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THE USE OF NATURAL GAS AT PITTSBURG.

It has only been within the past few years that natural gas has been utilized to any extent, in either Pennsylvania or New York. Yet its existence has been known since the early part of the century. As far back as 1821, gas was struck in Fredonia, Chautauqua County, N. Y., and was used to illuminate the village inn when Lafayette passed through the place some three years later. Not a single oil well of the many that have been sunk in Pennsylvania has been entirely devoid of gas, but even this frequent contact with what now seems destined to be the fuel of the future bore no fruit of any importance until within the past two or three years.

It had been used in comparatively small quantities previous to the fall of 1884, but it was not until that time that the fuel gave any indication of the important role it was afterward to fill. At first ignored, then experimented with, natural gas has been finally so widely adopted that to-day, in the single city of Pittsburg, it displaces daily 10,000 tons of coal. The change from the solid to the gaseous fuel has been made so rapidly, and has effected such marked results in both the processes of manufacture and the product, that it is no exaggeration to say that the eyes of the entire industrial world are turned with envious admiration upon the city and neighborhood blessed with so unique and valuable a fuel.

Where the gas comes from, and how long it is going to last—and where it is going to, we might add, now that the scheme of piping it to distant cities is under consideration—are questions which involve so many elements for discussion that we do not propose to take them up at present. The manner of distributing and utilizing the gas, and the industrial revolution its introduction has effected, are more than sufficient to occupy our space. As many of these facts are still involved in mystery to a large majority of our readers, it will, perhaps, be advisable to start at the well itself, and from there follow the gas in its various wanderings until it is finally consumed in the mills and works or in the home.

The regions in which natural gas is found are for the most part coincident with the formations producing petroleum. This, however, is not always the case; and it is worthy of notice that some districts which were but indifferent oil-producers are now famous in gas records. The gas driller, therefore, usually confines himself to the regions known to have produced oil, but the selection of the particular location for a well within these limits appears to be eminently fanciful. The more scientific generally select a spot either on the anticlinal or synclinal axis of the formation, giving preference to the former position. Almost all rock formations have some inclination to the horizon, and the constant change of this inclination produces a series

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thin copper disks, pierced in the center, split, and soldered together in such a way as to form two interlocking and independent spirals—a sort of double threaded screw, whose intervals are filled with parchment paper, so as to secure a perfect insulation between the two metallic circuits, one of which is the inducting and the other the induced. All the inducting circuits are mounted in tension (Fig. 4), and connected with the terminals of an alternating current dynamo machine. This latter is excited by a continuous current machine, which in turn is excited in a derived circuit. A rheostat maneuvered by hand, or by the current itself through automatically regulated apparatus, keeps the intensity constant in the line and inductors. In the induced circuit of each of these transformers, A, B, C, D, are mounted the various apparatus that are to be supplied.

The qualities of the induced currents are modified at will by properly connecting the disks that form the inducting and induced circuits. An electromotive force of greater or less strength is obtained by coupling a varying number of disks for tension, while, when, on the contrary, an intense current is needed, the induced disks form a series of short bobbins connected for quantity. When all the apparatus supplied by a transformer are lighted and extinguished together, the transformer is reduced to its essential elements—two series of disks and a soft iron core in the center. When the lamps are extinguished, the two extremities of the inducting circuit are connected by a short circuit, and nothing passes into the inducting one. Lighting is effected by opening the short circuit. The alternating currents then traverse the inducting circuit, and produce the proper alternating currents in the induced one.

Regulating is performed at the central works by varying the electromotive power of the generating machine in such a way as to keep the intensity constant, whatever be the number of transformers in service at each instant.

