A VISIT TO A FRENCH GAS WORKS.

BY JACQUES BOYER.

In the evening of the very day on which Napoleon I. was crowned at Notre Dame de Paris, Philippe Lebon, the gifted founder of the manufacture of illuminating gas, was stabbed and killed by an unknown person in the Champs Elysées, which at that time were deserted and unsafe after nightfall. But his invention survived him. The Englishman, William Murdoch, of Redruth in Cornwall, substituted coal, which abounded in that region, for wood, which at the beginning of the nineteenth century had already become scarce and dear. Soon afterward he went to Scotland, where he continued his experiments and lighted with coal gas his property at Old Gunnoch. He next (1803) applied his system of illumination to James Watt's factory at Soho, near Birmingham, and two years later a spinning mill at Manchester also adopted it.

But the timorous talked of the dangers of suffocation and of explosions, to which the gas, which was still imperfectly purified, exposed the citizens. Scientists confirmed these assertions, and the first gasometers erected in London, by Samuel Clegg, so terrified the people that no workman would venture to light the gas jets which had been placed on Westminster bridge. But Clegg soon overcame this difficulty by lighting a torch and applying it to the burners with his own hands. On another occasion, before a committee of the Royal Society of London, he bored a hole in the gas holder and put a lighted candle to it, to the great alarm of the spectators, but without causing the slightest accident. Gradually the eyes even of the most prejudiced were opened to the truth. The German, Winsor, introduced gaslight in France, and Panwells started gas works in the Faubourg Poissonnière. Soon the Carrousel, the Rue de la Paix, the Rue de Castiglione, the Place Vendôme, the Odéon, the Luxembourg, and the galleries of the Palais Royal were illuminated successively with the new light derived from coal.

Let us visit, then, camera in hand, the two most interesting establishments of the Paris gas company—those of La Villette and Clichy. The former is some thirty years old, while the latter, constructed according to the plans of M. Maurice Louvel, is provided with improved apparatus, designed to simplify the operations as much as possible. In fact, although the same general method of gas making is adopted in the nine plants which supply Paris and its suburbs, there are many differences of detail between the works of Saint Mandé and Ivry, which were built in the infancy of the industry, and that of Landy, which is now in course of construction. The latter, when completed, will cover an area of 40 hectares (100 acres), exclusive of an equal space reserved for future extensions, and its 3,000 distilling retorts will produce 400,000 cubic meters (14,124,000 cubic feet) of gas daily.

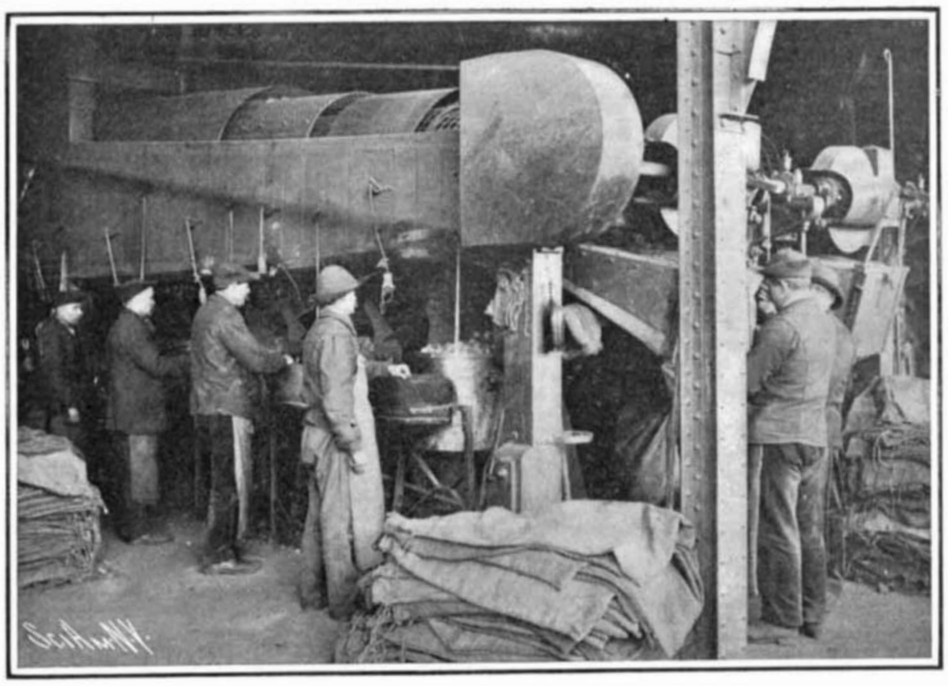


Fig. 8.—"Hectolitres-verseurs," or Measuring Tubs, Used in Measuring and Bagging Coke.

In order to save expense for labor, the Paris gas works are located on railways (like La Villette, on the Northern, Eastern, and Ceinture lines), on water courses (like Boulogne and Alfortville), or on both (like Clichy). A track usually runs beside the retort rooms, so that cars may be unloaded very near the furnaces.

At Clichy the coal trains compete with boats (Fig. 1). From the latter, the coal is hoisted to a platform 82 feet above the Seine, where it is dumped into cars, which are drawn to the storage yard by a small locomotive, an operation which is performed very expeditiously. The huge coal heaps are watched very carefully, for they are liable to spontaneous ignition. The temperature of the heap is determined roughly by means of iron rods plunged deeply into the coal.

