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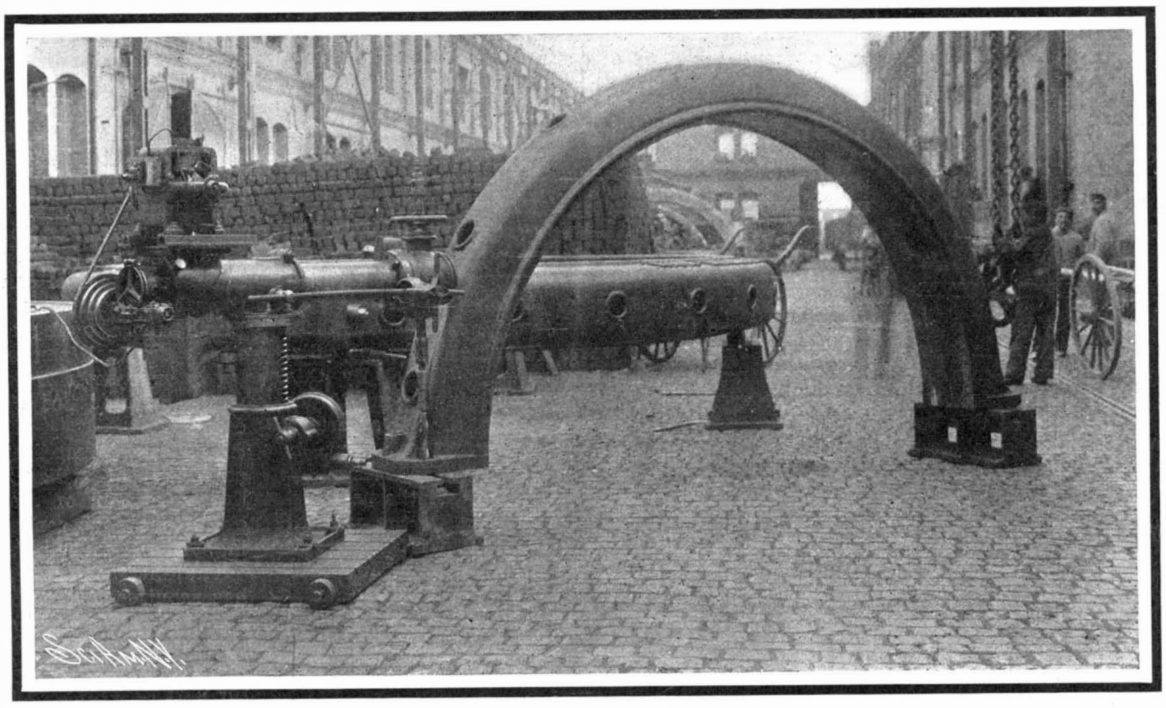
PORTABLE ELECTRIC DRILLING MACHINES.*

By the Belgian Correspondent of the SCIENTIFIC AMERICAN.

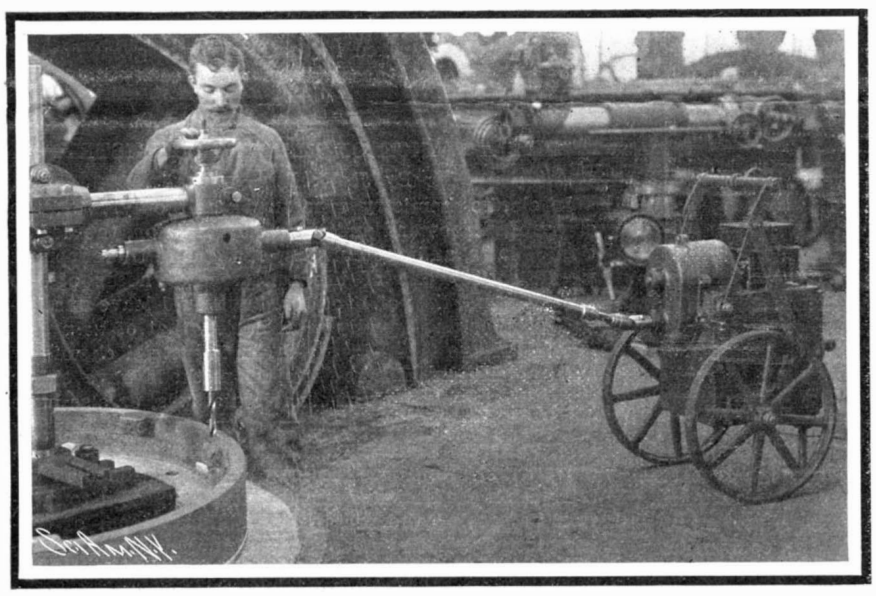
FOR the working of metal pieces of large size it is in many cases advisable to carry the machine tools to them, since the moving of such pieces to a stationary tool is often difficult if not impossible. Sometimes, even, the piece to be worked cannot be brought close to a stationary tool, either because of its shape or of its size. Then, again, the form and regulation of stationary machine tools are often ill adapted for the performance of certain work, such, for example, as drilling in places difficult to reach, etc. In such cases, it becomes necessary to employ transportable tools, especially when it is impossible to change the position of the piece, as in the mounting or repairing of large engines, in the building of ships, and in iron constructions, etc. Such apparatus are practical also for the boring of steam and pump cylinders.

The types of transportable drilling machines devised by the Société d'Electricité Lahmeyer & Cie., of Frankfort, Germany, are very interesting from this point of view, and greatly facilitate the work and advantageously replace long and expensive manual labor. They may be placed at any height and in any position without regard to the distance from the source of power. The various speeds of the drills are obtained very simply. The actuating of the tools by an electric motor may be effected in

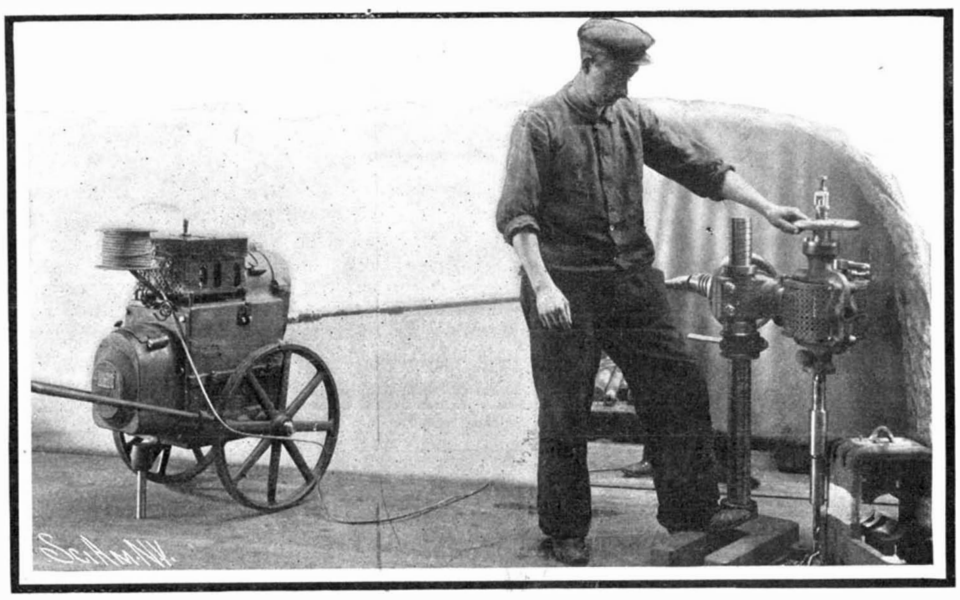
* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



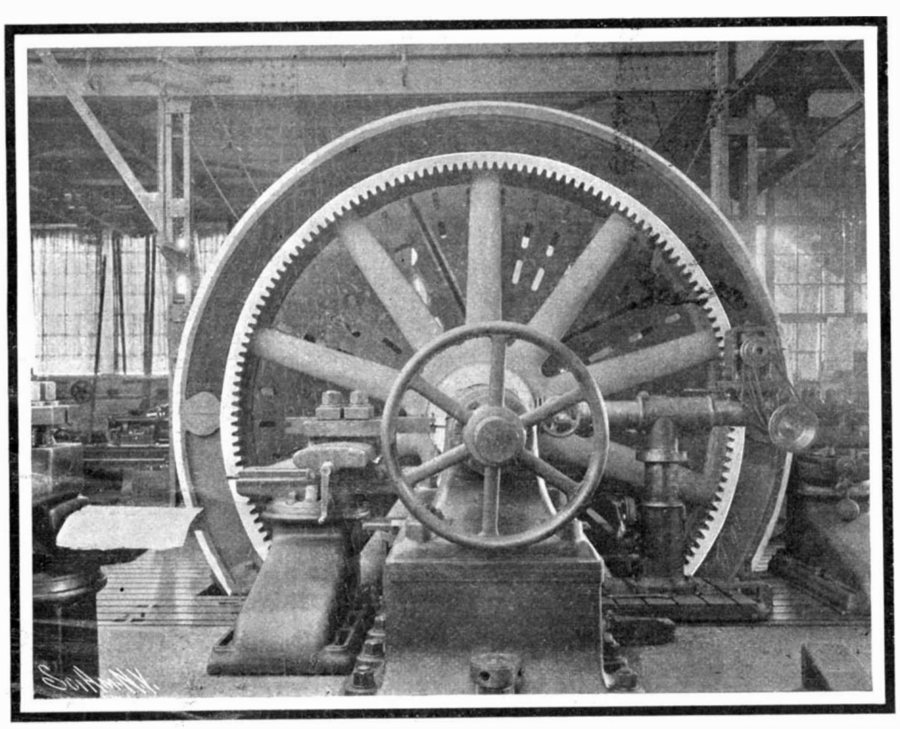
BORING APPARATUS APPLIED VERTICALLY.



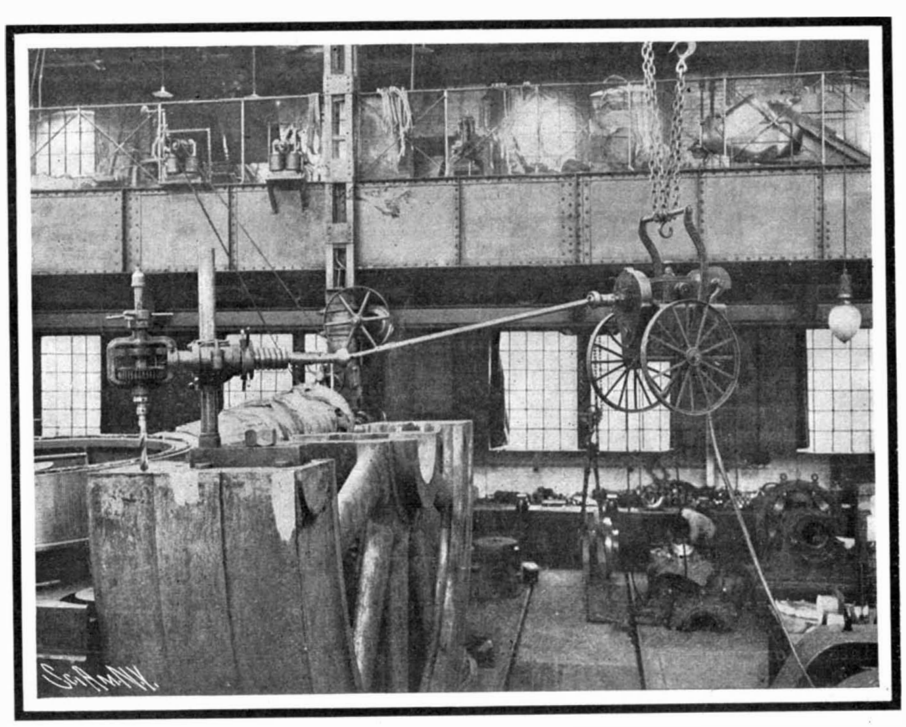
ELECTRICALLY-CONTROLLED DRILLING MACHINE.



ELECTRICALLY-CONTROLLED BORING MACHINE.



BORING MACHINE MOUNTED HORIZONTALLY.

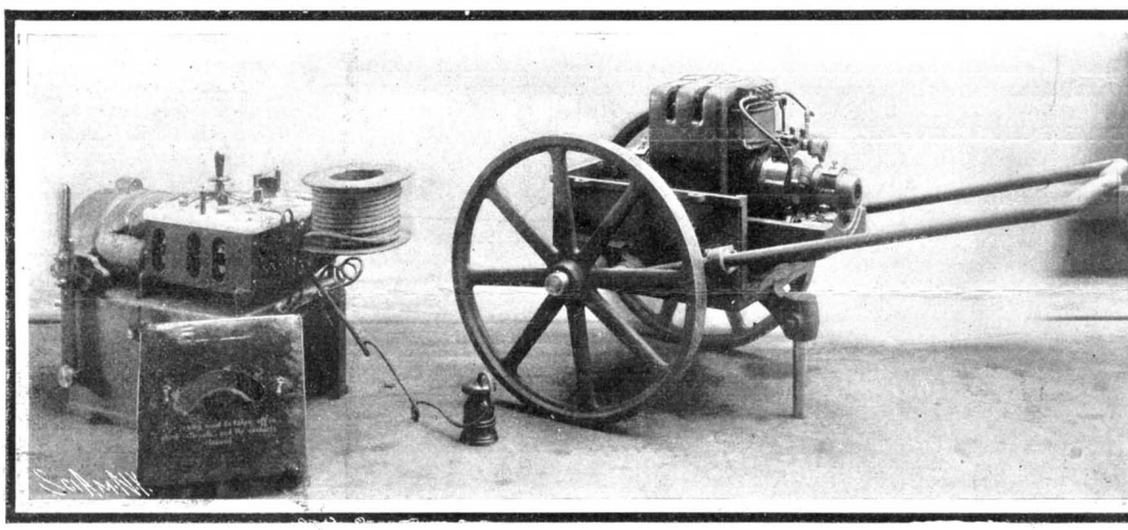


ELECTRICALLY-OPERATED BORING MACHINE WITH SUSPENDED MOTOR.

PORTABLE ELECTRIC DRILLING MACHINES.

different ways. Usually, the motor and its accessories are mounted upon a carriage and connected with the machine tool by a double-jointed shaft. The motor and machine tool can also be direct connected. Both systems are employed by the Lahmeyer establishment. In the first case it employs Hollberg drills, consisting essentially of a column with a base and of a bracket movable in a vertical direction and carrying the drill proper. The frame of the carriage that carries the motor is of cast iron and completely closed. The gearing that actuates the jointed shaft is likewise inclosed in a tight case. The apparatus is equipped with a rheostat for regulating the speed of the motor, the speed reduction being, at will, 1:4 or 1:8. The frame contains a drum upon which can be wound the conducting wires, a starting gear, fusible plugs, etc.

In the second system, Lorenz machines are employed. The whole apparatus is fixed upon a firm base provided with rollers. The vertical column is displaced by a handwheel, an endless screw, and a rack. The horizontal radial arm is placed in a clamp and is so arranged that it can turn at the top of the vertical column. At its end, on the under side, it carries the drill, which can be set in any position desired. The motor is placed on the upper side of the horizontal arm, and transmits its motion to the drill through the intermedium of belts, cones, and an endless screw upon a shaft arranged in the column and connected with the drill through a train of gear wheels.



ELECTRIC MOTOR FOR BORING MACHINES.

PORTABLE ELECTRIC DRILLING MACHINES.

A NEW ELECTRICAL PROCESS OF MANUFACTURING PEAT FUEL.

A NEW method for conversion of peat into a combustible fuel, by an electric process, in such a manner as to be commercially valuable, has been devised by Mr. J. B. Bessey, of England. By the aid of this invention peat can be converted into a hard smokeless steam coal, equal in calorific value to the best steam coal such as the Welsh variety.

The utilization of peat as fuel is by no means a modern development. In Germany, Sweden, Holland, Belgium, and other European countries, where peat abounds in enormous quantities, it is employed as fuel in many industries, and is also used to fire railway locomotives and for steam raising in large works. One iron-smelting company in Germany has consumed about 20,000 tons of peat per annum for the last forty-seven years. Peat is essentially a valuable fuel, having all the elements which make for high calorific efficiency. Peat charcoal is especially useful in the smelting of iron because of the absence of injurious ingredients which impair the value of the iron. The drawback in the way of its utilization economically, however, is that peat usually contains about 80 per cent of moisture, and before it can be profitably employed, the greater part of this moisture must be expelled.

Yet, notwithstanding these attempts to utilize peat in lieu of other fuels, it cannot be described as a commercial fuel owing to various inherent difficulties. Owing to this heavy percentage of saturation it takes a long time to dry. In some cases months have to elapse before the peat is ready for burning, while even when ready it forms a loose, spongy material which is not well suited for transport, and as the drying is practically confined to fine weather, it will be seen that the manufacture is of an intermittent character.

Various attempts have been made to release the moisture from peat by mechanical means, and to prepare the substance suitably for combustion with as high a heat value as possible. Squeezing, rolling, spreading, drying in furnace heat, and other devices have been used toward this end. The native method of cutting the peat into sods and exposing it to the drying action of sunlight is the crude forerunner of these elaborate machine processes.

By means of the Bessey invention it will be possible to convert the vast peat tracts of Ireland and Scotland into a commercially valuable product. It is estimated that one-seventh of the area of Ireland is composed of peat bog. There are 2,830,000 acres of it, the greater part of which is suitable for manufacturing into fuel. Of this vast quantity the mountain bog covers 1,254,000 acres, and the flat red bog is situated principally in the central plain, and its average depth is 25 feet.

The most salient feature of the Bessey process is the expulsion of water from the peat by electrical agency, though the utilization of the electric current is only one stage in a treatment which is mainly mechanical.

The peat is cut in the form of slabs or sods, and in its green condition is thrust into a large vertical cylinder called a centrifugal dryer, with its sides pierced to form a sort of grating. This cylinder is then revolved rapidly by means of an electric motor, and the centrifugal force whirls the free water out.

While the cylinders are rotating at a high velocity, heating fans are actuated, and in this manner about 60 per cent of the water contained in the peat is expelled. After revolving the cylinder for about a quarter of an hour, water ceases to be driven off. The material is then raked from the sides of the cylinders. Electrodes are now inserted in the cylinders, to which are attached electric wires, directly or otherwise connected with the dynamo.

The axle of the barrel forms one electrode and the rim another, the peat thus constituting the medium of completion of the current between the electrodes. The current, which is of a strength of about 230 amperes at 230 volts, gradually diminishing to about 100 amperes for 20 minutes, passes through the mass of peat from the center to the circumference. The resistance offered by the mass to the electric current generates heat, which disintegrates or pulverizes the material, separating it freely into particles, without loss to any of the valuable properties primarily contained in the peat—the conductivity of certain peats, by the way, is greatly assisted by the employment of chemicals—that is to say, the passage of the electric current ruptures or breaks the microscopic cells of the peat fibers and thus liberates the water contained in these cells, disintegrating the peat at the same time. By this means the greater part of the remaining latent 20 per cent of water in the peat is expelled, though a certain proportion of moisture—from 10 to 12 per cent—is essential to the fuel.

But although the water is expelled and the peat disintegrated, there is no interference with the natural oils. They are retained and uniformly distributed throughout the whole mass of the peat. The disintegrated peat is now conveyed from the centrifugal dryer smoking hot and is passed through a set of rollers to a kneading apparatus where a teasing manipulation is applied to bring the mass into a putty-like or plastic condition, when it readily concentrates, or contracts, into any form, shape, or size found most desirable, which may be expedited by the use of hot or cold pressure.

From the mixer the mass is passed on to the molder, by an automatic process, and the material is then formed into briquettes, or any other form or shape required. The contraction is materially hastened by the use of heated drums or surfaces and mechanical presses, acting in combination or alone. From the form or presses the finished product is directly carried by conveyor to the storage shed. Unless urgently required the forced drying process can be eliminated, and treated briquettes can be stacked for about a week to dry. The finished samples are as hard as ordinary coal, which in fact they closely resemble in appearance, the color having been changed by the process from brown to a dull blacklead color.

The fuel produced by this process is of a very high quality, and is in every way equal to steam coals. There is no smoke during combustion, it is free from clinkers, and leaves but a slight quantity of ash. Its calorific power is about 9,000 British thermal units of heat and upward. One of the most prominent features of this electrical process, which is unobtainable by any other heat method, is that although the transmission of the electric current through the mass of peat, in the manner already described, results in the heating of the peat, yet the effect of the heat thus generated is quite different and distinct from that which is afforded by fire or other calorific means. For, whereas, with fire heat the particles of the peat become, as it were, case-hardened and confine their various constituents, the effect of the heat obtained by electricity is to disintegrate the peat and liberate the cellular constituents, and to cause them to be uniformly distributed throughout the whole mass of the peat, and render all those constituents readily available for combustion.

To obtain charcoal, the disintegrated peat is further subjected to the electric current in the same receptacles, the air being excluded by a suitable covering, after which the material is treated with an adhesive solution, causing the particles to unite.

There is another vital feature which should recommend development of the process, and that is the valuable utilization of by-products and the production of peat moss and fibrous peat. This material is also treated with the electric current, which causes the shredding or separating of the mass of peat without destroying its fiber. It is then in a state for pressing or baling by mechanical presses, into such forms or sizes as may be found most desirable for litter or any other purposes for which it may be desired.

In view of the high percentage of water existing in the crude peat—80 per cent—it would appear that the process of excluding the superfluous water would be too costly to render the process commercially possible. Out of every 100 pounds of crude peat treated there is only some 20 pounds of real combustible fuel. Yet, notwithstanding this high proportion of water, a ton of this fuel can be manufactured much more cheaply than a ton of steam coal can be produced at the pit's mouth. The latter costs $2 a ton, while the cost of manufacturing a ton of this peat fuel is, under favorable circumstances, no more than 90 cents. The cost of production naturally varies with the situation and conditions governing the excavation of the crude material, but the inventor is sanguine that under adverse conditions the cost will not exceed $1.25 per ton. Moreover, the fuel can be manufactured very quickly, the whole process not occupying more than 2½ hours. Furthermore, owing to the simplicity of the plant by which the fuel is manufactured ready for market, no heavy expense is incurred concerning the installation, while maintenance charges are also appreciably reduced.

Another salient fact concerning this process is the possibility of utilizing a portion of the peat fuel for the generation of the electric power required in the operations, thus rendering the installation self-sustaining. It will consume a portion of its own products.

The Electro-Peat Coal Company, of London, which has acquired the patents of the process, has purchased a large tract of peat land in Ireland for the exploitation of the system. One thousand tons of this fuel are to be manufactured daily. There is a great demand for peat fuel provided it is satisfactorily manufactured for combustion purposes. Owing to the hardness of the briquettes in which the Bessey electro-peat is placed upon the market, it facilitates storage. This important factor will be of inestimable value for vessels, where economy of space is a great desideratum. With this fuel stacked in the bunkers, a great deal of valuable storage space will be rendered available for other purposes.

THE ADVANCE OF ELECTRO-CHEMISTRY.*

By J. W. RICHARDS.

IF electro-chemistry concerned itself only, with the study of phenomena and their classification, the deduction of laws, and the building of theories thereupon, it would satisfy one of the fundamental needs of the human mind, that of *knowing*, but would leave unsatisfied another and equally vital desire, that of *using*.

The various items in which, in industrial chemistry and metallurgy, electro-chemical methods have either superseded ordinary non-electric methods, or else have created new industries, form a catalogue sufficiently long to arrest the attention of the most superficial observer, and altogether too long to be mentioned in detail within the limits of this address. Suffice it to mention in passing the millions of dollars' worth of copper electrolytically refined, not annually, but monthly; the 100,000 horse-power consumed in producing calcium carbide; the reduction of the cost of aluminium from $5 a pound to 30 cents; of sodium in almost an identical ratio; the revolution being wrought in one of the largest chemical industries by the production of electrolytic alkali and bleach; the capturing of the potassium chlorate industry and the manufacture of phosphorus.

The whole story, if related at length, would be the old story of *homo sapiens* having discovered a new tool, a new instrument wherewith to torture Mother Nature; a new means of reaching old or of creating new results, and he is necessarily immersed in enthusiasm for this "genius of the lamp," which has performed so many wonders and promises so many more. For the use of electricity puts at our disposal temperatures never before industrially attained; gives us a decomposing agent at whose bidding the most powerful chemical compounds resolve into their constituents; enables us to attack and solve chemical problems in a manner before unthought of; opens up a world of possibilities whose scope we even yet but dimly comprehend. This is the fascination of the subject, the attractive force, the absorbing interest which is reflected in the enthusiasm of the electro-chemist for his profession.

