—METHODS BY PREPARATION DIRECT FROM THE ORE.

The Siemens direct process: The ore is melted alone, without addition of reducing material, at a very elevated temperature; then the iron is reduced and transformed into wrought iron or into steel by adding coal.

F.—CAST STEEL.

For the purification of steel by fusion, cemented, forged, and puddled steel are employed. To improve the qualities of the steel, and notably to augment its hardness, diverse substances are added. Thus we have: 1, silver steel, 2, nickel steel, and 3, wolfram or Mushet special steel.

THE RUSSIAN SYSTEM OF TRADE EDUCATION.

Our correspondents at the Centennial Exposition have already briefly described the courses of study in many of the institutions of learning there represented. There is one great school, however, which is worthy of something more than passing notice; and for many reasons its exhibit may be profitably studied by all interested in the important question of how best to impart practically valuable technical education. While, with all mechanical schools, the cardinal object of the Imperial Technical School of Moscow, Russia, is to eliminate all useless or routine labor in the acquisition of a trade, and to require the student to perform only such as is best adapted, in connection with proper advice, to give the necessary knowledge, it adopts to this end a different method from any hitherto practised; and for the first time it has successfully proved the value of absolutely systematic instruction applied to the acquirement of industrial skill. The method of teaching the mechanical arts here initiated has gradually spread itself into all the Russian technical schools; and it is not unsafe to believe that, judging from the reported results, the same must eventually supersede other modes of instruction elsewhere. It is our purpose in the following to exhibit briefly the practical way in which the system is carried on.

The auxiliaries of education appointed for the teaching of any mechanical work whatever—for example, fitting—are divided into three categories. Taking fitter's work as an example, under the first division belong collections of tools used in the various operations, with which the beginner must make himself perfectly familiar before entering upon practical labor. Some of these collections are exhibited at the Centennial. There are collections of instruments for measuring, for drilling, and for finishing, models of files increased to 24 times ordinary size for the purpose of exhibiting the shape of teeth, etc., models of taps and dies magnified 6 times for the study of the direction of the angles of incision, and models of drills similarly magnified for the practical study of cutting angles; and there is also a collection of instruments and apparatus for teaching the tracing of yet unworked metal articles. Similarly in turning both in metal and wood, and in joinery, there are like collections, in which every tool is represented either in actual or in largely magnified form, so that the most accurate knowledge is thus imparted relative to every characteristic of the implements.

Having learned what he is to work with, the student is next taught practical manipulations. These are included in the second category, and it is worth while to review them. In wood turning, the pupil begins by following exercise models of various channelings, then he learns to turn a cylinder, a cone, a bullet, and so on, through thirteen articles, up to a vase and cover. In model and pattern making, the first lesson is to saw straight and along fiber, then to saw in a curved line, then to plane wood of different sections, to make joints, and the last of 25 operations is cross scarring by a skew abutting. At the forge, the student begins by forging square out of round iron, then round out of square. Nuts are next made, then screw heads of all shapes, then bolts of various kinds, then welding and steeling; and the last operation is to make welded ears to square bar iron. Metal turning starts with a simple cylinder and ends with right and left worms of a screw. Fitting begins with cleaning castings, which is followed by chiseling of various surfaces. There are 29 filing operations, beginning with the filing of thin edges according to marked lines, and ending with the filing of cast conical apertures. Then come punching and boring, drilling, and finally screw cutting.

These are merely general operations. Models are followed and the work is accurately graded, so that the beginner overcomes by degrees the difficulties presented. The teacher sees that each number of the programme is satisfactorily executed, and keeps the learner on that particular piece of work until it is mastered. Then the next operation in the series is undertaken, the instructor giving all the requisite explanations. Hence it is impossible for a student to become a good chiseler and a poor filer at once, or skillful at the drill and bungling with saw and plane. In every course the order is inflexibly followed, and the acquirement of each integral advance is the only road to progress.

