NATURAL GAS AND PETROLEUM.

BY S. S. GORBY.

The application of natural gas to economic use for heating and lighting purposes, at Pittsburgh, Pa., a few years ago, soon resulted in a complete revolution of the fuel business in that city and vicinity. The new fuel was so readily adapted to all kinds of manufacturing, it was found to be so cheap and convenient that it at once supplanted all other kinds of fuel in use. The "City of Smoke," on account of the cleanliness of natural gas as a fuel, become immediately a city of sunshine.

Careful experiments were made in every line of manufactures, and it was found that natural gas answered nearly all the purposes of wood, coal and coke. The value of the new fuel having been ascertained, an active search for it was at once commenced in every locality that gave a promise of success. It was known that gas abounded in the petroleum-producing areas of Pennsylvania, and into those fields the drillers again entered, and began their search for gas with the same energy and success that attended the pioneer efforts of the oil drillers during the earlier periods of the oil excitement. The Murraysville and other gas fields contiguous to Pittsburgh, were developed immediately, and pipes were laid to convey the gas to the city.

The appliances and fixtures for the use of natural gas in furnaces, stoves, etc., are simple and cheap, and easily adapted to furnace, stove or grate. Various devices have been invented for the use of gas in stoves and grates, and where the plumbing is properly done, accidents can only occur on account of the gross carelessness of those who start the fires. Automatic regulators have been applied, by which the temperature of a room may be continued at the same degree, with scarcely any variation, for an indefinite period of time. The cheapness of natural gas, together with its convenience, makes it the most desirable fuel known. It requires no store-house, nor handlers, produces no ashes nor other waste matter, and if proper care is exercised, may be used for domestic or manufacturing purposes with as much safety as any other fuel.

The demand for gas in the Pennsylvania areas is enormous, and the supply is fully equal to the demand—hundreds of millions of cubic feet being consumed daily. From the Pennsylvania fields the search for gas extended to portions of New York, Ohio and West Virginia, resulting in the discovery of large areas of gas-producing territory in each of those States. The gas-producing rocks of New York, Pennsylvania, West Virginia and Eastern Ohio, as the developments exist at the present time, extend from the base of the Coal-Measures down to and include the Devonian. The gas-producing rocks of Western Ohio and Eastern Indiana lie far below in the Lower Silurian formation. The petroleum and gas of Western Ohio and Eastern Indiana have been derived from the decomposition of organic remains that were deposited in the sediment that now forms rocks vastly older than the rocks of the Pennsylvania fields. Many layers of impervious shales and other rocks lie between the horizons of the gas-bearing rocks of Indiana and those of Pennsylvania.

The paleozoic rocks of Indiana, the only rocks that are exposed at the surface in this State, or that are penetrated by the drill in boring for gas or water, with their superincumbent deposits of drift, consist of the following series:

Quarternary	Drift, sand, gravel and clay	0 to 400 feet.
Coal-Measures	Upper Coal-Measures	50 to 196 "
	Middle Coal-Measures	600 to 888 "
	Lower Coal-Measures—Conglomerate	60 to 210 "
Sub-Carboniferous	Chester sandstones and limestones	0 to 100 "
	St. Louis limestones and shales	0 to 330 "
	Keokuk limestones	6 to 106 "
	Burlington limestones (?)	0 to 20 "
	Knobstone—sandstone	12 to 532 "
Devonian.	Genessee, Hamilton and Marcellus shale	60 to 420 "
	Corniferous limestone	5 to 84 "
Upper Silurian	Lower Helderberg—Waterlime	0 to 80 "
	Niagara limestone	20 to 728 "
	Clinton limestone	0 to 40 "
Lower Silurian	Hudson River limestone and shales	185 to 715 "
	Utica shales	25 to 380 "
	Trenton limestones	451 to 626 "
	Potsdam sandstone	300 to — "

In the series of rocks given above the maximum thickness of the different groups is given in the last column. The drill within the last year has shown that the Devonian shales are about three times as thick in the northern part of the State as they were supposed to be, estimating from the known thickness of these rocks further south. The Niagara limestones and shales, also, are more than twice as thick in the northern and northeastern parts of the State as they are in the central part of the State, where their thickness was known. The drill has shown, too, that the Hudson River limestones and shales have a maximum thickness of more than 700 feet in the eastern part of the State, and the Utica shales have a total thickness of about 400 feet in many places. Summarizing, the geological formations of Indiana, so far as known at the present time, have a maximum thickness as follows:

Drift	400 feet.
Coal-measures	1,300 "
Sub-carboniferous	1,100 "
Devonian	500 "
Upper Silurian	850 "
Lower Silurian to bottom of Trenton	1,720 "
Total	5,970 "

Natural gas, in greater or less quantities, is found in every county in Indiana, and it is well known that it occurs in every geological formation from the drift down to and including the Trenton limestones. Throughout several counties of the State it is found in the Trenton rocks in enormous quantities. The Trenton rock gas-producing area of Indiana is one vast, connected field, embracing more than a dozen counties and containing an area of about 5,000 square miles. Throughout all this area the initial pressure, or rock pressure, is about the same. The average pressure is about 320 pounds. Where the gas-producing rock is quite porous, and has a thickness of several feet, the closed pressure will run to 320 pounds, or there about, in one or two minutes. Where the rock is very close in texture it requires several hours to accumulate the same pressure. In some instances even days would be required to accumulate the maximum pressure. But where wells all draw from the same reservoir, as all the wells of Eastern Indiana evidently do, if the wells are all shut in for a considerable length of time they will all finally show about the same pressure in pounds.

When gas was first found in Indiana, at points considerably remote from each other, various inaccurate methods were adopted to ascertain the initial pressure of the gas, and it was thought by many that this pressure determined positively the amount of gas that would flow from a well in a given time. For instance, it was thought that a well showing 200 pounds pressure on a steam gauge would flow twice as much gas as one measuring only 100 pounds, and if a well of 100 pounds pressure would flow 1,000,000 cubic feet per day, then a well of 200 pounds pressure would flow 2,000,000 cubic feet per day and so on.

The inaccurate measurements and estimates reported were calculated to create the impression that there is a multiplicity of gas reservoirs in the State, with initial pressures varying from 200 pounds to 600 pounds per square inch. More careful measurements, however, have recently been made, and these show that the initial pressure of the great Trenton rock gas field of Indiana is about the same at all points, viz., about 320 pounds per square inch. This immense field, extending from Portland to

Kokomo, and from LaFontaine in Wabash County, southward to Greenfield, Morristown, Greensburg, and even to Lawrenceburg, expanding, to some extent, beyond all these points, evidently consists of one vast connected reservoir. If all the wells within this vast area were kept closed for a period of several days, there would be but little difference of pressure shown by the gauge after the full accumulation of gas had been secured in each well.

While the initial pressure of the gas (that is, the pressure of the gas in its compressed condition as it is confined in the rocks) determines to a large extent the volume of gas that issues from a well, there are other conditions existing which also largely determine the amount of gas which flows from any well. One of these conditions, and one, too, of the utmost importance, is what is termed the *porosity* of the rock that forms the reservoir. It has been claimed by some geologists of eminence that *porosity* is a condition unknown in limestones; in other words, it has been denied that there are such things as *porous* limestones. It is quite clear that those who entertain such an opinion have never had an opportunity to examine the fragments of rock brought up by the sand pump from the Trenton limestone, nor pieces from the same formation that have been blown out by the gas. The gas-producing rock is composed of small granular crystals, varying in size, and the manner in which the crystals unite and interlock forms a net-work of small interstices, which are the so-called pores. All our limestones are *porous* to a limited extent. They will all absorb more or less water and gas or air, and any rock that will absorb gases or liquids is *porous*. Where the rock is very close in texture, however, it so obstructs the movement of gases through its mass that, although the initial pressure of the gas confined within it may equal the maximum, the flow of gas from such rock will necessarily be small. A very open, porous rock permits free movement of the gas and makes a strong well, while a close grain or texture will obstruct the flow largely, and the result is a small well.

In addition to the initial pressure of the gas and the porosity of the rock, there is one other thing essential to the largest productiveness of a well, and that is a considerable *thickness* of porous rock; and to insure the largest returns the drill must penetrate entirely through the porous rock. The gas-producing stratum of Trenton rock in Indiana varies greatly in thickness. In some localities the porous rock is only a few inches or a few feet thick, while in other localities it is twenty-five or thirty feet thick. All will readily recognize the fact that where two wells are drilled into rock of exactly the same texture, and where the initial pressure of the gas is the same in each, that if in one the drill penetrates twenty feet of porous rock, and in the other only four feet of porous rock is passed through, that the flow of gas will be several times as strong from the first well as from the second. The three things, then, that modify the productiveness of a gas well are:

First. The initial pressure of the gas.
Second. The porosity of the rock.
Third. The thickness of the porous rock.

The horizon of the gas in the Trenton limestones of Indiana is near the top of the formation. If gas is not found within a few feet of the top of the series, it is not found at all in paying quantities. And I have observed in this connection that wherever, in Indiana, a porous rock is found immediately after reaching Trenton, gas is always present in paying quantities. If the rock is moderately close in texture a small flow of gas is obtained, and where the rock is very close no gas is found. A slight flow of gas, from a moderately close-grained rock, may, in many instances, be made a paying well by exploding a heavy cartridge of nitro-glycerine in the bore at the horizon of the gas. If the well has been drilled to a considerable distance below the gas horizon, it is necessary to pack it below, so that the cartridge will rest exactly at the horizon of the gas. The effect of the discharge is to shatter the rock for several feet in every direction from the bore, which will permit a freer and much stronger movement of the gas. The volume of escaping gas is, as a rule, greatly increased by the explosion. In some instances, wells that could scarcely have been termed paying, have been made very valuable by shooting.

Another condition necessary to secure gas in large quantities is an impervious covering of shale, or other rock. The reservoir must also be bounded on every side by impervious strata, and the underlying rocks must be equally impervious. The reservoir must consist of porous rocks, bounded above and below, and on every side, by impermeable strata. The covering must be sufficiently thick to give the necessary weight to compress the gas, and confine it. These conditions are absolutely necessary, for without them the gas would expand to an unlimited extent, and its value would be wholly lost for economic purposes.

THE ORIGIN OF GAS.