Basing our remarks upon present developments, it may be perceived, to start with, that the electrical methods in chemistry and metallurgy which are most successful are either, first, those applied to the more powerful chemical compounds, whose decomposition by non-electric methods is highly difficult and expensive, or else impossible; or, second, those applied to new fields of very high temperature reactions impossible of attainment by other means; or, third, those applied to ordinary chemical processes, in which the directness

* Abstracted from Science, June 17, 1904. An address by Professor Joseph W. Richards, of Lehigh University.

of the electrical influence, be it decomposing, reducing, or producing, can not be duplicated or competed with by known non-electric methods.

Primitive man took his first lesson in metallurgy by learning to make iron; to this the ancients added lead, copper, silver, gold, and even the volatile mercury. Many centuries later zinc was distilled, and only in the most recent times have sodium, aluminium, and magnesium been possibilities. Painfully and slowly alchemy and modern chemistry toiled up the heights of the electro-chemical series, from the easy conquest of the *noble* metals to the powerful mastery of the *strong* metals, and the steepest part of the ascent has been lightened by the aid of electricity, which has in many cases furnished the easy path to the conquest of the most difficult chemical problems.

It is related of our renowned geologist, Clarence King, that he was an enthusiastic mountain climber, and having from a distance spied a steep mountain, he conceived the ambition of conquering it. Taking a respite from surveying, he equipped himself for difficult climbing, and after several hours of desperate effort finally stood on the summit of the seemingly impregnable butte, only to find an easy trail leading up on the other side.

The most abundant materials in nature are the fixed, difficultly transposable compounds of the strong metals, and their conquest and utilization are the peculiar and special province of electro-chemistry.

According to the estimate of the indefatigable chemist of the Geological Survey, F. W. Clarke, silicon oxide forms 58.3 per cent of the contents of the solid crust of the earth, aluminium oxide 14.7 per cent, iron oxide 7.8 per cent, calcium oxide 5.3 per cent and magnesium oxide 4.5 per cent; or, expressed in another way, silicon 27.2 per cent, aluminium 7.8 per cent, iron 5.5 per cent, calcium 3.8 per cent, and magnesium 2.7 per cent.

With these figures in mind, may I not ask whether we fully realize the significance of one of the latest electro-metallurgical triumphs, the production of metallic silicon on a large scale in the electric furnace at Niagara Falls by Mr. F. J. Tone? While the catalogues of dealers in rare chemicals are still listing silicon at dollars an ounce, an electro-chemist has two barrelfuls of it which he is wondering if any one will buy at a fraction of a dollar a pound! Could anything better illustrate the revolutionary character of the electro-chemistry?

To say a word or two more about silicon. I had a somewhat uncanny feeling when Mr. Tone introduced me to his half a ton of silicon. "Here is," I soliloquized, "the first chance which mankind has had to utilize the most abundant solid element on earth. What will be made of it? Can it become as useful as iron? Probably not. Can applications be found for it which will bring it among the ordinary metals of every-day life? Possibly. In any event, here is the material, ready to hand, and no one but the electro-chemist could have made it."

Something of the same feeling must have arisen in the mind of the chemist who first made aluminium a commercial possibility, but his expectations, based on his chemical process, were only actually realized when the electro-chemist gave his solution of the problem. This very element illustrates one of the chief characteristics of electro-chemical processes, viz., their potentiality for improvement. Chemically produced aluminium was out of the race when the metal sold for one dollar per pound, yet the present market price is only one-third of that. After the chemical process has done its utmost, has said its last word, the electro-chemical process, which supersedes it, has only *begun* its march of improvement.

CONTEMPORARY ELECTRICAL SCIENCE.*

Electrolytic Treatment of Cancer.—S. Leduc describes a remarkable cure of a cancroid growth after a single introduction of the ion zinc. The growth was in the right wing of the patient's nose, and had existed in a constant state of ulceration for five years. The author applied to its whole surface a plug of hydrophil cotton impregnated with a 1 per cent solution of zinc chloride. This was connected up with the positive pole of a battery whose negative pole was connected with any other part of the body through a large indifferent electrode. A current of 8 milliamperes was passed for 12 minutes without causing any pain, and boric vaseline alone was subsequently applied. The crusts detached themselves immediately, and 10 days afterward the ulcer was completely scarred over and of good aspect. Ten weeks afterward, the scar remained perfect, with the exception of a slight sore at the tip of the nose, which was treated similarly.—S. Leduc, Arch. d'Electr. Méd., December 15, 1903.

N-Rays.—H. Zahn has vainly endeavored to observe the N-rays discovered by Blondlot. He says that the latter's experiments as described by him have been repeated in several quarters, but so far without success. He himself employed a method which he claims to be more sensitive, as well as more objective, than that of Blondlot. He allowed a small sensitive flame to illuminate a selenium cell, hoping to find the existence of N-rays indicated by a change in its resistance. An Auer burner was surrounded by sheet-iron as in Blondlot's arrangement, and its light was concentrated upon a small gas jet placed in front of a selenium cell of 6,000 ohms normal resistance. An alteration in the resistance, amounting to 5 per cent, could have been determined with certainty, and as Blondlot's results lead one to expect a change in the brightness of the flame, amounting to at least 100 per cent, the experiment ought to have been successful. But the result was entirely negative. So it was when the author operated with a small spark worked with a string interrupter with terminals of various shapes and materials. The author does not go so far as to deny the existence of the N-rays, but points out that their discoverer has not described his experiments with sufficient detail, and that the rays can certainly not be so easily observed as he alleges.—H. Zahn, Phys. Zeitschr., December 15, 1903.

* Compiled by E. E. Fournier d'Albe in the Electrician.

N-Rays Emitted by the Human Body.—A. Charpentier has successfully repeated some of Blondlot's experiments on N-rays, and has observed that they are emitted by the muscles and nerves of the human body when in a state of activity. He worked with a barium platino-cyanide screen brought to a state of faint luminosity by means of a piece of radium inclosed in black paper. The luminosity of the screen was enhanced whenever N-rays fell upon it. "I recognized at first," he says, "that the small phosphorescent or fluorescent object became more luminous when brought near the body. Further, this increase is more considerable near a muscle, and is the greater the more strongly the muscle is contracted. It is the same in the neighborhood of a nerve or a nerve center, where the effect increases with the degree of activity of the nerve or nerve center." The effect is transmitted across aluminium and other bodies transparent to N-rays, and stopped by moist paper, and partly by lead. The rays may also be reflected, refracted, and condensed. They are not an effect of heat, for they are transmitted through several layers of aluminium separated by air spaces. Neither are they an effect of stored sunlight, since they remain the same after nine hours spent in complete darkness. The author points out the great importance of these physiological actions in view of the fact that we now have a direct external reaction of an excited nerve. He also describes a process for mapping out active muscles in the living subject, notably the heart, which is a muscle in a continuous state of activity.—A. Charpentier, Comptes Rendus, December 14, 1903.

Magnetic Rotational Dispersion.—J. Disch has tested Wiedemann's law, according to which the Faraday effect is strictly proportional to the natural rotational dispersion of the substance. For this purpose he determined both the natural and the magnetic rotational dispersion for a number of transparent substances showing no absorption within the visible spectrum and requiring no inactive solvent. The substances investigated included oil of turpentine of German, French, and American manufacture, paraffin oil, valerianic acid ethyl, diethyltartrate and quartz. The Arons mercury arc was employed as a source of light, the particular line required being sifted out in the polaristrobometer. In the case of quartz, the proportionality appears to be almost perfect. In the case of valerianic acid ethyl, however, there is a distinct lag in the magnetic dispersion in comparison with the natural dispersion as the shorter wave-lengths are approached. Taking the ratio for 656 $\mu\mu$ as unity, the natural rotational dispersion becomes 2.573 at 436 $\mu\mu$, but the magnetic rotational dispersion becomes only 2.267 for the same wave-length. The other substances show similar discrepancies. The fact that quartz does not show them is attributed by the author to the fact that right-handed quartz is optically homogeneous, and contains no trace of left-handed quartz. The other substances probably contain active aggregates of molecules which modify the natural rotational dispersion. The author tested the equations formulated by Boltzmann, Carvallo, and Drude to express the dispersion in terms of the wave-length, and found that they apply equally well to the magnetic dispersion.—J. Disch, Ann. der Physik, No. 13, 1903.

Simple Form of Wehnelt Interrupter.—Referring to Zehnder's simplified form of Wehnelt interrupter—which, by the way, appears to have been already patented by Ernecke—W. van Dam describes a further simplification. The difficulty of mounting the platinum pencil in such a manner that no liquid can pass it is overcome by using India rubber instead of ebonite. As long as the current does not exceed 0.6 ampere per square millimeter, good Para rubber is consumed exceedingly slowly. The author has only once renewed the rubber in his apparatus within the last two years. In any case, the operation is one of extreme simplicity. The brass rod with the soldered-in platinum wire can be placed directly in the glass tube without using an extra brass tube. Hard solder need not be used, since the joint does not come into contact with acid. The concussions are deadened by the rubber in such a manner that there is practically no danger of breakages. The author uses a tube of 8 mm. internal diameter, to one end of which another tube half that width and about 3 cm. long is fused. The brass rod with platinum wire 1 mm. thick is introduced into the glass tube, and a piece of tubing of the best Para rubber and less than 1 mm. in internal diameter is slipped over the projecting platinum wire. It is wetted with water and then pressed into the narrow tubing.—W. van Dam, Ann. der Physik, No. 13, 1903.

Suppression of Hysteresis.—P. Duhem discusses Maurain's observations of the suppression of hysteresis by a rapidly varying field from the point of view of a theory which he has developed in numerous publications. In this theory, an essential part is played by a line which he calls the "line of natural states." Traced on a diagram, in which the abscissæ are the field strengths H and the ordinates are the intensities of magnetization M, it passes through the origin and is symmetrical with respect to it. It is this line of natural states which marks out what Maurain would call the "curve of normal magnetization." One of the results of the author's theory is stated as follows: "Given a magnetic field undergoing a double and symmetrical oscillation between two finite values positive and negative, what will be the limiting form of the effect produced as the time of oscillation tends toward zero? It is found that this magnetic cycle, described very rapidly between two finite values, is equivalent to a magnetic cycle described slowly between two infinitely small values, which are, of course, incapable of magnetizing iron." If a piece of iron is simultaneously subjected to two finite fields, both in the same direction, but one of which is constant while the other oscillates with extreme rapidity between two equal values of opposite sign, the result will be the same as if it had been submitted to the action of a field undergoing very slow, very small and very numerous oscillations about the value of the constant field. Marconi attributed the effects produced in his receiver to the suppression of magnetic viscosity, whereas Tissot was the first to postulate the suppression of magnetic hysteresis. The author's theory takes both these processes into account, but shows that it is just the intervention of the viscosity which leads to the suppression of hysteresis in rapidly oscillating fields.—P. Duhem, Comptes Rendus, December 14, 1903.

EARNINGS AND EXPENSES OF AMERICAN RAILROADS.

The gross earnings of the railways in the United States from the operation of 205,313.54 miles of line were, for the year ending June 30, 1903, $1,900,846,907, being $174,466,640 greater than for the previous year. Their operating expenses were $1,257,538,852, or $141,290,105 more than in 1902. The following figures give gross earnings in detail, with the increase or the decrease of the several items as compared with the previous year: Passenger revenue, $421,704,592—increase, $28,741,344; mail, $41,709,396—increase $1,873,552; express, $38,331,964—increase, $4,078,505; other earnings from passenger service, $9,821,277—increase, $962,508; freight revenue, $1,338,020,026—increase, $130,791,181; other earnings from freight service, $4,467,025—decrease, $379,693; other earnings from operation, including unclassified items, $46,792,627—increase, $8,399,243. Gross earnings from operation per mile of line averaged $9,258, the corresponding average for the year 1902 being $633 less.

The operating expenses were assigned to the four general divisions of such expenses, as follows: Maintenance of way and structures, $266,421,774; maintenance of equipment, $240,429,742; conducting transportation, $702,509,818; general expenses, $47,767,947; undistributed, $409,571. Operating expenses were $6,125 per mile of line, having increased $548 per mile in comparison with the preceding year. The statistical report contains an analysis of the operating expenses for the year according to the fifty-three accounts prescribed in the official classification of these expenses, with the percentage of each item of the expenses as classified for the years 1897 to 1903.

The income from operation, or the net earnings, of the railways amounted to $643,308,055. This item when compared with the net earnings of the year 1902, shows an increase of $33,176,535. Net earnings per mile for 1903 averaged $3,133; for 1902, $3,048, and for 1901, $2,854. The amount of income obtained from other sources than operation was $205,687,480. In this amount are included the following items: Income from lease of road, $109,696,201; dividends on stocks owned, $40,081,725; interest on bonds owned, $17,696,586; and miscellaneous income, $38,212,968. The total income of the railways, $848,995,535—that is, the income from operation and from other sources—is the amount from which fixed charges and similar items of expenditure are deducted to ascertain the sum available for dividends. Deductions of such nature totalized $552,619,490, leaving $296,376,045 as the net income for the year available for dividends or surplus.

The amount of dividends declared during the year (including $420,400, other payments from net income) was $197,148,576, leaving as the surplus from the operations of the year ending June 30, 1903, $99,227,469, that of the previous year having been $94,855,088. The amount stated above for deductions from income, $552,619,490 comprises the following items: Salaries and maintenance of organization, $430,427; interest accrued on funded debt, $283,953,124; interest on current liabilities, $9,060,645; rents paid for lease of road, $112,230,384; taxes, $57,849,569; permanent improvements charged to income account, $41,948,183; other deductions, $47,147,158.

It is perhaps appropriate to mention that the foregoing figures for the income and expenditures of the railways, being compiled from the annual returns of leased roads as well as of operating roads, necessarily include duplications in certain items of income, and also of expenditure, since, in general, the income of a leased road is the rent paid by the company which operates it. The report, however, includes a summary presenting the income account of the railways considered as a single system, from which intercorporate payments are eliminated.

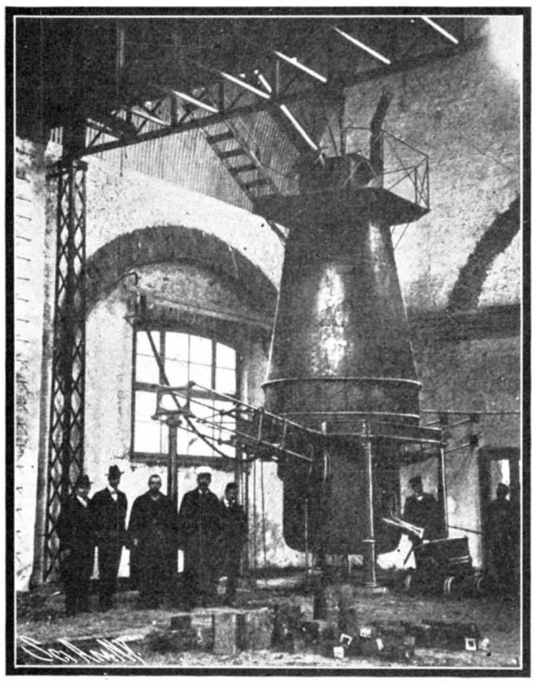
The summary showing the taxes and assessments of the railways by States and Territories and per mile of line, and also the analysis of taxes showing the basis of payments according to the various laws under which railways are taxed, are repeated in the present report.

[Continued from Supplement No. 1491, page 23896.]

THE ELECTRO-METALLURGY OF IRON AND STEEL.*

By Emile Guarini.

We now come to the induction system, which, in our opinion, constitutes the ideal as regards electric furnaces. This system has all the advantages of the resistance arc without its inconveniences. In it the furnace mass constitutes the secondary of an induction coil that may at some time be a converter. The current may, therefore, be one of a very high tension requiring very small wires. This constitutes a great advantage for the utilization of the current coming from a very remote hydro-electric central station. What really constitutes the advantage of the system, however, is the abolition of electrodes and of all the drawbacks that result therefrom in the two preceding systems. Among other advantages may be maintained the possibility of greatly increasing the charge of the furnace, of employing silicate and magnesia for the lining of the furnace, and, finally, the absence of contact of the steel with the gases of combustion that injure its quality. A very high efficiency may be predicted for this system if we consider that in certain converters whose furnaces are well-nigh perfect, as high as 97 per cent efficiency is obtained. We shall now give a short description of the different kinds of furnaces, and dwell especially upon those that have been actually used.



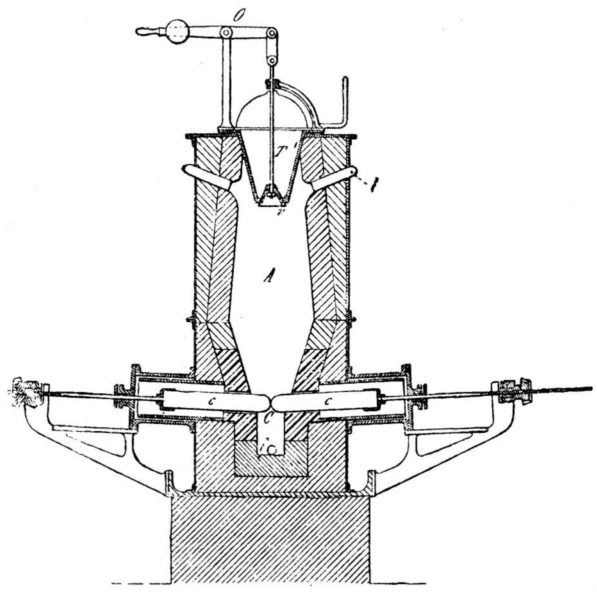
Stassano's 500-Horse-Power Electric Furnace, Operating with a Current of 200 Volts and 1,800 to 2,000 Amperes. This Furnace Represents the Intermediary Stage Between Stassano's First and Latest Designs.

ARC FURNACES.

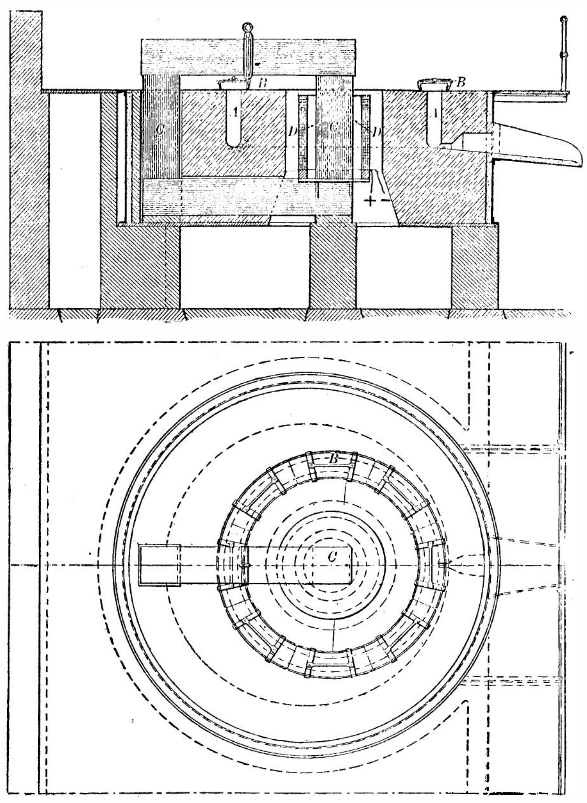
Let us in the first place mention the Siemens and Moissan furnaces, which have an historical importance. Siemens devised the furnace with independent electrodes and with an electrode formed by the material to be melted. His first furnace comprised a refractory crucible, the bottom of which formed one of the electrodes. The carbon electrode was afterward exchanged for a copper one cooled by water.

* Specially prepared for the Scientific American Supplement.

The Moissan furnace is formed of a block of quicklime in two parts, each containing a semi-ellipsoid cavity. The lower arc receives the metal, and above the latter is formed the arc that heats it by radiation. The Ruthenburg furnace, which is especially designed for the treatment of magnetic ores in powder, consists of two hollow cones connected by their bases and surrounded by a strong electro-magnet for directing the particles of the arc. The arc forms between the two points.



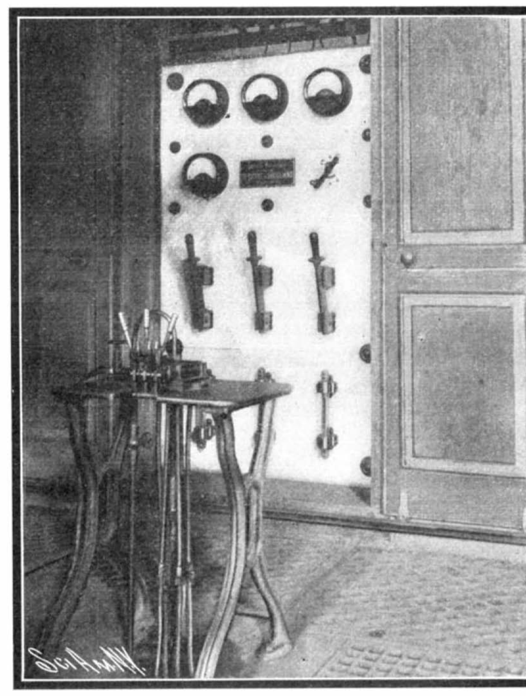
Stassano's Original Furnace, Built at Rome.



The Kjellin Electric Steel Furnace.

M. Furnace room. *B B.* Covers. *C.* Quadrangular core or cone. *D D.* Coil.

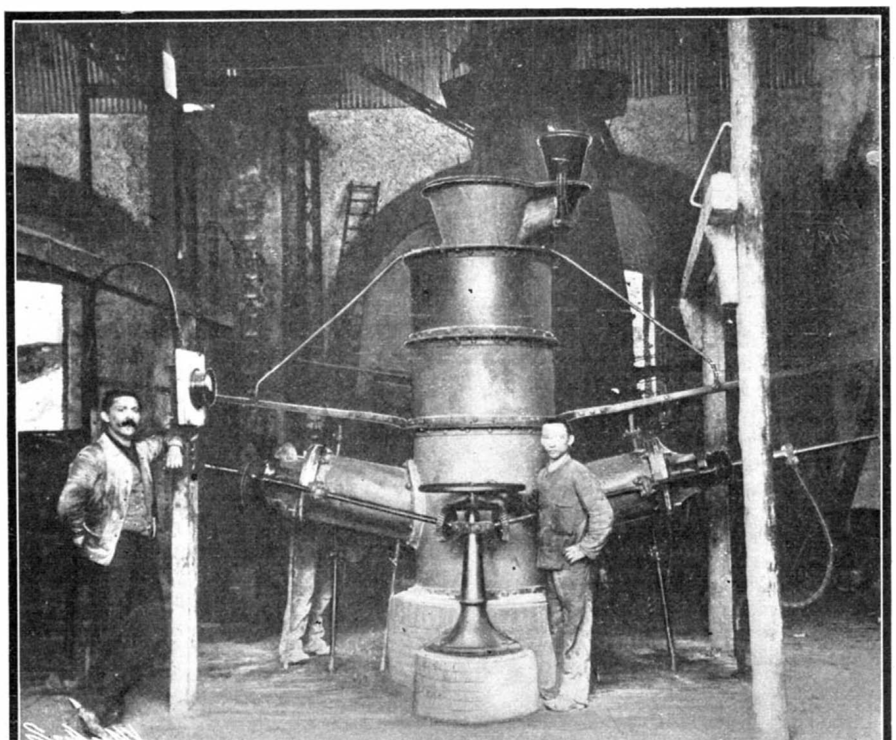
The Stassano furnace, in its most recent form, is the most highly improved of the arc furnaces, and, despite the defects inherent in the use of the arc, has given remarkable results. The inventor for a long time struggled with innumerable difficulties created by adversaries, but seems to be upon the point of triumphing over all opposition, thanks to the aid of the steel works of Turin. A furnace of this type was constructed and experimented with for an entire year. The experiments, which were interrupted, are to be resumed, and a syndicate is about to be formed to exploit the system.