Lastly comes the third category, or the practical application of all that has been learned. And here another series of lists meets us. But instead of the objects being, as it were, merely abstract, they are parts of machines, etc., selected so that in their execution all the practical resources of the art which the pupil has been studying are brought into play. The wood turner begins by producing a stuffing box cover. Then follows the shell for a step, a valve with a bullet seat, oil cups, rollers, star and bevel wheels, cylinder cover, same with stuffing box, pulley, and so on through a list of 43 pieces, ending with the chamber of a bullet valve. The model maker following models of wood joinings starts with a tongue joint, and, after producing 25 kinds of joints, scarrings, etc., begins on patterns. The list includes a grate bar, crank, puppet, wall box, sheave drum, and eccentric bevel wheels; and the eighteenth and last requirement is a set of patterns for a horizontal feed pump. The metal turner makes a steam cylinder, piston, cylinder cover, and lastly a crank shaft. The last five operations required of the fitter are the fitting of a toothed coupling, of a clutch coupling, of brasses to a plummer block by five planes, of a parallelopiped to an aperture, and the fitting of sliding plates.

That the pupil who has gone through this course becomes a skilled workman, it is hardly necessary to point out. He must be so if he succeeds in graduating at all. But all this is merely preliminary. The student has yet to learn to be an engineer, and to this end he has been taught theory for a portion of his time. He now advances to a new school of practice, namely, the mechanical works. There, while he may not labor at the bench himself, he sees others do it, and he is taught construction. There is a large force of hired workmen carrying out orders on a commercial footing, for engines and machines of all kinds. There are iron and brass founderies, engineers' shops, builders' shop, forge, joiners' and painters' shops, drawing office, and counting room. The student is obliged to study everything, from iron smelting to book keeping, and thus his course is completed.

It is the fortune of a large number of graduates of the scientific courses of our colleges, when thrown for the first time upon their own resources, to take positions as draftsmen; some few enter works to learn the practical part of a trade. The latter are neither apprentices nor skilled hands. Those who become draftsmen, not possessing as a rule the practical groundwork for an industrial career, nor from their position having opportunities for acquiring the same, too often remain draftsmen for their best years, if not for all their lives. The trade learners, meaning some day to follow their profession, perhaps learn the truth that, while the professions are overcrowded (except at the top), the trades are not, and, concluding to adhere to the trade, become educated to a certain branch, and, under the principle of the division of labor (in these times constantly expanding), find in the end that their knowledge is confined within the limits of a narrow specialization.

With such an education as we have outlined, it is difficult to imagine either of the above results; for even should professional opportunities fail, the shop is ever open to a workman whose skill is as broad as a trade itself and not confined to any one branch thereof. Such acquirements, moreover, could not be of the greatest value to any person in any walk of life. The Emperor of Germany, should he lose his crown, can earn a good living by setting type, for he is an excellent practical compositor and printer. The Queen of England is a skilled seamstress, a successful authoress, an artist of ability, and a mistress of the spinning wheel and loom. These are but well known instances,out of the scores of examples, of the highest of dignitaries protecting themselves against reverses of fortune by acquiring trades.

THE PROFITABLENESS OF IRRIGATION.

During recent years the British Government has invested something like seventy millions of dollars in irrigation works in India, and it is proposed to spend thirty millions more for such purposes during the next five years. In almost every instance, the works have proved immediately re munerative, while in some cases the profit has been enormous.

On a few of the larger complete works, the expenditure has been as follows:

Ganges Canal	$13,223,325
Eastern Jumna Canal	1,038,615
Western Jumna Canal	1,671,085
Godavery Delta Works	3,221,405
Kistnah Delta Works	2,164,470
Cauvery Delta Works	211,020
Sind Inundation Canals	2,980,000

For all India the net annual revenue from irrigation works now amounts to upwards of five million dollars, or 7·7 per cent of the capital invested. From Oude and the Central Provinces, the returns have been *nil*. In Rajapootana there has been an annual loss of 19 per cent of the capital. Elsewhere the profits were very encouraging. In the Northwestern Provinces, the revenue shows a profit on the outlay of 4·6 per cent, in the Punjaub 5·6 per cent; in Madras 27·6, in Bombay, including Sind, 16·9, in British Burmah 3·27 per cent. The Ganges canal yields 4·88 per cent, the Eastern Jumna 25 2, the Western Jumna 30, the Godavery delta works 42·16, the Kistnah works, 19·73, the Cauvery works 273·31, the Sind canals 33·3 per cent annually.