It is generally recognized among geologists and others that gas and petroleum have the same, or a common, origin. The two substances are always found associated together, sometimes both occupying the same reservoir, and again seemingly occupying separate but closely connected reservoirs. They have a vertical range through all formations of stratified rocks. Indeed, they seem to be wholly confined to the sedimentary deposits. The drill has penetrated the azoic rocks in many places, but I have yet to learn that gas or petroleum has ever been found in quantity below the sedimentary accumulations. In view of these facts, the conclusion must be that gas and petroleum have had their origin in the rocks that confine them. From what substances, then, have gas and oil been derived? The only known substances that could be drawn from by nature, at the present day, in the manufacture of oil or gas, are animal, vegetable or mineral. It is well known that all forms of organic matter contain more or less of the elements of both oil and gas. Many forms of animal life, and many forms of plant life, are large oil producers. All forms of organic matter decompose spontaneously, and it is well known that, in the decomposition of matter, gas is generated. It is also well known that vast amounts of organic matter, both animal and vegetable, were deposited with the sediment that forms the stratified rocks. During many periods of the formaton of the sedimentary rocks, organic matter decomposed very slowly. So slow, indeed, did the bodies decompose, that, as atoms were eliminated, one at a time, in the form of gas, an atom of mineral matter, lime or other substance, slipped into the place made vacant by the eliminated atom, and, being held firmly in its new position by chemical forces, served to preserve exactly the structural appearance of the animal or plant. Thousands of species of animals and plants have been found in a fossillized state in the stratified rock deposits. They begin with the oldest of our formations and continue to the latest. Thousands of distinct species have been found in a fossilized state, but tens of thousands of species, perhaps, have perished—wholly decomposed—and left no trace of having existed, further than that which is found as residual oil or gas. In the breaking up of organic matter under the natural process of decomposition, a considerable proportion of oil and gas is the result. The process of nature is disintegration, decomposition, complete separation into elements; the elements enter at once into new combinations, new compounds, new forms of plant life, new forms of animal life; death, decay and dissolution again, and so the round continues.

Oil (petroleum) and natural gas are the imprisoned elements of decomposed organic bodies. If organic bodies decompose upon the surface, or in shallow water, complete dissolution takes place. Tissue and fiber of every kind, every portion of the body except the mineral matter, is resolved into gas, escapes into the air and is distributed over the surface of the earth. Precipitated by the rainfall or other forces, it mixes with the soil again, is absorbed by the plant again, the plant is eaten by the animal, which in the course of nature dies, decomposes, and the elements are freed again in the form of gas, to go the round again and again. But, where organic bodies perished and were buried under conditions that did not permit immediate decomposition, where they were buried under accumulations of sediment in seas, lakes or lagoons, and shut off from the air—hermetically sealed, as it were—decomposition was not completed for ages. The accumulated super-lying deposits excluded the air and prevented complete decomposition. If decomposition was complete the petroleum would all be resolved into gas, for gas is near the ultimate limit of nature's analytical work. Where organic bodies decomposed slowly, under heavy accumulations of sediment, decomposition was not perfect.

The oil (petroleum) was not all resolved into gas, nor was the generated gas permitted to escape. The super-lying accumulations formed an impenetrable covering, confining both oil and gas to their original horizon.

As before stated, petroleum and gas are but the imprisoned elements of decomposed organic bodies. They are the result of chemical decomposition by Nature's ordinary process, hence we find both oil and gas throughout all formations of sedimentary rocks. Under favorable conditions decomposition is very rapid; under other conditions it is inconceivably slow. Organic bodies, whether animal or vegetable, buried far beneath the surface, where the air is almost wholly excluded, remain in an unchanged condition for almost infinite periods of time. For example, it is no unusual thing to find trunks of trees, or even the branches, twigs and leaves of plants, a hundred or more feet beneath the surface of the drift deposits in Northern Indiana. Though this vegetation has lain in its clayey or sandy matrix, far beneath the surface of the earth for probably thousands of years, much of it is yet in a well-preserved condition, although, by infinitely slow processes, it is surely decomposing—changing into petroleum and gas. Proof of this fact is constantly being produced. Much of this ancient vegetation accumulated around the margins of, and in, the beds of lakes and swamps at the close of the drift period. The surface of the drift area, at the close of the glacial period, consisted of high hills and ridges and low valleys and gorges. In the valleys and gorges, and in and around the swamps and lakes, vegetation with the advance of genial seasons, accumulated in vast quantities. By the erosive force of time the hills and ridges were leveled, the valleys and gorges were filled with the accumulations washed in from the hillsides, and the masses of vegetation were buried beneath the accumulated debris. It is no unusual thing for well-drillers, in Northern Indiana, to strike these buried swamps in drilling wells. At depths varying from thirty to one hundred feet they frequently reach masses of buried vegetation that are from ten to fifteen feet in thickness. In connection with these buried masses of vegetation frequent accumulations of gas are found. Throughout all of Northern Indiana, where there is a considerable depth of glacial deposits, and over a considerable portion of Illinois, in Kansas, Wyoming and other sections, gas is found in varying quantities in the drift. In many localities wells of considerable volume have been found. This is notably the case in some portions of Illinois, Kansas and Wyoming. The gas is usually found immediately upon reaching the ancient swamp bed, or its horizon. The strongest flows are obtained from the strata of sand that formed the margins of ancient lakes or swamps, and which form perfect reservoirs for the gas. Beneath the swamp beds and sand margins of the lake beds, there are usually thick layers of blue clay, which are compact and wholly impervious to gas, oil or water. There is no evidence in any instance that these accumulations of gas in the drift have been derived from any other source than the decomposition of the vegetable matter that was buried in the ancient swamp beds. In every instance that has come under my observation, the drift reservoir is one of very limited extent—a mere "pocket" that is soon exhausted. In some instances the flow is quite strong at first, but diminishes rapidly, and soon seems to cease altogether. But it often occurs that after the gas seems to be wholly exhausted in these wells, slight flows are noticed occurring at irregular intervals, as though the process of generation is still going on. It is certainly quite true, in these instances, that after the first flow of gas has apparently exhausted the well, and subsequent slight flows occur, that the later flow is an accumulation from the continued decomposition of the buried vegetable matter.

The gas of the drift deposits is derived from the decomposition of buried vegetable matter. Much of this buried matter is not yet wholly decomposed; the process of decomposition under natural processes is still going on, and in the drift area, gas, and probably petroleum, in places, is still being generated. The vegetation from which the gas is derived accumulated upon the margins of, and in small swamps and lakes that were hemmed in by steep hillsides. The gas reservoirs are small, and the supply necessarily limited. As already stated, thick layers of bowlder clay lie below the gas-bearing sands, and as a general thing clay accumulations of varying thickness lie above.

It is quite often assumed, when small pockets of gas are found in the superficial drift deposits, that the gas has escaped from a leak in the rocks below, and that by drilling in the paleozoic rocks the principal reservoir may be found. Frequent attempts have been made, at various points in Indiana, to find the reservoir that was supposed to lie below, but, in every instance, so far, that has come to my knowledge, the efforts have been futile. All the gas confined in the drift has been generated from decomposed organic matter that was buried in the drift deposits.

It will scarcely be denied that the drift gas has had its origin in the manner indicated above. It has been generated by nature's simple, only process—chemical or spontaneous decomposition. The drift gas, to a practical extent, is identical with the Sub-Carboniferous and Trenton gas. Some little difference of environment has changed the chemical qualities to some extent, but virtually there is but little difference between the one and the other. No two contiguous gas wells will produce gas consisting of exactly the same chemical elements, even in the Trenton rocks. There is a difference between the Trenton and the shale gas, and between shale gas and gas from a sandstone reservoir, but the difference is the result of environment, very slight at most, and may not be attributed to method of origin. Possibly, however, gas derived wholly from decomposed animal matter would vary considerably in chemical constituents from gas generated from some form of vegetable matter. However, the question is not one of elements, but of origin, and the conclusion seems forced that the gas of all geological formations has been derived from organic matter, both animal and vegetable, by nature's simple method, spontaneous decomposition.

All the sedimentary rock formations were, during the period in which they were deposited, in exactly the same condition that the bottoms of our existing seas, lakes and lagoons are now. The bottoms of ancient seas and other bodies of water consisted of vast accumulations of sand, of oozy, black accumulations of finer silicious particles, or vast areas of great depth composed of decomposed and decomposing shells; the surface of the shell deposit being composed wholly of masses of living shell fish. Other areas consisted of smaller proportions of shell fish in various conditions, from living animals to the dead, decomposing and wholly decomposed remains, mixed with which were larger or smaller proportions of impurities of various kinds. Those areas where the remains of shell fish accumulated to the exclusion almost of every other kind of material, after the lapse of ages, and under natural processes, hardened into almost pure carbonate of lime. Where mineral impurities, to a greater or less extent, were mixed with the accumulations of decomposing shells, the cemented mass became an impure limestone, magnesian limestone, silicious limestone, argillaceous limestone or shale.

The immense accumulations of sand became sandstone, and the areas of finer silicious deposits, areas where various kinds of mineral matter in the finest state of mechanical separation, with which were sometimes mixed vast amounts of vegetable matter, were the principal deposits, became shales.

The pure limestones are derived almost wholly from the decomposition of organic bodies, of which the bony outside skeleton, the shell, formed by far the larger portion. It is no unusual thing to find layers of limestone several feet in thickness that are composed wholly of fossil shells in a good state of preservation. It is said by anatomists that a bony skeleton consists of mineral and animal matter. The animal matter is the gaseous portion, or the portion that is resolved into gas when decomposition takes place. The skeleton of a shell-fish also consists of mineral and animal matter—the mineral matter forming the larger portion. Aside from its shell, the mollusk contains but a small per cent. of mineral matter—the remainder resolving into gas upon decomposition. The purest limestones, the carbonates, are remarkably free from vegetable remains. The organic forms that entered into their composition were almost, if not wholly, animal. Hence, if a reservoir of gas is found which is confined wholly to a stratum of carbonate of lime, the inference is that the gas confined within it was derived almost exclusively from the decomposition of animal remains. And so with a formation containing remains principally of a vegetable growth. The inference is that the gas from that horizon is derived largely from the decomposed vegetable matter.

Some of the Devonian and other rocks contain a large proportion of bituminous matter, oil and gas, that has evidently been derived in part from the decomposition of cryptogamous plants—the algæ of the sea—and in part from decomposed animal remains. Some of the Devonian shales contain both animal and vegetable remains in large quantities.