The arrangement is no longer quite as simple when the transformer is to supply a number of apparatus which is variable at will, since then the operation must be regulated in order to keep up a sensibly constant difference in energy at the terminals of the induced circuit. Fig. 1 shows one of the arrangements adopted by Mr. Gaulard for this purpose, and which is based upon the action of soft iron cores. Let us suppose, for example, as in the case of the apparatus, C (Fig. 4), a certain number of incandescent lamps mounted in derivation upon the induced circuit; then, when all the lamps are lighted, the transformer must produce its maximum, and the soft iron core (Fig. 1) is wholly within the bobbin. If the lamps be put out, the electromotive power of the apparatus will tend to increase, and an intenser current will then pass in the two solenoids, which are placed to the right and left of the transformer, and are mounted in derivation upon the terminals of the induced circuit These solenoids will more strongly attract the two soft iron cores, which, in descending, will, through the intermedium of two cords, lift the core of the transformer, put a portion of it outside of the action of the bobbins, and thus diminish the inductive action. It will be seen that the relative independence of the lamps supplied by one and the same transformer is purchased at the price of complications introduced into the apparatus itself. The performance of the transformer is variable with the number of apparatus supplied, and it diminishes in measure as we require less electric energy per unit of time in the main circuit.

Messrs. Zipernowsky, Deri & Blathy's transformers differ from the preceding in their mounting, their arrangements, and the results that may be obtained from them. They are mounted in derivation on the alternating current machine that supplies them (Fig. 5), and this must produce a constant difference of energy at the terminals, permitting of easier regulation.

An independence of the various apparatus is thus secured, and if one of them happens to be accidentally in short circuit, it will require but an automatic circuit-cutter to isolate it from the line without disturbing the operation of the other apparatus.

As the distribution is effected under a potential of 2,000 volts, it will be seen that it takes but a very weak current to disseminate considerable electric power, reducing the loss in the line to an insignificant figure.

These transformers have been variously arranged. Fig. 3 shows the principle upon which the most recent ones are constructed. Let us imagine a Gramme ring composed of a certain number of insulated bobbins, and let us connect all the bobbins of even series, in order to form an inducting circuit, and all those of uneven series to form an induced one. On connecting the inducting circuit with the terminals of an alternating current machine, the bobbins will be traversed by currents that are alternately of contrary direction, and that will develop in the core a magnetic field which will be closed, now in one direction and then in another. These alternating magnetizations of the core—these inverse fluxes of magnetic force, to speak according to the most modern ideas—will develop in the bobbins of uneven series induced currents, whose qualities may be modified at will by a suitable coupling. We shall thus have a transformer with closed magnetic circuit, in which each spiral, by reason of the symmetry, will exert identically the same actions, thus rendering the calculation of them much simpler. But this is not all; between very wide limits, from a current that is *nil* up to the one that is the maximum for which the apparatus has been constructed, the difference in potential energy at the terminals of the induced circuit remains constant, provided the difference at the terminals of the generating machine remains so too, and the intensity in the inducting current increases proportionally to the intensity in the supply circuit.

These valuable features permit this system to effect a distribution, that is to say, to vary the number of apparatus supplied each moment by a given transformer without touching the latter, this remaining inert and immutable. The regulating must be done at the central works.

In Fig. 3 will be seen another style of the transformer, which is nothing else than the Gramme ring reversed. The inducting and induced wires here take the place of the circular core of soft iron wire, and constitute two simple bobbins wound together with the number of revolutions and sizes of wire suited to the transformations to be effected. The wire of refined iron forms a sort of external annular core, and covers the inducting and induced bobbins.

Fig. 2 gives a general view of a transformer constructed as we have just described. The induced wire upon which the lamps are branched is coarser than the inducting one, since the role of the transformer is to reduce the initial potential of the line from 2,000 to 100 volts or less, while at the same time increasing the intensity in the supply circuit in an inverse ratio.

Without entering into a discussion of the respective merits of these apparatus, let us say that the arrangement of the one last described is better adapted for a true distribution, whatever be the dissemination of the lamps, since, without any regulating, we can at will vary the number of the apparatus supplied and secure an independence thereof. The Gaulard & Gibbs apparatus would be more specially indicated when we had a series of apparatus grouped in a certain number of centers easy to connect in a circle, and all operating together in each of these centers under the same circumstances and at the same moment.

