MANUFACTURE OF ILLUMINATING GAS.

I. COAL GAS.

In the present illustrated description of the modern method of manufacturing coal gas, we have chosen the large station at the foot of Fourteenth Street, near the East River, in this city, as being thoroughly representative of the present state of the art, as carried out on a large scale. By the courtesy of Dr. Elliott, the chief chemist of the Consolidated Gas Company, our artist was enabled to make the accompanying drawings, in which the salient features of this vast plant are grouped together in such a way as to enable the reader to follow the process from the charging of the retorts to the final delivery to the city mains.

The station which is herewith illustrated is one of ten which are owned by this company, in three of which coal gas is manufactured, while the others are devoted to the manufacture of water gas. The Fourteenth Street station covers an area of several city blocks, and in the course of each year, 125,000 tons of bituminous coal are consumed in producing gas at the rate of from 3,000,000 cubic feet per day in the summer to 5,000,000 cubic feet per day in the winter season. The plant is in constant operation for the whole twenty-four hours, and although the exigencies of manufacture require that certain parts of it be briefly closed for repairs, there is no time in the year, or from year to year, in which the whole establishment is idle.

Illuminating gas is obtained from coal by the operation which is chemically known as destructive distillation, and technically as carbonization. The carbonization is accomplished by placing the coal in closed air-tight retorts which are raised to the proper temperature for driving off the various gases and converting the coal into coke. The retorts employed at the works under consideration are of the D shaped pattern, and are manufactured of fire clay, which, on account of its refractory nature and its cheapness and durability, has been proved to be the best material for this purpose. The retorts are 25 inches in width, 14 inches in height, and 9 feet in length, and they are arranged in three tiers, as shown in the sectional view at the bottom of our first-page engraving. They are grouped in series of six. Each six constitutes a "bench," and each bench is supported within an arched setting, while below is provided a deep and somewhat narrow furnace, the air for the supply of which passes up from below through the fire bars. The heating furnace is charged with a portion of the coke which forms the solid residuum in the retorts. For purposes of economy, the furnaces are fired on the regenerative principle, only sufficient air being supplied through the fire bars for the production of carbon dioxide gas, which, passing up through the upper stratum of coke, serves to maintain it at a steady glow of heat, the final carbon monoxide gas being ignited and burnt beneath the lowest tier of the retorts by means of heated air, which is led in through special air ducts provided for the purpose. These ducts will be noticed in our sectional view of the retorts.

The view referred to shows one side of what is known as a "range" of retorts. In this particular range we see the front face of twelve benches which contain in all seventy-two retorts. On the opposite side, or what is technically known as the back of the range, are twelve other benches, thus making a total of 144 in all. There are in the Fourteenth Street station six of these ranges, and the total number of retorts will thus be seen to amount to 864. Each retort of the particular type shown can make 10,000 cubic feet of gas in every twenty-four hours.

Although the principles of coal gas manufacture are the same to-day as they were in the early days of the art, there has been a vast advance in the details of the plant, the development of special appliances and tools, and the general systemization of the work. Our illustrations show two of the most remarkable machines of recent design, known as the "charger" and "discharger," the latter being shown in some detail at the nearer end of the range, while the former is seen further down the line. Each machine travels on a track which completely surrounds the range of retorts. It carries its own steam boiler and engines for moving the machine down the front of the retorts and performing the various operations of charging and discharging. At the top of the discharging machine is a hopper capable of carrying six tons of coal, or sufficient to charge the whole line of retorts on one side. Below the hopper and placed vertically below one another, are three automatic scoops which are arranged at heights corresponding to the level of the three tiers of retorts. The scoops are rectangular in section and of such length and capacity as to contain the proper amount of coal for charging the retorts. They are loaded by gravity from the hopper and are thrust simultaneously into the retorts, where, by means of a very ingeniously contrived mechanism, the scoops are withdrawn, leaving their charge of coal behind. As soon as the retorts are charged, they are closed by means of special self-sealing doors, and the charger is moved forward by its own engine to a position in front of the next series. The carbonization of the coal usually takes about four hours, at the end of which time the gases have been completely driven off, leaving practically pure coke behind. The lid of the retort is then opened and the coke is withdrawn by means of the discharger, which is driven up into position on the railway. This discharger is very similar in construction and operation to the charging machine. It has three long rakes arranged vertically, one above the other, at an elevation corresponding to that of the retorts. The rakes are thrust into the furnace and withdrawn by means of a steam cylinder 8 inches in diameter by 3 feet stroke operating a rack and endless chain and a drum. The rake is lifted as it enters the retort, in order to clear the fuel, dropped as soon as it reaches the back of the retort, and then withdrawn, bringing the charge of coke with it. During the process of distillation there is deposited on the inner surface of the walls of the retort a deposit of carbon known as "scurf," which is utilized in the electrical industries. Once in every six weeks it is necessary to burn out this deposit by means of air and steam until it is sufficiently thin to be broken with chisels and withdrawn.