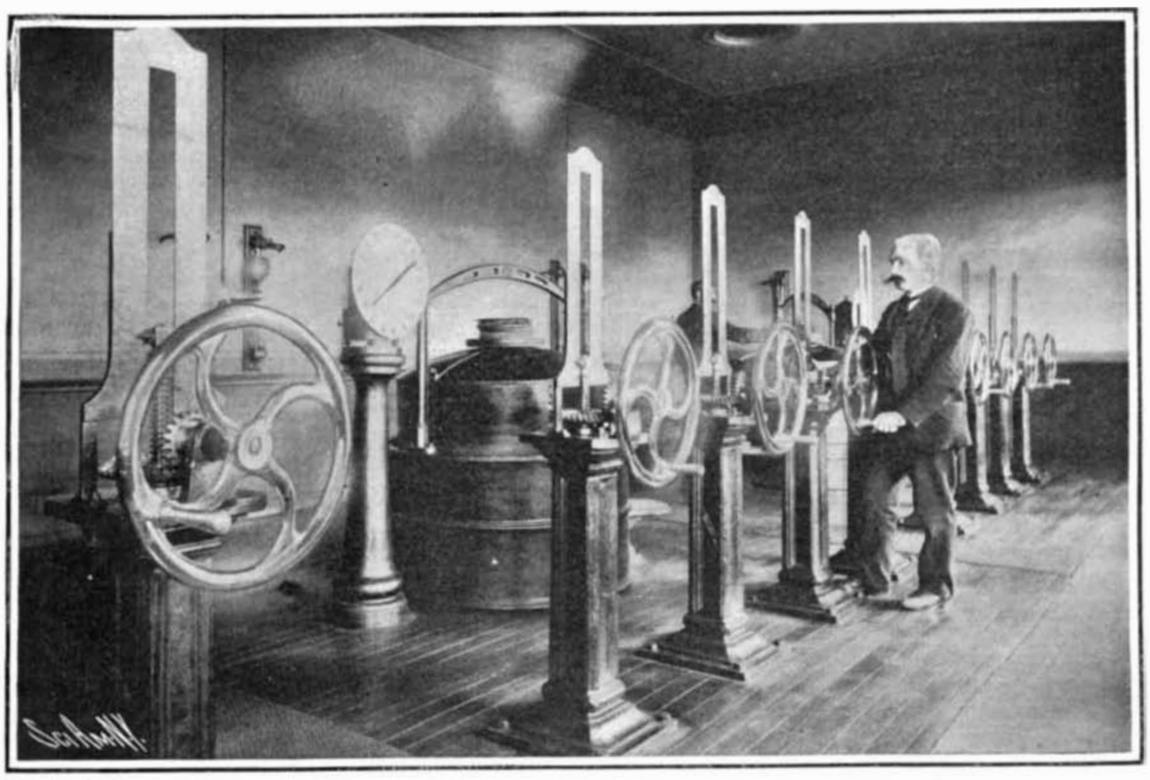


Fig. 6.—Distributing Office, Clichy Gas Works.

But in order to obtain gas of good quality, attention must be paid to the character of the coal supplied to the retorts. If this is too hard, the gas will possess little illuminating power; if too rich in bitumen, the apparatus will become clogged with tar. The product of French and Belgian mines is, therefore, blended skillfully with English boghead and cannel coals.

The loaded and weighed cars of the various coals are run into an immense building, where the furnaces are grouped in "batteries," or transverse rows of eight, on each side of a passage 20 feet wide. The furnaces of one battery are in contact with those of the next, back to back. The retorts are

Fig. 2.—Quenching Glowing Coke.

