play nowadays is to lock it up. The impending reformation will not be wrought in a day, nor a year, but there is no lack of signs of a coming change for the better. The managers who read them aright will reap great advantage; the managers who neglect them will admit, when the day of grace is past, that public taste can be improved a great deal more quickly than they believed to be possible.

J. Ranken Towse.

Natural Gas Wells.

NATURAL gas wells have been common in the oil country for years. Their use and value have not been understood by the public until within a short time past. The people are now surprised to learn what a valuable fuel they have so long neglected, and with that reckless energy characteristic of the country are sinking wells in every direction. The district of natural gas covers a much greater area than that of oil. In general, it may be said to include a section of country extending from western New York, through Pennsylvania into West Virginia and Ohio and lying nearly parallel to the Alleghany mountains. The width of this section varies considerably. The boundary lines are very irregular, and are being rapidly extended by the finding of new wells. While the outlines inclose a large territory, gas is found in only a small portion of it, and then in spots and narrow belts or lines. When a company concludes to drill for gas, the first and most important thing is locating the well. As was the case with oil, there are a number of theories concerning the formation of natural gas, and the deposit of the sand-rock in which it is obtained. In this the "practical man," having more faith in luck than science, does not agree with the geologist. The only satisfactory explanation of the formation of the gas is that it is produced by the decomposition of vegetable matter deposited in the carboniferous age. Geologists say the gas district seems to be a vast caldron filled with deeply buried carbonaceous matter, subjected to great heat, and therefore constantly generating gas, which has been condensing for ages in the strata where it is found. They believe the strata to be general formations in this section, and doubt whether a well was ever put down without finding some gas, or at least where it might not have been found had the well been drilled to a proper depth. The experience of the "practical man" strengthens his belief in the belt theory. The degree of uncertainty accompanying its development has a strong fascination to his venturesome spirit; and the term "gas line" has now all the attractions of the "oil belt" of former days.

The general course of the oil districts is north-east, on what is known as the forty-fifth degree line. Profiting by this knowledge, the gas prospector ran lines from old "wild-cat" wells, where gas had been found, out of the oil country, and discovered that they marked the same general direction.

In locating a well, a survey is usually made, and the well is placed as near to the line as possible. Two such lines nearly parallel, running from Washington county, Pa., through the city of Pittsburgh, up the Alleghany valley, on either side as far as Kittanning, and on to the upper oil regions, are tolerably well defined. At several points a number of good wells are found upon them, and a larger number of dry holes upon either side and between them. The drill has demonstrated the fact that the oil- and gas-bearing rock is deposited at intervals only, even on well-defined belts. The same is true of these lines, as good wells and dry holes are found upon them within a short distance of each other. So that locating a gas well is still very much a matter of chance.

The process and tools used in drilling for gas are the same as used in boring for oil. The gas-bearing strata are soft, pebbly sandstones, which dip toward the south. At Kittanning the wells are eight hundred feet deep; at Pittsburgh, forty-four miles south, they are sixteen hundred feet deep. In good territory, when the rock is perforated, the gas rushes out with great force. Instances are reported where this force was sufficient to throw the drilling tools out of the well. The latest case of the kind was the Westinghouse well, at the East End, Pittsburgh. This well was plugged for three days, shortly after gas was struck. When the plug was drilled out, the tremendous force of the gas threw the ponderous tools, weighing over three thousand pounds, out of the hole and fully three hundred feet into the air. This pressure varies. With the well shut off, it has been known to reach four hundred and fifty pounds to the square inch. The quality of the gas is not the same in the different wells. In some it is light and dry, in others it is wet and heavy. Most wells throw out a quantity of salt water, which contains a heavy precipitate that sometimes clogs the hole. To prevent this, the wells are entirely closed a few minutes each day, until a strong pressure is procured, when it is suddenly opened. The rush of the liberated gas through a short escape-pipe carries the precipitated matter with it, and the wells by this means are kept open. Near to the well the gas goes through a strong iron tank. The object of this is to catch the water-drip from the well, and prevent its passing into the distributing pipes, where it would freeze in the winter time. The objections to the use of natural gas in dwellings are the high pressure on the pipes, and consequent danger of leaks and explosions, and the fluctuations of the pressure. (It is well established that the pressure in the well is weaker in the morning and stronger in the afternoon. A general fluctuation is also noticed, simultaneous with the changes of the moon.) These objections are overcome by the use of automatic valves, which reduce the pressure and regulate the flow of gas. From these valves the gas is distributed through the town in the same manner as the illuminating gas, excepting that a high-pressure line is run to mills and factories. The pressure for dwellings is about one pound, for boilers and furnaces from thirty to forty pounds.