Petroleum and gas, being confined exclusively to the sedimentary rocks, have certainly originated in the rocks that confine them. Organic matter contains all the elements of petroleum and gas. All stratified rocks contain greater or less quantities of organic remains. Since organic bodies are known to possess all the elements of petroleum and gas, and since it is known that petroleum and gas are confined to those rocks that contain organic remains, the conclusion is forced that the gas and oil have been derived from the decomposition of organic matter.

After concluding that petroleum and gas have been derived from decomposed organic matter, and recognizing the fact that all stratified deposits contain organic remains, the question arises: Why may not gas and oil be found in all the sedimentary deposits? Or why may not oil and gas be found in one portion of the Trenton rock as well as another? It is probably true that about as much gas was generated in one locality as another, and in one horizon as another; but the gas in different horizons was generated under different conditions. In those localities where little or no gas is found in the rocks, the probability is that the organic matter deposited with the material that forms the rocks decomposed about as fast as it was deposited, and the gas escaped as fast as decomposition took place. At those localities where gas is found in paying quantities the accumulations of sediment deposited with the organic bodies was sufficient to bury the matter before decomposition took place, and sufficiently heavy when decomposition did occur to confine the gas, and, to a certain extent, to prevent, or to retard for a long period, at least, the complete analytical work of nature. The petroleum, distributed largely through all the sedimentary rocks, having an origin common with gas, is but a residual portion of organic matter that is still undergoing a change from a compound to the simplest state of nature. Wherever petroleum exists in the rocks, the process of decomposition is still going on; the oil is being slowly but continually resolved into gas.

While it is a recognized fact that the limestones form the reservoir in which the gas in the great Indiana field is confined, it is highly probable that the greater proportion of it, by far, was derived from the super-lying black shale of the Utica group. These shales, as a rule, are highly bituminous, and are probably not only the source of the gas in the Trenton rocks, but the petroleum as well.

Along the Ohio River, in Harrison County, Indiana, and more especially along the opposite side of the Ohio River, in Meade County, Kentucky, there are about thirty wells producing gas in quantities varying from a few thousand to four millions or more cubic feet per day, and all the gas is derived directly from the Devonian black shales. The shales, themselves, form the reservoir. These shales, of course, are not crystallized and porous, like the limestones, but they consist of innumerable, slate-like layers, and the gas is confined in the spaces between the layers. On account of these structural features of the shales, shooting the wells in this region has not been productive of satisfactory results. As a rule, the flow of gas has not been increased by the explosion.

The fact, that in this region the gas is confined wholly to the shales, leads strongly to the conclusion that it has had its origin in the immediate reservoir that confines it, more especially since these shales are known, at every point of exposure, to be highly bituminous.

PERMANENCY OF THE GAS SUPPLY.

The thing next in importance to securing natural gas in available quantities is to secure a permanent supply, and perhaps no question is more frequently asked concerning gas than this: "Will the supply be permanent—will it last?" No means are at hand yet to determine this matter. The extent of the reservoirs is not absolutely known. The porous rock, however, that forms the reservoir is known to be but a few inches thick in some localities, and to be as much as twenty-five or thirty feet thick in other places. In undeveloped places the porous stratum may even exceed thirty feet in thickness. If the generation of gas is not going on at the present time at a sufficiently rapid rate to keep up the initial pressure in the reservoirs, then the supply will be exhausted after a time. In the older rocks petroleum is undoubtedly the only source from which gas is being derived at the present time. There can be no doubt of this. It has been shown to some extent, in the discussion of the origin of gas, that both substances, petroleum and gas, are intimately associated together in the rocks, and that they have a common origin. The process of decomposition is never completed until the elements that enter the structure of organic bodies are resolved into their simplest form. Petroleum is a residual portion of organic matter confined in the laboratory of Nature upon which the disintegrating forces are still operating. The work of nature, in this particular, is not yet complete, and will not be until all the petroleum distributed through the rocks is resolved into gas. While this work is still going on, the stock of gas upon which enormous draughts are made, and which are likely to be increasing for a considerable length of time, will be, to a certain extent, replenished. But it is not at all probable that the amount of gas generated from petroleum will nearly equal the quantity drawn from the reservoirs by artificial means. Indeed, it is highly probable that the natural waste of gas is greatly in excess of the amount generated from all sources. There is a tendency of the gas to expand to extreme tenuity. There is a repulsive force operating upon the molecules of matter in a gaseous form that tends to produce the most extreme subtilty in this fluid. It is this repulsive force, this tendency of the gas to expand to almost unlimited extent, that forces it out through the minute interstices—the pores of the rocks. It acts upward and downward, and in every direction with exactly the same energy. This force is sufficient to carry the gas out through the rock in every direction, and the expansion is only limited when an area of wholly impervious rock is reached. Where there are fissures in the rock extending from the gas reservoir to the surface, or where the porous rocks extend to the surface, the gas finds its way to the atmosphere, where it is immediately dissipated. It is this same tendency of gas to expand that gives it a force sufficient to lift several hundred pounds per square inch. Confined in its reservoir of rock the gas is compressed to an enormous extent. There is no means of determining the capacity of the interstices of a cubic foot of porous rock that forms the gas reservoir. When the exact limits of a gas area are known, and when the average thickness of the porous rock is known, the capacity of a gas reservoir may be estimated to an approximate degree, but it will never be possible to estimate to any satisfactory extent, the capacity of the interstices that contain the gas. If it was known just how many cubic inches of gas in its compressed state there are in a cubic foot of porous rock, and if it was known, too, just how many cubic feet of gas those cubic inches are equal to, reduced to atmospheric pressure, then we could determine, approximately, how many thousand of millions of cubic feet of gas there are in a reservoir.

The statement is frequently made by writers in newspapers that the natural tendency of oil and water is to move downward, and of gas to move upward in the rocks. This statement is not in a strict sense correct. The tendency of gas and every other substance is downward, in the direction of the center of the earth, in obedience to the law of gravitation. The tendency of gas is to expand equally in all directions until complete separation of elements is attained. When gas is brought to the surface and comes in contact with the atmosphere it moves upward, but not because there is a natural tendency in the gas to do so, but because there is a law which draws the air, a heavier substance downward. The atmosphere displaces the gas and lifts it upward, just as a piece of cork is lifted to the surface when sunk to the bottom of a tank of water. There is no tendency on the part of a piece of cork to rise in water, but the law of gravity draws the water, which is the heavier substance in proportion to its bulk, downward, and the cork is lifted by the water. Cork will not remain suspended in the air for the reason that it is heavier in proportion to volume than air. Air is heavier in proportion to volume than gas, consequently the latter is lifted by the former. There is no tendency of the gas to move upward farther than that produced by the law of expansion.

An idea prevails, to some extent, that when gas escapes to the atmosphere it is carried upward, and being lighter than air, it remains forever afloat on the surface of the heavier substance, and is wholly lost to the earth. It is more probably true that the gas is carried to an altitude where the tenuity of the air equals or exceeds that of the gas; to an altitude where the point of ultimate expansion may be attained. At this elevation complete separation of elements takes place, and the particles fall back to the earth again as simple, ultimate atoms.

It is certainly true that all gas reservoirs, upon which draughts are made, will be wholly exhausted after a time. Whether that time will be extended to a long period, or limited to a few years, is yet to be determined. Even if the generation of gas from petroleum is equal to the natural and artificial waste, the supply of gas is certain to be exhausted at some period, for the stock of petroleum will be entirely dissipated after a time. But the probabilities are that the amount of gas being generated in the rocks from all sources is inconsiderable in comparison with the enormous quantities that are drawn off by natural and artificial agencies.

No satisfactory method of ascertaining the amount of gas stored in nature's reservoirs has yet been suggested. I think, however, that by a series of carefully made experiments, continued through several months of time, that it is possible to determine approximately how long gas may be secured in paying quantities. Assuming that the Trenton rock gas area of Indiana consists of one vast connected reservoir, which is evidently true, these experiments should be made at several different points at the same time, say, for instance, at Kokomo, Noblesville, Marion, Anderson, Greenfield, Muncie and Portland. If the initial pressure of the gas is accurately ascertained at one of the average wells at each of these points, at the same time, say September 1st, and the pressure of each of these wells is accurately taken again in three months, and once every three months thereafter for a considerable period of time, it can be ascertained to a certainty whether the initial or rock pressure is diminishing any or not, and exactly to what extent. Also, at the time the initial pressure is taken, the volume of gas escaping from the wells should be accurately measured. A series of such experiments will determine whether the amount of gas flowing from the wells is diminishing or not, and, if so, to what extent. Such measurements willl give the ratio of decrease both in initial pressure and volume of gas. Having the ratio of decrease, an approximate estimate of the durability of the wells can readily be made.

Since it is altogether probable that the Trenton rock gas area of Indiana is one vast, connected reservoir, containing, possibly, more than 4,000 square miles, the stores of natural gas contained within it must be enormous; certainly enough, if used economically, to last the population for many years. But the certainty that the supply will be exhausted after a time, however remote that may be, must be clearly apparent to any one who has given the subject any careful thought.

The importance, then, of husbanding the supplies and guarding carefully against any unnecessary waste ought certainly to be appreciated by all. One million cubic feet of gas is worth one hundred dollars in gold. For the past six months there has been an average waste of about 100,000,000 cubic feet of gas per day in Indiana.* This is worth $10,000 in currency or coin. The volume of gas wasted in the last six months is not less than 15,000,000,000 cubic feet, worth $1,500,000. Is not such extravagance wrong? Is it not foolish? Many of the wells have been thrown wide open and the gas allowed to burn as an advertisement. Is not such advertising too costly? No operator would think of setting fire to his coal mine merely as an advertisement, and yet the volume of gas escaping from an average well in Indiana is equal to 250 tons of coal per day for heating purposes. The daily flow from an average gas well in this State, at a coal value, is worth $625 Can a city or town afford to pay $625 per day for advertising?

Whenever a well is drilled into Trenton rock, or any other rock containing gas, and a satisfactory flow is obtained, it should be immediately packed and securely capped in. If it is an average well it is worth to the consumers six hundred dollars per day. To the owner it is stored wealth which he is certain to realize at no remote period. If it is allowed to flow out and burn or waste for six weeks, it is worth $25,000 less to the owner, for that is the value of the gas that will escape in that length of time.