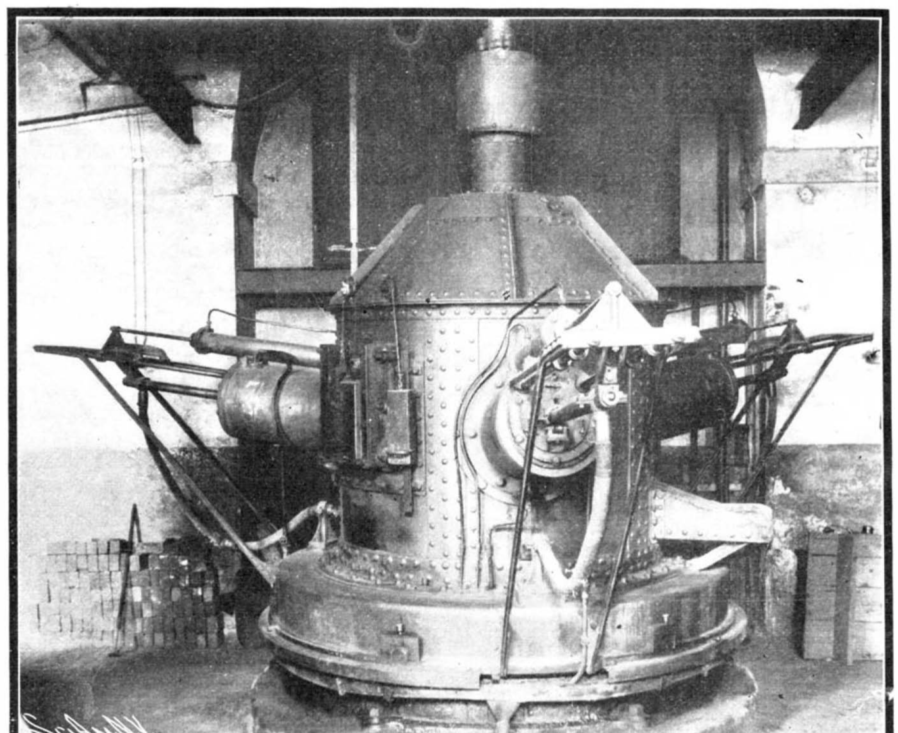
Switchboard and Valves for Operating the Hydraulic Cylinders Controlling the Electrodes of the Stassano Furnace.

The first model of the Stassano furnace in its general form resembles a blast furnace. The molten metal collects in a crucible provided with a tap-hole. The arc forms between two carbon electrodes, the spacing of which is regulated by hand according to the readings of a voltmeter and amperemeter. The electrodes are above the crucible. A special system of pipes affords an exit to the gas. In order to prevent the materials from offering too great a resistance to the passage of the gas, the whole is reduced to powder and agglomerated into briquettes by means of tar. These briquettes are broken into 1½ to 2-inch pieces for charging the apparatus.

The new Stassano furnace is of the revolving hearth type. The materials are pulverized, as before, with coke and flux. Instead of using air as a carburant, what is known as the ore process has been adopted. This consists in introducing, as an element for furnishing oxygen, an oxide of iron, which, upon becoming reduced, sets at liberty the oxygen that is to burn the carbon of the molten metal. In order to regulate the quantity of heat supplied to the furnace, which must be greater at the beginning of the reaction than during the operation, M. Stassano has adopted a coupled arc arrangement in which a variable number of arcs are connected in circuit according to requirements. The revolving base plate renders it possible to obtain a perfect agitation of the material during the fusion. The inventor



Stassano 150 Horse-Power Electric Furnace at Darfo. The Lower Part of the Furnace is Similar to that Used by Stassano in His Earlier Experiments and is the One which Showed to Him the Necessity of Adopting His Latest Type.



The Stassano Electric Furnace at the Turin Plant. This Furnace Represents the Latest Development in Stassano's Researches.

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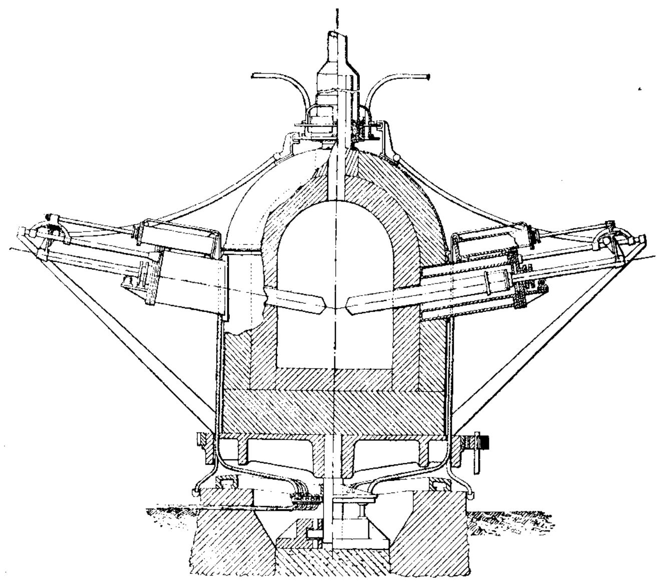
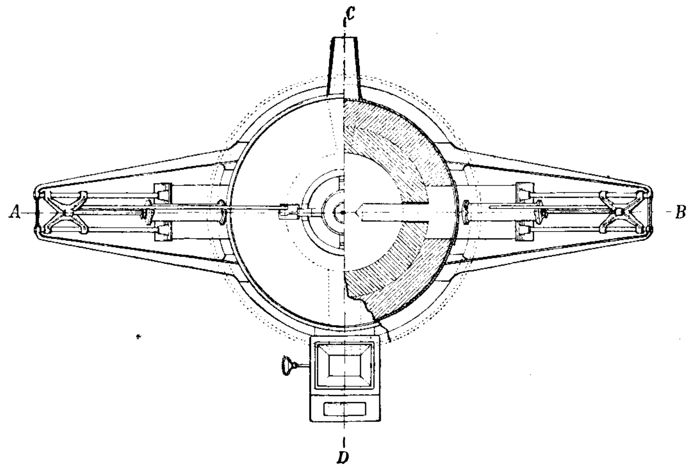
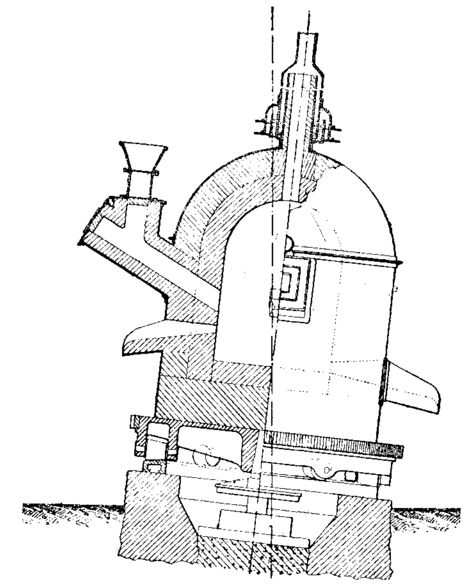
has, moreover, remedied the inconveniences of the Martin-Pernot revolving hearth by setting in motion the entire fusion chamber, so that there is no longer any fear of a foreign body falling into the molten mass and of the entrance of cold air into the bath. The last



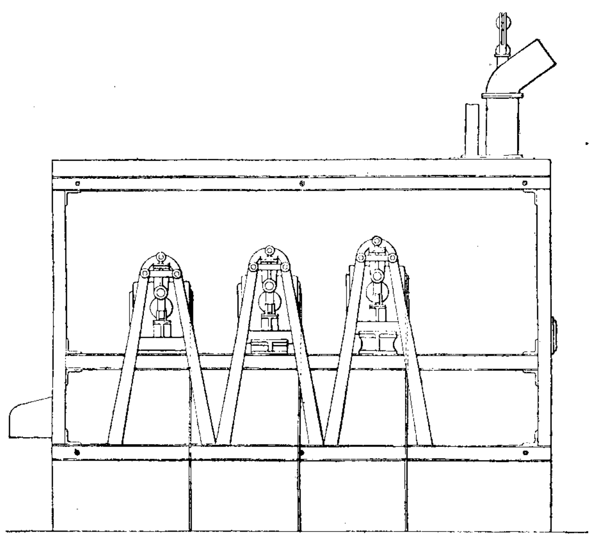
Stassano's Latest Form of Revolving Electric Furnace. Vertical Section.



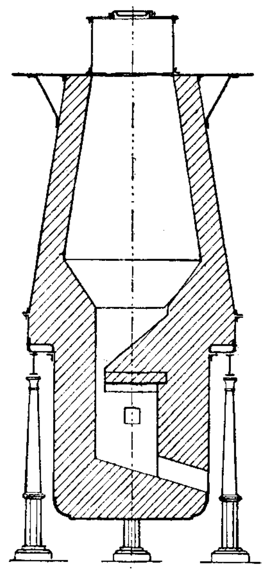
Stassano's Latest Form of Revolving Electric Furnace. Partial Plan and Section.



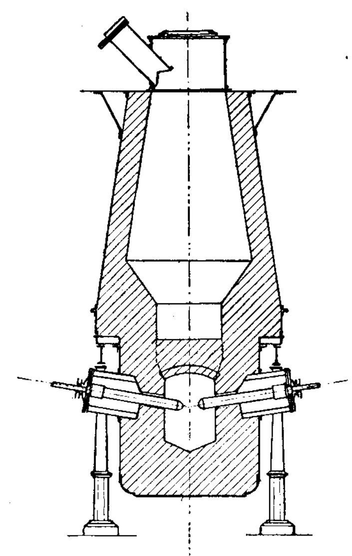
Stassano's Oscillating Furnace for the Electrical Reduction of Iron Ores.



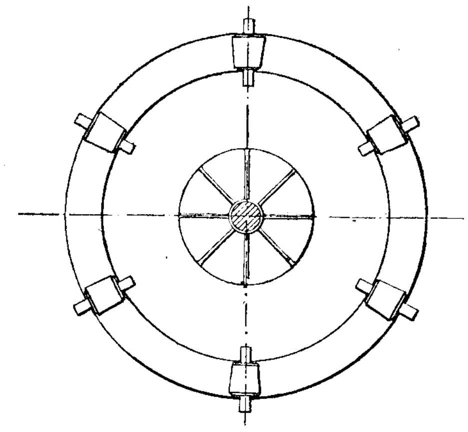
Stassano Electric Furnace with Several Pairs of Electrodes.



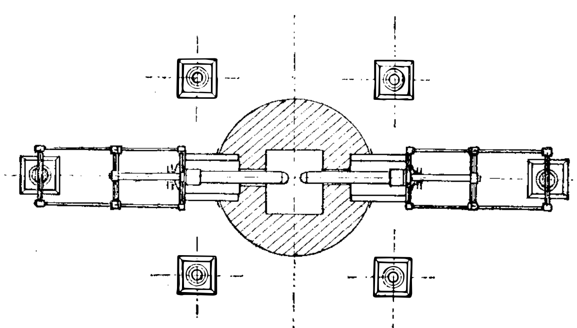
Stassano Electric Furnace, Built at Darfo.



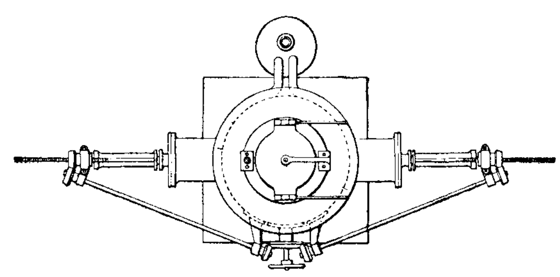
500-H. P. Stassano Electric Furnace, Constructed at Darfo.



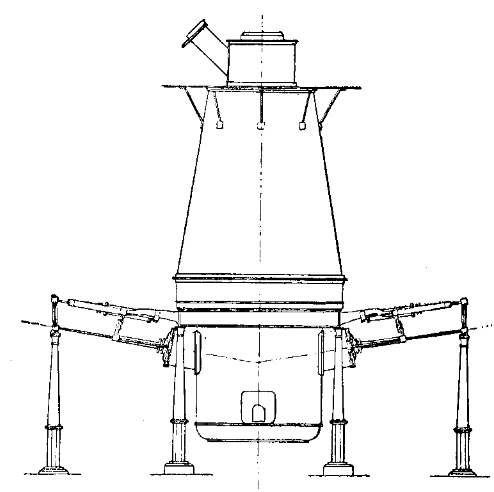
Stassano Electric Furnace with Revolving Dead-plate for the Reduction of Iron Ore. (Bearing Wheel.)



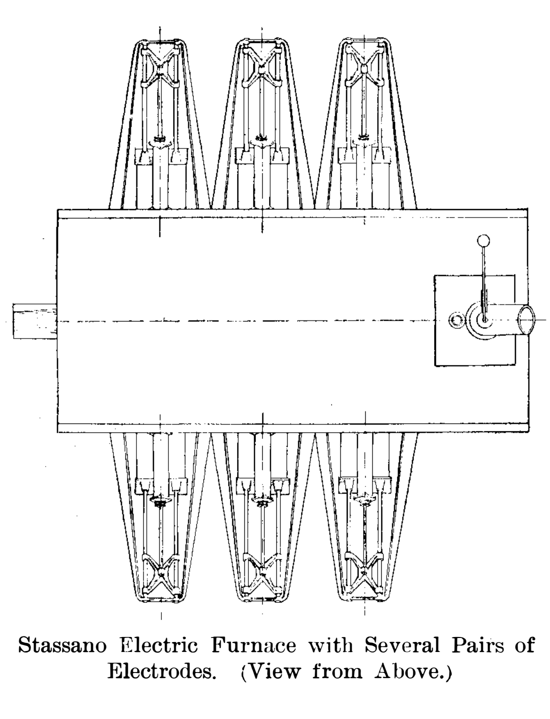
Stassano Electric Furnace Constructed at Darfo (Plan).



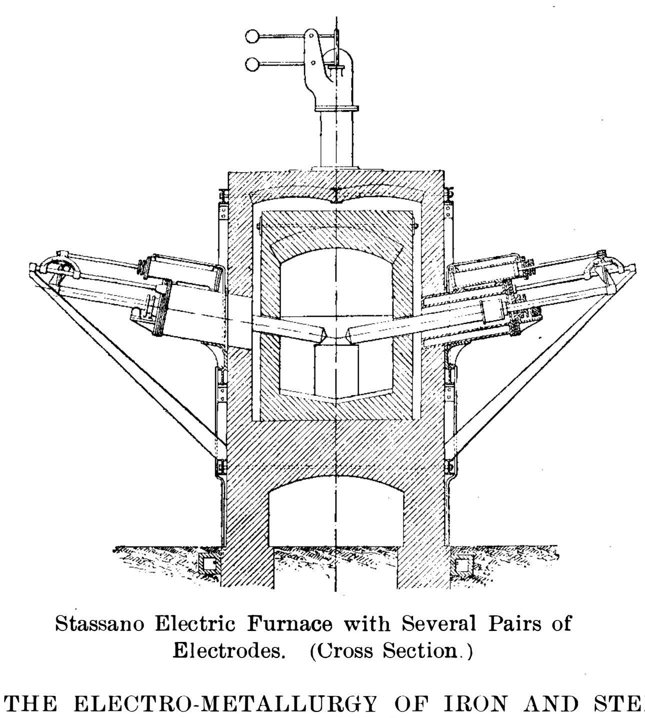
The Stassano Electric Furnace. (Primitive Form Experimented with at Rome.)



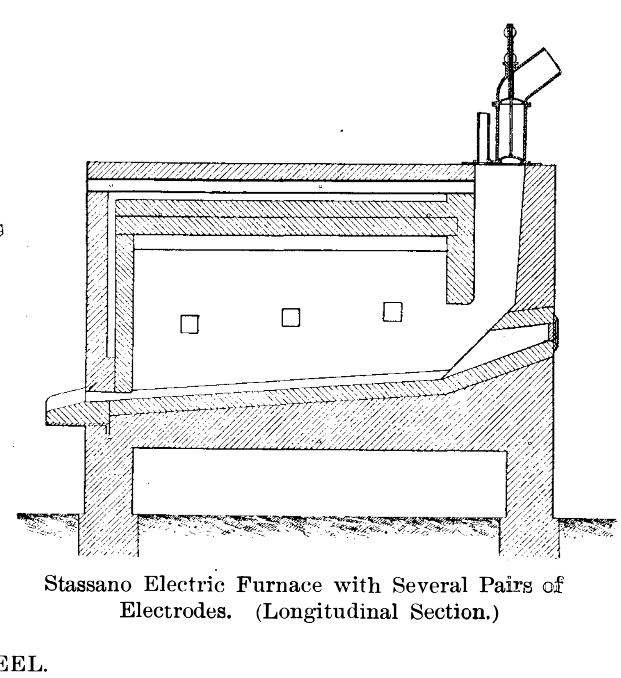
The Stassano Electric Furnace. (Modified Type Constructed at Darfo.)



Stassano Electric Furnace with Several Pairs of Electrodes. (View from Above.)



Stassano Electric Furnace with Several Pairs of Electrodes. (Cross Section.)



Stassano Electric Furnace with Several Pairs of Electrodes. (Longitudinal Section.)

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experiments showed the possibility of obtaining products that are uniform and very pure, especially soft iron containing but very little manganese and capable of meeting all the requirements of the industries, especially the electric.

(To be continued.)

PUBLIC SERVICE OF RAILWAYS.

THE number of passengers reported as carried by the railways in the year ending June 30, 1903, was 694,891,535, indicating an increase of 45,013,030 as compared with the year ending June 30, 1902. The passenger-mileage, or the number of passengers carried 1 mile, was 20,915,763,881, having increased 1,225,826,261.

The number of tons of freight reported as carried (including freight received from connecting roads and other carriers) was 1,304,394,323, which exceeds the tonnage of the previous year by 104,078,536 tons. The ton-mileage, or the number of tons carried 1 mile, was 173,222,278,993, the increase being 15,932,908,940. The number of tons carried 1 mile per mile of line was 855,447, which figures indicate an increase in the density of freight traffic of 62,096 ton-miles per mile of line.

The average revenue per passenger per mile for the year mentioned was 2.006 cents, the average for the preceding year being 1.986 cents. The average revenue per ton per mile was 0.763 cent. This average for the preceding year was 0.757 cent. Earnings per train

mile show an increase both for passenger and freight trains. The average cost of running a train 1 mile appears to have increased between 8 and 9 cents. The ratio of operating expenses to earnings, 66.16 per cent, also increased in comparison with the preceding year, when it was 64.66 per cent.

A summary of freight traffic, classified on the basis of a commodity classification embracing some thirty-eight items, is continued for the year under review.

[Continued from Supplement No. 1491, page 23895.]

RESULTS OF BORAX EXPERIMENTS.*

By Dr. H. W. Wiley.

MEDICAL SUPERVISION.

It was deemed important to have competent medical supervision of the members of the experimental class in order that the results of the investigations might be studied also from the point of view of the physician. It was also thought best that this supervision should come for this purpose from an official source. To this end the Secretary of Agriculture addressed the following communication to the Secretary of the Treasury:

"I have the honor to ask that you request the Surgeon-General of the Public Health and Marine Hospital Service to detail a physician from his staff to make physical and medical examinations of the young men employed in this Department in testing the effect of preservatives upon the health of the consumer.

"There will not be any very great drain upon the time of this expert, since the examinations are to be made only about once in ten days, on six young men, and will not consume, probably, over two hours, making a total of not to exceed six hours' service per month.

"In this connection I beg to suggest that the Surgeon-General arrange with Dr. H. W. Wiley, the Chief of the Bureau of Chemistry, for the details of these examinations."

The following reply was received to the above communication:

"I have the honor to acknowledge the receipt of your communication of January 28, 1903, requesting that the Surgeon-General of the Public Health and Marine Hospital Service be asked to detail a physician from his staff to make physical and medical examinations of the young men employed in your department in testing the effect of preservatives upon the health of the consumer.

"In reply I have to inform you that your communication has been forwarded to the Surgeon-General of the Public Health and Marine Hospital Service, who informs me that he will detail Assistant Surgeon-General H. D. Geddings to make the desired examinations.

"The Surgeon-General further informs me that he has communicated with Prof. H. W. Wiley, the Chief of the Bureau of Chemistry of your Department, and that Doctor Geddings has been instructed to arrange details with Prof. Wiley in the matter."

In harmony with the above arrangement, Dr. Geddings regularly visited the young men under experiment once a week, giving them a careful physical examination, inquiring in regard to symptoms of any disturbances in their physical state, and prescribing for them when they fell ill, either incidentally to their work or independently thereof. Unfortunately, in several cases, the members of the training table suffered severely from colds, influenza, and grippe to such an extent as often to lose the value of their services during a whole period. These cases of illness, not due to the action of the preservatives, are duly noted in the proper places in the details of the experimental work.

Examination of the Blood.

Any changes which might take place in the relative number of corpuscles in the blood, or in the blood coloring matter, are of value in determining the general effect of the added preservatives upon health and digestion. To study this, the ordinary methods of counting the blood corpuscles and measuring the coloring matter in the blood were followed. Valuable help in the initiation of this work was obtained from Dr. William B. French and Dr. E. B. Behrends. The actual examination of blood, for the purposes mentioned, was conducted by Messrs. B. J. Howard and C. P. Knight. The work on the examination of the blood was not commenced at the beginning of the experiment, and so it does not cover the whole time of the experimental work.

Determination of Temperature.

The temperature of the blood was taken *sub lingua* before and after dinner each day. This method is probably the least accurate of any in common use. It is, however, convenient and easy. Since the chief object of the determination was to disclose any notable departures from the normal, the method was considered fairly reliable.

Standard clinical thermometers of maximum registration were used for this purpose, each subject being supplied with a separate thermometer. These thermometers were all graduated through the courtesy of the Bureau of Standards.

The rate of pulse was also determined in connection with the determination of the temperature. This is, however, not a matter of so very much importance because of the ease with which the rate of pulse is varied by exercise and emotional influences.

In general, an attempt was made to control as fully as possible all the avenues which might lead to any useful information concerning changes, even of a minute character, in the functional activities of the body during the period of observation. As has already been intimated, the final verification of any small changes of an organic nature, especially of incipient lesions which may take place, is denied in experiment upon human beings, but, in so far as possible, any intimations of such changes, which could have been secured by any of the ordinary methods of study, were noted.

In data of this kind, namely the determination of the temperature, pulse beat, etc., where dependence is placed upon the subject himself, there are doubtless errors of observation which are undetected. Instructions, however, were given, and in so far as possible carried out, to the effect that any variation of a marked character must be verified by a second observer. This rule applied, not only to the variations in the body weight from day to day, but also to the departure of the temperature from the normal, and to the variations in the rate of pulsation of the heart. Thus, whenever one individual in the class noted any marked variation from the normal he called upon either one of the superintendents or one of his fellows to verify the numbers which he had observed. By taking this precaution many errors which otherwise would have crept into the reports were avoided.

Body Weights.

The weights of the body were ascertained by means of a platform scale with agate bearings, and of a delicacy sufficient to register easily differences of weight of 10 grammes when carrying a man of average weight. The subjects were weighed naked, as it is not safe to assume that the weight of clothing remains constant, for even if the same kind or character of clothing be worn, the variation in weight is very great because of changes in the hygroscopic condition of the atmosphere. Thus a given amount of clothing would show very different weights on a dry and on a wet day.

In the general discussion of the influence of weights it is always advisable to take the average weight for a period of days rather than the separate weight for any one day. In the interpretation of the value of the body weight it should not be forgotten that a loss in weight must not be interpreted to mean always defective nutrition, nor a gain in weight be attributed always to conditions favorable to health. The accumulation of an excessive amount of fat is not an evidence of excellent digestion or normal increase. It may be due to a perversion, to some extent, of the processes of assimilation. On the other hand, a loss of weight is not always to be interpreted as indicating an unfavorable condition of nutrition, because in persons who indulge in over-feeding, or who have accumulated excessive fat for other reasons, a diminution of weight may be distinctly favorable to better digestion and health. Nevertheless, in a state of normal equilibrium when the food supply remains constant, any marked variations in weight can not be regarded as wholly normal.

DIFFICULTIES CONNECTED WITH THE WORK.

Collection of Excreta.

Aside from the usual difficulties connected with analytical practice, which must always be taken into consideration, there are some special points in connection with a work of this kind which must be mentioned. These difficulties are connected chiefly with the collection and analysis of the excreta. The principal object in the analysis of the excreta, as is evident, is to establish the relation between certain ingested elements and those which appear in the excreta. Certain forms of food are more or less completely changed in passing through the body, and are oxidized and manifested as heat and energy. The fats and carbohydrates are types of food of this kind. Certain other elements in foods, while they undergo marked changes of combination during digestion, assimilation, and excretion, appear in the excreta in practically the same quantity in which they are found in the food. Among these substances may be particularly mentioned nitrogen, sulphur, and phosphorus.