The gas produced by the carbonization of the coal leaves the retorts by means of vertical ascension pipes, by which it is conveyed into a large horizontal half-round pipe known as the hydraulic main, which runs the whole length of the range, as shown in the engraving. The ascension pipes terminate in what are known as dip pipes, which descend a few inches below the surface of the collection of tar and ammoniacal liquor that fills the half-round bottom of the hydraulic main. The liquor is kept at a predetermined level by means of an adjustable overflow, which is shown just to the right of the hydraulic main. The gas enters the main through the dip pipe, bubbles through the liquid, and escapes from the main by means of a large pipe which conveys it to the condensers. The object of the dip pipe is to provide a seal which will prevent the return of any gas to the retorts. The tar and ammoniacal liquor, as they accumulate in the main, flow to the adjustable valve and are conducted through a trap to what is known as the tar and ammoniacal liquor well.

The condensers, which are shown in our engravings to the right of the retorts, are two in number. Each consists of a huge cast iron box 22 feet in height, 45 feet in length, and 6 feet in width, which is filled with a mass of vertical 4-inch tubes which extend between two tube sheets arranged a few feet from the bottom and from the top of the condensers, as shown in our sketch. Circulating water is kept continually flowing around the tubes, while the gases from the retorts are made to travel alternately up and down through the tubes until they have traversed the whole length of the condensers. The tubes are divided into groups of fifty-four, there being eighteen groups in each condenser. The gas enters at the bottom of the first group, passes up through it to the top of the next group, down through that group, then up through the next, and so on, until the series has been traversed. The gas enters at a temperature of between 110 and 115 degrees at one end, while the circulating water enters at 70 degrees at the opposite end, the gas finally leaving at 70 degrees, while the water escapes at the original temperature of the gas, of from 110 to 115 degrees. The cooling of the gas causes the vapors of the various hydrocarbons and the aqueous matter distilled from the coal to condense into the liquid form. We have seen that much of the heavy tar and some of the weak ammoniacal liquor was deposited in the hydraulic main, and the further cooling which takes place in the condensers results in the condensing of most of the strong ammoniacal liquor and some of the light tar. These liquid products collect at the bottom of the condensers, flow out along the bottom of the inlet pipe from the retorts, pass through a trap, and finally collect in the tar and ammoniacal well before referred to. In the two condensers there is a total cooling surface of 18,000 square feet.

At the opposite end from which it entered, the gas is led from the condensers by a large main and passes through what is known as the exhausters. Of these there are three at the Fourteenth Street works, two of which are constantly at work, the other being in reserve. The exhausters are simple Roots blowers, which serve to draw the gas through the condensers from the retorts and force it through the scrubbers and purifiers on its way to the holders. The exhauster, one of which is shown in our engraving immediately in front of the condenser, performs the double duty of relieving the pressure in the retorts, and producing the proper pressure in the holders for distribution through the city mains. The pressure in the retorts is maintained at about 1 inch of water, while the pressure in the holder is maintained at 7 inches.