Before the industrial use of these apparatus is sanctioned by practice, there are two questions remaining to be solved: Will the saving effected in the conductors compensate for the expense occasioned by the intermediate apparatus and the complications introduced by them? Will it be possible to easily and cheaply convert alternating currents into continuous ones in such a way as to satisfy all the exigencies of a truly complete distribution of electric energy? The results thus far obtained do not as yet allow us to answer yes or no, and it is necessary to wait for the lessons of experience before pronouncing.—*E. Hospitalier, in La Nature.*

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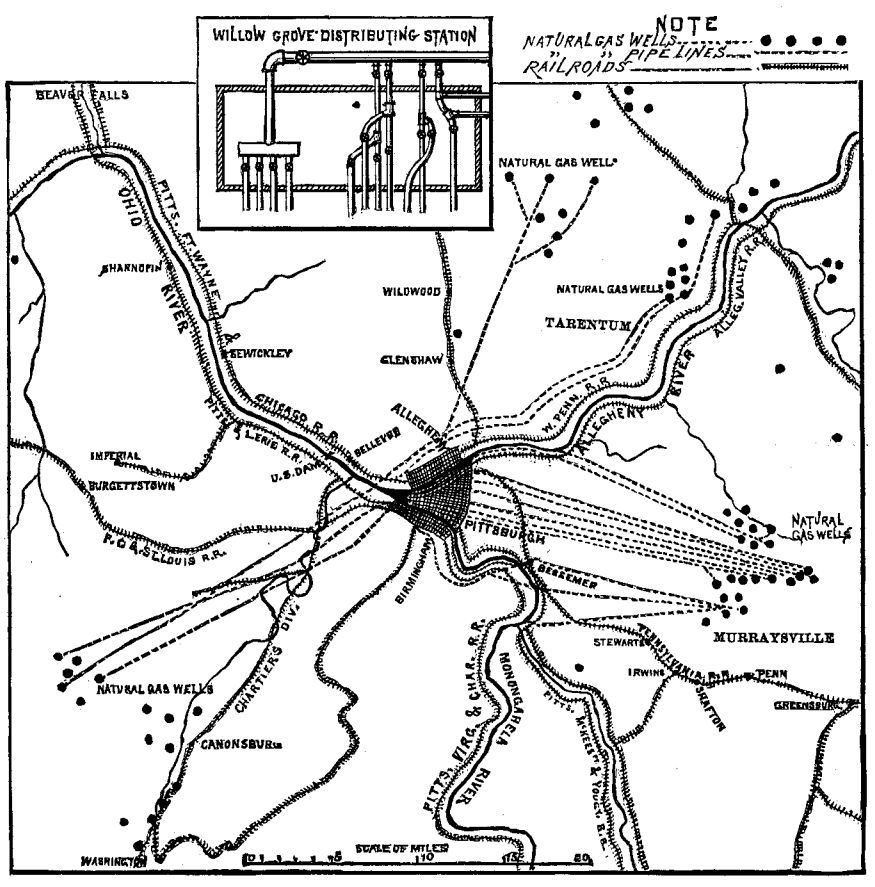
of waves, the crests of which are known as anticlines, and the troughs as synclines. Many drillers suppose that the gas seeks the anticlines and the oil the synclines, but others, equally long-headed, discard entirely all theory of this kind, and drill wherever it may be most convenient or where other operators have already demonstrated the existence of gas. It will surprise many of our readers to know that the divining rod, that superstitious relic of the middle ages, is still frequently called upon to relieve the operator of the trouble of a rational decision.

The site having been selected, the ordinary oil-drilling outfit is employed to sink a hole of about six inches in diameter until the gas is reached. In the neighborhood of Pittsburg, this is usually found at a depth of 1,300 to 1,500 feet, in what is known as the Third Oil Sand, a sandstone of the Devonian period. Where the gas comes from originally is an open question. When the driller strikes gas, he is not left in any doubt of the event, for if the well be one of any strength, the gas manifests itself by sending the drill and its attachments into the air, often to a height of a hundred feet or more.