In a state of equilibrium, where the body is exercising all of its functions in a normal manner, and where there is neither increase nor decrease in body weight, the quantities of nitrogen, sulphur, and phosphorus which are excreted should be the same as those which are ingested in the food. This should not be construed to imply that the actual elements eaten on one day appear in the excreta of the next day. This is far from being the case. It may require many days, weeks, or even months, for a given particle of nitrogen, sulphur, or phosphorus ingested in the food to reappear in the excreta. It is sufficient, however, for the purpose of establishing the balance between these ingested substances and those which are recovered in the excreta to assume that the quantities forced out of the body each day when in a normal state are equivalent in all respects to those which are introduced. As an illustration, the case of a tube long enough to hold a hundred marbles may be cited. If an additional marble be forced in at one end of the tube, a marble of equal magnitude will be forced out at the other, and thus the balance will be maintained in the tube. So, in a state of equilibrium, each molecule or atom of nitrogen, phosphorus, or sulphur entering the body will be represented by a similar molecule or atom of these respective substances forced out of the body.

Were it practicable in experiments such as these to collect absolutely every particle of emergent nitrogen, for instance, the balance between the entering and departing nitrogen should be complete. In these experiments, however, no attempt was made to collect any of the nitrogen except that removed from the body in the urine and feces. This, of course, represents nearly all of the nitrogen excreted, but not quite all. Small amounts of nitrogen are separated from the body in the hair, the nails, and the desquamations from the surface of the body. Thus, in a perfectly normal state of the body, the sum of the nitrogen excreted in the urine and feces would not represent the total amount ingested in the food. On the other hand, in abnormal states of the body, where the breaking down of the tissues is going on more rapidly than their building up, just the reverse condition would prove true. The same statements may be made with reference to the sulphur and phosphorus.

It is evident, however, that, if a relation can be established between the total amount of these substances entering the food and that leaving the body in the urine and feces, any disturbance of that relation by the addition of an abnormal constituent to the food, such as a preservative, can be easily detected. Therefore, for the purposes of these investigations, the fact that complete collection of these elements from the body is not secured is not a valid objection to the deductions which are made from the data. Nevertheless, it should be pointed out with clearness and frankness that in the conditions in which these experiments were made there are possibilities of error which must not be overlooked. Carelessness on the part of the observer himself in the collection of the excreta, a violation of the pledge in regard to the conduct of life, or an error in analysis would each tend to render the results of less value. That such errors have been wholly excluded from the data submitted is not likely. On the other hand, errors of this kind which may have been introduced could not have been purposely made in order to modify the final results of the investigation. Hence it is fair to assume that such errors are to a certain extent compensatory, and that they do not affect seriously the conclusions based upon the data as a whole. Those who have worked in investigations of this kind, however, will understand the great difficulties which attend them, as well as the care which has to be exercised in their conduct, and will be the more ready to excuse any unavoidable error which may have crept in, either in the conduct of the work or the morale of those who were subjected to the experiment.

Effects of Regular Habits of Life.

Another important factor must be considered in the interpretation of the data which have been obtained in these experiments, namely, the effect of regular habits of living, uniform quantity of diet, and general control of the appetite upon the physical well-being of the subject.

It is usually considered by physiologists and physicians that regular habits of life conduce to health and strength. This theory has been corroborated by the results of the experimental work here detailed. While it is true that in many instances during the progress of the investigation the members of the table were made temporarily ill by the quantities of the preservatives administered, it is, nevertheless, an interesting fact to note that at the end of the year, after the final "after period" had been passed, they appeared to be, and declared themselves to be, in better physical condition than when they entered upon the experimental work seven months before.

This fact, as has already been stated, must not be neglected, since it is evident that the tendency toward a good physical state and good health produced by the regular habits of life might counteract the unfavorable tendency of any exhibited preservative, so that at the end of the observation, if the results were judged only by the condition of the subject at that time, they might be pronounced negative or even helpful, whereas in point of fact, the preservative might have produced injurious effects. Self-restraint, temperance, regularity of exercise, regularity in hours of sleep and hours of work are believed to have favorable effects, and these were manifested in a marked degree throughout the whole of the experimental work.

Mental Attitude.

That the personal attitude of the individual experimented upon influences, to a certain degree, the progress of digestion is undoubtedly true. Every physician and physiologist is familiar with the marked effect which mental states produce upon the bodily functions. These effects may be either favorable or unfavorable. Cheerful surroundings, good company, and, in general, an agreeable environment tend to promote the favorable progress of digestion. A reversal of the conditions of environment to the disagreeable, combined with mental depression, bad news, and other unfavorable conditions, have exactly the opposite effect.

The question, therefore, arose in connection with the experimental work as to the advisability and possibility of preventing the mental attitude from producing any effect. A careful consideration of all the conditions of the problem made it clear that it would be impossible to conduct the experiments in any way which would exclude from the knowledge of the participant the fact that preservatives were added to the food. It was fully understood that he was employed for this purpose, and the very moment that the observation began upon his daily life, by weighing the food and collecting the excreta, he would be aware of the fact that he was under observation and was probably partaking of preservatives.

The question also arose whether or not the preservatives should be given in capsules openly or whether they should be concealed in the food itself. Both of these methods received a thorough experimental trial. When the preservative was mixed with the food in such a way as to conceal its physical appearance, a certain dislike of the food in which it was supposed to be was manifested by some of the members of the table. Those

* Digest of Bulletin No. 84, giving the plan of work and conclusions as to effects of boric acid and borax on digestion and health.

who thought the preservative was concealed in the butter were disposed to find the butter unpalatable, and the same was true with those who thought it might be in the milk or the coffee. When, on the other hand, the preservative was given in the capsules with the full knowledge of the subject, much less disturbance was created. In fact, after a day or two, when the subject became used to the fact that he was taking a preservative, it was apparent that the effect of the mental attitude was not at all noticeable. All the foods offered were relished because they were known to contain no preservative, while the preservative, itself, exhibited in the form of a capsule, imparted no bad taste or other disagreeable effect.

If an experiment of this kind were to be continued only a few days, it is evident that the mental attitude of the subject would be a matter of much concern, but when from 30 to 70 days are employed in one series of observations, and especially when the observations are continued for many months, this effect rapidly wears away, and probably does not influence the final results in any appreciable manner.

The young men were cautioned to avoid discussing the development of any symptoms which they might notice among themselves and were urged not to dwell upon any indications of abnormal conditions which they might experience, but to keep their minds employed on their usual vocations and to avoid thinking, as much as possible, about the experiments which they were undergoing. In most cases this course of procedure had its desired effect, and from the general deportment of those upon whom the experiments were made it may be stated, with a considerable degree of confidence, that the mental state as a whole had very little influence upon the course and progress of digestion.

It is in this particular, namely, the mental attitude, that experiments conducted with artificial digestion and experiments conducted upon the lower animals have decided advantages. Yet it must be admitted that in the latter case the confinement to which the animals are subjected probably produces a mental attitude more prejudicial to normal physiological processes than that produced in the case of the man who understands fully the conditions which surround him.

Classification and Interpretation of the Data.

The great difficulties of correctly studying the extensive data which these experiments have given and drawing therefrom the proper conclusions are fully realized. The utmost care must be exercised in these cases to remove all possible personal bias and to free one's self, in so far as possible, from the weight of authorities which have been consulted. Public opinion, also, must not be forgotten in this respect, especially when it is considered that it is almost universally believed by the great majority of our people that added preservatives are always injurious and in many instances poisonous. But even when personal bias, weight of authority, and public opinion are eliminated from the problem, it is still a most difficult one. So many elements enter into its study, so many conditions difficult to control, so many idiosyncrasies are to be reckoned with, so many external causes influencing health are beyond control, that it is difficult in many cases to decide, where variations are noticed, as to the exact or even the apparent cause which has produced them.

The problem, therefore, has been attacked with a full knowledge of its difficulty and with the desire to be conservative and free from dogmatism. It would probably be better if all the detailed data which have been secured could be printed in connection with this discussion, so that the critical reader might be able in every instance to refer to the original figures. Enormous space, however, would be occupied by the data, and the fact that in most cases they would be of little use in detail has led to the decision to publish only summaries, with such detail as may be necessary to point out the way in which the general data have been obtained. If, as may appear later on, all points of the problem have not been elucidated, the failure has not arisen either from lack of desire or from want of industry in the conduct of the experiment. It is to be attributed rather to the limitations placed upon the observers, either by lack of experience or by lack of knowledge how to properly classify, digest, and study the data at their disposition. A serious attempt has been made to present these data in their full significance, and in no case has any tampering therewith been counseled, desired, or permitted. The unfortunate fact that many of the data are contradictory must be accepted without question. As the judge and the jury in the light of contradictory evidence seek to decide which is the more trustworthy, so have the data herein contained been interpreted with a view, if possible, to give the greater weight to those which deserve the greater credit.

To give an idea of the volume of work involved in this investigation, the following approximate estimate is given of the number of samples analyzed and the number of record and calculation forms used, though this but inadequately represents the details of the work in all its phases.

Number of samples analyzed, etc.
[Number of days of observation, 196.]

Food samples	2,550
Urine samples	1,175
Feces samples	1,175
Microscopical examinations:	
Urine	125
Blood	60
Total	5,085

Number of record sheets, balances, etc.

Menu sheets	3,618
Daily sheets	1,206
Amount and composition of food	1,206
Food calculation sheets	75
Feces:	
Amount and composition	35
Calculation sheets	65
Urine sheets	20
Balance tables	200
Total	6,425

Each one of these analyses, forms, and tabulations was used in preparing the summaries and conclusions which follow.

(To be continued.)

THE EYES OF ANIMALS.

Look at the eye of a deer and marvel at its liquid depth and beauty; the eye of a dog, and see your affection mirrored in his worshipful gaze. This wonderful organ, though small, is the principal factor in giving character and expression to a living being. When a creature is dying, it is the glazing eye which quickly and most surely betrays the passing vitality; and the history of eyes is as wonderful as their function.

If we recall the saying that, with no eyes to see, color has no existence, we will realize at one time the earth and its surroundings were perhaps uniform. But even our "mind's eye" refuses to image such a state of affairs; sky, sea, land, crystals, flowers, all a dead neutral tint. However that may have been, there was certainly a time long ago when no eyes or anything like them had appeared.

In creatures now living upon the earth, we may trace a series of eyes from the highest and most efficient to the simplest dot of black pigment. The eye of the eagle may stand for the first, and the eye-spot of the *amphioxus* or the eight sense-germs of a jellyfish for the other extreme of the series.

The *amphioxus* is a little worm, or fishlike creature which most of the time lives buried in the sand of our seashores. He is interesting and important out of all proportion to his size, two inches, for he is one of the lowliest creatures to be honored with a backbone, the class mark of all higher animals. He has no skull and no brain, but near the front end of the thin thread of nerve (the foreshadowing of our spinal chord) is a tiny black dot. By means of this, he distinguishes light from darkness, which is all his simple life requires. Let us not forget the position of this single, most primitive of eyes—in the center of what would be the brain if the lowly creature had one.

The eye of a jellyfish is so primitive that we can hardly say whether it sees or feels. That is, when a floating jellyfish begins to sink below the surface of the water as the shadow of an advancing ship falls upon it, it is probably affected by the sensation of darkness, but perhaps the pressure of the onrushing wave has something to do with it.

HOW INSECTS AND FISHES SEE.

Insects have eyes which as a whole are much more highly developed than that of the *amphioxus*, but in a different direction from the creatures which stand higher in the scale of life. Their compound optical apparatus consists of many nerves leading to a honeycomb-like mass of lenses, each cell of which is a very simple lens, so that the image is reflected like a mosaic. And yet insects must be able to perceive colors, as the differing hues of the two sexes are appreciated by many of them and the various tints of flowers are recognized, white blossoms attracting certain species, yellow blooms being visited more constantly by others.

That the eye is considered a vulnerable and precious organ is shown in certain fishes, which have a "false" eye outlined upon the long tail fin, which, perhaps, attracts the attention of any enemy, which bites at it supposing it to be the head, thus taking a piece harmlessly out of the tail, while the fish is given a chance to escape. This is even more plainly seen in the wings of certain moths and butterflies, and the pieces torn out by birds are very often these conspicuous blotches of bright color. But the strange thing about this is that the "eyes" in the wings of the insects are not like real insect's eyes, but somewhat like those of higher animals about which the insect, of course, knows nothing. And we, too, know little as to how these things came about, through methods of evolution more wonderful than fairy tales.

But insects and fishes have two eyes (or at any rate most insects have two clumps of eyes), and what has become of the central single eye of *amphioxus?* If we will examine a bottle of water from almost any stagnant pool or even from the edge of a pond, we will find many tiny creatures somewhat related to crabs and lobsters with a single great eye in the middle of their "forehead." On account of this scientists have named these Cyclops, and at night this eye occasionally glows with a strange unearthly light, and, indeed, the whole creature becomes phosphorescent, and our oars may disturb thousands of them, making the water shine as with a myriad sparks.

THE CYCLOPEAN EYE.

If we would see an eye which has actually been evolved from one like that of *amphioxus*, let us examine the head of a lizard. Disregard for a time his two bright eyes, one on each side of his head, and look directly down on the center of the skull between them. Here we will find an oddly-shaped scale marked with a little depression, and this is, indeed, what is left of our Cyclopean eye in the tiny sand creature. Lizards doubtless derive very little benefit from it, as the nerve leading from it is very small, but in some of their ancestors it must have been of great value in detecting the presence of enemies from above. In all creatures above lizards this third median eye (called the *pineal*) is found, although of no use whatever; this persistence, perhaps, showing of what great importance it once was. In a chick in the early stages of incubation this eye is very considerably developed, while yet the paired eyes are but small structures. But suddenly nature seems to realize that the old régime has passed—that the little bird will need other more modern eyes, and the two side eyes begin to develop with wonderful rapidity, and soon catch up with and distance the Cyclops eye, whose early start ends only in promise.

A horse, a bat, a mole, a monkey, a seal, all have a trace of this third eye, and when we put a finger on the "soft spot" of the head of a tiny baby, we realize the wonderful import of it—that the softness is due to a near approach of this same third eye to the surface, striving as it has done in so many lower creatures to push its poor imperfect lens to where the light can act upon it. But the old ways have given place to new, and the child's blue eyes look out at you and the world and see all that is necessary for its life and needs.

CREATURES THAT ARE BLIND.

We can hardly imagine anything more terrible than the loss of our eyesight, and yet there are many creatures which have found life more pleasant in the darkness of caves and underground tunnels or to roam only at night, when their eyes are useless, and by the lack of use these organs have degenerated to mere specks and in some cases the skin has grown completely over them. Thus we find blind fishes and lizards in dark caves, and blind ants and moles all but blind in their dark subterranean homes. Certain bats, too, have but tiny dots for eyes, and depend chiefly upon their acute hearing and some sense by which they can feel the vibrations in the air.

Snakes have but poor eyesight, and, like fish, have no eyelids. Their eyes are covered with a thin, transparent scale which is ever open, in sun and shade, at noon and midnight, in an awful, never-winking stare. We cannot imagine how sleep can ever come to such creatures.

Finally, let us turn to the most perfect eye nature has ever produced. We can read and write and do many things by the aid of our eyes that are forbidden to other creatures of the earth; but this is because of the brain behind directing the eyes. We can look closely at the stars, and we can watch the actions of a tiny dot of life many thousands of times smaller than a mote of dust. All this we can do by means of the two "magic tubes," the telescope and microscope. But when the unaided eye is alone considered, birds put us to shame. "Observe an eagle," writes a noted scientist, "soaring aloft until he seems to us but a speck in the blue expanse. He is far-sighted; and scanning the earth below, descries an object much smaller than himself, which would be invisible to us at that distance. He prepares to pounce upon his quarry; in the moment required for the deadly plunge he becomes near-sighted, seizes his victim with unerring aim, and sees well how to complete the bloody work begun. A humming bird darts so quickly that our eyes cannot follow him, yet instantaneously settles as light as a feather upon a tiny twig. How far off it was when first perceived we do not know, but in the intervening fraction of a second the twig has rushed into the focus of distinct vision from many yards away. A woodcock tears through the thickest cover as if it were clear space, avoiding every obstacle. The only things to the accurate perception of which birds' eyes appear not to have accommodated themselves are telegraph wires and lighthouses; thousands of birds are annually hurled against these objects to their destruction."—C. William Beebe in the Evening Post.

The results of some interesting experiments carried out by the Massachusetts Board of Health to ascertain the effects of heat and sunlight upon the organisms in water polluted by sewage matter, are given in the thirty-fourth annual report of that body. The colon bacillus is typical of sewage pollution, the number of this species present in a sample being generally taken as a measure of the pollution. The no less objectionable typhoid bacillus is frequently found accompanying B. colon, and these two organisms show a remarkable similarity in their power to withstand adverse conditions. Tubes containing equal volumes of virulent cultures of the two species were submitted in turn to different temperatures for a period of five minutes, after which a cubic centimeter of the contents of each tube was allowed to incubate for 24 hours, the number of bacteria present in it being then counted. At temperatures of from 30 to 40 deg. Cent. both species diminished gradually in numbers, the percentage reduction being greater for typhoid than for B. coli, about 88 per cent of the former and 30 per cent of the latter being eliminated at 45 deg. At 50 deg. the B. coli were practically all destroyed, and the typhoid germs did not survive beyond 55 deg., with the exception of some half-dozen individuals. At temperatures up to 80 deg. some few germs still remained, but both cultures were completely sterilized at 85 deg.—a limit of temperature somewhat higher than usually accepted. Both species were rapidly destroyed by sunlight, an exposure of from 30 minutes to one hour being usually sufficient to sterilize the culture when spread out in a thin layer. With typhoid 95 to 99 per cent of the germs were destroyed by 10 to 15 minutes' exposure to direct sunlight, and very similar results were obtained with B coli. Both show the same phenomenon as noted in other experiments—that while the majority

of the germs are destroyed in a very short time, a few individuals nearly always appear to be better able to withstand adverse conditions.

THE SOUTH AT THE WORLD'S FAIR.*

By the St. Louis Correspondent of the SCIENTIFIC AMERICAN.

FIFTY tons of metal, modeled into a statue of Vulcan that stands fifty feet high, and commanding a central spot in the Palace of Mines and Metallurgy at the Louisiana Purchase Exposition, marks the triumph of the South in the industrial world.

Iron mined, melted, and cast in Alabama is the product of which this heroic figure is composed; and, as a typical progress, it must attract as much attention as any exhibit at this centennial display.

In writing of the South at this World's Fair, one must forget the imaginary lines that were drawn years ago, and pencil another across the United States that shall extend from the Atlantic to the Pacific, and in the new region is included the San Joaquin Valley of California, the mineral regions of Arizona and New Mexico, as well as Texas cotton fields, the orange groves of Florida, and the tobacco lands of the Virginias.

By all right, Louisiana takes rank in this story. It is her name that graced the entire region purchased from France; her forests were penetrated by De Soto on his memorable march from the Floridas, in search of the wealth of treasure that was the quest of Spaniards for two-score years after they had conquered in Peru; it was into the waters of the Gulf that wash her shores that La Salle sailed with his fleet from France; it was in New Orleans that occurred the first uprising against an Old World power, and it was in her Cabildo that the formal treaty of transfer by Napoleon was ratified.

This Cabildo, over which within a fortnight floated three flags—first, the standard of Spain, then the tricolor of France, and last, to remain forever, the stars and stripes—has been reproduced as it was in 1803; and in front of the building is a reproduction of Jackson Square, which the structure still faces in New Orleans.

* Photographs of this article copyrighted 1904 by the Louisiana Purchase Exposition Co.

It was in the supreme-court room of the Cabildo that the famous transfer was ratified; and to-day, in the replica of this room, is a facsimile of the treaty itself, bearing the signatures of Marbois, Livingston, and Monroe, while on the walls are portraits of the men who placed their names to the instrument and, bearing them company, pictures of Jefferson, Napoleon, Salcedo, Lausat, Wilkinson, and Claiborne. So faithfully is everything reproduced that in the courtyard one is confronted with an original stone filter and the drinking "monkeys" which were used at that time; and in the prison cells are the instruments of torture used by the Spaniards, the garrote with which criminals were choked to death, and the stocks in which those guilty of misdemeanors were held captive.

All furniture in this historic building is the same as it was in 1803, and visitors can see the desk at which the instrument of transfer was signed, and the chairs occupied by the persons whose names are so intimately associated with this great peace conquest of land, from which fourteen States and Territories have been carved. The lower room of the Cabildo, which in New Orleans is now used as a city court, has been transformed into a reception room at St. Louis, and here natives of the State and their guests can rest when fatigued from sight-seeing, can read, write, and receive letters.

Aside from this display of historic interest, Louisiana has prepared exhibits for the various main buildings and outdoor spaces fully commensurate with her wealth and position, for which purpose her commissioners have a fund of $150,000 at their disposal. Of this $100,000 was appropriated by the Legislature, $25,000 came from private sources, and the remainder was donated by individuals.

One most interesting and at the same time educational exhibit is that of rice. Taking advantage of the Exposition's keynote, "Revealment of processes," Louisiana said: "We propose to demonstrate to the world that few people understand the value of our great agricultural staple. Americans know less about rice than do Germans about corn. We will make a display that will evoke wonder, and which we hope will cause the Agricultural Department of the United States to interest all citizens in the value of this product of our soil. Persons of the North know of rice only in the rice pudding or boiled rice. We shall show that rice can be cooked in four hundred different ways, and that the true boiled rice should be as light and flaky as freshly fallen snow."

To that end the commissioners have constructed a rice kitchen in the Model City, and will give illustration of all processes, from the time when the kernels are threshed until they are taken, ready for the table, from the boiling pot, the steamer, or the oven.

Sugar also will be a large display, and a toothsome place to visit is the sugar-cane plantation, for there will be free distribution of the segments of sweetness to all those who wish to extract the succulent sap.

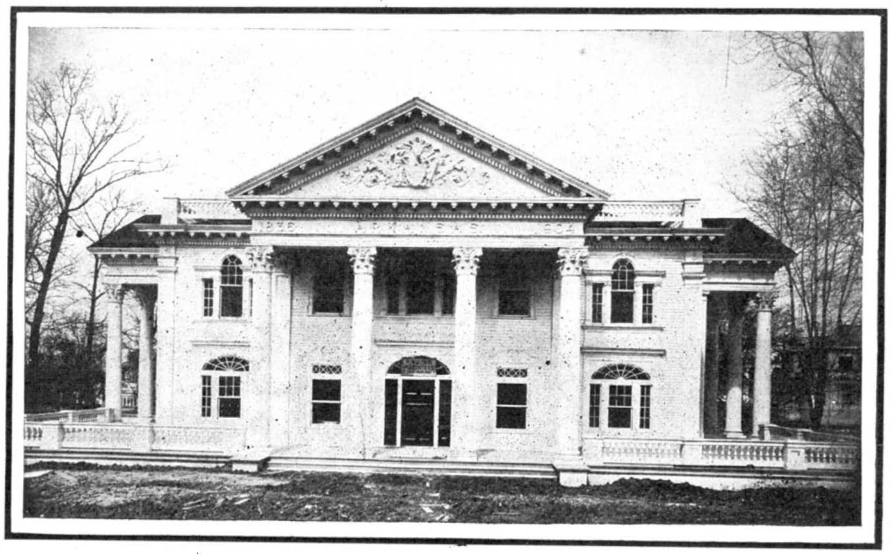
In other branches of agriculture the State will be well represented, and the exhibit of Louisiana University in the Palace of Education is one of the strongest features of that department, which for the first time in the history of the Exposition has a special building devoted to its interest.

La Salle's reports concerning Texas were anything but encouraging. Fate chose that he and his adventurous band should be cast upon the most barren bit of coastline, and that their wanderings should be through regions of the least production.