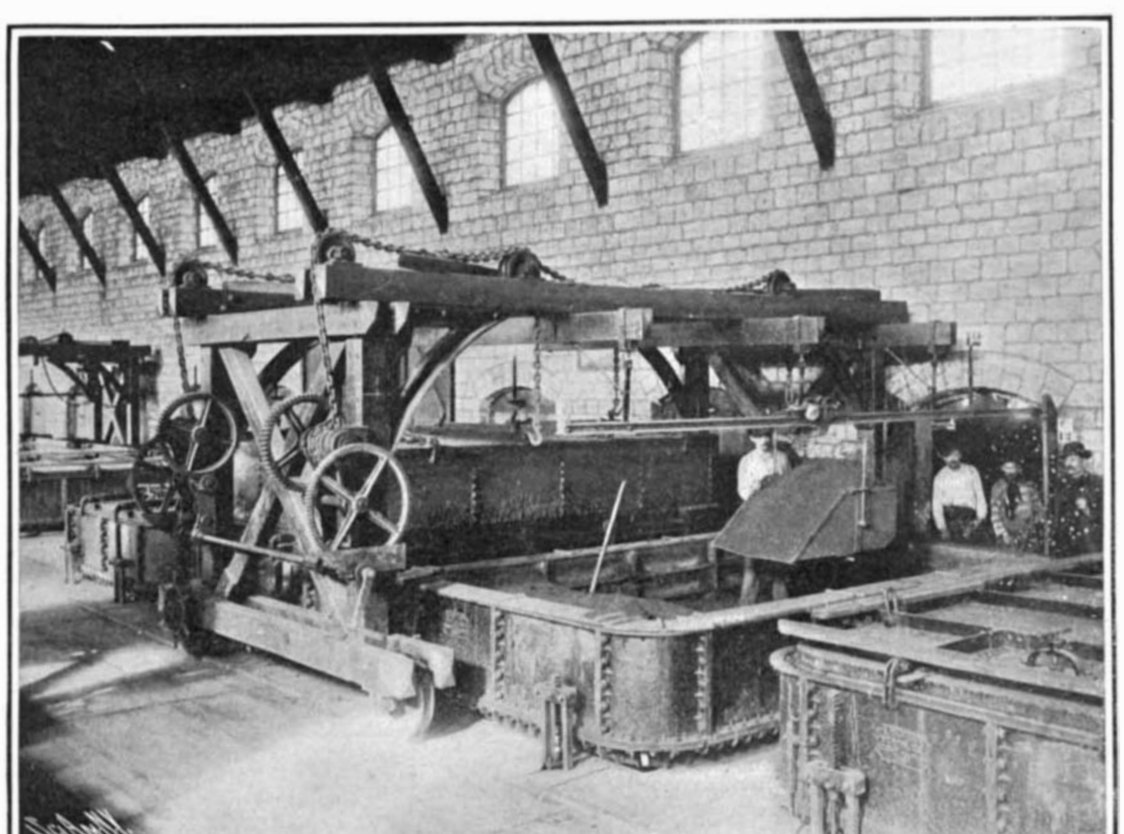


Fig. 4.—Tank for the Chemical Purification of Gas. (Shown Open and in Process of Being Filled With the Purifying Mixture.)

A VISIT TO A FRENCH GAS WORKS.

tubes of refractory clay of semi-elliptical cross section and 10 feet long, and are arranged in three tiers.

In the spaces between the coupled batteries, in an atmosphere overheated by the contact of the hot pipes and the frequent opening of the glowing retorts, are the workmen dripping with sweat and covered with black dust. The crew of a battery is composed of two stokers, three retort chargers, three openers, and two coal passers, whose duty it is to bring coke for the fires and coal for the retorts. There is also a man, ironically dubbed "Mylord" in the slang of the trade, who stands by the furnaces, watching for leaks and performing various small and occasional duties.

The work of these men is performed as follows: Three retort men manipulate the "spoon," a hemicylindrical spade exactly 10 feet long, which the passers have filled with 75 kilogrammes (165 pounds) of coal (half the charge of a retort). At the foreman's signal two of the men lift the spoon with the aid of a bar slipped crosswise under it, and the third grasps the handle at the end of the shank. Then all three move toward the retort, in which they deposit the charge in an instant and with mathematical precision. At the proper instant the third man depresses and turns the handle to empty the spoon. In less time than it takes to describe it, the second spoonful is added, and the opener shuts the door of the retort and closes it hermetically by two or three turns of the screw. The men then pass to the next retort, and the entire battery is charged in a few minutes.

About four hours later the sound of a whistle indicates that the foreman considers the distillation finished. The retorts are now opened. An opener, bearing a burning scrap of paper in his hand, approaches a retort and "lights" it, opening the door very slightly to avoid the explosion which a sudden entrance of air would occasion. This done, he opens wide the door, or plug, and proceeds to the next retort. At the same moment a second opener pushes up to the open retort a *marmite*, a heavy sheet-iron vessel mounted on two wheels, and with long pokers rakes into it the 2 hectoliters (5½ bushels) of the coke which form the first residue of the combustion.

Then these men proceed to the yard, dragging after them this white-hot furnace on wheels, which they quench with floods of water (Fig. 2). This task is the hardest work of the whole process. Bathed in sweat, though clad only in cotton jackets and trousers, the men work amid dense clouds of white smoke. They continue this severe labor for six hours through biting winter winds and snowstorms. Stalwart peasant lads of Brittany and Auvergne for the most part, they spend only the winter in Paris and, at the first breath of spring which heralds the approach of the dull season in the gas business, they return to their homes, where farm work in the open air recruits their health.

But let us leave the coke for the present, and return to the retorts. The crew is not idle during the four hours occupied in distilling a charge. The retorts in each tier must be charged, opened, emptied, and recharged in succession, the fires must be fed and kept clear, and when the last battery has been filled with coal, it is time to empty the first. Moreover, the work of these men is not without influence on the quality of the product. Atmospheric conditions affect the draft of the furnaces and, consequently, the rapidity of distillation, which should take place at a temperature between 1,000 deg. and 1,100 deg. C. to produce gas of maximum illuminating power. The proper temperature having been attained, the volatile principles of the coal escape through vertical tubes, which unite in a horizontal collector running around the upper part of the furnace, whence they pass into a common reservoir called a *barillet*, which is a large sheet-iron cylinder half full of water. In its passage through the layer of liquid the gas is partially freed from tar and sulphurous and ammoniacal impurities. From the reservoir the still impure gas is drawn by aspirating pumps through groups of tubes called "organ pipes" (Fig. 3) where, as it cools in its progress, it deposits tar, naphthaline, and other heavy hydrocarbons and another portion of its ammoniacal impurities.