The most prolific wells are appropriately called "roarers." During the progress of the drilling, the well is lined with iron piping. Occasionally this is also blown out, but as a rule the gas satisfies itself with ejecting the drill. When the first rush of gas has thrown everything movable out of its way, the workmen can approach, and chain the giant to his work. The plant at the well is much simpler than one would suppose. An elbow joint connects the projecting end of the well piping with a pipe leading to a strong sheet-iron tank. This collects the salt water brought up with the gas. Ordinarily, about half a barrel accumulates in twenty-four hours. A safety valve, a pressure indicator, and a blow-off complete the outfit. When the pressure exceeds a prescribed limit, the valve opens, and the gas escapes into the blow-off. This is usually 30 feet high or more, and the gas issuing from the top is either ignited or permitted to escape into the atmosphere. The pipe line leading from the tank to the city is of course placed underground. Beyond a little wooden house, the blow-off, and a derrick, the gas farms differ little in appearance from those producing less valuable crops.



The pressure of the gas at the wells varies considerably. It is generally between 100 and 325 pounds. As much as 750 pounds per square inch has been measured, and in many cases the actual pressure is even greater than this, but, as a rule, it is not permitted to much exceed 20 atmospheres in any receiver or pipe. The maximum pressure in the lines of the Philadelphia Company is 340 pounds. The supply of Pittsburg is largely in the hands of this organization, and drawn from its wells at Tarentum and Murraysville. A number of other companies are also in the field, but the chief business of the city is still controlled by the Philadelphia. The question of pipeage is one of immense importance, and, with increased knowledge of the best conditions for securing an even flow of gas, becomes even more prominent, for the lines are being rapidly extended in length, and it is asserted by many practical gas men that they will some day reach the seaboard.

The pipe lines of the Philadelphia Company vary in diameter from 4 to 10 inches. The Chartiers Company, however, have one line of 16 inches in diameter. In the city, the distributing mains are from 4 to 24 inches. The general tendency is to an increase of diameter, in order to lessen the friction and enable the supply to meet any unexpected demand without interfering with the usual flow. The average diameter of the city mains may be stated at 16 inches. The distributing pipes vary from 4 to 10 inches. The pipe lines have to be laid with the greatest care, to withstand these high pressures and avoid leakage. They cost from $2,000 per mile for pipes of 4 to 8 inches up to $30,000 for 24 inches. The Philadelphia Company alone has about 375 miles of pipes 4 inches in diameter and over.

Every day, line walkers go over the entire line, and submit reports of its condition to the central office. Every leak, no matter how small, is included in the report. In addition to this daily inspection, a man is sent by the company to every fire, and it is his duty to turn off the gas from the burning building and from any that may be in immediate danger. The question of pressure throughout the lines is one of vital importance, and its regulation demands constant attention. For this purpose, valve houses, or stations, to the number of 22, have been established at various points on the line as well as in the city, and at Tarentum, Mur-

raysville, and Dick Farm. At each of these stations the pressure is registered every hour. The company has four telephone lines of its own, of a total length of about 80 miles, and each station is connected with the central station on Penn Avenue. In this way the supply all over the city is closely watched.

Should it become deficient in any district—which would be indicated by a marked decrease in the pressure—it is but a moment's work to call up the central station, and have more gas turned into the needy district. An early disadvantage in using natural gas was it constant liability to failure, but this system of telephonically connected stations has done away with this, and created a confidence in the reliability of the supply. The arrangement of the pipeage and gates at these stations is shown in our diagram of the Willow Grove Station. Coming, as most of the gas does, a distance of twenty miles or so, its pressure is much reduced during the journey by friction against the sides of the pipes. It is contrary to law to maintain a pressure of more than 15 pounds within the city limits. Consequently, blow-offs are established at various points; and whenever the pressure exceeds 10 pounds, the safety valve opens, and the gas escapes.