Charging against the capital outlay of these works the interest lost on the money invested before the works became productive, compensation paid to landowners, money spent on unfinished and impractical schemes, etc., in addition to the direct outlay, the revenue still shows a considerable balance of profit. The corrected capital, and the percentage of annual revenue thereon, appear in the following table:

	Capital invested.	Percentage of revenue on capital.
Northwestern Provinces	$17,827,225	5·2
Punjaub	15,671,010	4·8
Madras	9,467,200	22·72
Bombay (with Sind)	11,113,940	11·9
Gauges Canal	14,400,890	4·5
Eastern Jumna Canal	2,349,890	11·2
Western " "	6,531,965	7·6
Godavery Delta Works	3,418,525	39·7
Kistnah " "	2,337,135	13·2
Cauvery " "	1,467,890	36·6
Sind Inundation Canal	5,930,000	18·6

But the revenue returns from these great undertakings are not the only source of profit. In a country like India, where rains are irregular and transportation difficult—and often in the wet season impossible—a failure of seasonable rain is apt to be followed by loss of harvests and consequent famine, entailing great loss of life, loss of revenue to the government, and sometimes the abandonment of thousands of square miles of fertile soil to the jungle, for lack of cultivators. All this is prevented by irrigation.

In 1860, when a large part of the Northwest Provinces was baked as in an oven, the Ganges canal preserved grain crops enough to feed a million of people who must otherwise have perished unless kept alive at the cost of the Government. And again in 1874 a great multitude were saved from the horrors of starvation; and the enormous outlay consequent upon the famine in the low provinces was kept from being still more enormous by the Soave canal, which even in its unfinished condition enabled luxuriant harvests to come to maturity when otherwise every green thing would have been destroyed by the drouth. In other parts, the seats of some of the worst famines of history have been thoroughly watered and placed beyond the reach of such disasters.

COMPARATIVE COST OF ILLUMINATION.

A number of experiments have been made lately in London to test the comparative cost of illumination with the various materials used for that purpose. Below is the result, the first column containing a description of the materials tested; the second, the price of the material in London, reckoning twenty-four cents to the shilling; the third column shows the duration of the light furnished for one cent, the light being reduced to equal one sperm candle. With tho exception of the last named material, common gas, the prices do not vary sufficiently from those which prevail here to effect the value of the comparison. London gas is reputedly of inferior illuminating power, so that the economy of its use can scarcely be so much greater than ours as its cheapness would seem to indicate.

Standard sperm candles, per lb.	$ 48	1h. 7m.
Best wax candle per lb.	48	1: 6
Sperm oil in moderator, per gallon	2.28	1: 12
Belmont sperm candle, per lb.	30	1: 27
Stella, or Burmese wax, per lb.	30	1: 37
Petroline candle, per lb.	36	2: 15
Composite candle, No. 1, per lb.	22	2: 5
" " " 3 "	16	2: 45
Common dip candles, per lb.	12	2: 52
Almond oil, in moderator, per gallon	2.22	3
Colza, per gallon	1.20	4: 37
Paraffin oil, in lamp, per gallon	72	9: 35
Common gas, per 1,000 feet	90	26

The price of gas being about three times as great here as in London, no such marked advantage as appears in the table can accrue from its use on the score of cost. Still it must rank among the most economical of artificial illuminations, at least three or four times as economical as common candles, for a given amount of light.

A British Steam Tramway.