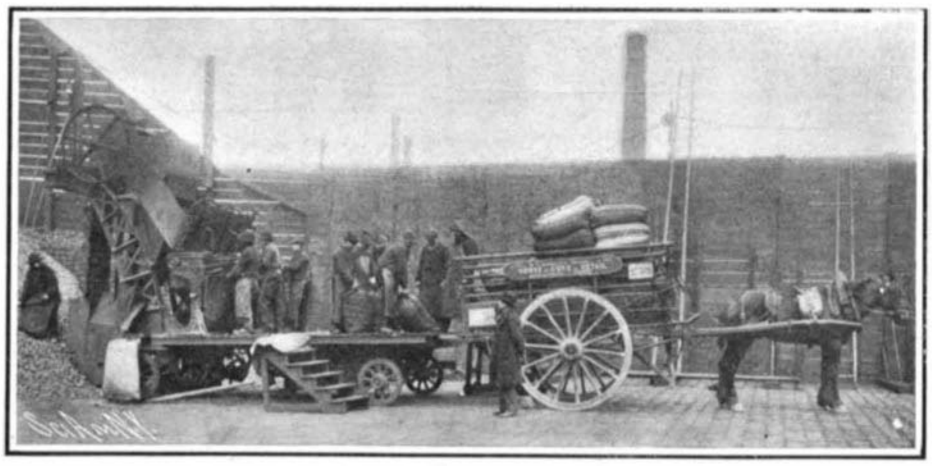


Fig. 9.—Loading a Wagon from the "Drague."

After this first physical purification, the gas, still drawn forward by the same pumps (which at the same time diminish the pressure in the retorts) is freed from the minute drops of tar which it still carries with it by passing rather rapidly through a Pelouze & Audoin condenser. This consists essentially of a series of metal plates with fine perforations which are not opposite each other, so that the tar drops are dashed against the plates and adhere to them.

Now comes the chemical purification, which takes place in sheet-iron tanks, one of which is shown in Fig. 4, in process of being charged with the purifying mixture of sawdust, lime, and oxide of iron. This mixture is spread on sieves, through which the gas passes slowly. To renew the mixture it is only necessary to expose it to the oxidizing action of the air. After it has been used a number of times, however, it is rejected, and then sold to manufacturers of Prussian blue.

The gas is now freed of every impurity which could diminish its luminous power or vitiate the atmosphere of a room in which it is burned, and it is ready for storage and distribution to consumers. First, however, its volume must be measured. In the great hall of the Clichy works (Fig. 5) we see the meters employed for this purpose, through which flow daily, at midwinter, about 400,000 cubic meters of gas. They are ten gigantic sheet-iron cylinders, 13 feet in diameter and height, ranged like so many monstrous casks in a hall 200 feet long. At the center of each, behind a pane of glass, appear figures indicating the quantity of gas received. Now, as the supply pipes are 32 inches in diameter, before the unit wheel has registered one cubic meter the next has entered the apparatus, so that the wheel appears to

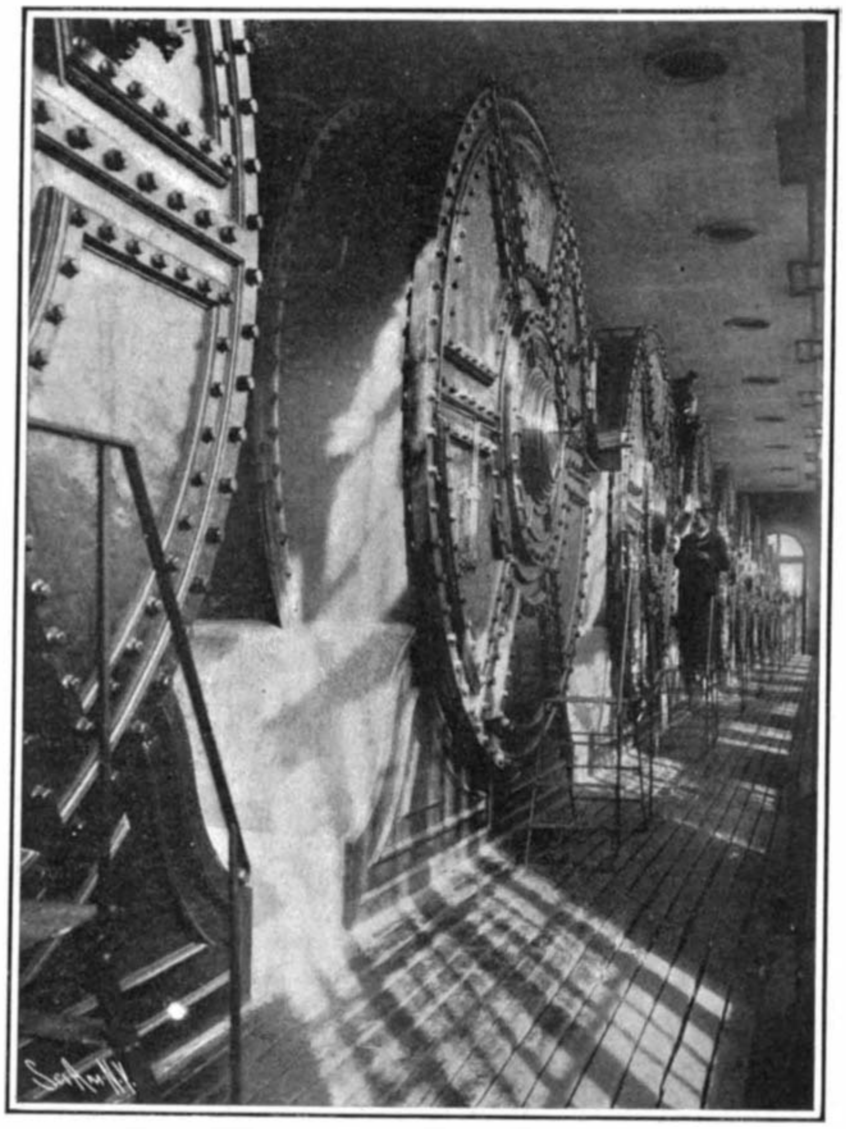


Fig. 5.—The Great Meters of the Clichy Gas Works.