This leaves a margin of five pounds, but in some of the older and smaller pipes the pressure does sometimes exceed 15 pounds, as a heavier force is needed to overcome the increased friction.

During the day, when the mills are running at full force, the pressure in the city mains is from 2 to 5 pounds; but at night, and more particularly on Sundays, the pressure becomes greater, and large volumes of gas escape at the top of the blow-offs. The one on the Allegheny River at the foot of 10th St., shown in our illustration, Fig. 1, as it appears on Sunday evening, is 40 feet high, and perforated at its upper end for a distance of 3 feet. The immense flame, 40 to 60 feet long, as it is blown about by the wind, has the appearance of a giant torch. To a stranger there are few sights more striking than that presented when he looks down from one of the surrounding hills, and sees the city at night illuminated by these lurid flames. The custom of keeping these torches lighted is not maintained, however, entirely for scenic effect, but in many cases is intended to avoid the noise of the escaping gas. At such a height, the gas would do no damage, if permitted simply to escape into the air. Having a specific gravity of only about half that of air, it is dispersed immediately into the upper regions of the atmosphere.

There are now few mills or furnaces in Pittsburg or the vicinity that are not using gas exclusively. At the Edgar Thompson Steel Works, at Braddocks, the gas is used in all departments where coal was formerly employed. The furnaces used for reheating the steel billets, that are afterward rolled into rails, are shown in Fig. 2, and will give some idea of the scale upon which this immense establishment has been built, and the importance which such a change of fuel means. If one has visited Pittsburg in the days of coal and smoke, he has only to go on the streets and notice the comparatively clear atmosphere and the clean faces to realize what a blessing natural gas has been, aside from its economic value. In the boiler room the change is no less marked. The bricks are neatly whitewashed, the ironwork painted, and the engineer sits in one corner of what might be a parlor as far as neatness goes, quietly watching a water gauge and indicators. The best arrangement for burning the gas under the boiler is that practiced by the Electric Light Company at their central station in Virgin Alley, shown in Fig. 3. The gas passes into a 4 inch drum extending in front of the boilers, and thence by a 1½ inch pipe into T-burners in the front of the firebox. These are simply perforated pipe, 2 inches in diameter.

The air for combustion is first heated before mixing with the gas. Sheet iron is placed upon the grate bars to within about 4 inches of the rear, and 2 inch tiles are placed between this and the boiler, leaving sufficient space in front for the flame to play over them. The air enters beneath, and passing along the under side of the tiles is heated before coming in contact with the gas. It is very important at such an establishment to be able to burn coal at very short notice, should any accident happen to the gas supply. As at present arranged, the entire change can be made and a coal fire started within eight minutes. The gas is burned under the boilers at a pressure of from three-fourths to one pound. As the pressure in the mains is considerably in excess of this, it must be reduced by an automatic regulator. In dwelling houses the gas is seldom burned under more than 2 to 6 ounces.

The regulator, Fig. 6, is a very important piece of apparatus, as it must be used in every mill or house where natural gas is burned, as well as in regulating the pressure where the mains enter the city limits. It is not understood, even by the majority of the people who use it; but if the reader will follow closely our description, he will at least be able to get a general idea of its action. The city inlet terminates in a small cast iron chamber, having two valves on opposite sides. These valves are on the same piston rod, and consequently, when this is moved, one opens toward the interior and the other toward the exterior of the chamber.