From the exhausters the gas is forced through a large valve into the bottom of two huge circular towers technically known as "scrubbers." The scrubbers are in duplicate, and the following description of one will apply fully to the other. The tower, which is built of sheet iron, consists of an inner and an outer shell, this construction being adopted to guard against freezing in severe winter weather. The diameter of the inner shell is 13 feet, and its height to the platform is 62 feet, the total height of the structure over all being 84 feet. Down through the vertical axis of the tower extends a large 24-inch pipe for the return of the gas after it has ascended to the top of the tower. The space between the 24-inch main and the outer shell is filled with a vast number of slats of wood ¼ of an inch in thickness and 6 inches in depth. These are carried vertically on a series of superimposed radial arms, the object being to provide the largest possible amount of surface consistent with leaving sufficient space for the upward passage of the gas. At the top of the mass of slats is what is known as a "distributer," which consists of a rotating arm which extends entirely across the scrubber and is fed with a constant stream of water, which, as the arm rotates, is sprinkled evenly over the mass of slats below. The effect of this constant sprinkling is to keep the whole surface of the innumerable slats that fill the tower constantly wet, with the result that as the gas passes up through the slats it is thrown into intimate and thorough contact with the water and the ammonia gases are completely absorbed and carried down to the base of the tower, where they pass off through a trap to the ammonia well.

After leaving the scrubbers the gas is conducted through a large valve shown in the engravings to a series of purifiers, where whatever carbonic acid and sulphureted hydrogen remains is abstracted, together with some of the sulphur compounds. The carbonic acid must be removed, because it would lessen the illuminating strength of the gas, while the sulphureted hydrogen, for obvious reasons, must be completely taken out also. The purifiers measure 24 by 26 feet and 4 feet in depth. They contain a number of superimposed trays which are filled with oxide of iron and lime, the oxide of iron serving to remove the sulphur and the lime the carbonic acid. The gas is introduced at the bottom of the purifiers and passes up through the trays, finally leaving by way of the center seal valve, shown in the engravings. From this valve it is conducted to large water meters 15 feet in diameter and 12 feet in length, where its amount is registered. From the meters it passes underground through a main extending vertically into the center of the gas holder and terminating a few feet above the water level.

The gas holder, which not long ago was the largest of its kind in the country, is a huge affair 194 feet 6 inches in diameter and 165 feet in height when it is raised to its full lift. It is of the three-lift, telescopic type, and when it is down the whole of it telescopes into a large water-tank 42 feet in height, whose foundations are laid several feet below the surface of the ground. This tank has a capacity of 3,300,000 cubic feet. Huge as it is, however, it will be seen that it is by no means equal to accommodating the maximum output of the station, which, when everything is in full blast, amounts to 5,000,000 cubic feet per day.

In closing, it should be mentioned that the weight of the holder is not raised, as is often popularly supposed, by the lifting power of the gas, but by the actual pressure produced direct from the exhauster already referred to. This pressure is equal to about seven inches of water. The gas is led to the mains by the vertical pipe shown adjacent to the main by which the gas enters the holder. Before being delivered to the mains, however, the pressure is reduced to 3 inches for night consumption and 2 inches for day service.

Relative Corrosion of Wrought Iron and Steel.

At the recent International Engineering Congress on methods of testing construction materials, an address on the corrosion of iron and steel was delivered by H. M. Howe, the Honorary President. Mr. Howe, as the result of a long series of experiments, arrived at the following conclusions: First, that despite the common and widespread belief among engineers that soft steel corrodes much more rapidly than iron, there is really very little difference between the two in this respect, except where they are exposed to the action of salt water. If the corrosion of wrought iron be taken as 100, that of steel would be 114 in salt water; in fresh water, 94; and where the exposure is simply to the atmosphere, 103. In 3 per cent nickel steel the corrosion is about 80 per cent of that in wrought iron; in 26 per cent nickel steel, about 30 per cent. Although the latter metal has an enormous advantage over wrought iron, it cannot be called a non-corroding metal, but, rather, a slowly corroding one.

Photographing by Light from Venus.

Dr. William R. Brooks, director of the Smith Observatory at Geneva, N. Y., has succeeded in photographing objects solely by the light from the planet Venus. The experiments were conducted within the dome of the observatory, so that all outside light was excluded except that which came from Venus through the open shutter of the dome. The time was the darkest hour of the night, after the planet had risen, and before the approach of dawn. The actinic property of the light from Venus was much stronger than anticipated, the photographic plates being remarkably clear, intense, and fully timed. The experiments will be continued every clear night. Dr. Brooks was an early worker in photography, and has used it for many years in his astronomical researches.