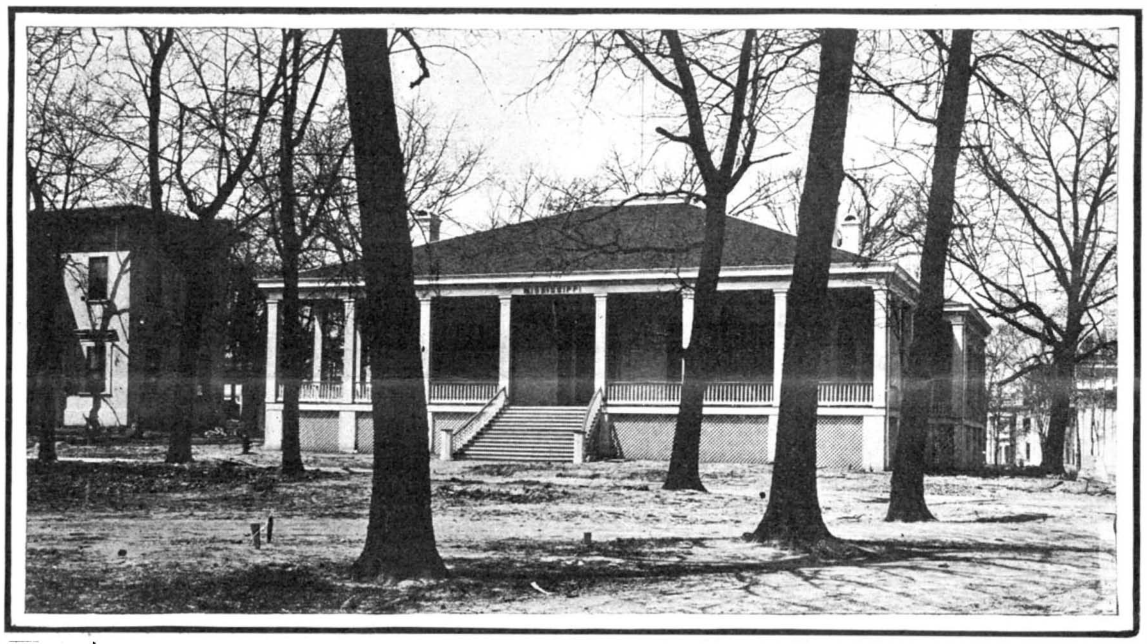
How different the Texas of to-day—the Texas around which could be built a Chinese wall, preventing the importation of a single article, yet the inhabitants could live on forever, finding everything sufficient to maintain life and add to the enjoyment thereof in their own commonwealth. This is what Texans claim, and this is what they propose to show the millions who visit St. Louis this year.

"In our land we can grow anything that is grown anywhere else," is their proud boast. "In the ground we can find all minerals, and in the ocean all the fish." To prove the amplitude of their resources, Texans have secured space in all the exhibit palaces and outdoor displays. In the Department of Agriculture, wheat grows by the side of cotton, and rows of sugar-cane alternate with those of corn; in Mines and Metallurgy the oil of the Beaumont district competes with the eastern product for favor; in education, methods as far advanced as those of the East are demonstrated; and so on through the list.

In her own building, on the Plateau of States, Texas adheres to the stellar *motif* that was brought into being early in the last century, when the pseudonym "Lone Star" was applied. A massive building, costing over $45,000, has been erected in the form of a five-pointed star, capped with a dome that rises 144 feet above the ground. Where every pair of walls meet is an entrance, approached by flights of steps 28 feet long, which are furnished with buttresses. Two col-



ARKANSAS STATE BUILDING.



THE MISSISSIPPI BUILDING.

CALIFORNIA'S QUAINT MISSION-LIKE STRUCTURE.

SOME STATE BUILDINGS AT THE ST. LOUIS FAIR.

umns and a porch adorn each point of the star, and the architectural features of these apices signify the five great industries of the State.

Entering the building, one passes through heavily vestibuled doors—and here again the star *motif* is carried out on the panels of glass—into a rotunda 75 feet in diameter, ornamented by many massive columns. Rooms furnished in native woods and minerals open from this rotunda, and are for the use of the State commissioners and officials of Texas; and other rooms, similarly furnished, on the second floor, are for reception and such other entertainment as the hosts desire.

But one must not forget King Cotton in mentioning the exhibits of this State. Its wealth of fluffy whiteness is one of the central points of interest in the Palace of Agriculture.

Florida can lay claim to the fact that it was on her shores that man first set foot, to make exploration of the country which subsequently became known as Louisiana Territory. It was on her east coast that De Soto landed and commenced his memorable journey, that, starting in conquest, ended in utter rout. Because of the prominent part the peninsular State has played in history, it is a pity that she is not better represented at this great Exposition. But her executive officers have seen fit not to urge an appropriation; she has no State buildings on the grounds, and such exhibits as are distinctively hers in the horticulture division have been made at the expense of private capital.

How different Georgia, whose Legislature made liberal appropriation of moneys, and whose citizens responded with additional aid, to the end that the wonderful resources of their State in building stone and agriculture and horticulture might be shown. It was first proposed that the building where hospitality should be dispensed on the Plateau of States should be a replica of "Liberty Hall," the famous home of Alexander H. Stephens at Crawfordsville; but after the death of General John B. Gordon, it was agreed that no better testimonial of the love and respect cherished for the illustrious soldier and citizen could be shown than by reproducing at the World's Fair his home at Kirkwood, one of the suburbs of Atlanta, that beautiful residence which bears the name "Sutherland."

A novel sight in the Forestry Building are trees burdened with clinging Georgia moss, and another is the happy arrangement of Georgia marble in the Palace of Mines and Metallurgy.

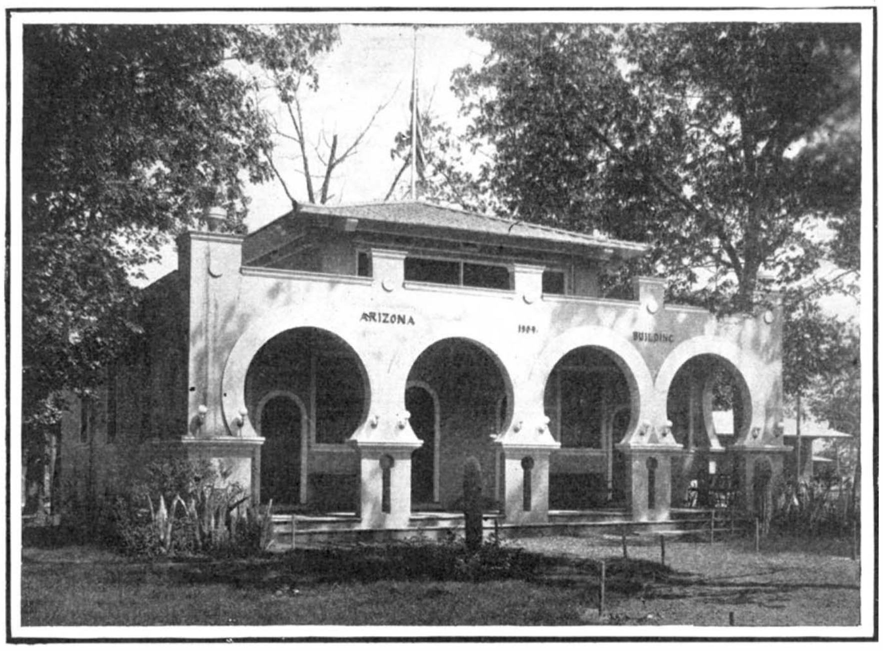
South Carolina has at Charleston a majority of the exhibits from that State which were displayed at her own centennial celebration, so that the collection of new material is not necessary. Just how much of this valuable material is to be transported to St. Louis for distribution among the various main buildings has not been decided at this writing, but it is probable that the main portion will be seen at St. Louis when the gates shall open. As the South Carolina Legislature failed to make appropriation for the purpose, that State will not have a home of its own on the plateau.

Neither will North Carolina be able to receive within its own portals, but her display in the main exhibit palaces is unique, in that she is represented in every one of the fifteen divisions. She is particularly attractive in agriculture, horticulture, and in the department of forestry. Although none of the collections is large, they are remarkable for their completion and the tasteful arrangement.

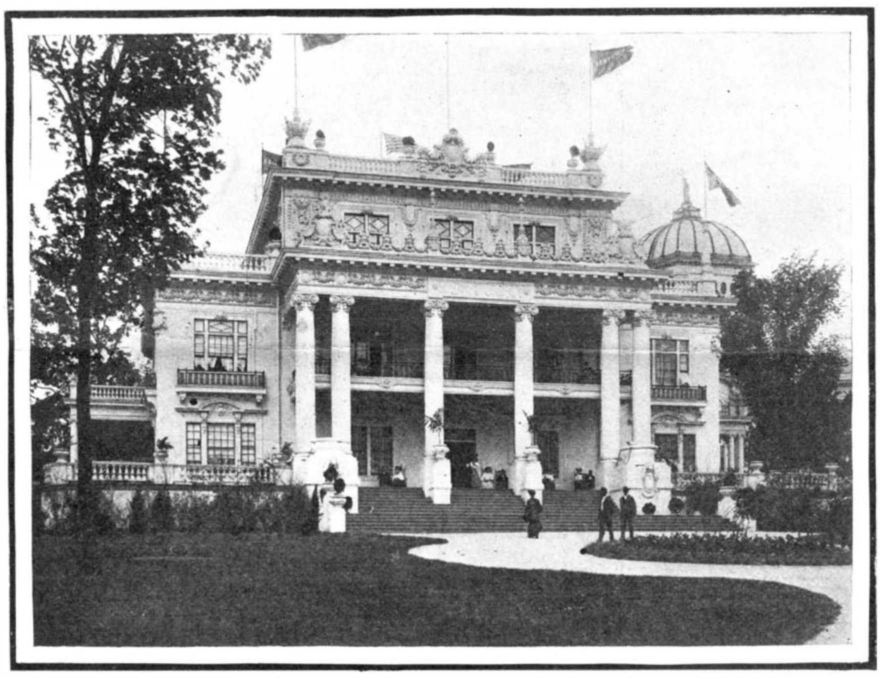
One of the main attractions from this State is the material that comprises the State Museum at Raleigh, and which has been brought in bulk to St. Louis for distribution in the Palace of Education and other palaces.

The only building in the United States which rivals the Cabildo of New Orleans in point of Louisiana Purchase historical interest is "Monticello," the home of Thomas Jefferson, under whose administration was acquired the great country west of the Mississippi. Therefore Virginia points with pride to the replica of "Monticello" which she has caused to be erected in the World's Fair grounds, and which will be the place of her entertaining this summer. Thomas Jefferson was an enthusiast on the subject of architecture as well as art, and brought with him from his foreign travels studies of famous old buildings as well as choice canvases. The plans and specifications for "Monticello" are in his own hand, and have been preserved to this day. Millions of patriotic Americans can now visit the replica of this famous homestead on the Louisiana Purchase Exposition grounds, who would never be able to take the journey to the State of Jefferson's nativity, and they can thank Virginia for this opportunity of viewing in all its detail, and furnished even as it was in the dawn of the last century, the beautiful residence which was occupied by the illustrious author of the Declaration of Independence

In both the Palaces of Agriculture and Mines and Metallurgy Virginia has liberal displays, which have been made possible by an appropriation of $50,000 by the Legislature and an additional subscription by private individuals. In the great tobacco exhibit this State is especially prominent, showing the process from the growing of the plant to the manufacture of articles for smokers' consumption.



THE PICTURESQUE BUILDING OF ARIZONA.



THE STATE OF KENTUCKY'S BUILDING.

Maryland belongs in this new classification of the South, and to Maryland must be given credit for what she has done in the face of one of the greatest calamities known in the history of the United States. The question of an appropriation for the World's Fair was before the Legislature at the time when Baltimore was scourged by fire. For days it was believed that all moneys would be needed within the State for the rehabilitation of the city. Discouraging letters came to the officials of the Exposition. They were answered in cheerful language. "We have had our experience," was the tenor of the epistles sent in reply. "St. Louis was swept by a tornado, but when a final estimate was made it was found that the damage was greatly less than the first estimate, and we are certain you will meet a similar experience." These words gave heart, and the Legislature set aside $40,000 for the purpose of exhibiting this summer, which sum was added to a substantial fund previously secured from individuals. Immediately this had been done, a contract was let for a State building, and now Maryland will join her sisters in entertaining on the beautiful Plateau.

Her main exhibits as a State are to be seen in the Palace of Forestry, Fish, and Game, where the succulent bivalve and the deep-sea creatures live even as they do in their native element.

But Maryland should also have credit for the Baltimore and Ohio exhibit in the Palace of Transportation, which is as complete a histo.ical picture of travel by rail as exists in the world. Here can be seen the "Rocket," invented by Stephenson and driven by him as engineer; here the curious locomotives, the boilers of which appear to be immense kettles; here the bulging smokestacks that are featured in prints of locomotives of the civil war period, and here also the modern railway engines of to-day.

West Virginia has erected a building of Colonial

MARYLAND'S COLONIAL MANOR.

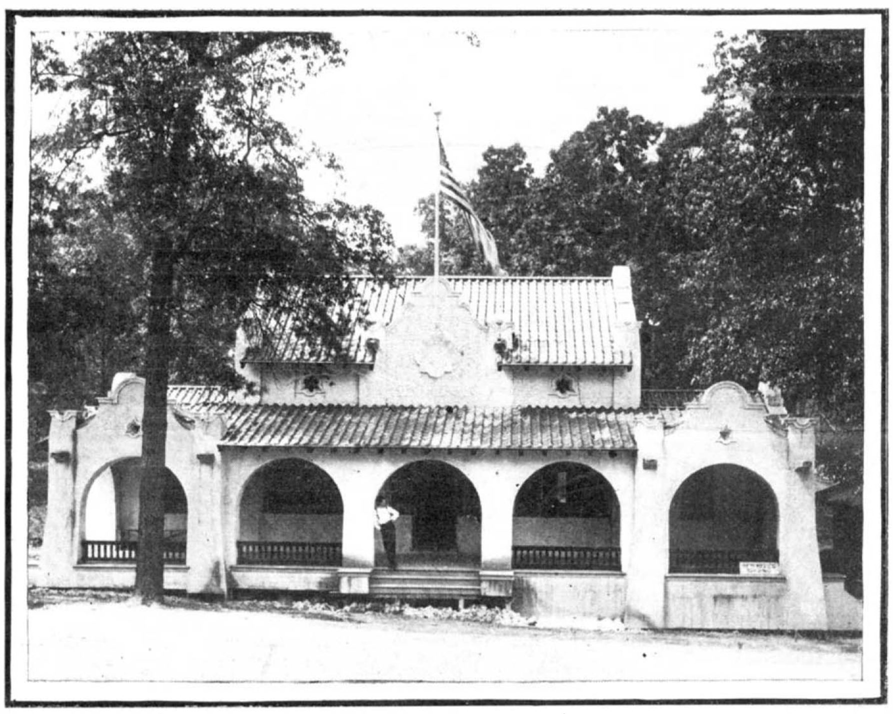
SOME STATE BUILDINGS AT THE ST. LOUIS FAIR.

style of architecture on the Plateau. It has classic domes on the corners, and a large dome in the center that serves as an observatory. Two porches on the front and two on the sides are 16 feet wide, while the one in the rear is 10 feet wide. Broad entrances on three sides, ornamented with large columns, give the structure a massive and imposing appearance. On the first floor a large reception hall covers one-third the space, and opening therefrom is a ladies' reception room, the commissioners' room, a bureau of information, and a smoking room. A stairway 10 feet wide leads to the second floor, where is a large banquet hall, and opening therefrom offices and bed chambers. These in turn open onto wide balconies.

In addition to her beautiful home, West Virginia shows a splendid exhibit of coal in the Mines and Metallurgy Division. It is unexcelled in the Exposition, even by Pennsylvania, say experts; indeed, it is one of the finest displays of the black diamonds of commerce ever made.

Kentucky is represented in nearly all the exhibit divisions. With $100,000 at the disposal of her commissioners, this State is showing the wonderful resources of mountain and valley and proving the worth of the New South. The memories that cling to the "Old Kentucky Home" are associated with the "New Kentucky Home," which is the appropriate name given to the beautiful structure that is an ornament of the Plateau. It covers an area of 138 by 80 feet, and has entrances on four sides, emphasized by massive porches flanked by sculpture groups symbolical of mines, forestry, manufactures, and horticulture.

The principal feature of the interior is a large reception hall, the floor of native hardwoods. The second floor is similar in construction, with a banquet hall in the center, and a third floor has many rooms which open upon roomy balconies. Kentucky has expended $29,000 in the construction and embellishment of this place for entertaining her residents and visitors.



THE BUILDING OF NEW MEXICO.

SOME STATE BUILDINGS AT THE ST. LOUIS FAIR.

The "Hermitage," that historic home of General Andrew Jackson, has been reproduced in all its details by Tennessee on the World's Fair grounds. It is of the old, dignified colonial style of architecture, and attracts attention both because of its comfort and convenience. The main building is two stories in height, and the commodious wings are one story each. The double portico, that extends the full length of the main building, is supported by six large fluted columns. Stone flagging is on the floor of the lower portico and cedar forms the base of the upper.

On entering, one finds himself in a large, deliciously cool hallway, 16 feet wide and 40 feet long. At the rear is a winding stairway, thoroughly Colonial, and on the east a cross hallway, through which the visitor views the room which was occupied by General Jackson—the very room in which he died January 5, 1845, at the age of 78 years. A library adjoins. Four large bedrooms on either side of the hall comprise the second floor of the "Hermitage," and a portico in the rear is similar to that in the front. One visits this place with reverence, as well as interest, for many Jackson relics are seen in the rooms and carry the thought back to the days of the Rebellion.

But turn from the past to the present, and visit the Exposition palaces, especially those of Mines and Forestry, and view the modern exhibits that Tennessee has so liberally displayed with the aid of $80,000 placed at the disposal of her commissioners. Do they not illustrate better than words can tell the wonderful resources of the South? Again view the treasures of Peabody Institute, which have been shipped in their entirety from Nashville to St. Louis and placed in the different divisions where they belong under the various classifications.

Of Alabama mention was made in the commencement of this story in describing the statue of Vulcan, typical of her wealth in iron. This, by the way, is the most difficult and expensive piece of ironwork ever created in this country, and is next in size to the Bartholdi statue of Liberty, the largest statue in the world. It was cast in ten separate sections, which fit together so closely that the whole appears as one piece. Alabama's display at the fair is more the display of sections than one of homogeneity, and the money for the purpose was principally appropriated by districts, like that of Birmingham. For this reason she is not represented on the Plateau by an individual State building. But in carrying out the revealment-of-process idea she is as active as her sisters, and while her mines find representation in the palace devoted to them at the east end of the site, her cotton gins are humming elsewhere by the side of those shipped from New England.

On a splendid site south of the Iowa Building and east of New Jersey stands the pavilion where visitors from Mississippi can feel at home and entertain their guests. It is a replica of "Beauvoir," the mansion presented to Jefferson Davis by Mrs. S. A. Dorsey. It was in this comfortable home that the President of the Confederacy passed the last days of his life, and it was there that he wrote "The Rise and Fall of the Southern Confederacy."

With $60,000 at their disposal, the commissioners of Mississippi have arranged attractive exhibits in the buildings of the main picture, particularly in those of Agriculture and Forestry, where cotton and the woods are tastefully displayed.

Arkansas expects to attract much attention by a display of mineral resources in the Palace of Mines and Metallurgy, especially the showing that is made from the lead and zinc fields, the veins of which are practically the same as those in southern Missouri. In agriculture and horticulture she is also very well represented, the fruits of the vine comparing with those from California.

Her home on the fair grounds is located on the highest elevation of the site, and from its broad, sweeping verandas one can enjoy views of the many beautiful pictures on all sides. The main entrance opens into a large reception hall, the floor of which is native wood, light and dark fibers being in contrast. The walls are tinted a rich empire green. Hand-painted, on a three-foot frieze, are boughs of apple blossoms—the State's floral emblem—with glimpses of sky showing through. A handsome mantelpiece of Eureka Springs onyx, of light color and highly polished, faces the entrance. In the open fireplace the hearth is tiled with native marble. Photographs of picturesque Arkansas scenery adorn the walls and are framed in native wood. And so the chairs and settees are creations of persons who live in the State.

The first building which the visitor sees on entering the grounds through the Chouteau Avenue entrance is that erected by Indian Territory. It is two stories in height, covers an area of 109 by 72 feet, and cost nearly $16,000. It is crowned in the center by a dome 32 feet in span, which is flanked by two smaller domes. On the first floor is a large reception room, from which a wide staircase leads to the big assembly hall above. Smaller rooms for offices, for retiring places, and for sleeping apartments open upon the larger rooms on both floors.

Oklahoma has erected a handsome building on the Plateau of States. Although not quite so large as that built by Indian Territory, its construction was somewhat more expensive, and it possesses several features that are different from others. One is the view from the second floor of the reception room on the first, which is given through a well-hole, surrounded by a wide railing, behind which is a large gallery. Wide porches with ornamental arcades surround the structure on both floors, the Corinthian effect being produced by columns on the lower, and the Moorish, broken by filigree arches, on the upper.

Attractive as are the buildings of Indian Territory and Oklahoma, they form only a moiety of the display from these Territories, which maintain that their exhibits in the main palaces, when compared with those made by the States, will give ample proof that they should be admitted to the Union. They show how rich are these new lands in agriculture and horticulture, and what a wealth of minerals exists beneath the soil.

New Mexico has erected a very attractive building of the Spanish Renaissance style of architecture, a feature being the wide, shaded veranda in the front. It is small, but the interior is tastefully fitted and well arranged for comfort. Her principal exhibits are in the departments of Mines and Metallurgy, Anthropology, Agriculture, and Horticulture. Perhaps her most attractive display is one showing the revealment of process in turquoise mining and turquoise dressing, actual work going forward under the eye of the visitor from the time the stone is taken from the ground until it is polished and ready for the market.

Arizona's home has the distinction of being the smallest of the many on the Plateau of States, but it is considered a model of the particular style of architecture which it exemplifies. An attractive feature is the frontal arcade, made of four arches and shaped like a horseshoe. Notwithstanding the fact the commissioners have been handicapped by the smallness of the funds at their disposal, their territory is well represented in several of the exhibit buildings, particularly in that of Mines and Metallurgy.

South of this imaginary line which has been drawn to indicate the region to which this article refers, is the lower part of the State of California, which includes the agricultural and horticultural wealth of the San Joaquin Valley, the orange groves of Los Angeles and Santa Barbara, and the sea life that abounds in this region. Therefore, in summing up what the South has done, one must consider California's most lavish displays from vine and tree and the denizens of the fisheries buildings that came from her shores.

Particularly is the California building on the Plateau a Southern feature, in that it is a replica of La Rabida, the famous old mission at Santa Barbara. Arcaded cloisters enter into the construction and the architectural mass is centered in two big bell towers, square, that taper upward in tiers to a lantern-crowned dome. These towers are heavily buttressed and between them a pediment rests on an engaged colonnade. A lower building, two stories high, with an arcade and cloister on each floor, runs from either side of these towering structures. On the lower floor the arcade has semicircular arches, while on the upper an entablature forms square openings in front of the cloisters. These arcades and cloisters surround the building on three sides, thus supplying cool promenades 11 feet wide. And when standing on one of these breeze-swept verandas one can imagine that the foundation rests in sand, at high water is wave-swept by the Pacific, on the extreme western end of the country which has become the New South.

ARTILLERY IN BATTLE YESTERDAY AND TO-DAY.*

By E. Thionville, Major of Artillery.

Since the adoption of the rapid-fire field gun, the tactics of the artillery have been oriented anew. While the old regulations laid down that the first duty of the artillery was to seek out the enemy's guns and endeavor to secure as quickly as possible superiority of fire, our present book tells us that, in the preparatory engagement, that is to say, in the beginning of the battle, we should facilitate the advance of the infantry, support its partial attacks, that *we shall in this manner be led into a series of successive struggles with the enemy's artillery.*

It is a fair question to ask why we have been thus led to turn our attention from the enemy's guns and concentrate it on his infantry. The nearer the field gun is brought to perfection the more does infantry suffer from its fire. It would seem, then, at first sight, that the improvement in material, instead of causing the disappearance of the artillery duel, would make it still more necessary. On the other hand, in the past as at present, the infantry had need of us in its advance, and the close union of the two arms was laid down in the old regulations as a fundamental principle. Why is it, then, that our present book seems to establish a new axiom, and that what was necessary yesterday becomes still more so to-day?