The fact that Indiana has an enormous reservoir of natural gas is everywhere recognized at the present time. There is not an intelligent manufacturer nor other well-informed citizen in the United States that is not aware of it. The enormous flame produced by a well yielding 5,000,000 cubic feet of gas per day is a great advertisement of the capacity of the well, but the intelligent manufacturer or capitalist who views the monstrous flame, and is informed that it has been burning with undiminished vigor for a month, mentally calculates that in that length of time $15,000 worth of gas has been consumed, consequently the amount of gas that can be delivered to the consumers from it is diminished to the value of $15,000.

If used economically the supply of gas is not likely to be exhausted for years to come, but it is certain that the entire accumulation will fail sooner or later. Extravagant waste, therefore, is foolish and criminal.

The foregoing chapter on the permanency of the gas supply was written in November, 1887. The developments of the past year have established the fact that the supply of gas is gradually diminishing in all the wells. This is not noticeable as yet, perhaps, in the stronger wells, since no accurate methods have been used to determine the facts, but in many of

* This part of the Report was written in November, 1887.

the smaller wells the volume of gas produced daily has greatly diminished. I have data at hand, which, perhaps, need not be published in detail here, but which show positively that the volume of gas produced daily, not only in the wells of Indiana, but in those of Ohio and Pennsylvania also, is gradually diminishing. And while, in most instances, the volume of gas is not diminishing at a sufficiently rapid rate to produce immeditae alarm on account of the apprehension of an early exhaustion of the supply, the fact is clearly apparent that the entire supply of gas in the present fields, if the present degree of consumption and waste is continued, will become wholly exhausted in a few years. It is important, therefore, that great care should be exercised in husbanding the supply, and economy should be practiced in the use of it.

At this time, as this report goes to press, the large wells have all been closed in and the gas confined, but there are yet many small wells which the owners have not deemed it worth while to cap nor confine, and the gas flowing out of them is assisting in the gradual exhaustion of the entire field. The average daily waste at this time probably approximates 10,000,000 cubic feet. If possible, legislative enactment should compel the owners to securely cap all wells, and properly confine the gas within a reasonable length of time after they are drilled. Since the Indiana gas area evidently consists of one vast, connected reservoir, it is undoubtedly true that a single well, in time, would exhaust the entire field. It is true that the fee simple of land entitles the owner to all the minerals or other substance that lie beneath the surface, to whatever distance he may penetrate, and none may question his rights, but if his lands adjoin a lake of water around which other farms are situated, and upon which other farmers depend for water, he has no right, in law, to drain the lake, even if the ditching may all be done upon his own land, and thus deprive the joint owners of their rights. And so no one should be allowed to wastefully drain the great gas reservoir, which is common to all, for the reason that he not only exhausts the reservoir situated under his own land, but that under his neighbors' land also.

It occurs to me that a law might be enacted that would deprive no individual of his rights in the legitimate use and sale of gas, but would, at the same time, restrain him in the extravagant use and waste of it.

THE ANTICLINAL THEORY.

All the largely productive gas areas, so far developed, lie in regions of ancient disturbance. This is true of the Pennsylvania and Ohio fields, and Indiana also. Wherever these disturbances occur they usually appear as long, elevated ridges with intervening troughs or valleys. The arches, or ridges, are termed anticlines and the troughs synclines. Throughout the Indiana gas area the accumulations of foreign material transported to this region during the glacial period, have covered, to a large extent, the sedimentary rock deposits, and but few exposures remain at which examinations can be made. However, along the Wabash, Salamonie and Mississinewa Rivers, and other streams, the exposures are frequent enough to permit satisfactory examinations. To any one who will take the trouble to examine the rock exposures along the Wabash River and other streams in that region, the fact will at once be manifested that a series of disturbances extends entirely across the State of Indiana, which, in a general way, follow a northwest and southeast course. This area of disturbance consists of a broad arch in the western part of the State, while in the eastern portion it spreads out into a wide table-land. The eastern portion of the arch, the table-land, is the area in which the natural gas reservoir occurs.

Concerning the connection of anticlines with the accumulation of natural gas, in areas affected by slight upheavals, Prof. I. C. White, of the U. S. Geological Survey, who first presented the anticlinal theory to the public, in a paper published in *Science* for June 26, 1885, says:

"The writer's study of this subject began in June, 1883, when he was employed by Pittsburgh parties to make a general investigation of the natural gas question, with the special object of determining whether or not it was possible to predict the presence of gas from geological structure. In the prosecution of this work I was aided by a suggestion from Mr. William N. Earsman, of Allegheny, Pa., an oil operator of many years' experience, who had noticed that the principal wells then known in Western Pennsylvania were situated close to where anticlinal axes were drawn on the geological maps. From this he inferred there must be some connection between the gas wells and the anticlines. After visiting all the great gas wells that had been struck in Western Pennsylvania and West Virginia, and carefully examining the geological surroundings of each, I found that every one of them was situated either directly on, or near, the crown of an anticlinal axis, while wells that had been bored in the synclines on either side furnished little or no gas, but in many places large quantities of salt water. Further observation showed that the gas wells were confined to a narrow belt, only one-fourth to one mile wide, along the crest of the anticlinal folds. These facts seemed to connect the gas territory unmistakably with the disturbance in the rocks caused by their upheaval into arches, but the crucial test was yet to be made in the actual location of good gas territory on this theory. During the last two years I have submitted it to all manner of tests, both in locating and condemning gas territory, and the general result has been to confirm the anticlinal theory beyond a reasonable doubt.

"But while we can state with confidence that all *great gas wells* are found on the anticlinal axes, the converse of this is not true, viz: that *great gas wells* may be found on all *anticlinals*. In a theory of this kind, the *limitations* become quite as important as, or even more so than the theory itself, and hence I have given considerable thought to this side of the question, having formulated them into three or four general rules (which include practically all the limitations known to me, up to the present time, that should be placed on the statement that large gas wells may be obtained on anticlinal folds), viz:

"(*a*) The arch in the rocks must be of considerable magnitude. * * *

"(*b*) Very fair gas wells may also be obtained for a considerable distance down the slope from the crest of the anticlinals, provided the dip be sufficiently rapid, and especially if it be irregular or interrupted with slight crumples. And even in regions where there are no anticlinals, if the dip be somewhat rapid and irregular, rather large gas wells may occasionally be found, if all the other conditions be favorable. * * *

"The reason why natural gas should collect under the arches of the rocks is sufficiently plain, from a consideration of its volatile nature. Then, too, the extensive fissuring of the rocks, which appears necessary to form a reservoir for a large gas well, would take place most readily along the anticlinals, where the tension in bending would be greatest."

The foregoing quotation from Prof. White is a brief statement of the anticlinal theory. The stratified rocks, which were originally deposited in a nearly level plain, or, at least, with only such irregularities in structure as invariably occur in sea bottoms, either by upheavels from beneath or contraction of the earth's volume, have in many places been wrinkled up. If the corrugations were produced by contraction of the earth, they are certainly wrinkles. These wrinkles consist of a series of arches (anticlines) and grooves (synclines). Where the wrinkles appear in the surface deposits, it is known that they continue downward through all the sedimentary rocks. The surface of the rocks is generally covered by accumulations of transported material or the local residum of disintegrated and decomposed rocks, so that examinations have usually to be made along the streams where the erosions have denuded the rocks. Bluff escarpments frequently show exactly the amount and direction of the dip.

Where disturbances have produced low folds in the strata, and have not been sufficient to totally upheave the rocks and fracture them so as to permit the gas to escape, the effect upon the position of the fluids confined in the strata is supposed to be quite marked. The average thickness of the porous, gas-bearing stratum of Trenton rock in Indiana is in the neighborhood of twelve feet. This rock in some localities contains gas, oil and salt water. If the stratum was lying in a horizontal position the water would naturally settle to the bottom of the porous rock, and the interstices of the lower part of it would contain nothing but water. The petroleum, which is lighter than water, would fill the interstices in the rock just above the salt water, and gas would occupy the upper portion of the stratum, being lighter than either water or oil.

Now, what would be the effect upon the relative position of the substances, gas, oil and water, if by the contraction of the earth's volume or upheaval, or other force, the strata were forced into a series of wrinkles or corrugations? Manifestly the water would work its way down the inclines and fill the lower portion of the synclines or troughs. The oil would finally adjust itself to a position just above the water in the syncline, or along the slope of the anticline, and the gas would occupy the summit of the anticline. This would all probably occur where a stratum of porous rock was wholly filled with salt water, petroleum and compressed gas. While the disturbance that affected the position of the rocks in the Indiana gas area undoubtedly date back to the close of the Niagara period, it is evidently true that the generation and accumulation of petroleum and gas in the Trenton antedates even the formation of the Niagara rocks by ages. The petroleum and gas were probably generated long before the beginning of the Niagara period, hence the disturbances that affect the structure of all the strata at the close of the Niagara period had no agency in the generation nor accumulation of the Trenton gas. But the change of structural conditions, affected by the disturbance, had the effect of modifying the relative position of the various fluids confined in the rock reservoirs. Water, the heaviest fluid, occupied the trough; gas, the lighter, accumulated in the arches, and the oil was forced into the intermediate position. The facts developed in Indiana, though not wholly conclusive, are largely corroborative of this view. Where the disturbances were of such a nature as to wholly upheave the strata, or to fracture them to a great extent, as was the result along the Wabash River, the gas escaped to the atmosphere and was at once dissipated.

It does not, as a necessity, follow that gas will be in all arches, nor that water will be in all synclines, but where the porous stratum, before the disturbance occurred, contained gas, petroleum and water, the different substances will be found occupying positions relatively as stated. Where no water is present, the oil, if any, will occupy the syncline. If neither water nor oil is present, then the gas will permeate every portion of the porous rock, syncline as well as anticline, and the pressure will be just as strong, and, other things being equal, the flow will be just as great from a syncline as from an anticline. In areas where the organic remains decomposed as fast as deposited the gas escaped as it was generated; hence, however favorable the structural conditions may be, no gas is to be found in such rock. This is the case, usually, where areas occur in which the limestones are nearly pure carbonate. There was no accumulation of transported sediment sufficient to bury the organic remains deep enough to prevent immediate decomposition, nor to confine the gas. Strata, consisting largely of carbonate of lime, have, so far, yielded but small supplies of gas.

As a rule, the larger supplies of gas are found in anticlinals in this State, though by no means is it to be found, always, in the higher Trenton rocks.