Science Notes.

Prof. A. A. Michelson, of the University of Chicago, has been awarded a Grand Prix at the Paris Exposition for his echelon spectroscope.

After January 1, 1901, the Centigrade thermometer will be used exclusively in Germany, the Chancellor of the German Empire having issued an order to that effect.

Last year Berlin was visited by 1,000,000 strangers; Vienna, by 500,000; Munich, 600,000; Dresden, 500,000; Hamburg, Leipzig, and Zurich, each 400,000; while Düsseldorf, Bâle, and Stuttgart each had over 250,000 visitors.

The printing of the British Museum Authors' Catalogue is now completed up to the end of 1899. The compilation of this enormous work has occupied twenty years' incessant toil, and has entailed a total cost of $200,000. The catalogue comprises 400 large thick volumes and 70 supplements. The staff which has been engaged upon this work is now devoting its attention to the compilation of a subject index, which it is estimated will keep them fully occupied for another ten years.

The incessant vibration of the shutter in the biograph, necessary to impart the essential life-like veracity to the movements on the film, has been entirely obviated by a clever invention of a gentleman in London, Mr. Walter Gibbons, and his device is being employed in connection with the biograph at the London Hippodrome. By this new mechanism there will be no further irritation to the eyes of the audience, a drawback which is very painful after staring for some time at an abnormally long film.

Mr. Carl Linde, who has recently been giving great attention to machines producing liquid air, describes, in a recent issue of a German technical journal, a furnace designed by Mr. Hempel for an ingenious application of this substance. The furnace is intended to burn low-class fuel, such as lignite and peat, and the combustion is intensified by turning the gaseous mixture obtained by evaporating liquid air on the fire. Nitrogen is first set free, after which there remains a gas containing at least 50 per cent of oxygen. The price of this gaseous mixture is 81 cents per thousand cubic feet.

A curious effect of a bullet wound has just been exemplified in the Boer war. An English soldier in the storming of a position at the beginning of February last was struck in the face by a Mauser bullet. The projectile lodged in the head somewhere, but all attempts to reveal its precise position by the X-rays were futile. The soldier was discharged from his hospital as cured, and participated in several other battles. The only ill effect he experienced from the wound was a slight impediment in his speech. On July 11 he was seized with a violent attack of sneezing, and during his exertions disgorged what proved to be the missing bullet. It had been firmly embedded point downward in the lower part of his jaw.

Dr. A. Baginsky has recently visited Odessa, and during his sojourn in that district visited the "limans," which are in the vicinity of that port. The "limans" are vast sheets of water, which were originally connected with the sea, but through gradual silting up of sand have been isolated and are now extensive salt water lakes. By means of evaporation the waters in these lakes have become concentrated, and have been proved to be of such therapeutic value that the "liman cure," as it is called, is rapidly growing into popular favor. At the Kujalnitzki liman, about six miles distant from Odessa, and which is the most important liman, as many as 232,318 baths were taken last season, and the patients reaped appreciable benefits from this course of treatment. Thirty-three per cent of the patients were sufferers from chronic articular rheumatism; 495 were scrofulous; and 254 anæmic.

On the first of September M. Jacques Faure, a member of the Aero Club of Paris, crossed by balloon from the Crystal Palace, London, to France. He set off on his journey at six o'clock in the evening, and safely descended at Alette near Boulogne at ten minutes to eleven, the journey having occupied four hours and fifty minutes. The balloon traveled almost throughout the entire distance at a height of 2,000 feet. This is by no means an exceptional performance, since Mr. Percival Spencer, the well known aeronaut of London, has crossed from the Crystal Palace to France on several occasions with varied success, but the trip has never before been attempted by night. The advantage of the night journey is that the air being condensed does not rarefy the gas in the balloon, as is the case when the sun's rays are directed upon the vessel during the day time. So long as the temperature of the atmosphere remains at a certain point, the balloon will maintain its equilibrium at a regular altitude. M. Faure intends to recross from France to England, starting from Cherbourg, with the first suitable wind. On this occasion, special floats will be attached to the balloon, so that, in the event of its unexpectedly descending into the water, it will be kept afloat.