A second chamber is divided into two parts by a rubber diaphragm, the upper portion being in communication with the atmosphere, and the lower with a space surrounding the small chamber first mentioned. The diaphragm is weighted above, and below acts upon an elbow lever connected with the valve rod. It will be understood that the lever is in the chamber under the diaphragm, and that the valve rod operates in the inclosed space communicating with this chamber. Bearing this disposition of the apparatus in mind, when the gas enters the small chamber it opens the valves and passes through into the surrounding space and into the chamber under the diaphragm. As the house inlet opens from this inclosed space, the gas has now free access to the service pipes. But the gas raises the diaphragm, and through the lever closes the valves, shutting off the supply. As the gas is consumed the diaphragm sinks under its weights, and more gas is admitted. By altering the weights, the regulator may be set to deliver gas at any desired pressure less than that of the initial. Should the supply of gas be cut off, the regulator automatically locks itself, and will deliver no gas until locked by hand. This prevents the escape of gas, should it be put out by a temporary failure of the supply and then turned on again. As it is so largely composed of marsh gas, it forms, when mixed with air, an explosive compound similar to the deadly fire damp of the coal mines. Consequently, fire must be applied to the orifice before the gas is turned on, or else there will be an explosion. To avoid such a possibility, a small jet of gas is often allowed to burn all the time, in order to light the larger burner as soon as it is turned on. The new fuel is becoming extremely popular for domestic use. In grates, a flat perforated box, as shown in our engraving, Fig. 5, is commonly placed in the bottom, and covered with fragments of fire clay. In cook stoves, Fig. 4, T-burners are used, generally in pairs, though usually only one is lighted unless a large amount of hot water is wanted in the boilers. In round stoves, it is common to use simply the Bunsen burner without the box attachment. The price of gas is usually a matter of contract, based upon former coal bills or upon the mill product. In Allegheny City, however, it is sold at 10 cents per thousand feet, and at this rate may be a little more expensive than coal, but is used nevertheless on account of its great convenience. There have been a number of distressing accidents attending the use of the gas, but the total fatality, it is well to remember, is much less than that of a single mine disaster such as that at Nanticoke.

Microscopical Notes.

Cocaine for Killing Animalcules.—The action of the reagents in general use for killing animalcules for mounting disturbs the natural appearance and position of such delicate structures as the tentacles of hydroids and bryozoa. Prof. J. Richard has successfully employed in these cases the anæsthetic power of cocaine hydrochlorate. Several of the animalculesare placed in a watch glass with five cubic centimeters of water. When they are fully expanded, a one-half per cent solution of cocaine hydrochlorate is added drop by drop until it forms a fifth part of the entire fluid. Half a cubic centimeter of the anæsthetic is then added, and the animals become completely fixed. Ten minutes afterward they are quite dead, and can be mounted in the ordinary way.

Microscope, Microscopic, Microscopical.—The practice of even the most scholarly microscopists is not quite uniform in the employment of the words microscope (used adjectively), microscopic, and microscopical. Is it not desirable to make an effort to bring about uniformity? The usage which best commends itself to us is in accord with the following directions:

1. Apply "microscope" (the adjective) to the component or essential parts of the microscope, *e. g.*, microscope stand, microscope stage, microscope objective.

2. Restrict "microscopic" to objects or features too minute to be seen or appreciated by the naked eye.

3. Reserve "microscopical" for uses to which the term "microscopic," as above restricted, would be inappropriate, *e. g.*, microscopical society, microscopical accessories, microscopical science, works, observations, researches, themes, purposes, uses; microscopical examination.

As an epithet to the word "examination," microscopical is certainly preferable to microscopic, since the idea intended to be conveyed is of an action performed with the aid of the microscope, rather than of one too minute to be visible to the naked eye.