A practical application of the anticlinical theory, in the location of gas wells, may result greatly to the advantage of the explorer, will surely do so if the theory is true, and, in any event, I can not see that any harm can result from prosecuting the work on the supposition that the theory is true. The boring of a gas well, in undeveloped territory, is largely an experiment at the best; and, inasmuch as it is confidently asserted by some experienced, practical geologists, who have given the subject the most thorough investigation, that where gas is contained in a reservoir, the largest accumulation invariably occurs in the anticlinals, prudence should dictate the location of a gas well on an arch.

The accumulations of drift are usually so great throughout the Indiana gas area, that, as a rule, it is impossible to determine the location of an arch in advance of drilling. The anticlines, in a general way, have a northerly and southerly direction, but in many instances they go zigzagging in various directions. It is also quite probable that throughout the Indiana gas area there are many rounded cone-like elevations of the strata, more like a hill than a continuous arch. These elevations would, of course, be governed by the same conditions that prevail in the arches. The larger flows of gas might be expected from the crown, or summit of the elevation.

Opinions, similar to those entertained by Prof. White, are entertained by many eminent, practical geologists, men who have investigated the subject in a practical way most thoroughly; while a number of others, equally prominent in the profession, are of the opinion that practically the anticlinal theory possesses no importance whatever. The discussions of the geologists are important in this, they tend to more thorough investigations of the subject, and a final development of the truth.

THE SEA LEVEL THEORY.

In the productive gas area of Indiana the Trenton rocks are found at geographical horizons varying from 158 feet above sea level to 1,072 feet below it. The higher level is at Lawrenceburg, in Dearborn County, and the lower one at Auburn, Dekalb County. The largest well drilled at Lawrenceburg to date flows 1,240,000 cubic feet of gas per day, while the best well at Auburn produces probably not less than 2,000,000 cubic feet per day. The Trenton limestone, in all the larger producing wells of the State, is found at a horizon varying from sixty to seventy feet above sea level to 110 feet below, except at Lawrenceburg, where, as stated, it is 153 feet above, and at Auburn and other points in Dekalb County, where it is from 1,050 to 1,200 feet below sea level. In the great gas wells of the Ohio field, Trenton rock is found at from 300 to 400 feet below sea level. In Ohio the geographical oil horizon lies a little below that of the gas, and the salt-water horizon is just below the oil. As yet no great gas reservoir has been found in the Trenton limestones where these rocks lie at a greater depth than 1,200 feet below sea level. Gas has been found at many points, both in Ohio and Indiana, at greater depths than 500 feet below sea level, but none of the wells are of the first nor even the second class, perhaps, except those at Auburn and vicinity. At well No. 1, Ft. Wayne, Trenton rock was found at a depth of 693 feet below sea level. A sufficient amount of gas was obtained from this well to run the engine for drilling well No. 3, when piped about one-half mile. The initial pressure of the well is 160 pounds. Gas and oil both have been found at Bryan, Williams County, Ohio, where the Trenton limestone is found at about 1,200 feet below sea level. In well No. 3 the gas was found at a depth of 2,035 feet, and the drilling continued to the depth of 2,092 feet.

Prof. Orton, of Ohio, has entertained the opinion that neither gas nor oil would be found in paying quantities at greater depths than 500 feet below sea level. If he is correct in this view, which is generally referred to as "The Sea Level Theory," for the field at Auburn may be a single exception, a great deal of money may be saved by first obtaining a knowledge of the geology of a locality in which it is proposed to bore a well.

An examination of the evidence upon which this theory is founded shows that it is wholly of a negative character, the same kind of evidence precisely upon which was founded the opinion which prevailed among geologists a few years ago, that neither gas nor oil were likely to be found in paying quantities in the Trenton rocks. When gas and oil were actually found in large quantities in the Trenton rocks the facts were accepted and the theory abandoned. When gas was found in the Trenton rocks geologists readily accounted for its presence there, for it was undoubtedly derived from the decomposition of organic matter deposited with the sediment that formed the Trenton limestones or the overlying shales. All admit now that there is gas in the Trenton rocks, and there is a general agreement upon its origin. Since it is known that these rocks contain gas and oil, and the origin of these substances seems plain, is there any reason why they should be limited to any particular geographical horizon?

It does not occur to me that structural disturbances assisted in any way in the generation of gas. The disturbances that affected the strata of Ohio and Indiana occurred long ages after the accumulation of gas and oil in the Trenton rocks. The effect of the disturbances was to increase the capacity of the reservoir in some places and diminish it in others. Water flowing into the synclines expelled the gas from them and forced it into the anticlines; but the elevation of an area, like the Indiana plateau, did not affect the accumulation of the gas in a general way. The gas confined in the rocks accumulated there while they were in their original position—before any disturbance took place. The Trenton rocks of the Indiana gas area have been elevated above their original position from one hundred to three hundred feet. The gas reservoir, with its confined gas, was raised with them. Had the disturbance never occurred, the gas would still be retained in the rocks. Along the Wabash River, near the northern rim of the reservoir, the disturbances were of such a nature as to fracture the strata greatly, and tilt them to various angles, thus permitting the gas to escape. The evidence is clear that the accumulations of gas along the Wabash River escaped through the numerous fissures in the rocks ages ago. If the Trenton rocks of Indiana and Ohio were all lying in their original position, whether that was one hundred or one thousand feet below sea level, the gas would still be confined within them.

The conditions that prevailed at the time the organic matter was deposited from which the gas was derived are the only ones that affect gas accumulations. If the matter decomposed as fast as it was deposited, the gas was immediately dissipated. Wherever the sediment accumulated above it sufficiently to prevent immediate decomposition, the gas was generated by slow degrees, and is yet confined in the rocks, except in localities where local disturbances have fractured the strata, and permitted it to escape.

The gas horizon of Indiana, varying from one hundred feet above to twelve hundred feet below sea level, and that of Ohio varying from three to four hundred feet below sea level, are mere accidents of structure which in no way affected the generation, nor general accumulations of gas and oil. It is possible, of course, that gas may rarely be found in large quantities at greater depth than five hundred feet below sea level, but the cause must be attributed to other conditions than the structural features. Organic matter formed a portion of the sediment throughout the entire extent of the Trenton limestones, and, indeed, all other limestones. The author of the "Sea Level Theory" is among those geologists who agree in the conclusion that gas and petroleum are derived from decomposed organic matter. Since it is well known that vast amounts of organic matter were distributed through nearly every portion of the Trenton rocks, why is it not as likely that gas may be found in that formation one thousand feet below sea level as that it may be found at from one hundred to five hundred feet below? The rock assumed its crystalline, porous structure when the gas was generated. No subsequent structural changes ever occured to create the crystals and interstices. The decomposition of the organic matter, the generation of petroleum and gas, and the crystallization of the rock, all occurred at the same time. Gas and petroleum could not have remained in the rock without the interstices to contain them, nor could the decomposition of matter have taken place after the crystallization and perfection of the rock. The Indiana plateau and the Ohio plateau are structural features that came into existence long after the gas had accumulated in the Trenton rocks. May there not be other areas, then, where structural disturbances never occurred to a great extent, where large quantities of gas may yet be found in the Trenton rocks, even though the deposit may lie one thousand feet or more below sea level? Or may it not be found in other formations of sedimentary rocks, where they lie one thousand or two thousand feet above the level of the sea?

The fact that the surface of the Trenton limestone in the Indiana gas area lies from one hundred feet above sea level to twelve hundred feet below it, and that the surface of the same formation throughout the Ohio gas area lies from three hundred to four hundred feet below sea level, is a fact of coincidence merely, and not one that is related in any way to the generation nor accumulation of gas. The conditions that prevailed at the time the rock material was accumulating at the sea bottom, and those alone, affected the gas and petroleum accumulations. Wherever the conditions were favorable for the rapid decomposition of matter, the gas all escaped; but, where the accumulations of mineral matter were sufficient to cover the organic bodies completely, decomposition was slow, and much, if not all, the gas is yet confined in the rocks.

The horizon of salt-water is as variable as that of the gas and oil. At Tipton, Ind., salt-water was found at a depth of thirty-three feet in Trenton rock—one hundred and sixty feet below sea level; at South Bend salt-water was found at a depth of about a thousand feet below sea level in the same rocks. Ocean level does not in the least affect the vertical distribution of water, oil nor gas. The salt-water, the brine, found in the Indiana rocks is confined in local pools or reservoirs, and is not generally distributed. Wells have frequently been bored to the depth of one thousand feet, or more, below sea level, in this State, without finding it. It is an element that certainly does not affect the gas accumulations in this State to any measurable extent, though in some localities it is likely that the gas is slightly compressed by hydrostatic pressure.

Gas and petroleum are found only in the sedimentary rocks. They were derived from the decomposition of organic matter that was buried with the sediment that forms those rocks. They are not confined to any particular geological nor geographical horizon. The only conditions which governed the accumulation of these substances were those that prevailed at the time the rocks were forming.

The finding of gas at a particular horizon at one point in Indiana does not prove that it will be found where the same rocks approach the same horizon at another point. Neither does it prove that gas will not be found at places where the same rocks are reached at an altitude one thousand feet lower.

CONTRACTING FOR WELLS.

By far the larger proportion of the wells drilled for gas and oil in Indiana have been drilled under the direction of local stock companies. As a general thing the Board of Directors, acting for the company, has contracted with a practical workman, who is to drill a well to a certain depth, or to a certain depth in Trenton rock, for a specified sum of money. It s quite often the case that the contract between the parties is so indefinite in its terms that serious misunderstandings arise, and serious controversies, and sometimes lawsuits, are the result. All contracts should be so explicit in their terms as to be readily understood, and to admit of no misconstruction. Before a well is drilled it should be ascertained as nearly as possible how far it is to Trenton rock, or any other rock that it is desired to penetrate, and the contract made for a specified depth, with a provision to continue the drilling to a greater depth, at a specified price per foot.

In several instances serious trouble has arisen where the contract required that the well should be drilled to a fixed number of feet, or fifty feet into Trenton rock. In these instances the trouble grew out of difference of opinion as to the identity of the strata passed through. The contractors claimed that their contract was complete when Trenton rock was reached, and a mistake in the identity of the strata by one party or the other caused the trouble.

In one instance in the northern part of this State, a contract required the well to be drilled 1,600 feet, or fifty feet into Trenton rock. At the depth of 550 feet the contractor claimed that he had struck Trenton rock. He continued the well to the depth of 615 feet, and then stopped, claiming that he had completed the contract. A serious controversy arose which was not settled for several weeks, and resulted in a great loss to both the company and contractor. In this instance the contractor was mistaken, for the bottom of the well at 615 feet was just 1,200 above the Trenton rocks.