Engineering Notes.

Paris is experimenting with oil lamps for the street. They are a thousand candle power each and are set up on the river side of the Tuileries garden.

A Western road has a flat car equipped with an air compressor and boiler to operate a sand blast for cleaning bridges and iron structures preparatory to painting.

A new steel process is being tested at Pittsburg, for making compound steel ingots. The experiments are being made under the direction of W. D. Corcoran, of the Crucible Steel Company, of America. Solid ingots of graduated carbon, from one side of the ingot to the other, or from the center of the ingot, were made. It is claimed that the new process will be important for armor plate, as any desired thickness of very high carbon can be given the surface of the plate, rendering it, with a low carbon back, absolutely impenetrable.

A report has recently been published upon the coal fields of China, and those around Tse-chau were recently visited by Prof. Drake, who found that the workable coal lies in one bed about 250 feet above a flint-bearing limestone stratum, below which there may also be coal. The thickness of the same is probably not less than 22 feet and at one place it is worked through a shaft 329 feet deep. Prof. Drake estimates that within 150 square miles around Tse-chau there are about 3 000 million metric tons of coal. Most of Shan-si has been found underlaid by large coal beds. It is also considered that the anthracite coal alone of Shan-si amounts to 3,000 million metric tons, and that the coal area is greater than that of Pennsylvania. Nearly all the coal is mined through shafts varying from 50 to 300 feet. No steam is used for raising the coal to the surface, and explosives are not employed. Very little coal is mined through inclines. For local use coal is taken away in carts drawn by oxen. It is practicable in the Shan-si coal beds to run long lines of railroad tunnels through the bed and load the cars in the mines for distant transportation.

Some particulars of cellulith are given in La Revue de Produits Chimiques. It is well known that in the making of paper, a continuous beating of the pulp produces a transparent and elastic mixture, which hardens on drying and greatly strengthens the paper. The cellulith is prepared by a process exclusively mechanical—the beating of the pulp for a much longer time than is necessary in the production of mere paper. According to the properties of the pulp and the rate of revolution of the cylinder, the operation may last from forty to one hundred and fifty hours, or until there is a homogeneous mass having no trace of fiber. The air in the substance is removed by beating for two more hours; if allowed to remain, it might destroy the regularity of the material. If desired, suitable colors are added, and then the substance is heated, the hot cellulose liquor passing into a vessel having a perforated bottom, through which it drips. Containing 96 per cent of water, the material has the consistency of thick honey. The water is evaporated either by natural or artificial heat, and the pulp hardens, gradually attaining the consistency of horn, its specific gravity being about 4·5. The cellulith may be worked as is horn or ebonite. Combined with sawdust and 30 per cent lampblack, the result is a kind of dark ebonite; this is dense and may be polished.

The efficiency of the steam turbine motor for the propulsion of such craft as torpedo-boat destroyers has been amply demonstrated, first with the little "Turbinia," and more particularly by the "Viper," which has passed through her official steam trials under the direction of the Admiralty officials with pronounced success in every respect, attaining on a three hours' trial the satisfactory speed of 33·838 knots. More could probably have been done, but this more than satisfied the contract conditions. The only point remaining to settle had reference to the economy of the steam turbine in comparison with the reciprocating engine; and the results are now available. As the power developed could not be determined, the only measure for fair comparison is the consumption per hour for a given speed. On a three hours' trial at 31·118 knots the "Viper" burned 8·86 tons of coal per hour, or 19,846 pounds, and on a three hours' trial at 33·838 knots the consumption was 11 tons 9 hundredweight 1 quarter 9 pounds, or 25,685 pounds per hour. The "Albatross," which was built and engined by Messrs. Thornycroft, is the only destroyer with reciprocating engines which has on official trials made a speed approaching to that of the "Viper," and here the speed was 31·552 knots, with the engines indicating 7.732 indicated horse power. The displacement of the "Albatross" is 384½ tons, and of the "Viper" 385 tons; while the coal consumed per hour for 31·552 knots for the former was 17,474 pounds per hour, and for 31·118 knots of the latter 19,846 pounds per hour, so that here is a fair basis of comparison which requires no comment. The 30-knot destroyers, with reciprocating engines, consume about 15,150 pounds per hour, this result being the mean of 45 boats.—The Engineer.