The Wantage line was only opened for public traffic in October last, and lies in a somewhat remote district. Perhaps it may be well to state, for the information of those who are unacquainted with its formation, that it is about 2½ miles in length, laid down along the side of the turnpike road leading from the town to the station of the Great Western Railway at Wantage Road. It consists of a single line of 4 feet 8½ inches gage, with four turnouts or passing places, with movable facing points at intermediate distances. The rails are of the ordinary bridge section, 40 lbs. per yard, bolted to longitudinal timbers of the dimensions 10 inches by 6 inches, with transoms 5 inches by 4 inches, 10 feet apart. The line crosses the turnpike road once only in the distance, and passes over the Wilts and Berks canal by an iron bridge of 38 feet span; its sharpest curves are of 70 feet radius, and its steepest gradient is 1 in 47, the length of the longest being 330 yards. The machine in use on the line is Mr. Grantham's patent combined steam car. The car has from the commencement continued to run daily with satisfaction, and without in any way obstructing the traffic on the road; and from its freedom from noise, steam, and smoke—the two latter being scarcely observable—horses traveling on the road appear to take no more notice of it than of an ordinary horse car. It may be stated also that on the occasion of the Berks volunteer review, which was held on August 7 last, on ground adjoining the Great Western Railway station, when it was computed that not less than 5,000 persons traveled on the road in vehicles of all descriptions during the day, and the car was running backwards and forwards the whole time, no inconvenience or difficulty with the horses was experienced. The car, which is 27 feet 3 inches in length, 11 feet 1 inch high, and 6 feet 6 inches wide, is divided into first and second passenger compartments, with the boiler and machinery fixed in the center, and runs on four wheels, one pair for driving, the other pair fixed to a radial axle for easing the curves; it is propelled backwards and forwards without turning at either end of the line, and only requires to be replenished with water after a double journey; it is driven from either end by removable levers, the driver having complete control of the machine as regards turning on, shutting off, or reversing steam, as well as applying the brake power, which is so perfect that the car can be brought to an almost immediate standstill. It is constructed to carry, both inside and outside, 60 passengers, and the full complement has often been conveyed by it; it appears highly popular with the public, and the traveling is much prefered to that of the horse cars; and judging from the silence with which it glides along on the rails, the absence of clatter and noise, as well as the ease with which the machine can be worked, it is considered, by those competent to form an opinion of its action, that the time is not far distant when the expensive system of working our street traffic on tramways by means of horse power will be succeeded by the use of steam under proper restrictions, especially as it must be apparent to all acquainted with the subject that the cost of working must be greatly in favor of steam. For the information of those interested, the cost of working the Wantage line, per day of twelve hours, as nearly as can be ascertained, is submitted:

DISTANCE TRAVELED PER DAY, 40 MILES.

Weight of gas coke, 240 lbs.		
Weight of steam coal, 56 lbs.		
—296 lbs. cost	67	cents.
Fuel for lighting	3	"
Oil and light for car	6	"
Driver's wages	$1.20	"
Stoker's wages	72	"
Conductor's wages	56	"
Estimated wear and tear	96	"
COST OF WORKING PER MILE, 11 CENTS FOR STEAM CAR.	$4.20	
Cost of horse cars—Four horses, at 72 cents	$2.88	cents.
Two drivers.	1.44	"
Conductor	56	"
Oil and light	4	"
Estimated wear and tear	1.44	"
Rent of stables, etc	24	"
COST OF WORKING PER MILE, 16·5 CENTS FOR HORSE CAR.	$6.60	

It will be seen by the above table that the cost of working the Wantage line by horse power is greatly in excess of the cost of working it by steam power; but the time occupied, owing to the restrictions laid down by the Board of Trade, confining the speed to eight miles per hour, is the same.

The Lowe Gas Process.

The long effort to obtain the gases of water upon a practical scale, that is, in unlimited quantity and at an economical cost, is too old and familiar a story to need repetition here. It has covered so many unsuccessful attempts and so many misrepresentations that the very name has been a synonym for failure and fraud. Nevertheless it is to-day an accomplished fact, as real as the systems of steam power and telegraphy; and it is peculiarly gratifying that, after sixty-five years of unsuccessful experiments, in which the most enlightened nations have participated, our Centennial year should witness the complete demonstration by our own countrymen, of a method, the value and influence of which, on the industries of this industrious age, can hardly be estimated. This journal has heretofore directed attention to the earliest performances of the new method, which has now accepted and accomplished a test upon so large a working scale as to entitle it to a marked recognition. It has recently gone into operation at the Manayunk Station of the Philadelphia Gas Trust, with such excellent results as would seem to justify all that has been claimed for it.

Indeed, each successive trial appears to develop stronger points in the system. For example, in the able report of Professor Henry Wurtz upon its workings in Utica, where it distributed satisfactorily some 24,000,000 cubic feet, its facility was deemed remarkable at a yield of 3,000 cubic feet per single generator for a run of forty minutes. At Philadelphia, however, it has, in the first days of its operation, produced as high as 10,000 feet for thirty minutes, and it is believed that increasing familiarity with the apparatus will show again even on this. This advance is, in part, attributable to the delivery of steam at a temperature never before attained, and by a plan at once economical and efficient, the heat being derived from the products of combustion previously burned in a stack of refractory material, through which, when at a white heat, the steam is conducted. This ingenious method also avoids the oxidation so troublesome in all other superheaters.