Another instance, to still further illustrate, occurred rather in the southeastern part of the State. In this case the well was to be drilled fifty feet into Trenton rock. Trenton rock was found at 550 feet, but the company failed to identify it, and compelled the contractor to go nearly a hundred feet deeper, after he had actually completed his contract.

Many other instances might be mentioned where serious losses have been sustained by one party or the other, or both, on account of defective contracts.

There is no occasion for contracting to have a well drilled fifty feet into Trenton rock. The approximate depth to Trenton rock may be easily ascertained in any county in the State. Where a company determines to have a well drilled, they should ascertain, as nearly as possible, the depth to the rock they wish to reach. Then contract for the well to be drilled to that depth for a fixed sum, with a provision that if it is desired to continue the drilling to a greater depth, it shall be done at a specified price per foot.

It frequently occurs that trouble arises over the ownership of the casing and drive-pipes that are used in the construction of a well. It is usually understood that if the well proves to be a paying one, that is, if it yields gas sufficient to justify piping, the drive-pipe and the casings become the property of the company, otherwise, they may be retained by the contractor. Several wells have been drilled in this State from which a very small flow of gas was obtained, so small, indeed, that it could hardly be determined whether it would pay to lay the pipes and incur the other expenses necessary to put it in use or not. The indefinite terms of the contracts, in many of these cases, have caused aggravating disputes, and, in a few instances, law suits. All these disagreeable complications may be avoided if the parties to the contract will take the pains to have a complete understanding beforehand.

Drive-pipe is necessary in the construction of a well. It is the large pipe, usually eight inch, that is driven down through the surface soils, gravel and clays, to protect the well against accidents of caving in, etc. Wherever drift accumulations occur, drive-pipe is absolutely essential, and it must extend down to the solid rock. If the well is started on solid rock, drive-pipe is unnecessary. As drive-pipe costs from $1.40 to $1.50 per lineal foot, and the amount required to thoroughly protect the wells throughout the drift area of Indiana varies from a few feet to four hundred feet, or more, it becomes an item of considerable importance to both the driller and the company. In every case it should be definitely settled beforehand who is to retain possession of the drive-pipe. If the well should prove to be wholly unprofitable, of course the company do not need it, and the driller can readily pull it out and use it again. Perhaps the better way is for the contractor to furnish all his own materials in drillling a well, and, in the event that the company desire to use the well, they should pay him a reasonable price, previously agreed upon, for both drive-pipe and casing.

The casing, usually 5⅝ inches in diameter, is the pipe that is put down inside the drive-pipe, and extended through the limestones or water-bearing rocks, to shut off the water. It can not be determined positively beforehand how much casing will be required.

In the southeastern part of Indiana but very little is necessary, but in the northern part of the State 1,200 or 1,300 feet has sometimes been required. The cost of 5⅝ inch casing is from fifty to sixty cents per lineal foot. When a great amount of it is used the cost is considerable. The casing, like the drive-pipe, is useless to the company if the well is not profitable, while the contractor can readily draw it out and use it again.

Another source of disputes is the work of packing and anchoring the well after securing a profitable supply of gas. When Trenton rock has been reached, and gas in paying quantities obtained, it is necessary that the well should be properly packed and securely anchored. The packing, as it is termed, is the process of confining the gas in a pipe of convenient size from which it may be conducted to the mains for use.

Packing pipes of sizes varying from one inch to four inches in diameter are used. The size of the packing pipe is governed by the productiveness of the well. This pipe is put down inside of the casing, and extended to the gas reservoir. The packer, a device usually made of rubber, is placed around the pipe just at the bottom of the shales, and so adjusted as to completely shut of the gas from the outside of the pipe, thus securing the well against any waste.

Anchoring is the process of securing the packing pipe, or the casing, if no other pipe is used, so that it will not be left out of place by the compressed gas when the well is completely closed. As a rule the drillers consider their contract complete when the required depth is reached, though they sometimes perform the labor of packing and anchoring the well, the company furnishing the materials. It is more frequently the case, however, that the packing and anchoring is done by experts, who devote their time exclusively to that kind of work.

Where the terms of the contract are not explicit, disputes sometimes arise as to who shall incur the expense of packing the well, the company or the contractor. The contractor who has agreed to complete the well, understands that his work is finished when the required depth is reached, while the company understand that it must be packed and anchored—equipped ready for use.

The inconveniences arising from misunderstandings of this kind may all be avoided by a little care in the making of the contract.

A properly constructed contract would require the contractor to furnish all his own machinery, drive-pipe, casing and material of every kind that is used in the drilling of a well. The contract should require that the drive-pipe extend to the solid rock, and that a sufficient amount of casing should be used to thoroughly secure the well against damage by water. It may then be provided that the company may retain the drive-pipe and casing, in case they desire to utilize the well, by paying a specified price for the same. The contract should provide that the company should furnish the pipe and other material for packing the well. As a rule it is better to employ an expert to perform the labor of packing and anchoring the well, but provision should be made for securing the use of the contractor's machinery to perform this work. If it is desired to explode a cartridge of nitro-glycerine in the well, an expert is required for that labor also. The machinery of the contractor will be necessary in the performance of this work also, and provision should be made for its use.

It is better for the contractor to furnish the drive-pipe and casing for the reason that if the well proves to be unprofitable he can remove the same and use it for the construction of another well without sustaining loss. If the company purchase the pipes and the well is a failure, they sustain a loss unless they desire to drill another well.

SURFACE INDICATIONS OF OIL AND GAS.

The experience of the past year or more in Indiana has shown that surface indications of oil or gas, as a rule, are practically valueless. Wherever gas is discovered flowing out through springs of water, either in the drift area or from rock deposits, the fact may be taken as indicating an exhausted reservoir, rather than one from which may be obtained a remunerative supply of gas. Throughout the drift area of Indiana springs frequently occur, from which the gas is continually escaping in small bubbles. If a barrel, or other vessel, is carefully placed over a spring of this kind, and a small pipe inserted into the barrel, the gas may be lighted at the end of the pipe, and it will burn continually. But the amount of escaping gas is so small that it is practically of no value. This drift gas, as a rule, escapes through a sand deposit, that has been cut down into by the erosions of streams of water. The gas was generated in some mass of buried vegetation. The reservoir probably never contained any valuable store, and even if it did at one time contain a considerable accumulation, the waste that has been going on for years has practically exhausted it. Probably the greater amount of gas that escapes through the sand deposits and springs of the drift regions is that which is now being generated from the continued decay of vegetable matter in the buried swamps.

Along the Ohio River and its tributaries, in the southeastern part of the State, where the Hudson River rocks appear at the surface, the springs that flow out of the foot of the bluffs frequently contain a considerable amount of gas, but by no means a sufficient quantity to make it of economic importance. This gas, which had its origin in the Hudson River rocks, is assumed to indicate, in many instances, a large reservoir in the rocks below. But a brief consideration of the matter will certainly convince any one that where there are known to be numerous leaks, in a region where those leaks have evidently been uninterrupted for hundreds, if not thousands of years, the reservoir must certainly be virtually exhausted by this time. The slow generation of gas from the petroleum contained in the rocks may be manifested in the bubbles of gas escaping from springs for scores of years to come, but such manifestations should never be taken as evidence that a great reservoir may be found in the depths below.

Throughout large areas where the Niagara limestones are the surface rocks, the same occurrences of gas leaks are quite common. Also throughout the Niagara exposures it is common to see places where petroleum flows slowly out through fissures in the rocks. In some areas in Indiana petroleum is distributed through the entire mass of Niagara rocks, but it has never yet been found in them collected in a reservoir from which it could be obtained in paying quantities. The Niagara rocks are largely crystalline, in this State, and consequently, porous, so that the gas and oil are permitted to move freely through them. If there ever was any large accumulation of gas in the Niagara rocks, throughout the area where they are exposed, it escaped ages ago. The gas that escapes from them now is evidently that being daily generated from the petroleum contained within them.

A gas leak is a stronger evidence of an exhausted reservoir than *contra*. As already stated, where gas is leaking from the rock or drift deposits of Indiana, at the present time, it must be true that it has been leaking through the same channels, and perhaps hundreds of other channels, for ages, and has thus practically exhausted the reservoir. The gas observed to be leaking from the surface deposits at Findlay, Ohio, before the discovery of the great reservoirs beneath, was certainly not Trenton gas. The drift contains gas, the Niagara and Hudson River rocks contain gas, and the leaking gas at Findlay, Ohio, was evidently from some of these deposits. If the numerous leaks noticed throughout that region had been from the Trenton rocks, the immense reservoir below would have been long ago exhausted. The gas in the Findlay reservoir is wholly confined by impervious rocks. The over-lying Utica shales are two hundred to three hundred feet thick and so close in texture that gas can not permeate them. Just so in the great Indiana field. The gas reservoir here lies below from fifty to four hundred feet of impermeable Utica shales. Unless these shales have been fractured by shrinking of the earth's crust, or upheaval, they are wholly impervious to gas or any other fluid. To obtain gas in paying quantities, it must be completely confined in impervious rocks; and I repeat the statement that gas leaks are not favorable indications of large reservoirs in the immediate vicinity.

A knowledge of the geological formations to be penetrated is absolutely essential to an intelligent search for gas. It must be known that there is a formation of rocks lying below, capable of forming a reservoir under favorable conditions. All sandstone formations are porous, and all limestone formations are porous in certain areas. The shales, of course, as a rule, are impervions, but these are important, as they form the impenetrable covering for the gas, of which they are, probably, largely the source. Wherever it is known that there is an under-lying deposit of limestone or sandstone, over which there is a considerable thickness of impervious shale, it may be safely assumed that there is a possibility of finding gas in that locality. Careful examinations should be made to determine whether or not there have been structural disturbances of the strata. If the rocks have been greatly tilted, or fissured by upheaval, it will be a waste of means to attempt to get gas in that locality. But if the effect of the disturbance has been merely to wrinkle the strata, if the compression has been just sufficient to produce a series of low folds, or arches, then explorations may be prosecuted in that locality with the greatest of confidence. In locating wells in such territory, care should be taken to determine, as accurately as possible, the summits of the arches or folds. The location of a well, in unexplored territory, where the structural features admit it, should be upon an arch.