In the past, as in the present, artillery has but one object—to support the infantry. The infantry bears the brunt of the battle, the artillery is there only to help it to accomplish its task; to arrive at this result it must engage the enemy's artillery and infantry. Of these two objectives it is naturally led to select the one upon which it has the greatest effect; and the entire change in its tactics results from the fact that it is at present infinitely better prepared than formerly to act against infantry, while its effect upon artillery has become very much more uncertain.

With the old methods of fire—the narrow fork and fire for effect on a single elevation—artillery was effective against a continuous line of skirmishers or reserves in masses, but it was practically powerless against the many small columns scattered along a wide front, the actual formation adopted by the infantry in its advance. To reach these columns it would have been necessary to divide the battery, to assign, so to speak, a definite target to each gun—a method to

* Revue d'Artillerie, January 1904. Translated by Captain John E McMahon, Artillery Corps, for the Journal of United States Artillery.

which we were not accustomed, and which, moreover, would have produced no definite results.

With the rapid-fire field gun, on the contrary, we can cover uniformly, and in a very short time, a wide and deep zone, and we can thus prevent the movement of troops in this zone, no matter what their formation may be. It is true that there was no reason why this method of fire should not have been adopted for 90-millimeter gun; but think how much time it would have taken for a battery to accomplish the same results, and how many batteries would have been needed to produce these results in the same time.

The maximum rate of fire of a battery equipped with the 90-millimeter gun was twelve shots a minute, or two shots per gun; it would then have required four minutes for each gun to deliver the eight shots prescribed in zone fire. To fire thirty-two rounds in thirty seconds, as is done in zone fire* with the rapid-fire gun, would require sixteen 90-millimeter guns, supposing each to have been loaded and ready at the moment of fire, and also that the four elevations employed in zone fire should be divided among the sixteen pieces—which evidently would have been practically impossible.

We can safely say, then, that at least three 90-millimeter batteries would have been necessary to produce the same effect against infantry as one 75-millimeter battery; and it is evident, therefore, what a considerable quantity of artillery would have been necessary to support the infantry in its partial attacks as efficiently as is done to-day. There would not have been enough batteries in an army corps, nor enough ground on which to use them. This is why in the past we left the infantry to enter upon the preliminary engagement almost by itself, and we held off until the decisive attack, when the front became less extended, the objectives more vulnerable, and, as a consequence, the effect of our fire was greatly increased.

During the first part of the battle we had but one object—to seek out the enemy's artillery, engage it and obtain against it a superiority of fire. Let us consider under what conditions we now enter upon this contest.

The pointing apparatus used with the old material made it very difficult to use indirect fire, which was only exceptionally employed; direct fire was the rule, and, as a consequence, the artillery was always more or less visible. No doubt this visibility had been greatly lessened by the adoption of smokeless powder; but as a matter of fact a battery when firing could never completely conceal itself, and always furnished a target easy to find. As soon as a hostile battery appeared it became a target; and, as we could not hope to obtain superiority of fire except by employing a greater number of guns than the adversary, we hastened to call up another battery to add its fire to that of the first. The enemy naturally did the same, and so we came to the long lines of artillery, to the use of artillery in mass, in order to begin the artillery duel.

This duel once begun was fought to a finish; and the finish generally came when one side was made to realize its inferiority and partially to suspend its fire. The batteries equipped with the old material, being without any method of sheltering the cannoneers, had to continue their fire when once engaged; and when they could fire no longer, it was a fair conclusion that the guns had been dismounted, or the chests had become empty, and that in consequence they were out of action for a certain time.

Thus the artillery duel went on, furnishing for a long time a particular phase considered indispensable in every battle. To it was ascribed all sorts of tactical qualities—it made easy the deployment of the other arms, gave to the commanding general time to make his dispositions, etc.—things undeniably true, but which are only the consequences of this basic truth; the artillery duel was forced upon us artillerymen because it was the only means of effectively employing our material in the first part of the engagement.

Let us consider what conditions we should have to meet to-day if we were to pursue the above methods, supposing, of course, that our adversary is equipped with a material similar to ours. Since in the new equipment we are independent of the line of sight and hence can always use indirect fire, a battery of 75-millimeter guns, if skillfully handled, will be completely masked, and so it will be very difficult to locate the enemy's artillery. This artillery reveals its presence when it begins to fire; what are we going to oppose to it? In general, an equal number of batteries; remembering, however, that a battery can now cover a front greater than its own, and hence only the *least possible number of batteries* should be engaged, and not the greatest possible number, as formerly. As a consequence of this, a great part of the artillery will be for a time unused. Since the fire will be necessarily intermittent, we can not conclude that a battery has been put out of action because it is silent; it has ceased to fire only temporarily, because it wishes to do so, and it can re-enter the action at any moment. Having with more or less difficulty obtained the range of the battery thus concealed, we begin our zone fire; the hostile battery remains silent. Are we to increase to infinity the intensity of our zone fire, in the hope of destroying it? Evidently not. The personnel is safe behind the shields, and has not much to fear from our rafales;† we would be emptying our chests without producing any great result. Consequently, we follow their example; we remain silent, ready to resume the fire if they begin again. Thus it appears how difficult it is to mark the end of the artillery duel, and in what an uncertain state we find ourselves as to results produced. This is true, of course, only when the enemy's batteries make the fullest use of the advantages peculiar to their material and remain completely concealed; for if one of them becomes visible, we encounter the same conditions as prevailed in the past. We proceed at once to deliver against this imprudent battery zone-fire, fire with a single elevation, or fire against the material; in other words, we concentrate our fire upon it, not, as formerly, by directing the fire of several batteries against it, but rather by the *repetition of the fire of a single battery.* In every case the result is the same; for this battery the artillery duel is over, we have put it out of action. But this will be only the exceptional case; and if during the preliminary engagement several batteries allow themselves to be surprised, the others will quickly take advantage of the experience gained and will conceal themselves completely from view.

It is plain, then, that we cannot consider the artillery duel under the same aspect as formerly, that we can no longer invite the enemy's batteries to this strange combat, to this preliminary struggle, from which one or the other came forth completely victorious.

To-day the opposing batteries will feel around for each other, will deliver attacks short and violent, but never decisive. The more skillful of the two will soon succeed in paralyzing its adversary for the time being by keeping it under the menace of its rafales; but to do this it must watch the other unceasingly, and consequently cannot take advantage of its superiority by devoting itself to other work.

We thus get at a much more sensible idea of the artillery struggle. It is no longer a distinct and particular phase of the battle consecrated to the artillery alone; it is an episode, a consequence of the infantry combat which we must follow step by step from the preliminaries of the struggle up to the final act.

And as a matter of fact, since the hostile artillery is sheltered in a measure from our view and our projectiles, is it not natural for us to concentrate all our attention on the infantry, which cannot escape us and against which we are powerfully armed? Undoubtedly this infantry will also conceal itself, will take refuge behind cover, will shelter itself behind obstacles; but there will always be a moment when it will have to show itself, that is, when it wishes to fire. Our own infantry will enable us to take advantage of this moment; its advance will force the enemy to show itself and then it is that we will strike hard quickly, for it is only at this moment that we can count on producing any effect. It is thus easy to understand the necessity of watching unceasingly our own infantry, of not losing sight of it for a single instant, of going forward hand in hand with it. This co-operation of the two arms on the field of battle, this intimate union of the artillery and infantry, recognized from all time as a tactical necessity, becomes for us artillerymen a technical necessity, so to speak; for it is the infantry that makes our target appear, and that allows us to take advantage of the marvelous qualities of our gun.

But the enemy's artillery will not remain inactive; it will do exactly as we have done, and open fire either upon our own infantry or upon the batteries that are accompanying it. It is then that we shall engage it, and endeavor, if not to destroy it, at least to neutralize it and keep it quiet under our rafales.

The artillery, then, has two rôles to fulfill—to fight the hostile artillery and support our own infantry. And these two rôles, which are no longer successive as before, but simultaneous, cannot be filled by the same batteries and so arises the necessity of dividing the artillery into two groups—one to hold in check the enemy's batteries, the other to accompany the infantry.

All that we have said above in regard to the use of the rapid-fire field gun is to-day universally acknowledged, and is no longer a subject for serious discussion. This cannot be said to be true concerning the question which we now proceed to discuss.

What is meant by this division of the artillery into two groups, and this rôle of accompanying the infantry?

The name of "crest-artillery" is often given to the batteries whose duty it is to engage the enemy's guns, while those detailed to accompany the troops are called "infantry-artillery."* Taking literally this theoretical distinction, some officers seem to think that the technical use of the arm will be confined to the crest-artillery alone, which remains massed under the control of its chief, while the rest of the artillery will be split up into completely independent fractions, without any tactical cohesion, and scattered among the different fighting units of the infantry, so as to fill the rôle of machine guns or separate pieces attached to battalions. This artillery, divided into small groups of platoons, or even of single pieces, it is claimed will easily find protected routes of approach, and can thus follow the infantry step by step in its forward movement, giving it the moral and material support so much needed.

If this moral and material support for the foot soldier consists in seeing the gunners march alongside them, it is certain that this method of employing artillery will furnish it; but if, on the contrary, it consists in constant intervention by sudden and timely rafales, we fear very much that this manner of using the guns will not give the desired support.

How are we to admit that these little groups, constantly moving, will be able always to find emplacements from which they can *see* what is happening on the skirmish line? And even supposing that they do find such places, is it probable that their chiefs, who often will be officers of the reserve and even non-commissioned officers, will be sufficiently familiar with the necessities of the battle to intervene at the proper moment?

In his last study on "The Lessons of Two Recent Wars,"* Gen. Langlois enumerates the duties of the artillery in the preliminary engagements.

The artillery should intervene:

1st. When the firing line halts to fire. It is the enemy's fire that makes the line halt; the artillery must then, by its rafales, force the enemy's skirmishers to lie down and cease firing, thus allowing our own infantry to resume the advance.

2d. When our skirmishers halt to entrench themselves. During the pause the enemy must be prevented from firing.

3d. When the echelons, coming from the rear, join the skirmish line to carry it forward. This movement must be facilitated by a slacking of the enemy's fire.

4th. When the enemy's reserves advance to the fire line to reinforce it. This movement is generally made in the open, for the first line, in order to see, must come out in front of the crest. The artillery should stop this forward movement of the reserves and prevent them reaching the first line.

Now in order to take advantage of these different phases of the battle and be able to intervene in an effective way, should the artillery be on the heels of the skirmishers, or rather behind on a position dominating the field, from which it can see the entire scene of the struggle? Must we use platoons or isolated pieces, or rather batteries held well in hand by their chief? And finally, is it possible for the battery commanders to look after their men and their firing and at the same time give their attention to a surveillance of the battlefield?

There is no doubt about the answer. This rôle can be filled only by batteries so placed as to cover completely the ground over which the attack takes place, and by group commanders watching attentively the progress of the battle, and indicating to their captains the proper moment to intervene and the time when this intervention should cease.

This leads us to consider from an altogether different point of view the separation of the artillery into crest-artillery and infantry-artillery. Instead of assigning to one or more groups the duties of the crest-artillery, which, no matter how well placed, can with difficulty silence all the batteries which expose themselves along the front, and scattering the rest of the available guns among the different fighting units of the infantry, thus destroying all the links between the commander and his subordinates and all connection with the ammunition trains, we believe that this division should be made in the group† itself, whose chief can thus by applying the principle of the economy of forces, utilize in the way most suitable to the circumstances all the elements at his disposal.

Let us take, for example, the two groups of the divisional artillery. As the division has generally two regiments in the first line, we can assign one group to each regiment.

The divisional artillery commander indicates to the group commanders the mission and the objectives of each infantry regiment, and thus clearly limits the ground over which each group is to act. The fighting front of a regiment does not generally exceed 800 or 900 yards, so that in the majority of cases each group can find a suitable position allowing it to watch every portion of the front.

According to circumstances, the group commander will assign one or two batteries to the infantry combat, reserving to the other one or two the duty of countering.‡ Whenever the ground permits, he will mass his batteries, as much as possible, being careful to keep them concealed, so that he may communicate with them easily, and by simple variation in the deflection meet the numerous changes of objective which occur in the progress of the battle and which we have enumerated above. It is here, more than anywhere else, that he has the opportunity of utilizing that striking characteristic of our new material, which consists in the possibility of securing, by the announcement of a single number, the transmission of his ideas. Instead of using individual pointing on this occasion, as we are tempted to believe would be done, we shall more than ever have recourse to collective aiming.§

The intervention of the artillery at this stage of the infantry struggle should be sudden and of short duration. How can he better secure this than by the command: "(To the right or left) increase or diminish by so many thousandths,"‖ instead of having recourse to the conversations and blind groping to which the designation of an objective usually gives rise? The group commander can thus deliver, anywhere along the front, the sheaves of fire from his batteries, sup-

*Tir progressif, sans fauchage, or zone fire without sweeping, consists of 32 rounds per battery, or 8 rounds per gun, at four ranges, varying by 100 yards; in zone fire with sweeping, each gun fires 3 shots at each range, or a total of 48 rounds per battery.—Translator.

† Rafale, literally squall, is the name given by the French to the storm of projectiles thrown from their rapid-fire gun in a particular kind of fire. There seems to be no word in English to give its exact meaning.—Translator.

* On this subject see "Tactical Consequences of Progress in Armament," by General Langlois. Paris. 1903.

* The Lessons of Two Recent Wars, p. 83. Paris. Lavauzelle.

† The group, in the French artillery, consists of three batteries. Two groups constitute the divisional artillery.—Translator.

‡ The French term contre-battre is difficult to translate accurately in a few words. It is used here in the sense of returning a blow, and is applied to the functions of those batteries which are to return the fire of the enemy's guns.—Translator.

§ In individual pointing each gun is aimed directly at the portion of the objective assigned to it, and with the same deviation. In collective pointing, all the guns are directed on a common aiming point with different deviations, so that the whole front of the objective will be covered by the fire.—Translator.

‖ The French deviation scale is a circular plate, graduated in thousandths of the range.—Translator.

porting the different battalions in succession, and intervene at the proper time with the countering battery, if the enemy's artillery exposes itself along the front assigned to his group.

The batteries assigned to accompany the infantry have a rôle so important, that they must be prevented at all hazards from having their action impeded by the rafales of the enemy's guns. This can be done only by having behind them, under the control of the same chief, a countering battery ready to interpose. A distant line of crest-artillery having no tactical connection with them, evidently could not extricate them as quickly or as surely as a battery of the same group, which never loses sight of them and has no other mission than to watch over and protect them from threatened attack.

This seems to us to be the proper method of employment of the divisional artillery in the preliminary engagement. It secures the most effective possible support of the partial attack that the infantry have to make during this phase of the battle, while limiting these attacks to those delivered by a regiment, the smallest unit to which may be assigned an exact and complete rôle in the battle.

The regimental commander indicates to the group commander his intentions and the rôle of each of his battalions, and it then becomes the duty of the latter officer to support these battalions by making the best use of the elements at his disposal and by going to the assistance of each one of them whenever needed. If the artillery had been distributed from the first among the battalions, even admitting that these fractions of artillery were all well placed and well commanded, it might easily happen that the support rendered would be superfluous at one point and insufficient at another, without any means at hand of reinforcing one another. Here, as everywhere, the principle of economy of forces must prevail; and to economize forces, it is necessary not to scatter them, but to keep them massed under the same hand.

If this is the rôle of the divisional artillery, it may be asked what becomes of the corps artillery. We are often tempted to believe that the functions of the crest-artillery will be reserved for the corps artillery, and that the era of long lines of guns and of action in mass will, in consequence, appear again. Undoubtedly in order to be able to entrust to the divisional artillery the task of accompanying the infantry, it would be convenient to admit that the corps artillery is to assume the rôle of keeping in check the enemy's artillery. But to admit this is to admit that the old artillery duel is still possible, and that the enemy will allow himself to be hypnotized by this deployment of artillery and will hasten to oppose it with all his available batteries. As we have pointed out before, it will not do to count upon this.

The great advantage of our present artillery is in being able to cover a front larger than the one it occupies. If the enemy knows how to utilize his batteries, he will engage our corps artillery, with only the number necessary to keep them busy, keeping the others for use at other points on the battlefield.

In general, the principal duty of the corps artillery will be to reinforce or relieve the exhausted divisional artillery, and in consequence it will follow, in the conduct of the battle, exactly the same principles.

It may be asked, why not distribute all this artillery among the divisions, or in other words why not do away with the corps artillery? This solution, adopted by the Germans several years ago, does not appeal to us. Outside of the consideration that it might be inconvenient to burden the division by attaching so much artillery to it permanently it might easily happen that a division would not have enough guns at a given moment, while at another it might have too many. We would then be compelled to take from one division a part of its artillery in order to supply its neighbor, a measure which would not be very practicable; while it is always easy to borrow from the corps artillery and to obtain the same results thereby.

To sum up, we must not take too literally this division into crest-artillery and infantry-artillery; and we must be especially careful not to look on them as of different natures, having distinct tendencies and methods of fighting. The whole of the artillery has but one object: To support the infantry from the beginning of the struggle to the final act, by attacking the enemy's infantry and artillery. This necessitates a distribution of the batteries—a distribution varying at different points of the battlefield and at different periods of the fight, always regulated by the commanding officer of the artillery on the principle of the economy of forces. He must never lose sight of the fact that the infantry battle is the main object and the artillery combat is only a means thereto.

From this it results that every officer of artillery, of whatever grade, should become familiar with infantry, should study their tactics and modes of fighting, in order to understand, at every phase of the battle, just what they are doing and what they desire.

RACING AUTOMOBILES IN THE 1904 GORDON BENNETT CUP RACE.—III.

THE RICHARD-BRASIER RACER.

In this number we conclude our description of some of the principal racers that ran in the 1904 Bennett cup race, with a well-illustrated article on the 80-horse-power Richard-Brasier car, which once again won the cup for France.

The winning Richard-Brasier automobile weighs complete 950 kilogrammes (2,094.37 pounds) when empty, but with all accessories on board. In the French eliminating trials it maintained a mean speed of 99.416 kilometers (61.73 miles) an hour, while in the Gordon Bennett race its mean speed was 88.05 kilometers (54.97 miles). It is able to run at a maximum speed of 135 kilometers (83.83 miles) an hour.

The chassis is made up of an Arbel pressed-steel frame. There is no under or false chassis, but the motor and transmission are mounted directly on the frame.

The axles are hollow and of nickel steel, and were hardened at the Lemoine works. An examination of the front axle shows it to be cylindrical in the center section between the two side bars of the frame, but rectangular in the sections at the ends where the springs are mounted upon it. Each end of this axle has a horizontal T shape, one branch of the T pointing above and the other below. The upper branch of the T is lubricated from a Stauffer oiler, while the lower branch is mounted on a set of balls, which support the main weight of the car.

Simple, straight, steel springs are used, and these are fitted, both front and rear, with Truffault suspension. This suspension stops the vehicle from jumping. It performs the office of a gigantic invisible hand which holds the vehicle down upon the ground, thus causing it to utilize all its power in forward movement and to not lose any by leaps or bounds, as is so frequently the case with high-speed cars.

The wheel base of the machine is 2.60 meters (8.53 feet), while the tread is only 1.25 meters (4.1 feet). The wheels are mounted on ball bearings, and are fitted with 810 x 90 millimeter (31.88 x 3.55 inch) tires on the front wheels, and with 820 x 120 (32.28 x 4.72 inch) on the rear.

In place of a body, a gasoline tank is fitted around the seats of the driver and chaffeur, so that they literally sit within the tank. The capacity of the tank is 125 liters (33 gallons). The motor consists of two groups of two cylinders each, having a bore and stroke of 150 x 140 millimeters (5.90 x 5.51 inches). M. Brasier repudiated the steel cylinder because of the great friction on the pistons in a cylinder of this kind, which necessitates a great abundance of oil in order for it not to heat abnormally. The steel cylinder is lighter than the cast-iron cylinder, and the walls are much thinner, but it allows many more calories of heat to pass off in the water circulation system, on the same principle as a boiler having a thin bottom heats much more rapidly than one with a thick bottom. The eight valves of the motor are mechanically operated and are all interchangeable, as well as their springs. The shape of the cams which operate the inlet and exhaust valves are of course slightly different. All of the valves are on the same side of the motor. The compression in the cylinders is 4.3 kilogrammes (94.79 pounds). The flywheel is of large size, as it has a diameter of 600 millimeters (23.62 inches).

The maximum power of the motor is 80 horse-power at 1,200 revolutions per minute. It can be run easily from 200 to 1,300 revolutions per minute, which makes it possible to run on the high speed as low as 35 kilometers (21¾ miles) an hour, while, by simply opening the throttle, the driver can increase his speed up to 135 kilometers (83.83 miles) an hour.

The carbureter is of the usual atomizer type. It consists, besides the usual ordinary parts, of two nozzles inclined one toward the other and spaced 6 millimeters (¼ inch) apart. There are two air entrances, one below and the other at the side, for heated air. The two nozzles form a sort of liquid butterfly, which is caused by the suction of the motor, and the liquid does not collect upon the sides of the tubes, as it does in many carbureters that are defective. The consumption of gasoline during the Gordon Bennett cup race was 42 liters (11.09 gallons) a circuit (142 kilometers—88.18 miles), neutralizations included. On the road the constructors say that the consumption does not exceed 1 liter every 4 kilometers, or about 1 gallon every 10 miles.

The ignition is accomplished by a Simms-Bosch magneto, with movable armature. The igniters are of the Brasier make-and-break type. The ground contacts to the motor are assured at suitable points by small wires. The magneto is gear-driven from the motor crank-shaft. It should be noted that the racer, like all of the other Richard-Brasier machines, does not have a variable advance to the spark. Two ignition points are determined, the one at the minimum for starting the motor, and the other at a fixed advance (20 millimeters, or ¾ inch, in the present racer). The driver does not therefore have to bother himself about advancing the spark. This is one of the advantages of magneto ignition. The starting of this large motor, contrary to what one would expect, is very easy. The chauffeur takes the starting handle in his right hand and turns it. With his left hand he pulls out a small rod situated conveniently, which raises the exhaust valves about 2 millimeters (0.078 inch) when the compression occurs, and also retards the spark automatically. As soon as the motor starts, the compression relief rod is pushed back, and the spark is automatically advanced to the maximum point.

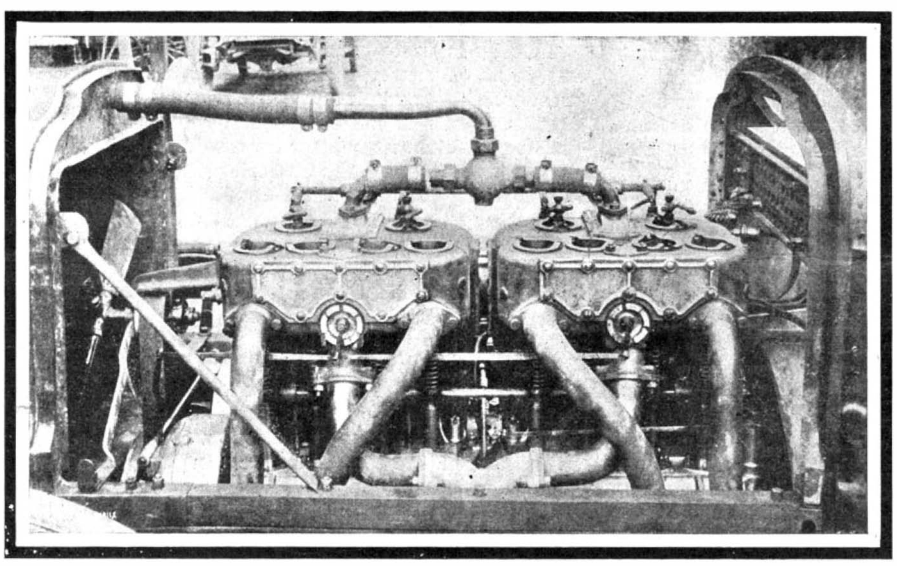


FIG. 1.—THE 80-HORSE-POWER MOTOR OF THE RICHARD-BRASIER RACER ON THE SIDE CONTAINING THE INLET AND EXHAUST VALVES.