The high heats evolved by this simple apparatus are like ly to reduce to a minimum the carbonic acid gas, already at a low proportion in this process. It would really seem that the question which has been so prominently before the public of late, as to the possibility of obtaining better and more economical methods of lighting, has been fully met and answered by this system.

It certainly furnishes a very brilliant illuminant at what is claimed to be an important reduction in cost, and it is to be hoped that those who control the gas-making interest will give prompt attention to the matter. Their business has grown to be one of the great industries of the period, and it should be conducted upon progressive principles.

But valuable as this process may be for illuminating purposes, it must be manifest that a demonstrated success in this department carries with it some great possibilities in the direction of fuel. There is scarcely a question of greater practical interest than that relating to improved methods of heating, as it affects so wide a range of manufactures in metallurgy, mechanics, and chemistry, to say nothing of the still wider realm of domestic uses. Our present systems are still grossly defective and wasteful, utilizing not more than one eighth of the heating power of coal, without reckoning the inconvenience and cost of handling so heavy a material.

It is hardly unsafe to predict that the coming fuel, for the next stage of swiftly developing civilization, will be in a gaseous form, the advantages of which are too apparent to need enumeration.

When this time comes, and we hope to see it, it is our belief that the gases employed will be the product of water by some such process as the one whereof we write. Air, which is similarly decomposed into gas, is employed to some extent now, principally in the case of the Siemens furnace for steel manufacture, but the excess of nitrogen and carbonic acid render it a very questionable economy. Certainly an element that would furnish hydrogen, in lieu of these two non-combustible gases, would possess great advantages.

The field of investigation presented by the Lowe process at Philadelphia is one of great interest, and should be improved. We shall watch its development and report upon it from time to time.

NEW BOOKS AND PUBLICATIONS.

NOTES ON BUILDING CONSTRUCTION. Part II. (Advanced Course). London, England: Rivingtons, Waterloo Place. For sale by J. B. Lippincott & Co., Philadelphia, Pa.

This is a continuation of a very admirable text book prepared for the use of students in the Government Science and Art Schools, South Kensington, London, and especially directed to the requirements of the examiners of that celebrated institution. If the architects and builders of the coming generation are educated up to the standard contemplated in this work, and are imbued with the thoroughly practical spirit it inculcates, an important improvement in our homes and public buildings, in regard to both the art and the science of architecture, may be looked for. Technical explanations are seldom given with such clearness as in this work; and it is a pity that the author's name is not given. as he has written a standard manual of the very highest excellence. Part I. of the book was published some time sitce, and reviewed by us at the time. Part III. is now in the press.

THE ELEMENTS OF GRAPHICAL STATICS. By Karl Von Ott, Professor of the Imperial and Royal German High School of Practical Science, etc. Translated by George Sydenham Clarke, Lieutenant Royal Engineers, etc. Price $2.00. New York city: E. & F. N. Spon, 446 Broome street.

The literature of the graphical method is rapidly extending, and its study now forms a large and important part of the education of properly trained engineers; but although Professor Clerk-Maxwell, and more notably the late Professor Rankine, have used this method in their many well known works, it has scarcely received the attention which it merits. Lieutenant Clarke has faithfully performed the translator's task, and has added some valuable notes to Professor Ott's book, which is an excellent introductory treatise on the whole subject.

ALGEBRA SELF-TAUGHT. By W. P. Higgs, M. A., etc., Author of "Scientific Notes for Unscientific People." Price $1.00. New York city: E. and F. N. Spon, 446 Broome street.

This is the book that we have been looking for for some time past, namely, a clear and practical introduction to the science of algebra, written in a way to interest the young and uneducated. The many correspondents who modestly inform us that they are "unacquainted with algebra and formulas" should read this little book carefully; and it will open before them a large field of knowledge of the highest practical value in all the mechanical arts.

ELECTRO-TELEGRAPHY. By Frederick S. Beechey, Telegraph Engineer. Price 60 cents. New York city: E. & F. N. Spon, 446 Broome street.

A very readable little text book, containing much information.

TABLES FOR SYSTEMATIC QUALITATIVE CHEMICAL ANALYSIS. By John H. Snively, Ph.Dr., Professor of Analytical Chemistry in the Tennessee College of Pharmacy, etc. Price $1.00, post paid. Nashville, Tenn.: C. W. Smith, 158 Church street.

This handy volume contains practical directions for the analytical processes used in the investigation of all common substances, which are ar