Among professional men an organized society of microscopists is now generally, if not universally, denominated a microscopical society. "Microscopic society" is sometimes heard, and, unfortunately, it sometimes gets into print. Its use ought to be actively discountenanced.—*Jour. N. Y. Microscop. Soc.*

White Resin as a Mounting Medium.—Mr. William Wales recommends white resin as a good medium for mounting. He says that it is easily soluble in alcohol, melts readily, cools quickly, and is more transparent than balsam. He has found it a better material than balsam for cementing lenses, and this he deems a good test. Mr. H. L. Brevoort indorses Mr. Wales' statement, and gives the following as his method of using the material:

On the center of the clean glass slide laid on the heating table, I put a small piece of resin of the purest quality. Heat is generally applied until the resin becomes as liquid as it can be made without burning it. To remove air bubbles, with a pointed glass rod I add to the liquefied resin, and stir in with it, a half drop of turpentine. A moment or two after the object to be mounted has been placed in the medium and the cover glass has been dropped upon it, the slide must be removed from the hot table and a spring clip applied. In five minutes the mount will be ready for finishing and labeling.

Cell Wall Markings.—Messrs. Lawrence and Raddin have been making a study of the markings of the cell walls of various exogenous trees, with the object of ascertaining whether it is possible to distinguish species by this means. The results of their studies are given in the *Microscope* for November.

The conclusion reached by them is that species cannot be distinguished by this means, and they further observe that the same species collected in different localities presented differences that were sometimes very great. They even assert that species of the same genus frequently bear no relation to each other in this respect, and that the markings on the cells of the red oak (*Quercus rubra*) sometimes so closely resemble those of the whiter pine (*Pinus strobus*) that there is danger of compounding the woods of these two trees.

A Method of Cleaning Stonework.

It is sometimes required to clean the surface of old masonry that has become weathered or coated by deposits from dirty water, either for the sake of appearance or to make a sound connection with new work. The only effectual method hitherto practiced for this purpose has been by completely redressing the surface with the chisel—a method which is tedious and costly at best, and which is seldom thoroughly carried out. A different and, it is claimed, more satisfactory process was devised by M. De Liebhabert, and used in 1884 for cleaning the walls of the quays of the Seine in Paris. These walls become in a few years covered with a shiny black deposit, which resists acids. To remove it, a paste composed of a solution of soda and lime, to which a little chloride of lime is added, was mixed to the consistency of honey, and spread over the surface, where it was allowed to remain for two or three hours, according to the condition of the stone. When it was removed, the deposit was still black; but it had become sensitive to acids. After this preliminary treatment, a workman passed over the surface (with a large gutta percha brush) a mixture called sulphochlorhydric, forming on the stone a kind of glue; and almost immediately afterward he syringed the surface with a jet of the same liquid. It formed an adherent paste, continuing to act upon the stone for about two or three hours. After the syringe came a gang of men who scrubbed the surface, finishing off with a hose pipe. The sulpho-chlorhydric mixture is composed of sulphuric and hydrochloric acids mixed empirically according to the nature of the stone and the necessities of the case. The cost of cleaning stone walls by this method in Paris is 0·46 franc per square meter for material and 0·50 franc for labor, by contract. The preliminary treatment by the caustic paste was paid for separately at 0·50 franc per square meter. It is said that the stone itself is not damaged by this treatment, and soon regains its natural color.

Fuel of the Future.

The house of the near future, the *Boston Journal of Commerce* thinks, will have no fireplace, steam pipes, chimneys, or flues. Wood, coal oil, and other forms of fuel are about to disappear altogether in places having factories. Gas has become so cheap that already it is supplanting fuels. A single jet fairly heats a small room in cold weather. A New York artist has produced a simple design for heating entirely by gas at a mere nominal expense. It is a well-known fact that gas throws off no smoke, soot, or dirt. The artist filled a brazier with chunks of colored glass, and placed several jets beneath. The glass soon became heated sufficiently to thoroughly warm a room 10x30 feet in size. This design does away with the necessity for chimneys, since there is no smoke; the ventilation may be had at the window. The heat may be raised or lowered by simply regulating the flow of gas. The colored glass gives all the appearance of fire; there are black pieces to represent coal, red chunks for flames, yellowish white glass for white heat, blue glass for blue flames, and hues for all the remaining colors of spectrum. Invention already is displacing the present fuels for furnaces and cooking ranges, and glass doing away with delay and such disagreeable objects as ashes, kindling wood, etc.