Electrical Notes.

The first electric street railway line in London proper will probably be built on the Victoria Embankment of the Thames from Blackfriars Bridge to new Battersea Bridge.

In the plant of the United Electric Light and Power Company of New York the largest steam turbine ever built is about to be installed. The normal output of the turbine will be 2,500 horse power, but it will have capacity sufficient to carry a 3,000 horse power load. The turbine will be direct-coupled to an alternating current generator rated at 1,500 kilowatts, or capable of supplying 30,000 sixteen candle power incandescent lamps.

An invention which is much needed at the present time is a telephone meter, attached to each subscriber's instrument, so as to show accurately the number of telephone connections made for the subscriber, or the total length of time the line is used on outgoing calls. Such a meter to be successful must be simple and easily read. It must also register accurately all connections actually obtained, and must not interfere with the necessary talking and signaling circuits. It must not involve any additional complication at the switchboard. If such a meter could be produced at a moderate price, it would be sure of success.

Sir William Preece read a most interesting paper before the British Association at the Bradford meeting, in which he stated that the first experiments in regard to wireless telephony were made in February, 1894, across Loch Ness, in the Highlands of Scotland. On that occasion trials were made to determine the laws which govern the transmission of the Morse signals by the electro-magnetic method of the wireless telegraph. Two parallel wires, well earthed, were taken one on each side of the lake, and arrangements were made by which the wires were systematically shortened with a view to ascertaining the minimum length necessary to record satisfactory signals. The trials show that it was possible to exchange speech across the loch at an average distance of 1·3 miles between the parallel wires, and the length of the wires themselves was reduced to 4 miles on each side of the water. The volume of telegraphic current was immensely greater than that of the telephonic current. Whenever through want of balance in a loop disturbance was evident, telephonic cross talk was also evident.

The Chief Inspector of French Telegraphs, M. Willot, has communicated a paper to the Electrical Congress in which he states that it is his belief that ether wave telegraphy will soon become obsolete. He is a well-known electrician and inventor of telegraph and telephonic devices. He has come to the conclusion that it is the earth, and not the air, through which signals are transmitted, without the use of wires, and that the curvature of the earth and intervening hills do not intercept the signals, and this suggested to him the question whether the matter telegraphed left the masts at the top or bottom. He believes that it left at the bottom, as the signaling is not affected by wind or fog, and is improved by giving the masts good electrical communication with the earth. According to his theory, communication is kept up through geological beds, in which the electricity of the earth has the same tension, so that any disturbance on one point at the same electrical level creates a swell in the lower level, leaving the higher and lower strata comparatively undisturbed. He proposes to tap these levels by means of shafts and measure the electrical tension with the electroscope. The French Telegraph Department has appointed a committee to sink the shafts to ascertain the distribution of electrical levels. M. Willot considers that he can construct an apparatus which will meet every case.

In the course of some experiments on liquid air, H. Ebert and B. A. Hoffmann noticed that a body suspended above the surface of the liquid acquired a strong negative charge. A series of test experiments revealed the fact that this charge is not due to the liquid air itself, but to the friction of minute particles of very cold ice suspended in it. The authors even succeeded in constructing a kind of electrifying machine by means of a tube containing a piece of wire gauze through which the vapor of liquid air was driven. This phenomenon of electrification should be allowed for in all experiments with liquid air, as it may account for many errors and anomalies. Ice acquires a positive charge by friction with any metal, and imparts to the metal and other bodies also a negative charge. It appears to be the more active in this respect, the colder and the drier it is. This may account for the strong electric effects of polar snowstorms. Even in our latitudes, ascending currents of air soon reach elevations at which all their water freezes, and the friction of the ice crystals against suspended dust particles would account for part of the atmospheric electrification. In the highest regions, a friction between atmospheric ice and cosmic dust, together with solar ionization and the consequent conductivity of the atmosphere, might account for the luminescence often observed, and even for the aurora.—Ebert and Hoffmann, Ann. der Physik.