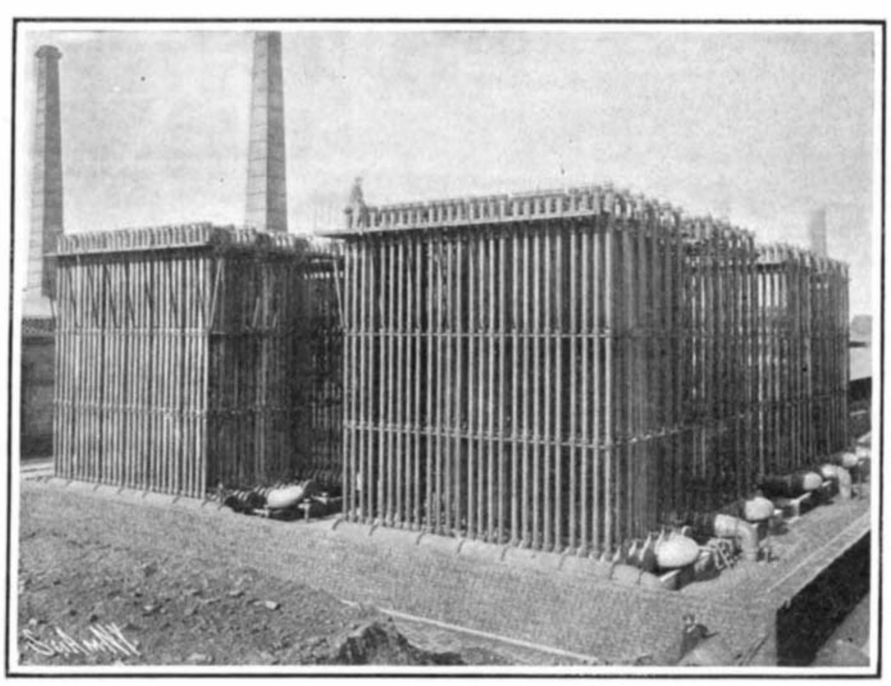


Fig. 3. –"Organ Pipes" of the Gas Works at Clichy.

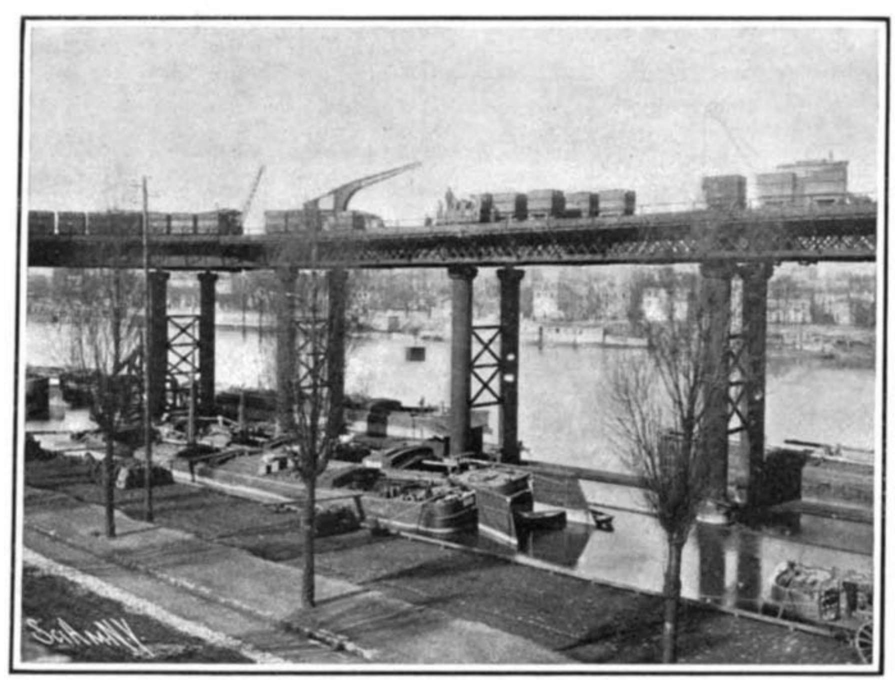


Fig. 1.—Elevated Landing Stage at Clichy, for Coal Brought by Seine Boats.

A VISIT TO A FRENCH GAS WORKS.

be always in motion. The gas next flows into the gasometers, those immense bells of riveted sheet iron with whose appearance everyone is familiar. Their lower edges dip into wells of water, and they can move up and down, guided by rollers which press against columns of cast iron. These enormous reservoirs are fed by jointed pipes, and rise to their full height or sink almost into the ground, according to the quantity of gas which they contain. Each of the gasometers at Clichy is 43 feet high and 178 feet in diameter, holds 30,000 cubic meters (108,000 cubic feet) of gas and costs nearly a million francs ($200,000).

From the gasometers, pipes lead to the distributing office (Fig. 6) where there are three small gasometers furnished with manometers, which indicate the pressure on dials. The pressure is regulated according to the demand by the aid of disks of lead placed on these small gasometers. The mains, the valve gear of which is shown in the foreground, conduct the gas to the 1,540 miles of pipes which ramify through the soil of Paris.