In areas where structural disturbances have not occurred, it is only necessary to acquire a thorough knowledge of the strata to be penetrated. It is not at all likely that structural changes assisted in any way in the generation of gas; hence the confinement of gas in the rocks does nor depend upon structural conditions. Where structural changes have occurred in gas reservoirs, the accumulations of stored gas have been affected to some extent, inasmuch as the filling of the synclines with water would force the gas into the arches; but it will probably be developed sooner or later that there are vast accumulations of both gas and oil in areas where structural disturbances have never occurred.

STRUCTURAL FEATURES OF INDIANA.

The surface elevations of Indiana vary from about 375 feet above sea level along the Ohio River in Vanderburg and Posey Counties, to 1,250 feet or more above in Randolph County.

There is, therefore, a difference of about 900 feet in the extreme elevations of the State. The average altitude is about 800 feet above sea level. The surface consists of one broad plain, broken only by the eroded valleys of the streams, and is a part of the eastern portion of the great Mississippi basin. The northern half of the State consists of a broad expanse of generally level lands, interrupted only by the gentle slopes of the water courses. Very few exposures of rocks occur throughout this portion of the State, the surface deposits being almost wholly of glacial origin.

The southern part of the State is, in many of the counties, considerably broken by the erosions of the numerous streams.

The general direction of the drainage line is southwesterly, following, as a rule, the direction of the dip of the strata in the southern part of the State. In the extreme northeast corner of the State the drainage is northeasterly, and in the northwest corner of the State, westerly.

The oldest rock formations are exposed in the southeastern part of the State. The rocks exposed there are those of the Lower Silurian formation, and are equivalent to the Hudson River rocks of New York. These rocks are the surface rocks, or may be seen outcropping in the following counties, viz.: Clark, Dearborn, Decatur, Fayette, Franklin, Jefferson, Ohio, Ripley, Switzerland, Union and Wayne. The greatest thickness of exposed Hudson River rocks, in this State, so far as my knowledge extends, is 536 feet, in Dearborn County. The greatest accumulations of Hudson River rocks yet penetrated by the drill are at Greensburg, Decatur County, where they are 713 feet thick.

From the various exposures of these rocks, or, at least, from the extreme limits of the exposures, there is a dip, more or less rapid, to the north, northwest, west and southwest. The extent of this dip varies considerably, in some places being scarcely distinguishable, while in others it amounts to 50 feet or more to the mile. The more rapid dips are to the north in the northern part of the State, and to the southwest in the southern part of the State.

The rocks that immediately underlie the Hudson River rocks in Indiana are the Utica shales. The drill, within the past year, has revealed the fact that these shales underlie every portion of the State. They vary in thickness from 20 to about 400 feet. Lying immediately below the bluish-gray limestones and shales of the Hudson River rocks, they may usually be recognized by their black or brownish-black color.

Immediately below the Utica shales lie the Trenton limestones. This group, which derives its name from the exposures at Trenton Falls, New York, has a thickness of 451 feet at Lawrenceburg, Indiana, 522 feet at Connersville, 510 feet at Richmond, 620 feet at Indianapolis, 626 feet at Bloomington, and 434 feet at Delphi, Indiana. These rocks, like the Utica shales, underlie every portion of the State.

Just underneath the Trenton rocks is a great sandstone deposit, of unknown thickness, which, for various reasons, I conclude is the Potsdam sandstone.

The Potsdam Sandstone.—This group, like the Trenton and Utica, probably underlies the whole of Indiana. Lying, as it does, several hundred feet beneath the surface, it is impossible to identify it positively without the aid of characteristic fossils, and these, of course, have not been found in the few wells that have penetrated this rock. At Lawrenceburg, Connersville, and some other points in the eastern part of the State, where it has been reached by the drill, it is a fine-grained, hard, pinkish or brownish colored sandstone, without any traces of lime. At Indianapolis it is still a fine-textured, hard and pure sandstone.. At Bloomington, where it was penetrated to the depth of 274 feet, it is somewhat coarse, white, and quite friable, or incompletely cemented at the top, becoming finer and harder lower down, with a considerable proportion of iron. At 270 feet it contains a considerable amount of lime. At Delphi, where the drill penetrated it 10 feet, it is a fine-grained, even-textured sandstone, nearly pure white, and almost pure silica. Throughout the whole of the eastern part of the State it is almost uniform in color, compactness and texture.

The Potsdam sandstone was found at a depth of 293 feet below sea level at Lawrenceburg, 402 feet below at Connersville, 580 feet below at Union City, 799 feet below at Indianapolis, 734 feet below at Delphi, and 1,734 feet below at Bloomington. The dip from Lawrenceburg to Bloomington, a distance of 104 miles westward, is 1,441 feet, or 14 feet to the mile. From Lawrenceburg to Union City, 95 miles due north, the dip is 287 feet, only 3 feet to the mile. From Lawrenceburg to Connersville, 45 miles north, the dip is 109 feet, 2½ feet to the mile. From Connersville to Indianapolis, 57 miles west, the dip is 397 feet, or 7 feet to the mile.

There are, doubtles, numerous contortions, or wave-like folds in these rocks at many points intervening between the places enumerated, but as the drill has penetrated to greater depths than the Trenton rocks at but few places, the arches and troughs have not been revealed. So far, the Potsdam sandstone has not been penetrated at any point north of the Wabash River.

The Potsdam sandstones have never yet yielded gas nor oil in paying quantities, if, indeed, in any quantity at all. The name was derived from the exposures at Potsdam, Lawrence County, New York.

The Trenton Limestones.—These rocks, although they are not exposed at any point in this State, on account of the vast accumulations of natural gas and petroleum found within them, have recently attained an importance scarcely exceeded by any other group of rocks within the borders of the State. They lie immediately above the Potsdam sandstones, and approach nearest the surface at Lawrenceburg, in the extreme southeastern corner of the State, where they are found in well No. 1, at a depth of 349 feet, 158 feet above sea level. At Brookville, 30 miles north of Lawrenceburg, they are 550 feet below the surface, and 174 feet above sea level. At Connersville, 25 miles north of Brookville, they are 705 feet below the surface in well No. 2, and 117 feet above sea level. At Cambridge City, 13 miles north of Connersville, they are 766 feet below the surface, and 174 feet 6 inches above sea level. At Winchester, 25 miles north of Cambridge City, in well No. 3, they are 1,076 feet 6 inches below the surface, and 68 feet 6 inches above sea level. At Ridgeville, 8 miles north of Winchester, they are 981 feet below the surface, and 1 foot above sea level. At Portland, 11 miles north of Ridgeville, they are, in well No. 3, 981 feet 3 inches below the surface, and 59 feet 3 inches below sea level. At Decatur, 27 miles north of Portland, they are 1,030 feet below the surface, and 223 feet below sea level. At Ft. Wayne, 21 miles north of Decatur, they are 1,437 feet below the surface, in well No. 2, and 650 feet below sea level. At Auburn, 28 miles north of Ft. Wayne, they are 1,937 feet below the surface, and 1,069 feet below sea level. At Butler, 11 miles northeast of Auburn, they are 2,057 feet below the surface, and 1,194 feet below sea level.

The following table, No. 1, shows the consecutive strata encountered in boring wells at each of the places above mentioned, with the thickness of each stratum, total depth of well, and the distance above or below sea level at which Trenton limestone was reached. Three wells have been drilled at Lawrenceburg, four at Brookville, four at Connersville, one at Cambridge City, six at Winchester, two at Ridgeville, seventeen at Portland, two at Decatur, five at Ft. Wayne, two at Auburn and one at Butler.*

* At the time this report was written.

TABLE No. I.

	Drift.	Waterlime.	Niagara.	Clinton.	Hudson River.	Utica.	Trenton.	Potsdam.	Trenton Below Sea Level.	Total Depth.
Lawrenceburg	139	...	...	...	185	25	451	40	*158	840
Brookville	...	...	...	...	518	32	120	...	*174	670
Connersville	90	...	...	...	375	240	61	...	*117	766
Cambridge City	96	...	2	...	400	268	133	...	*174	900
Winchester	131	...	69	22	553	240	95	...	*53	1,110
Ridgeville	30	...	200	12	436	303	167	...	*1	1,148
Portland, No. 2	58	...	192		500	240	24	...	63	924
Decatur	39	30	450	20	291	200	10	...	223	1,040
Ft. Wayne, No. 1	77	30	550	20	400	351	70	...	693	1,498
Auburn	280	†120	‡963	...	300	268	27	...	1,069	1,964
Butler	378	†108	‡1,064	...	300	200	89	...	1,194	2,139

* Trenton above sea level.
† Black shale, 120 feet.
‡ Corniferous, Waterlime and Niagara.

Trenton rock rises from Lawrenceburg to Brookville, falls from Brookville to Connersville, rises from Connersville to Cambridge City, and falls gradually from Cambridge City to Ft. Wayne and northward, at the rate of about 5½ feet to the mile. In Steuben County it will probably be found in the neighborhood of 1,400 feet below sea level.

At North Vernon, Jennings County, fifty miles west of Lawrenceburg, Trenton rock is found 980 feet below the surface and 253 feet below sea level. At Greensburg, twenty-five miles north of Vernon, it is 920 feet below the surface and 22 feet above sea level. At Rushville, twenty miles north of Greensburg, it is 860 feet below the surface and $124\frac{41}{100}$ feet above sea level. At New Castle, twenty-five miles north of Rushville, it is 876 feet below the surface, in well No. 1, and 104 feet above sea level. At Muncie, sixteen miles north of New Castle, it is 898 feet below the surface, in well No. 1, and 77 feet above sea level. At Eaton, eleven miles north of Muncie, it is 890 feet below the surface, and 20 feet below sea level. At Hartford City, seven miles north of Eaton, it is 935 feet below the surface, in well No. 2, and 40 feet below sea level. At Montpelier, nine miles north of Hartford City, it is 962 feet below the surface, and 110 feet below sea level. At Bluffton, thirteen miles northeast of Montpelier, it is 1,075 feet below the surface, in well No. 2, and 223 feet below sea level. At Huntington, twenty miles northeast of Bluffton, it is 995 feet below the surface, in well No. 1, and 255 feet below sea level. At Columbia City, twenty miles north of Huntington, it is 1,367 feet below the surface, and 545 feet below sea level. At Albion, twenty miles north of Columbia City, it is 1,980 feet below the surface, and 973 feet below sea level.

The following table, No 2, shows the thickness of the strata encountered at the various points above mentioned, total depth of well and distance of Trenton above or below sea level.

TABLE No. II.