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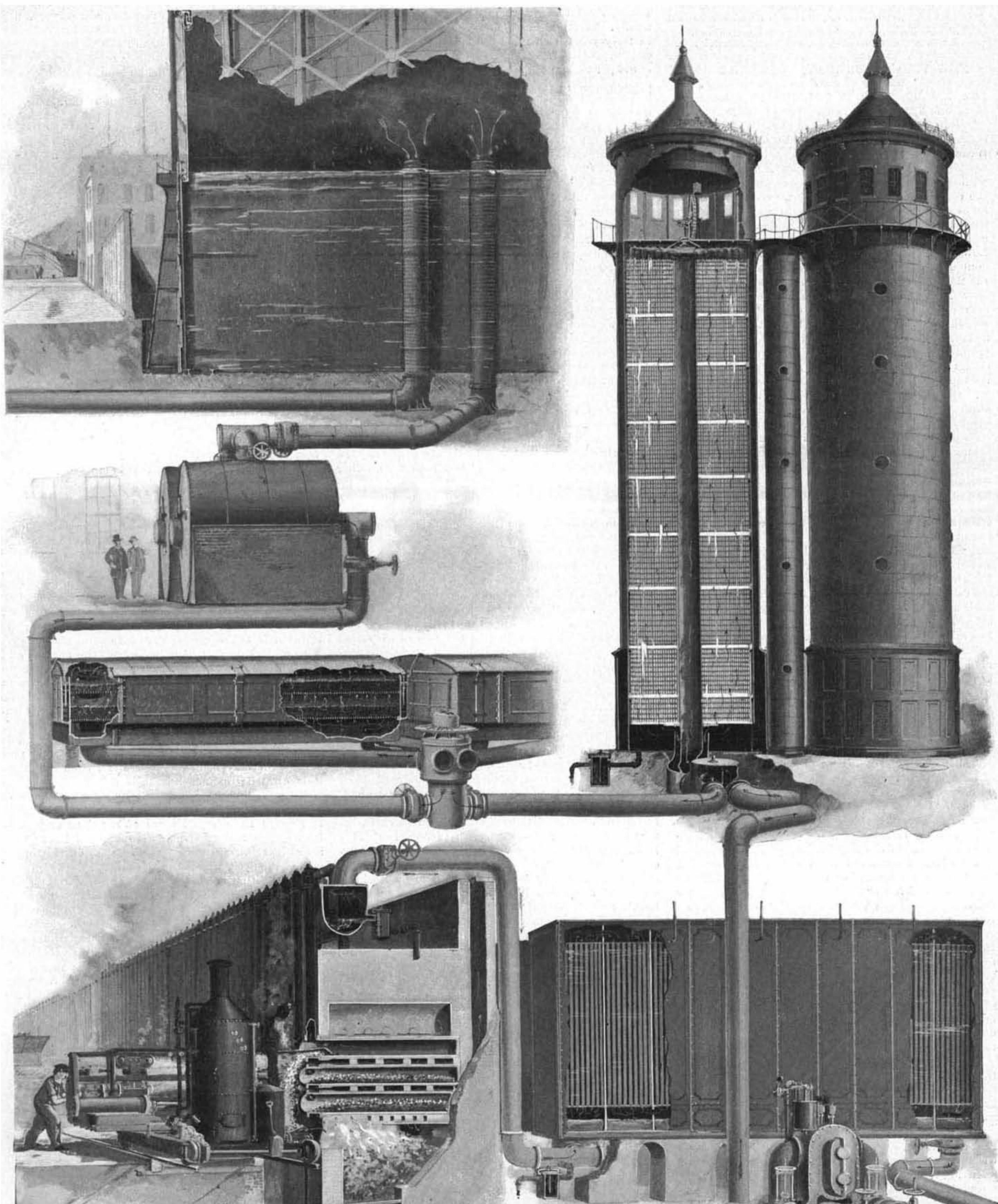

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