In the works of the Paris gas company the coke is disposed of by means of very efficient machinery devised by the engineers Gigot, Louvel, and L. Bertrand, and driven by electricity.

There are cars and automatic dumping carts, but the most interesting devices are the *convoyeurs*, *hectolitres-verseurs*, and *dragues*.

The conveyor (see front page) is used chiefly in piling up bags of coke. It is composed of a chain with buckets, in which the sacks are placed for transportation to a considerable distance and elevation to a height of 60 or 70 feet. The apparatus is supported by iron columns and girders.

The *hectolitre-verseur*, or measuring tub (Fig. 8), is used in measuring and bagging coke. It is placed under the sieve and operated by one man. When the tub is full it is dumped by means of a handle, but it rights itself automatically. The coke is poured into the sacks through an apparatus having the form of a funnel.

The *drague*, or dredge, disposes coke for city delivery. It is a chain with buckets, mounted on an iron arm which can turn about a horizontal axis, and is so arranged that its weight tends to press the lower part of the apparatus against the pile of coke. The buckets discharge their contents into a hopper, from the bottom of which the coke, freed from dust, runs through three spouts into three *hectolitres-verseurs*. The bagging is done on the platform of the apparatus, which is at the height of a wagon, so that the sacks are easily removed.

Finally, the by-products which result from the distillation of coal constitute an important source of revenue to the company. At La Villette there is a special and mysterious factory for the utilization of coal tar. In this sanctuary, jealously screened from profane eyes, the tar is transformed into benzine, phenol, and naphthalene, from which substances other chemists extract brilliant dyes and delicate perfumes. At Clichy the ammoniacal liquor of the gas works is converted into ammonium sulphate, which is largely employed as a fertilizer.

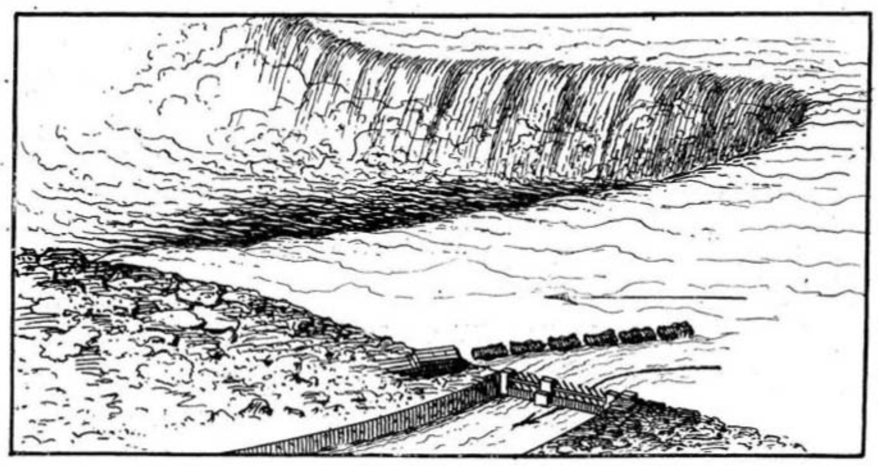
The manufacture of gas, therefore, is now a very successful industry because it involves, so to speak, no waste. The graphite which encrusts the interior of the retorts is used for electric light carbons, crucibles, and lead pencils, and even the ashes of the coke burned in the furnaces are bought by French brickmakers to mix with clay which is too stiff to be used alone.

Nearly all of the best arable land of the country has now been taken up, and those who are most vitally concerned with soil production realize that henceforward the main problem for the man who intends to make cultivation of the soil his occupation will be not so much a question of greater acreage as of greater production from a given acre. If America hopes to continue her phenomenal development, she must be able to produce not only the enormous quantities of food required for her own increasing industrial population, but a large share of the food for other nations as well.

CURIOUS ENGINEERING FEAT AT NIAGARA.