At Kittanning, Pa., natural gas is used almost exclusively for heating purposes—in stoves, heaters, open grates, under steam-boilers, in the foundries, and in the puddling furnaces at the iron works. It is also used for lighting the streets. The method giving the best results consumes about twelve parts of air to one of gas. This is done by means of an air-globe placed at the end of the burner, which is usually a piece of iron pipe, closed at the further end and perforated with rows of small holes. The globe has inlets for the air, and by the action of the gas through it the air is drawn into the burner and mixes with the gas

at the point of ignition. If the air is not used, the flame makes a great deal of smoke and soot. By consuming the air, perfect combustion is obtained, and a clean fire of intense heat is the result. In the private house it is the ideal fuel. Nothing could be so convenient: fires always ready; the turn of a stop-cock, the stroke of a match, and a fire is lighted; no coal to carry; no ashes; no shivering over a cold stove on a frosty morning. What a haven of rest and peace for the lazy husband! Housewives say their daily labors are reduced fully one-third by the use of natural gas. It makes a splendid fire for roasting and baking, and is equal to the good hickory coals for broiling meats. In open grates there is a variety of burners used, to suit the fancy of the owner. Some have the andirons and clay gas logs, in imitation of a wood fire; others fill the grate with broken sandstone, which is best for holding the heat. A beautiful fire is made by covering a number of the perforated pipes with a layer of asbestos. When the fire is lighted, the asbestos, becoming heated, glows and sparkles, and the room is filled with a cheerful mellow light. Under steam-boilers the natural gas is used in a number of ways. Some have the air-globes and long perforated pipes; others heat the gas before it reaches the fire by passing it through pipes in the boiler-flues. Ordinarily no change in the construction of the furnace is required, excepting to close it and shut off the draught. As a light, the natural gas does not equal that made from coal. The flame is not so bright and clear and is constantly flickering. In small rooms it is used in the common Argand burner with fair success. In large halls and factories, where a strong light is required, the Siemens incandescent gas-lamp has proved very satisfactory.

The greatest value of natural gas is for manufacturing purposes. In burning bricks and lime, or in melting glass, iron, and steel, it has no equal. Its freedom from smoke, sulphur, and other impurities makes it a perfect fuel. Most of the iron works in the city of Pittsburgh are using it, and are able to make a cleaner and better grade of iron than they could with coal. The steel works introduce it directly into the Siemens open-hearth furnace, and produce a superior quality of high carbon steel. Iron ore has been melted with it. It is believed by many that iron and possibly steel can be made from the raw material by the use of it. For making glass, in the words of a prominent manufacturer, "it is just the thing." At the Pittsburgh plate-glass works, it has proved especially valuable for tempering the large plates. By the use of gas this company saves one thousand dollars a day, and can make plate-glass superior to that of Europe. Since the striking of large wells near Pittsburgh, manufacturers have introduced it into their works as fast as it could be conveyed to the city. Considering its abundance, convenience, and economy, it will certainly revolutionize the manufacturing interests of this section, and possibly of the country.

That the reader may have an idea of how important a factor natural gas may be in the industries of the future, the following statement is given, based upon the information of gentlemen familiar with the facts. The heating capacity of natural gas is variously estimated at from 250 to 400 cubic feet to a bushel of coal. Assuming that three hundred feet, burned with the air and in a confined furnace, is the average, we may approximate its value. Within a radius of twenty miles, with Pittsburgh as a center, there are twenty-five wells, with an average output of 3,000,000 cubic feet each per day; 75,000,000 in all, or 22,500,000,000 per year. This would equal 250,000 bushels, or 9260 tons, of coal per day, or 2,778,000 per year. The cost of drilling a gas well is $3000, or $75,000 for the twenty-five. To convey this gas to the city, allowing a six-inch pipe to every two wells, and placing the mean distance traveled at fifteen miles, would cost $917,000. The average cost of coal per ton, delivered at the fires, is two dollars. The 9260 tons of coal, the equivalent of this amount of gas per day, would cost $18,520, or $5,556,000 per year. Deducting the cost of the gas, we have a saving in gas over coal of $4,557,240 for the first year. The life of gas wells is said to be eleven years. If this supply of gas could be maintained by the addition of new wells for ten years, which is not improbable, it would give a saving of over $50,000,000 — figures which are not more surprising to the reader than they are attractive to the Pittsburgh manufacturer. This is not all. It is estimated that there are 500 gas wells in the oil country and vicinity, which produce at least 200,000 cubic feet each per day, or 100,000,000 in all. This gas could be transported to one of the large cities in pipe lines, as petroleum is at present. It could easily be collected from the wells, and forced through the main pipes at a high pressure by using air-compressors stationed along the line. The idea is practical, the investment inviting, and the matter is receiving the attention of capitalists.

The products of natural gas are numerous. The most important thus far are lamp or carbon black and carbon points for the electric light. There are ten carbon-black works in operation, making 3000 pounds of black per day. At a remote point, in Armstrong county, Pa., a Boston firm has large works, locally known as "the mystery," on account of the secrecy with which it is conducted. Here they make the black, and it is supposed coloring material also, from the gas. At Stuartson furnace, in the same county, is another "works" where the carbon points are made. Both these works are guarded, and a stranger is not permitted to be about them. A number of persons are experimenting with the gas, with as many different objects in view. It is impossible to learn what has been accomplished, as they are quick to see the advantage of keeping secret any discovery they may have made.

What the future of this wonderful fuel is would be difficult to foretell. Natural gas springs are known to exist in many parts of the United States. This would seem to indicate a wide distribution of it. In August last a large well was struck at Crestline, Ohio, which may open a vast territory. Where gas may or may not be found can only be determined by the drill. How far it may influence the manufacturing interests of the years to come depends upon its supply. The success which is attending the use of it in this section has attracted the attention of manufacturers in others. Wells will be put down in all parts of the country. Upon their success or failure depends whether or not natural gas shall be the fuel of the future.

J. D. Daugherty.