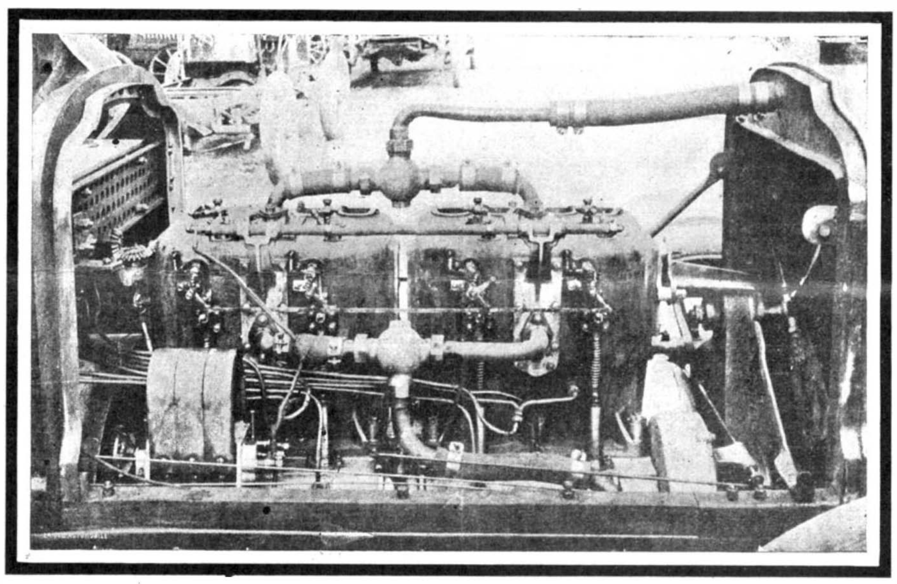


FIG. 2.—MOTOR OF THE RICHARD-BRASIER, THE WINNING RACER, ON THE SIDE CONTAINING THE IGNITERS AND THE MAGNETO.

The motor is fitted with a centrifugal governor identical with those on the ordinary Richard-Brasier cars. The governor acts on two valves, one of which is placed between each pair of cylinders in a part of the motor that is always warm, and consequently where the cooling effects of evaporation and rapid flow of gas are not to be feared. The governor tends constantly to close the valves even at slight speeds; but a small flat spring counterbalances in a slight measure its effort, and thus reserves always to the motor a small supply of gas, which is sufficient to run it at its maximum speed. A handle placed on the steering wheel permits of increasing the admission, while a pedal throws the governor out of action and allows the motor to give full power. Théry used his handle so that it gave him the same result as would the use of the pedal, which was not fitted on his car.

The exhaust gas passes through four pipes, one for each cylinder, which terminate in a large cylinder pierced with holes at one end. This evidently does not form a very perfect muffler, but it at least attenuates the effect of the sharp detonations usually produced by these powerful racing engines. Several contestants in the Cup race ran with the muffler cut out, except when passing through controls. Théry estimates that the muffler on his racer absorbs about three horse-power, and thus he did not employ at any time the full extent of the power which his engine could have been made to develop.

The cooling system in the ordinary Richard-Brasier cars is constructed on the thermo-siphon principle, and operated without a pump. But as the racer had an ex-

ceptionally powerful engine, a pump was found necessary, and a turbine pump driven by friction from a small aluminium flywheel on the forward end of the crank shaft, was fitted to the car. A Grouvelle & Arquembourg radiator, cooled by a fan, was used. The amount of water carried was 28 liters (7.39 gallons). The machine did not overheat any, however, even in the neutralizations.

A Hamelle mechanical oiler is used to lubricate the engine, which drives, through a universal joint, a horizontal shaft situated in the oiler and carrying ten eccentrics. These ten eccentrics each operate in turn a finger, which drives a small oil pump whose stroke is regulatable. Each pump, immersed in the oil, draws in a certain quantity when the piston is raised

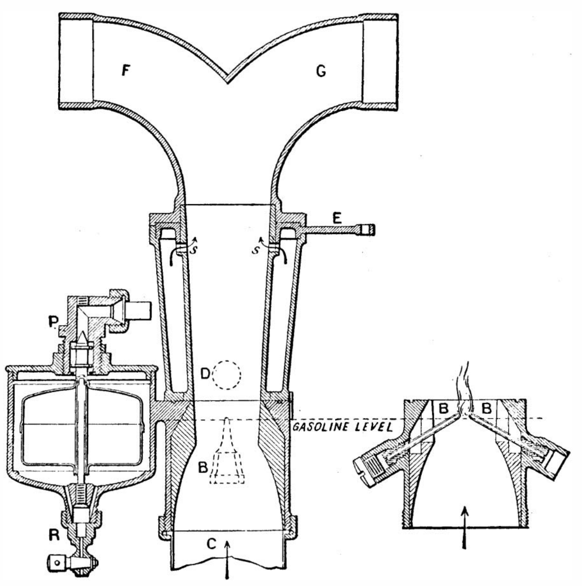


Fig. 3.—CROSS-SECTION OF THE RICHARD-BRASIER CARBURETER.

F, G. Inlet pipes to the motor. *E.* Handle regulating auxiliary air. *s, s.* Auxiliary air holes. *D.* Entrance hole to jacket of auxiliary air. *C.* Regular air supply pipe. *B, B.* Inclined atomizing nozzles. *P.* Needle valve of float chamber. *R.* Chamber for draining carbureter.

by means of a spring, and delivers it to the desired tube when the piston is driven back by the finger. The ten tubes oil automatically all the bearings of the motor, as well as the transmission and all other bearings which need oil, so that the driver has no care in this respect.

The clutch is one of the good features of the racer. It is made as shown in Fig. 4, of an aluminium cone, *C*, covered with leather, which is inserted within the flywheel, *V*, in the customary manner. Above forty horse-power, however, it is notorious that the adherence of these two parts is insufficient to transmit to the change-speed gear the full power of the motor. Many constructors have endeavored to improve upon or make certain this type of clutch, which has some very good qualities. Some have added to it near the center of the flywheel sliding bolts; on the contrary, others have placed lugs at the periphery of the flywheel. But, in the first place, all the transmission is made through the bolts, and the chauffeur has great trouble in throwing out his clutch, as all the power of the motor is being applied against these bolts. In the second case, the lugs were moving at too high a speed, and they often broke.

M. Brasier solved the problem in an analogous but modified fashion. He gave to the leather-covered cone all the diameter and inclination necessary for clutching in the motor and for utilizing as much of its power as can be transmitted in this way. Then he determined the exact distance from the center at which the supplementary lugs would not receive too much pressure from the motor, and would not be in danger of breaking from the shock of throwing in the clutch. He then installed a ring, having fastened to the cone six steel lugs, *B*, which can be made to enter six of thirty-six holes correspondingly placed in the flywheel. These holes number thirty-six in order that the lugs may enter easily. The two operations are made successively and automatically by the clutch pedal. The shifting fork applies at *F*. Fig. 4 represents the parts at the moment when, by means of the shipper, *G*, the pedal has withdrawn the fingers, *D*, and when, continuing the movement in a straight line, it is about to withdraw the cone, *C*. Experience has shown that the system is in all points perfect, and that it does not need any modification in order to be applied to the commercial vehicles.

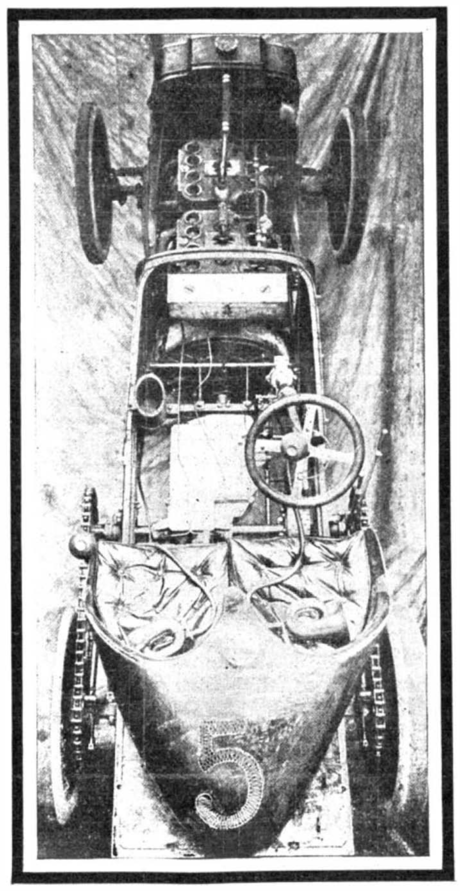


Fig. 6.—UPPER SIDE OF THE CHASSIS.

The change-speed gear is supported at three points. It contains three speeds and a reverse. The first two speeds are obtained by a sliding gear set, *O Q*, which is moved by means of a fork, *f*. On the first speed, the motion is transmitted through the gears *O, P, U, V;* on the second through *Q, R, U, V;* and on the third there is a direct drive through the jaw teeth, *S*, of the gear, *V*, which are inserted in suitable holes, *T*, in the pinion, *Q*. For the reverse, the two gears, *M* and *N*, are interposed, thus causing the gears to all turn in the opposite direction. The bevel pinion has 31 teeth, and the bevel gear on the differential 40. The driving sprockets have 26 teeth, and the sprockets on the rear wheels have 30 teeth.

The car is fitted with a worm gear steering device, which is very strongly built. The worm has a 40 thread; it is 86 millimeters (3.38 inches) in diameter, and inclines 18 degrees.

There are two foot brakes, consisting of two distinct bands lined with cast-iron plates, and each controlled through a separate pedal. Each brake acts on the same cast-steel drum keyed on the differential countershaft. The car had but a single brake and a single pedal in the eliminating trials, but M. Brasier added the second brake after he had learned of the many difficulties of the course to be run over in the Cup race. A hand brake acts on the rear wheels by expanding bronze segments pressing against the interior of drums, which are attached to the wheels.

Finally, the machine is fitted with a sprag, which was put on solely for the purpose of permitting the driver, who (as is known) had to make a start on a

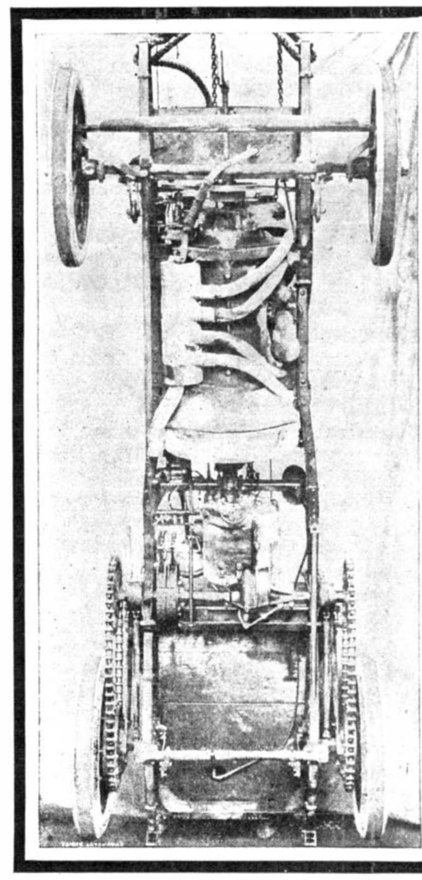


Fig. 7.—UNDER SIDE OF THE CHASSIS.

12 per cent grade, to hold his machine on the incline, and to start with the brakes all off.

The distinguishing feature of Théry's racer is the correct proportion of all its parts. It is mechanically harmonious, and from this point of view it creates a new type of self-propelled vehicle.—L. Baudry de Saunier in La Vie Automobile.

AMBERGRIS.*

By Charles H. Stevenson.

Ambergris is a wax-like substance found at rare intervals, but sometimes in relatively large quantities, in the intestines of the sperm whale. With the exception of choice pearls and coral, it is the highest-priced product of the fisheries, selling at upward of $40 per ounce. It has been a valuable object of commerce for hundreds of years. It appears to have been prized first by the Arabians, by whom it was called amber, and by this name it was first known among the Europeans. The name was later extended to the fossilized gum, the two being distinguished by their respective colors as amber gris and amber jaune.

In the writings of early travelers to the shores of the Indian Ocean and to southern Asia, references to ambergris are by no means infrequent. Before the time of Marco Polo (1254-1324), Zanzibar was famous for its ambergris. So plentiful was it on the shores of the Indian Ocean in the sixteenth and seventeenth

* From United States Fish Commission Report for 1902.

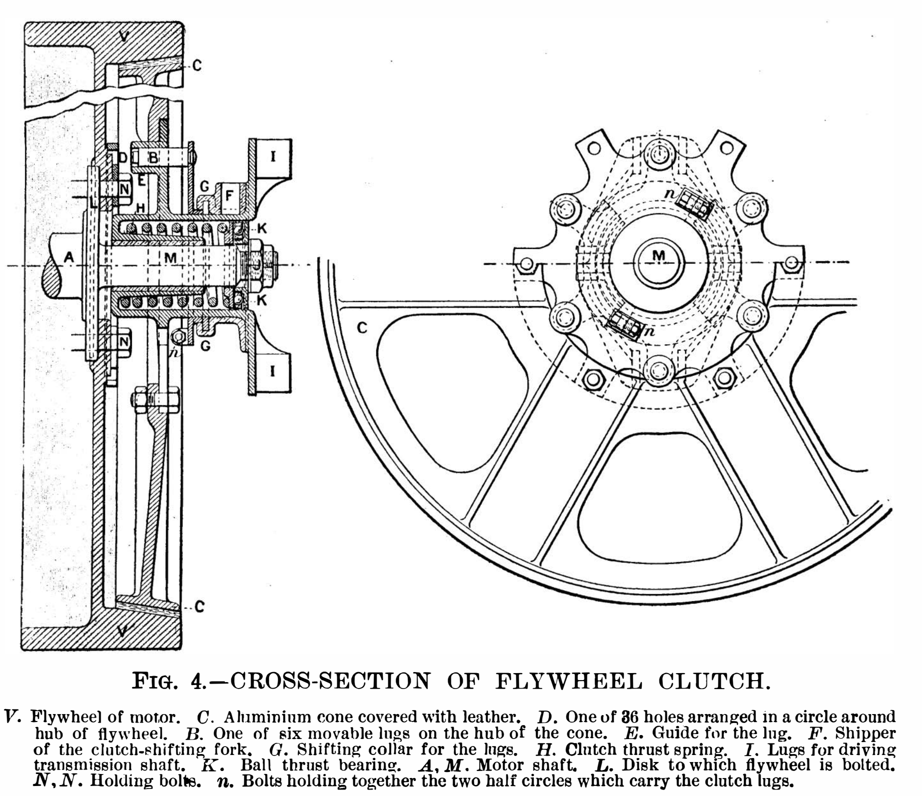


Fig. 4.—CROSS-SECTION OF FLYWHEEL CLUTCH.

V. Flywheel of motor. *C.* Aluminium cone covered with leather. *D.* One of 36 holes arranged in a circle around hub of flywheel. *B.* One of six movable lugs on the hub of the cone. *E.* Guide for the lug. *F.* Shipper of the clutch-shifting fork. *G.* Shifting collar for the lugs. *H.* Clutch thrust spring. *I.* Lugs for driving transmission shaft. *K.* Ball thrust bearing. *A, M.* Motor shaft. *L.* Disk to which flywheel is bolted. *N, N.* Holding bolts. *n.* Bolts holding together the two half circles which carry the clutch lugs.

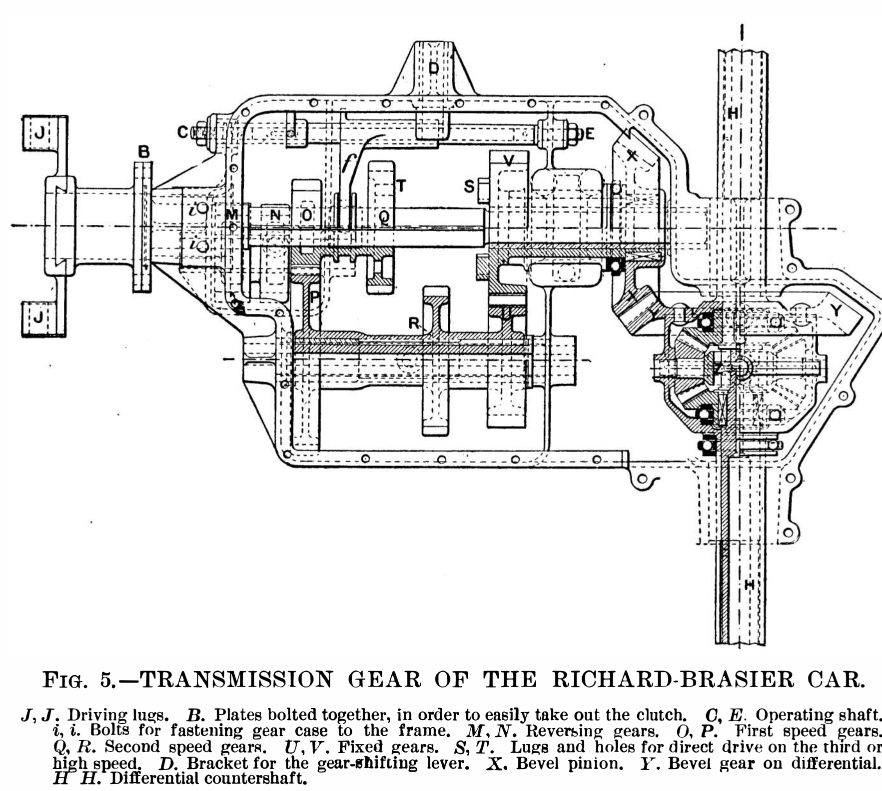


Fig. 5.—TRANSMISSION GEAR OF THE RICHARD-BRASIER CAR.

J, J. Driving lugs. *B.* Plates bolted together, in order to easily take out the clutch. *C, E.* Operating shaft. *i, i.* Bolts for fastening gear case to the frame. *M, N.* Reversing gears. *O, P.* First speed gears. *Q, R.* Second speed gears. *U, V.* Fixed gears. *S, T.* Lugs and holes for direct drive on the third or high speed. *D.* Bracket for the gear-shifting lever. *X.* Bevel pinion. *Y.* Bevel gear on differential. *H H.* Differential countershaft.

centuries that the name was given to various islands, capes, and mountain peaks of that region. It was also found on certain shores of the Pacific, notably the coast of Japan. From their station in Batavia the Dutch traders kept Europe supplied, and also exported it to Asiatic markets.

Though ambergris was a valuable commercial article, little or nothing was known of its origin before the eighteenth century. Some supposed it to be the "solidified foam of the sea," others that it exuded from trees and flowed into the sea, or that it was a "fungoidal growth of the ocean analogous to that on trees."

It is now generally conceded that ambergris is generated in either sex of the sperm whale, but far more frequently in the male, and is the result of a diseased state of the animal, caused possibly by a biliary irritation, as the individuals from which it is secured are almost invariably of a sickly appearance and sometimes greatly emaciated. It is not of frequent occurrence, many whalemen with half a century's experience never having seen any. The victim of the malady may eject the morbific substance, thus furnishing the lumps which have been found on the shores or floating on the seas frequented by sperm whales.

Although the ambergris is of such rare occurrence, the sperm whalers are always in search for it, especially in diseased or emaciated whales. It is found in all parts of the intestinal canal, but more generally at 2 to 6 feet from the vent. The instrument used in the search is a common cutting spade. The presence of the prize is detected by the peculiar feeling or impression on striking it, very much like the cutting of cork or rubber, and also by its sticking or adhering to the spade, or by its floating out upon the water when the intestines are opened.

Ambergris occurs in rough lumps varying in weight from less than 1 pound to 150 pounds or more. It generally contains fragments of the beak or mandible of squid or cuttle-fish, which constitutes the principal food of the sperm whale. When first removed from the animal it is comparatively soft and emits a repugnant odor, but upon exposure to the air it grows harder, lighter in color, and assumes the appearance it presents when found floating on the ocean. It is light in weight, opaque, wax-like, and inflammable. Its color ranges from black to whitish gray, and is often variegated with light stripes and spots resembling marble somewhat. When dried—the only curing process it undergoes—it yields a subtle odor faintly resembling that of honey. It softens under heat like wax, and in that condition may be easily penetrated by a needle. A proof of its good quality is a polished needle meeting with no obstacle when thrust through it, and if the needle be red hot the substance will exude an oil. It fuses at 140 deg. to 150 deg. F., and when heated to 212 deg. F. it dissolves into a blackish, thick oil, and gradually evaporates, leaving no trace of its presence. When stored for a length of time it becomes covered with dust like chocolate. It contains some moisture that gradually evaporates, reducing its weight, but increasing its intrinsic value.

The amount of ambergris produced annually from all sources varies greatly, scarcely an ounce being obtained in some years, while in others the product may exceed $50,000 in value. The small compass within which a very valuable quantity may be stored without attracting attention, and the ease with which it may be brought in where it is deemed advisable to preserve secrecy concerning a find, render it exceedingly difficult to follow closely the imports of the article. However, a brief account is here given of some of the principal masses obtained. In this compilation we are indebted to Mr. Francis H. Sloan and to Messrs. J. and W. R. Wing for information.

Probably the most valuable piece secured previous to the last century was a 182-pound lump purchased in 1693 from the King of Tydore by the Dutch East India Company for the sum of 11,000 thalers. Its origin is unknown. Probably it was found afloat on the sea or drifted ashore. It is stated that the Grand Duke of Tuscany offered 50,000 crowns for it—with what success is unknown.

An American fisherman is credited with finding a piece that weighed 130 pounds in a whale secured in 1782 about 150 miles southwest of Windward Islands. This sold for £500, the low price leading one to fancy that the reported weight is exaggerated.

Capt. Coffin, a British whaling master, stated before a committee of the House of Commons in 1791 that:

"He had lately brought home 362 ounces, troy, of this valuable substance. He had taken this from the anus of a female sperm whale captured off the coast of Guinea, and which he stated was very bony and sickly. At the time he brought this quantity to England the ambergris was selling for 25s. an ounce, but he stated that he sold his for 19s. 6d. per ounce to a broker, who exported it to Turkey, Germany, and France, among the natives of which it appears to have been long celebrated for its aphrodisiacal properties."*

The schooner "Watchman," of Nantucket, is credited with bringing home from the Bahama Islands, in 1858, the largest mass ever found, weighing nearly 600 pounds. This was on the market for many months, as the owners were unwilling to divide it and dealers were averse to taking the whole lot, but finally it was sold for $10,500.

The bark "Sea Fox," of New Bedford, in 1866, secured a 30-barrel sperm whale off the eastern coast of Arabia. A long-handled cutting spade was thrust into the region of the anus and a piece of ambergris fell out. Some of the men proceeded to cut open the large intestine, which was about 10 feet long and 3½ inches in diameter, and for the entire length it was literally filled and closely packed with ambergris. They cleaned out the stomach and found two large pieces weighing, respectively, 40 and 41 pounds. The ambergris in the large intestine, to all appearance, was originally composed of globular pieces, which, owing to pressure from all sides, were compressed into irregular shapes. The two large pieces found in the stomach were of a different shape from those found in the intestine. They measured about 36 inches in circumference, were flat on both sides, about 8 inches in thickness, and of a superior quality. The entire mass weighed 150 pounds and was sold to the Arabs of Zanzibar for $10,000 in gold.

During the year 1878 the bark "Minnesota," in the same locality, found 18 pounds of ambergris in a whale, which was sold in Zanzibar to the agents of the Sultan for $150 per pound.

The bark "Adeline Gibbs" in 1878 brought in the most valuable lot of ambergris obtained by an American vessel up to that time. It was taken from a 50-barrel bull sperm whale south of St. Helena, weighed 132¾ pounds, and was sold for $23,231. The piece was the only one that a fleet of 12 vessels had taken in 45 years. About the same time the "Bartholomew Gosnold" secured 125 pounds in the vicinity of New Holland, which sold for about $20,000, and the "Lettitia" brought in 100 pounds worth $17,500.

In 1882, the bark "Falcon," in latitude 16 deg. 55 min. S. and longitude 11 deg. 00 min. W., secured a 28-barrel male sperm whale, which was apparently in healthy condition and without unusual appearance. A spade was accidentally thrust into the abdomen, revealing the presence of ambergris in the viscera. A large piece of an ovate form, weighing about 60 pounds, and several smaller pieces, irregularly shaped, were found in the intestinal canal. Some of the ambergris was brownish black on the outside and some of a grayish yellow cast; the exterior coating was filled with mandibles of squid. The gross weight was 136 pounds, and it sold for $14,000.