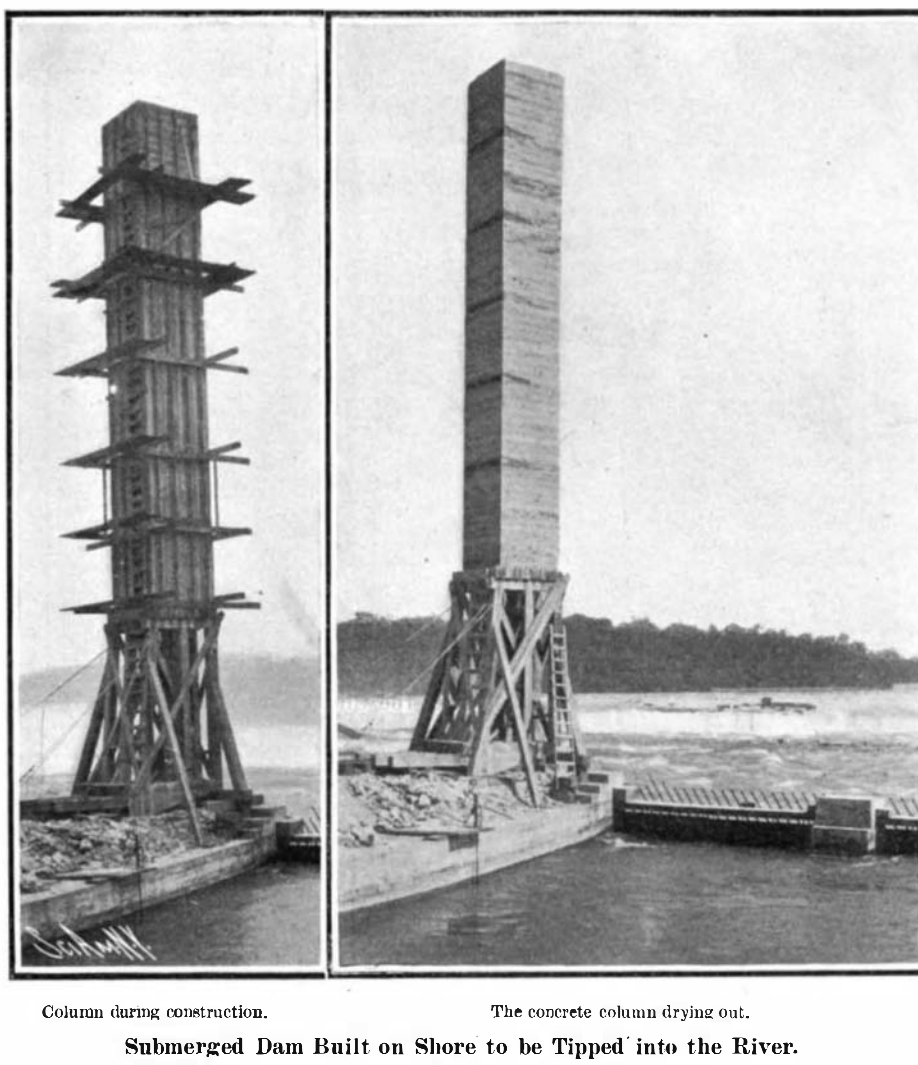
BY ORRIN E. DUNLAP.

The city of Niagara Falls, Ont., has had a great deal of trouble in getting a sufficient supply of water at its intake in Victoria Park. This has been especially true in winter, and several times the Canadian city has had to call upon the city of Niagara Falls, N. Y., to supply it with water for fire and other purposes by means of a line of hose stretched across the lower steel arch bridge. The Niagara Falls Park and River Railway, the electric line that skirts the cliff on the Canadian side at Niagara, and which develops its own power, has also had trouble, the intake being a joint one. Both interests made complaint to the commissioners of Victoria Park, alleging that the water at the joint intake had been lowered by works of construction for power development. The park commissioners held a hearing on the matter, and it was decided to grant a measure of relief. Mr. Isham Randolph, consulting engineer of the Chicago Drainage Canal, was called into consultation by the park commissioners, and he advanced a plan to remedy the alleged trouble.



The Concrete Column After It Has Been Thrown into the Stream.

In carrying out this plan, the park commissioners have constructed a concrete column 50 feet high and 7 feet 4 inches square on top of a trestle that stands 20 feet above the ground level. This column it is proposed to tip over into the river, to form a prostrate column, designed to raise the water level at the intake considerably. The column is made of concrete having proportions of one, three, five, and is reinforced throughout its entire length by a very heavy chain that runs through the center, the chain having a weight of about 800 pounds. The approximate weight of the column is 200 tons. About every eight feet of its height there is a wooden wedge that extends nearly half way through the column, the wedges being about 12 inches thick at the outer edge and tapering to 6 inches toward the center, and the blocks are further separated by strips of tarred paper. The purpose of these several wedges and paper strips is to break the mass in six parts as it falls in order that it may conform to the bottom of the river, while the parts will be held in place by the chain that extends through the center. The scene of the work is only about 600 feet up from the brink of the Horseshoe Fall, but when prostrate the column is not expected to make any difference in the flow of the waterfall. When prostrate, the top of the column will be 20 inches above the level of the ground, and in order that ice may be floated off, an opening will be left between the end of the dam and the river. The column will be tipped by jacks working under timbers at the bottom of the trestle, and when it falls it is expected to tumble slightly up stream. The column will be allowed to dry several weeks before it is tipped into place in the Niagara River.



Column during construction. The concrete column drying out.

Submerged Dam Built on Shore to be Tipped into the River.

CURIOUS ENGINEERING FEAT AT NIAGARA.

Niagara Falls and locality have witnessed many strange feats of engineering, but this construction of a dam up in the air and then tipping it over to the spot desired is certainly very new. However, it well portrays the adaptability of concrete work to peculiar and difficult situations such as those often found at Niagara.

The Bantu.

Roughly speaking, the whole of Africa south of the equator, with the exception of the dwindling Bushman and Hottentot elements, is inhabited by Bantu-speaking peoples, who are extremely heterogeneous, and who exhibit sufficient similarities in physical and cultural characteristics to warrant their being grouped together; the true negro may be regarded as a race; the Bantu are mixed peoples. It will be noticed that as a rule the Bantu approach the Hamites in those physical characters in which they differ from the true negroes, and owing to the fact that the physical characters of Semites in the main resemble those of Hamites, the Semitic mixture that may have taken place will tend in the same direction as that of the Hamitic. The diversity in the physical characters of the Bantu is due to the different proportions of mixture of all the races of Africa. What we now require is a thorough investigation of these several elements in as pure a state as possible, and then by studying the various main groups of Bantu peoples their relative amount of racial mixture can be determined. The physical characteristics of the Bantu vary very considerably. The skin color is said to range from yellowish-brown to dull slaty-brown, a dark chocolate color being the prevalent hue. The character of the hair calls for no special remark, as it is so uniformly of the ordinary negro type. The stature ranges from an average of about 1.640 meters (5 feet 4½ inches) to about 1.715 meters (5 feet 7½ inches). Uniformity rather than diversity of head-form would seem to be the great characteristic of the African black races, but a broad-headed element makes itself felt in the population of the forest zone and of some of the upper waters of the Nile Valley. It appears that the broadening of the head is due to mixture with the brachycephalic Negrillo stock, for, whereas the dolichocephals are mainly of tall stature, some of the brachycephals, especially the Aduma of the Ogowe, with a cephalic index of 80.8, are quite short, 1.594 meters (5 feet 2¾ inches). The character of the nose is often very useful in discriminating between races in a mixed population, but it has not yet been sufficiently studied in Africa, where it will probably prove of considerable value, especially in the determination of amount of Hamitic or Semitic blood. The results already obtained in Uganda are most promising. Steatopypy is not notable among men; fatty deposits are well developed among women, but nothing approaching the extent characteristic of the Hottentots and Bushmen.

The test of a scientific theory lies in the number of facts which it groups into a connected whole; it ought besides to be fruitful in pointing the way to the discovery and co-ordination of new and previously unsuspected facts. Thus a good theory is in effect a cyclopædia of knowledge, susceptible of indefinite extension by the addition of supplementary volumes.

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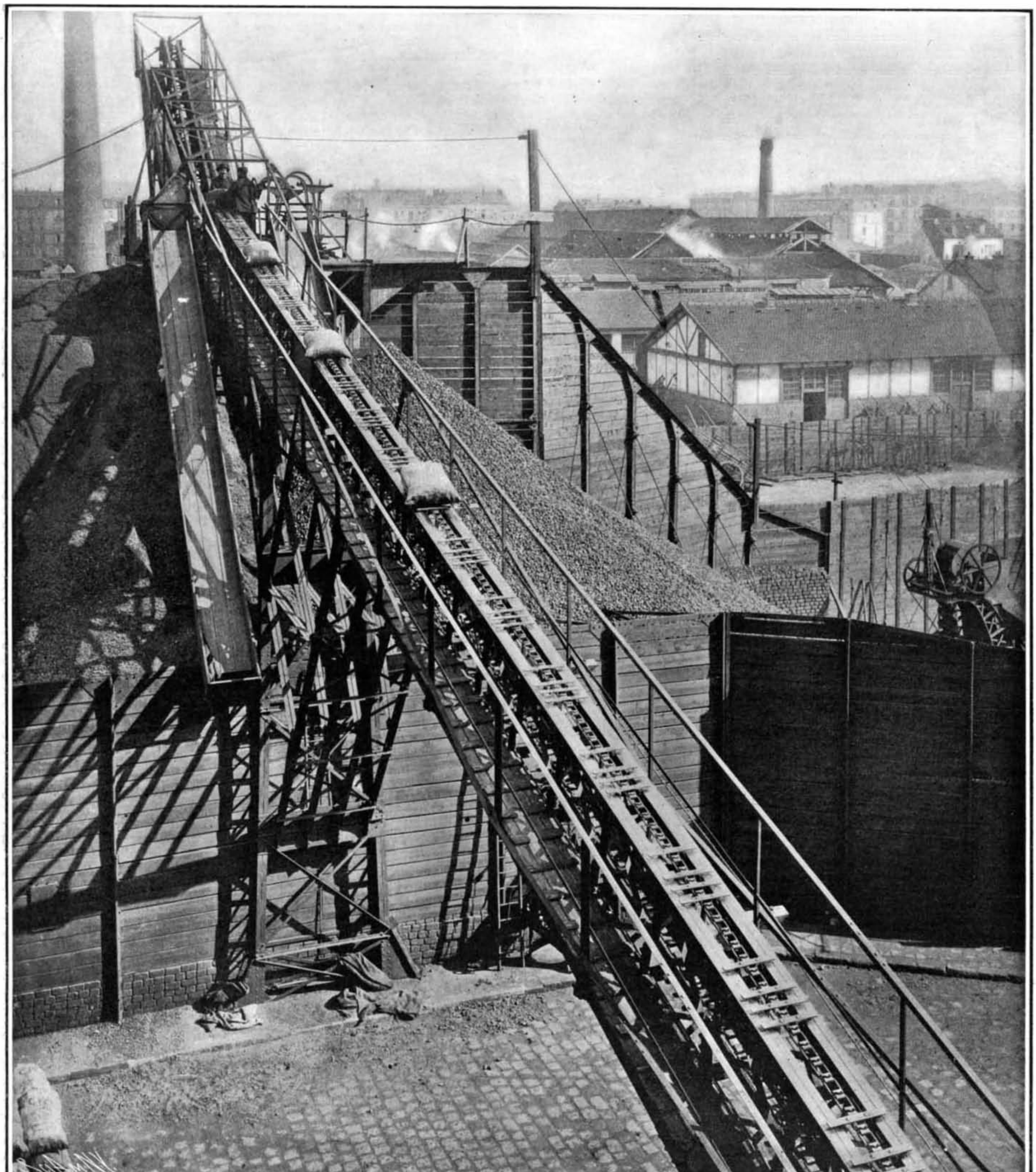

Conveyor for Bags of Coke, Clichy Gas Works.

A VISIT TO A GREAT GAS WORKS.—[See page 380.]