Doubtless the most valuable lot ever secured was a mass weighing 162 pounds 11 ounces, obtained in 1891, known as the "Bank" lot, which sold in London for about £10,000. The following communication from the brokers who effected the sale of this remarkable find furnishes an excellent description of the lump and of the state of the ambergris market:

"About the end of August, 1891, a gentleman called to consult us as to the best means of disposing of some ambergris which had been consigned to his firm. We suggested that if it were brought to us we could examine it and report upon its value, but when we were informed that the case which contained it weighed close to 224 pounds and was too large to go inside a cab our first feeling was one of incredulity as to the consignment being ambergris at all. It was finally decided that the case should remain in the strong room of the bank in which it had been deposited for safe custody and that we should go there to inspect it. This we did, and were shown a box measuring about 2 feet 4 inches in each direction and which we were told had with its contents been insured for £10,000.

"In the presence of the merchant who had consulted us and the bank officials the lid of the case was opened with the immediate result that everyone beat a hasty retreat from its vicinity, for the horrible smell which issued from the box was overpowering. When the odor had lost somewhat of its intensity, we began to take out the packing and found that the case (which was tin-lined) contained one huge mass of a blackish substance, measuring 6 feet 4 inches in circumference, nearly spherical, and which was undoubtedly ambergris. On being turned out of the case it was found to be saturated with moisture, as were the packings of paper and old gunny which had been put around it to prevent it from chafing to pieces during the voyage; and it was the liberation of the gases generated by the salt water and the animal matter which had caused the stench alluded to. By proper treatment this smell was eventually completely got rid of, and the ambergris obtained in marketable condition. The mass was next weighed and the certificate signed by the interested parties, the exact weight being at that time 2,603 ounces, or 162 pounds 11 ounces. This is probably the largest piece of ambergris which has ever been seen by anyone living, and approaches nearly in weight to the lump of 182 pounds purchased by the Dutch East India Company two hundred years ago.

"The next thing to do was to split the lump, so as to see what the interior was like. This was accomplished with the aid of long chisels and crowbars. We then saw that the substance consisted of layers or laminæ rolled around a central core, the laminæ varying a great deal in texture, color, and flavor. Speaking generally, the outer layers were thin, friable, and shelly; dark, almost black in color, and mixed to a considerable extent with the beaks of the cuttle-fish, on which the whale feeds. As the layers approached the center they were denser, grayer in color, thicker, and of better flavor, until the core itself was reached. This core really consisted of two pieces, one the shape of a rifle bullet, but with a deepish depression like the 'kickup' of a wine bottle in the base. It was from 10 to 11 inches high, with a diameter of about 6 inches at the bottom, tapering upward to about 2 inches at the top, which was slightly flattened. It was detached from the surrounding layers with the greatest ease, and stood alone, a pure, solid lump of the finest gray ambergris, weighing 83¼ ounces. Beside this magnificent piece was a smaller one, almost spherical in shape and about the size of a very large orange. It was rather darker in color and not of quite so fine a flavor, but was as easily detached from the surrounding layers as the others. Neither of these pieces contained any of the beaks which were so common in the outer layers, and it is almost needless to say that they realized by far the highest price which was obtained for any portion of the mass. The layers nearest to the core were of much finer flavor than the outer and darker. One of them was quite 4 inches in thickness, and the ambergris of which it consisted was of a silvery-gray color, different from the whitish gray of the core, and was of lower specific gravity. The layer outside this again was striated in places with the darker exterior, and the beaks began to show, though not to the same extent as in the black, shelly exterior layers.

"It is a matter of some regret to us that we did not secure a photograph of this extraordinary lump, but the fact weighed heavily upon us that if the real truth about it leaked out the depression of the market would be so great that we should not be able to do justice to our clients, and, consequently, as few people as possible were let into the secret. It is true that reports about it were rife for a month or two, but as nothing authentic could be ascertained they gradually died out, and we have ourselves been repeatedly assured that the thing was a myth altogether, one gentleman going so far as to tell one of our partners, about three months afterward, that he held three-fourths of the total quantity of ambergris in London, not knowing that we were controlling about 1½ hundredweight."

Probably the finest lot of ambergris received in America was taken in 1894 by the schooner "Adelia Chase" from a 50-barrel whale near Cape de Verde Islands. It weighed 109⅝ pounds and sold for about $26,000, the best parts fetching $350 per pound. No large finds have been reported since 1894. In 1899 50 pounds of poor quality was secured by the bark "Charles W. Morgan" off the coast of Japan. In 1900 the "Morning Star" secured 7 pounds, and in 1901 the same ship brought in 20 pounds of medium quality.

Ambergris has been used for centuries in the sacerdotal rites of the church, and, in connection with fragrant gums, it was formerly burnt in the apartments of royalty. It was formerly used in cookery, especially in the East, being added to flavor certain dishes. This custom spread through western Europe to a limited extent. Macaulay refers to rumors in connection with the death of Charles II. of England that "something had been put into his broth, something added to his favorite dish of egg and ambergris." The principal use of ambergris, however, was as a medicine and as a perfume, especially in Asia and Africa. Until recently it held a place in pharmacy, being regarded as a cardiac and antispasmodic, somewhat analogous to musk, and was recommended in typhoid fevers and various nervous diseases.

The principal and almost the only use of ambergris at present is in the preparation of fine perfumes, furnishing an important ingredient in the production of choice bouquet of "extracts." It also acts as a "fixer" and serves to impart homogeneity and permanency to the different ingredients employed. For perfumers' use it is generally made into an essence or tincture by dissolving 4 ounces in a gallon of alcohol. This is facilitated by first crushing and mixing it with sand.

Perfumers exercise much care in the selection of the ambergris which they use. The wholesale dealer grades his stock of the material according to its odor, appearance, etc. But this is by no means sufficient for the trained olfactory sense of the perfume-manufacturer. Before determining the use of a special lot he tests it by his own standards, and these tests may extend over a month, especially for durability of perfume. Some manufacturers prize most highly those lots and grades which another manufacturer would not accept. The selection of just the proper quality to produce the desired bouquet forms one of the niceties of the perfumer's art.

The value of ambergris depends largely on its scarcity at the time and its freedom from impurities. During the last thirty years it has varied in price from $5 to $40 per ounce. At the present time it is quoted at $8 to $30 per ounce. In 1880 crude ambergris brought home by the whalers was sold at $10 an ounce and the dried article at $20 an ounce. In 1876 the value, dried, was $25 an ounce. In the London Price Current of Colonial Produce in 1807 ambergris is quoted at 40s. to 45s. per ounce for "gray, fine." Considering the respective purchasing powers of money two centuries ago and at the present time, that price is quite equal to the average value in recent years.

* Beale on the Sperm Whale, p. 183.

THE ARMY OF AMERICAN RAILROAD MEN.

THE number of persons on the pay rolls of the railways in the United States, as returned for June 30, 1903, was 1,312,537, or 639 per 100 miles of line. These figures, when compared with corresponding ones for the year 1902, show an increase of 123,222 in the number of employes, or 45 per 100 miles of line. The classification of employes includes enginemen, 52,993; firemen, 56,041; conductors, 39,741, and other trainmen, 104,885. There were 49,961 switch tenders, crossing tenders, and switchmen. With regard to the four general divisions of railway employment it appears that general administration required the services of 45,222 employes; maintenance of way and structures, 433,648 employes; maintenance of equipment, 253,889 employes; and conducting transportation, 576,881 employes. This statement disregards a few employes of whom no assignment was made.

The usual statement of the average daily compensa-

tion of the 18 classes of employes for a series of years is continued in the present report, which shows also the aggregate amount of compensation paid to more than 97 per cent of the number of employes for the year 1903 and more than 99 per cent for the six years preceding. The amount of wages and salaries paid to employes during the year ending June 30, 1903, as reported, was $757,321,415; but this amount, as compared with the total reported for the year 1902, is understated for want of returns by $18,000,000 at least.

ENGINEERING NOTES.

One of the most important problems that confronts a mining man, especially if his mine is large and deep, is the selection of a suitable type of hoisting engine. And yet the question is too often decided simply in line with prevailing custom, and customs vary with locality. In one part of the world one type of a hoist is in almost universal use, while in other parts such a hoist is regarded as impractical and unsuitable. This is largely due to local prejudice, of course, and yet, where a prejudice is general it must surely be based on something worthy of consideration. The up-to-date manager rises above prejudice, and approaches the subject with a mind divested of all ready-made opinions. He looks at the problem from all sides, ready to adopt anything which promises advantages, and in doing so he soon finds that it involves much more than judging about price and quality alone. Hoisting ore out of a mine differs from all other hoisting in many ways. As a rule the depth from which ore is to be raised is great, while in lifting weights around a building under construction, at the shipyards, in the workshops, and on board ships the height is of no great consequence. The quantity to be raised from a mine in a day is also considerable, and as a rule the same engine which is to hoist the ore will also have to lift and lower the miners. The mining hoist is further a permanent appliance, and the cost of handling the ore depends in a very large measure upon the type of hoisting engine selected.—E. T. Sederholm in Mines and Minerals.

A new type of motor boat has been designed by a French inventor, Count de Lambert, capable of developing a high speed with a motor of 14 horse-power, whereas with the prevalent type of boat two or three times as much power is necessary to attain the same speed. In this latest design a novel principle of construction is adopted. There are two skiffs, each 18 feet in length, coupled side by side. The motor is placed in the center, and drives a single screw propeller at the stern, placed between the two boats. The feature of the invention is that the boat does not cut through the water, as is generally the case, but glides upon its surface.

This gliding motion is obtained by making the two skiffs flat-bottomed, and introducing a series of five transverse planes below the waterline and slanting downward from fore to aft in the water at an angle of about 30 degrees. These inclined planes remain, except the two at the bows, in the water when the boat is at a standstill. When the propeller revolves and drives the boat forward, the resistance of the water on the series of inclined planes beneath the craft causes the latter to lift until it rests merely on the surface, over which it glides along. The inventor, although his device appears curious, has yet attained some startling results with it on the Seine. With a motor developing 14 brake horse-power he has attained a speed of nearly 20 miles per hour, with the stream, and 17½ miles against the stream. The gliding boat, however, would not be practicable upon any water where there was the slightest wave motion, as its equilibrium would be seriously disturbed, and its commercial development therefore is distinctly limited.

An interesting return has just been issued showing the warships built in government as well as private yards in all countries. A careful analysis of the figures given shows that of the total displacement tonnage 37.6 per cent has been floated for the British navy, 20.6 per cent for the United States fleet, 9.45 per cent for the Czar, 8.15 per cent for the French fleet, and 7.1 per cent for the Kaiser. In other words, while the tonnage of British ships was 148,746, that for the United States measured 81,320 tons, for Russia 37,150 tons, for France 32,119 tons, and for Germany 28,170 tons. Italy comes next with 25,680 tons; then Austria, 17,900 tons; Japan, 12,640 tons; Turkey, 7,660 tons; Denmark, 3,500 tons; and Portugal, 630 tons. The total for the world thus becomes 395,615 tons, which is equal to nearly one-fifth of the merchant seagoing ship-tonnage launched in all countries in the same year. As regards the horse-power of the machinery for these ships, the fact that the ratio of power to tonnage is 2.3 to 1 is suggestive of the effort made to get high speed. Owing to the inclusion of a large number of torpedo craft this high proportion is most pronounced in the case of France, 3.7 of power to 1 ton; Russia, 3.3 to 1; and Japan, 2.7 to 1. The aggregate horse-power for all the ships works out to 908,800 I. H. P., of which 35.5 per cent is due to the British navy additions, 14.9 per cent to the United States, 13.5 per cent to Russia, 13.1 per cent to France, and 7.2 per cent to Germany. The ratio of power to tonnage in the case of Germany is about an average, for the British ships it is under the average, and for the United States low. These results, however, are only averages and count for little, being due to the inclusion of fewer or more high-speed destroyers. The horse-power for British warships totaled 320,100, for the United States 134,200, for Russia 122,800, for France 118,300, for Germany 64,900, for Japan 46,500, for Italy 44,000, for Austria 27,000, for Turkey 25,000, for Denmark 4,200, and for Portugal 1,800 I. H. P.

SCIENCE NOTES.

While the bands observed on the surface of the planet Jupiter are always quite parallel to the equator, yet oblique bands have been observed by Chambers. Amann (Comptes Rendus) has observed, in the southern hemisphere of the planet, such an oblique band four times between July 4, 1902, and January 22, 1903. The most striking observation was made on December 13, 1902, when the band was seen at an inclination of 12 deg. between 20 deg. and 40 deg. southern latitude. One end of the band was about 20 deg. from the eastern side of the planet, and the other 23 deg. from the western side. Amann considers that these observations should furnish valuable information as to the duration of formation of all the bands generally; the usual type of parallel bands can give no data as they, as a rule, completely encircle the planet. Further, he considers that the oblique bands are due to the formation of an immense solid mass which moved eccentrically to the axis of rotation in a more or less plastic surface medium.

The geological department of the California University is studying a fossilized egg, preserved in a hard nodule, which is claimed by the owner to have been purchased from an Arizona miner. As far as known, there is only one other specimen in existence, that in the California Academy of Sciences in San Francisco. According to the experts, there can be no mistake about the nature of the curiosity, as an examination has revealed the fact that the delicate shell has been perfectly preserved, even to the fine pitting of the outside. In places where the shell is cracked the inside is seen to be filled with some mineral substance, the exact nature of which is still undetermined. Prof. John C. Merriam, head of the palæontology department, is inclined to the belief that the original organic contents of the egg have been changed by the intrusion of some delicately percolating mineral substance to form a new material, and in order to settle this point, Dr. Arthur S. Eakle, instructor in mineralogy, has undertaken the investigation of the nature of the egg's contents. The specimen is about the size of an ordinary hen's egg, but a trifle longer. From its general character, Dr. Merriam judges that it must date from a period older than the Quaternary, and possibly older than the Pliocene.

G. W. Hough in Science puts forward the following theory as the one which, in his opinion, gives the most satisfactory explanation of the question of the physical constitution of Jupiter. The visible boundary of Jupiter is assumed to have a density of about half that of water. This medium is in the nature of a liquid; in it are located the great red spot and the egg-shaped white spots. In such a medium, all motions in longitude and latitude would be slow and gradual, and the shape and size of the object would have great permanency. The equatorial belt and the so-called polar belts may be located on the surface or at a higher level than the red spot. In the middle latitude, within 20 deg. of the equator, the higher atmosphere carries a layer of dark matter, in the direction of the rotation of the planet, at a velocity of about 250 miles per hour, making a complete circuit around the planet in 44 days. In this envelope are formed the openings known as white spots, and by unequal distribution, black spots. The great bay in the south edge of the equatorial belt may be accounted for by assuming that the great red spot is at a lower temperature than the medium in which it floats, and, owing to this, condenses a portion of the vapor composing the belt. The belts may be assumed to consist of some sort of vapor of considerable density. The cloud-like matter, which in the equatorial regions is moving over the surface at the rate of 250 miles per hour, would account for the minor changes on the surface of the equatorial belt.

It is generally said that colloidal gold solutions, as well as the permanent suspensions, are coagulated and precipitated by the passage of electric current, red colloidal gold solutions being simultaneously turned blue. Mr. J. C. Blake has investigated the behavior of completely reduced red solution of colloidal gold, formed by the action of an ethereal solution of gold chloride dried at 170 degrees, on acetylene water containing ether. If such a solution is contained in an ordinary beaker, there is no effect apparent upon passing an electric current for hours. This apparent inactivity is attributed to conditions favorable for uniform diffusion. On the other hand, if the solution is contained in an ordinary U-tube, with an electrode in each arm barely entering the liquid in order to avoid the diffusing effect of escaping gases, electrical migration and concentration of the gold may be observed. When contact is made, the gold immediately begins to settle around the cathode with a clear surface of demarkation, leaving a colorless liquid, but never passing the bend of the U-tube. The gold solution around the anode grows deeper in color for about half an hour, and then grows lighter in color, until, after twelve hours, only a faint pink tint remains, all the gold being now concentrated in a red cloud at the bend of the U-tube, except for a slight deposit of dark-colored slime on the anode. When the U-tube is so constructed as to have a long, horizontal portion between the two arms, the phenomena were unchanged, the cloud forming midway between the poles. The red cloud may be diffused by gentle agitation or warming, and diffuses simultaneously when the current is broken. The explanation given is that the gold particles are originally negatively electrified, and hence start toward the anode; but, upon concentrating around the anode, they give up their charges and, receiving a positive charge, are repelled. These positively charged particles meet negatively charged particles migrating from the cathode, and some sort of union is formed, which produces the red cloud at the bottom of the tube.—The American Journal of Science.

ELECTRICAL NOTES.

The principal thing which at present limits the distance to which electric power can be transmitted is voltage, or rather insulation. The amount of copper, which constitutes a large proportion of the total cost of any given transmission scheme, is directly proportional to the square of the distance and the amount of power transmitted and is inversely proportional to the square of the voltage used and the loss that takes place in the conductors. It is evident, therefore, that if we could increase the voltage indefinitely, we could increase the transmission distance indefinitely; but we soon come to a limit beyond which we find it is impossible to increase the voltage. Just what this limit in voltage is at present is somewhat a matter of individual opinion, and what it will be in the future involves an exercise of prophetic vision which it is beyond the scope of this discussion to assume. The highest voltage actually in use at the present time is about 55,000. This voltage is used in the Cañon Ferry-Butte transmission in Montana, a distance of about 65 miles, and in the Shawinigan-Montreal transmission in Canada, a distance of about 80 miles. Higher voltages have been proposed, and in some cases have even been prepared for, in the design of lines and transformers; but up to the present time none higher than 55,000 volts has been put into successful commercial operation. The most serious difficulties encountered in increasing the voltages of transmission are: Difficulty in maintaining perfect insulation. 2. Difficulty in obtaining proper protection from lightning discharges and other static troubles. 3. Loss of power due to brush discharges from high-tension conductors. 4. Deterioration of the high-tension conductors, due to the fact that compounds which attack the metal are formed by the action of these brush discharges upon the atmosphere.—Paul M. Lincoln, in Cassier's Magazine.

Among the many applications of electricity about mines, possibly the latest is in its use as a motive power in hoisting engines. While a number of small hoists run by electric motors have been in use in the United States for a number of years on underground slopes and shafts, it is due to Germany almost exclusively to show what results can be obtained by using this form of power in large units on main hoisting shafts. Approaching in this country to the latest German development are the electric hoists on the shafts of the Consolidated California and Virginia Mining Company, on the Comstock Lode, at Virginia City, Nev. There is at present much interest in electric hoists in England and on the Continent, as well as in the United States, and the successful solution of the problem will doubtless be of considerable importance to mine owners in all fields, notably in South Africa on the "Rand" where the reef goes to a great depth, and in some sections of our own country—in the Rocky Mountain region, for example, and the Lake Superior district. The hoists just described, the experiments being tried, and the development of electric hoists now under way by a number of manufacturers, are the outcome of the advance made in electrical engineering, the very general application of electricity to mining operations, and requirements demanding a hoist of this type. Mines in the Lake Superior region have attained a depth of a mile and over, and further extensions of the "deep-level" mines in the Rand, South Africa, involve vertical shafts of 3,500 to 5,000 feet to the intersection of the reef, with inclines from this point of 3,000 to 6,000 or more feet in length; and in planning the development and equipment of these properties, it has been stated that present hoisting methods must be considerably modified. Mr. H. C. Behr treated the various features of this hoisting problem in a paper on "Winding from Great Depths," and the consensus of opinion among South African engineers seems to be that these "deep-level" mines will be operated on an even larger scale than ever before, the output planned being 2,000 to 3,000 tons per mine per day; and that the greatest attention will be given to the economies that may be effected in working costs, by the use of machinery, and in economic methods of operating the same. It has been stated that the advantages of electric-power distribution are well recognized, and this method will be extensively adopted for what may be termed auxiliary power requirements. The underground workings will be arranged with a view to rapid removal of the ore contents, and it is probable that several incline shafts, operated by independent hoisting engines located underground, will be used to feed each single large vertical shaft, the latter having several pairs of hoisting compartments, and possibly arranged for hoisting in stages. In any case, there will exist within the next few years a demand for hoisting engines of considerable size, to be located underground, in a dozen or more of the "deep-level" mines, and from three to six hoists per mine. A number of these mines in the same neighborhood are controlled by the same financial interests, and it is perfectly feasible to consider the supplying to such a

group of mines of their electric power requirements from a single central power station. With the rapid development of water-power and the increasing use of long-distance transmission of electricity, the adoption of that power hoisting on main shafts would seem to be favored in many sections when electric hoists of larger capacity have demonstrated their fitness for the work.—Mines and Minerals.

TRADE NOTES AND RECIPES.

Pickling of Spangles and Other Objects.—Oxidized copper, brass, and German silver articles must be cleansed by pickling in acid solutions. In the case of brass alloys, this process, through which the object acquires a dull yellow surface, is known as dipping or yellowing. The treatment consists of several successive operations. The article is first boiled in a lye composed of 1 part caustic soda and 10 parts water, or in a solution of potash or soda or in lime water; small objects may be placed in alcohol or benzine. When all the grease has been removed, the article is well rinsed with water, and is then ready for the first pickling. It is first plunged into a mixture of 1 part sulphuric acid and 10 parts water, and allowed to remain in it till it acquires a reddish tinge. It is then immersed in 40 deg. nitric acid, for the purpose of removing the red tinge, and then for a few seconds into a bath of 1 part nitric acid, 1.25 parts sulphuric acid of 66 deg. Baumé, 0.01 part common salt, and 0.02 part lampblack. The article must then be immediately and carefully washed with water till no trace of acid remains. It is then ready for galvanizing or drying in bran or beech sawdust. When articles united with soft solder are pickled in nitric acid, the solder receives a gray-black color.—Der Metallarbeiter.

Use of Petroleum in Metallurgy.—Important experiments in the employment of petroleum in metallurgy have been actively conducted by engineer specialists in this important branch of industry. It is in Russia, especially, where coal and wood cannot rival petroleum, that experiments have yielded the best results. The first attempts were simply the combustion of the residues of petroleum on a kind of grate. This primitive installation was replaced by a system of buckets, constantly filled with petroleum by means of a special arrangement regulating the admission of the combustible liquid. The space separating the buckets from each other permitted the circulation of the air necessary for the combustion, which was complete.

These petroleum burners have been improved in the following way: The petroleum is brought in by a pipe. A valve regulates its admission into a chamber where air is admitted, and on the exit from this chamber the petroleum is ignited.

The burners employed in this system resemble acetylene burners. The gas conduit is divided into two small tubes, each perforated with a small orifice, and arranged so that the orifices are opposite each other. The two gas jets are united at the exit of these tubes into a single jet, which is then ignited. The flame passes over the metals and accomplishes their fusion and mixture.

We notice that petroleum has been successfully employed in Russia, not only in metallurgy, but in the glass industry. The glass works of Kroubsky employ it as a combustible.—Translated from La Journal du Petrole.

Rapid Production of Oxygenated Water.—The manufacture of oxygenated water at present is a long and delicate operation. MM. Gouthière and Laurent have sought to simplify the method and render it practical, even in inexperienced hands, while obtaining rapidly a product of good quality.

The operation is as follows: To water acidulated with chlorhydric acid in suitable proportions, a mixture of barium bioxide and crystallized sodium sulphate, prepared in advance, is added. The bioxide is decomposed by chlorhydric acid; oxygenated water and barium chloride are formed, and a disengagement of heat occurs.

The sodium sulphate dissolving in water, with absorption of heat, counterbalances the elevation of temperature, producing more stability in the oxygenated water. There is also formed with the barium chloride, sodium chloride and insoluble barium sulphate. The baryta is therefore precipitated in this way.

The operation is terminated by neutralizing the liquid by any alkali which will precipitate the ferric oxide, alumina, and silica in the insoluble state.

The oxygenated water may be utilized after decantation or filtration to separate the precipitate.

A variation of this operative mode consists in the employment without previous mixture, but in suitable proportions, of barium bioxide and sodium sulphate.

This process is equally applicable to the manufacture of oxygenated water by alkaline bioxides, sodium bioxide for instance. This compound on contact with the water produces a lively effervescence, and an elevation of temperature, resulting in a loss of oxygen. By mixing it previously in suitable proportions with crystallized sodium sulphate, these inconveniences are avoided.

Other alkaline salts can be employed, as sodium carbonate, sodium phosphate, etc. Preference is given to sodium sulphate, on account of its comparatively low price and the practical form in which it is offered in trade.—Translated from Revue de Chimie Industrielle.

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