	Drift.	Devonian Shale.	Carniferous Limestone.	Lower Helderburg or Waterlime.	Niagara Limestone.	Clinton Limestone.	Hudson River Limestone and Shale.	Utica Shales.	Trenton Limestone.	Trenton Below Sea Level.	Total Depth.
North Vernon	11	. .	58	. . .	222	29	440	220	470	253	1,450
Greensburg, No. 1	7	. . .	. . .	. .	90	. . .	713	110	63	*22	983
Rushville, No. 1	60	. . .	40	.	180	20	300	260	124	*124	984
New Castle, No. 1	333	. . .	. .	. . .	. . .	. . .	200	343	421	*104	1,297
Muncie, No. 1	. . .	. . .	. . .	. . .	265	. . .	300	311	22	*77	898
Eaton, No. 1	. .	. .	. . .	. . .	190	10	400	290	32	12	922
Hartford City, No. 2	82	. . .	. . .	. .	180	. . .	533	140	32	40	967
Montpelier, No. 1	17	. .	. . .	. . .	233	. . .	450	262	19	110	981
Bluffton, No. 2	51	.	. . .	30	479	. .	340	175	31	238	1,106
Huntington, No. 1	2	. . .	. . .	38	370	. . .	275	320	39	255	1,034
Columbia City	224	. . .	. .	46	480	. . .	400	218	40	546	1,409
Albion	375	65	65	†35	815	.	285	250	24	973	1,914

* Above sea level.
† Oriskany, probably 5 ft.

The drill has revealed that the Trenton limestones rise 275 feet from North Vernon to Greensburg, a distance of 25 miles, or 11 feet to the mile; from Greensburg to Rushville, a distance of 20 miles, they rise 102 feet, but a little more than 5 feet to the mile; from Rushville to New Castle, 24 miles, they fall 20 feet, less than 1 foot to the mile; from New Castle to Muncie, 18 miles distant, they fall 27 feet, 1½ feet to the mile; from Muncie to Eaton, distant 11 miles, they fall 91 feet, more than 8 feet to the mile; from Eaton to Montpelier, distant 16 miles, they fall 98 feet, about 6 feet to the mile; from Montpelier to Huntington, distant about 22 miles, they fall 145 feet, about 7 feet to the mile; from Huntington to Columbia City, distant 20 miles, they fall 291 feet, nearly 15 feet to the mile, and from Columbia to Albion, distant about 22 miles, they fall 427 feet, about 20 feet to the mile.

At Jeffersonville, on the Ohio River, the Trenton rocks lie 856 feet below the surface, and 401 feet below sea level; at Seymour, 49 miles north, they lie 1,100 feet below the surface, and 472 feet below sea level; at Columbus, 18 miles north of Seymour, they are 955 feet below the surface, and 325 feet below sea level; at Shelbyville, 24 miles north of Columbus, they are 837 feet below the surface, in well No. 1, and 79 feet below sea level; at Greenfield, 18 miles north of Shelbyville, they are 985 feet below the surface, in well No. 1, and 54 feet below sea level; at Anderson, 22 miles north of Greenfield, they are 814 feet below the surface, in well No. 2, and 66 feet above sea level; at Marion, 31 miles north of Anderson, they are 878 feet below the surface, in well No. 3, and 67 feet below sea level; at La Fontaine, 10 miles north of Marion, they are 900 feet below the surface, and 6 feet below sea level; at Wabash, 10 miles north of La Fontaine, they are 878 feet below the surface, and 198 feet below sea level; at North Manchester, 15 miles north of Wabash, they are 1,030 feet below the surface, and 255 feet below sea level; at Warsaw, 19 miles north of North Manchester, they are 1,387 feet below the surface, and 570 feet below sea level; at Goshen, 24 miles north of Warsaw, they are 1,815 feet below the surface, and 1,076 feet below sea level.

The following table, No. 3, shows the thickness of the strata encountered in wells at the various points mentioned above, together with the total depth of the wells, and distance of Trenton rock above or below sea level:

TABLE No. III.

STATIONS.	Drift.	Devonian Shale.	Corniferous.	Lower Helderburg.	Niagara.	Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.
Jeffersonville	45	...	40	...	105	20	500	146	...	401	856
Seymour	75	130	25	...	190	...	500	165	94	472	1,194
Columbus	26	74	21	...	259	...	440	135	155	325	1,110
Shelbyville, No. 1	48	...	20	...	202	...	450	117	86	79	923
Greenfield, No. 1	205	...	...	...	170	...	400	210	14	54	999
Anderson, No. 2	114	...	...	...	186	20	440	54	24	*66	838
Marion, No. 5	185	...	...	...	145	...	350	220	36	49	906
La Fontaine	300	...	...		225	...	175	200	23	6	923
Wabash, No. 1	25	...	...	40	425	30	200	158	54	138	932
North Manchester	274	...	...	...	300	...	250	306	50	355	1,180
Warsaw, No. 1	224	...	...	60	592	...	200	287	...	570	1,464
Goshen	165	308?	60	32	728	...	307	215	...	1,076	...

* Trenton above sea level.

The stations mentioned in the foregoing table are all very near to a due north and south line running entirely through the State. Anderson, almost in the center, is on the summit of the Trenton rocks. At this point they are 66 feet above sea level. Southward, from Anderson to Greenfield, the dip is nearly 6 feet to the mile; from Greenfield to Shelbyville it is 1 foot to the mile; from Shelbyville to Columbus it is 10 feet to the mile; from Columbus to Seymour it is 8 feet to the mile; from Seymour to Jeffersonville it is northward 1½ feet to the mile. Northward, from Anderson to Marion, the dip is 4 feet to the mile. From Marion to La Fontaine the Trenton rocks rise at the rate of 4 feet to the mile, but they fall from La Fontaine to Wabash at the rate of 13 feet to the mile. From Wabash to North Manchester the dip is 15 feet to the mile; from North Manchester to Warsaw it is 12 feet to the mile, and from Warsaw to Goshen, 25 feet to the mile.

At the Gas Works well, Indianapolis, Trenton rock is 179 feet below sea level; at Broad Ripple, nine miles north, it is 109 feet below sea level; at Noblesville, eleven miles north of Broad Ripple, it is 76 feet below sea level in the Banner well; at Tipton, seventeen miles north of Noblesville, it is 129 feet below sea level in well No. 1; at Kokomo, fifteen miles north of Tipton, it is 97 feet below sea level in well No. 4; at Peru, twenty-one miles north of Kokomo, it is 229 feet below sea level in well No. 2.

The following table, No. 4, gives a record of the strata passed through in boring wells at the stations mentioned along the line of the Lake Erie & Western Railroad from Indianapolis to Peru:

TABLE No. IV.

STATIONS.	Drift.	Devonian Shale.	Corniferous.	Lower Helderberg.	Niagara.	Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.	Remarks.
Indianapolis	118	..	68	20	200	20	300	74	620	179	1,520	Dry.
Broad Ripple	55	..	28	20	257	20	400	84	24	109	888	Gas.
Noblesville, No. 5	73	..	..	..	239	30	350	126	9	76	853	Gas.
Tipton, No. 1	139	..	..	30	260	36	400	132	33	129	1,030	A little gas & oil.
Kokomo, No. 4	61	..	..	59	270	30	265	251	22	97	958	Gas.
Peru, No. 2	10	..	..	50	360	15	249	200	27	229	956	Dry.
Rochester	245	..	..	..	525	..	200	191	24	351	1,185	

From Indianapolis to Broad Ripple the Trenton rocks rise at the rate of 8 feet to the mile; from Broad Ripple to Noblesville they rise at the rate of 3 feet to the mile; from Noblesville to Tipton they fall at the rate of 3 feet to the mile; from Tipton to Kokomo, they rise at the rate of 2 feet to the mile; from Kokomo to Peru they fall at the rate of 6 feet to the mile

At Martinsville, Morgan County, the Trenton limestones are 780 feet below sea level; at Bridgeport, twenty-one miles north, they are 247 feet below sea level; at Lebanon, twenty-two miles north, and six miles west of Bridgeport, they are 302 feet below sea level; at Frankfort, eighteen miles north of Lebanon, they are 227 feet below sea level; at Delphi, twenty miles north of Frankfort, they are 334 feet below sea level in well No. 1, and 350 feet below sea level in well No. 2.

The following table, No. 5, shows the thickness of the different groups of rock encountered in boring wells at the places above mentioned, together with the depth to Trenton, total depth of well, etc.:

TABLE No. V.

STATIONS.	Drift.	Sub-Carb.	Devonian Shale.	Corniferous.	Niagara.	Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.	Remarks.
Martinsville	85	323	120	62	216	20	420	131	51	780	1,448	No gas.
Bridgeport	140	...	134	20	220	24	455	55	70	247	1,108	No gas.
Lebanon	378	...	...	..	...	..	...	...	.	302	1,800	No gas.
Frankfort	278	...	...	60	300	30	250	150	260	227	1,328	No gas.
Delphi, No. 1	...	...	...	..	587	..	220	93	12	334	912	No gas.

From Martinsville to Bridgeport the Trenton limestones rise 533 feet, or nearly 24½ feet to the mile; from Bridgeport to Lebanon they fall 55 feet, about 2½ feet to the mile; from Lebanon to Frankfort they rise 75 feet, or 4 feet to the mile; from Frankfort to well No. 1, Delphi, they fall 107 feet, or 5½ feet to the mile.

In well No. 1, at Delphi, the Trenton limestones were reached at a depth of 334 feet below sea level, while in well No. 2, bored near by, they were found 16 feet lower down, or 350 feet below sea level. This fact clearly proves that the marked disturbances in the strata so clearly disclosed in the surface exposures at that place are just what the common observer will conclude that they are, simply distortions produced by physical or mechanical forces.

The paper entitled "The Wabash Arch," which appeared in the Fifteenth Report of the State Geologist, was written before the first well was drilled in the Indiana gas field, and the conclusions therein presented were the result of superficial examinations only, but the later facts revealed by the drill in the numerous gas wells of the State, when carefully studied, furnish still stronger and more direct evidence of the correctness of those first conclusions. The views set forth in that first article were undoubtedly correct in the main.

At Bloomington, Monroe County, the Trenton limestones lie 1,108 feet below sea level; at Crawfordsville, seventy-three miles north, they are 664 feet below sea level; at the Lafayette well No. 1, near Porter Station, thirty-two miles north of Crawfordsville, they are 548 feet below sea level; at Monticello, twenty-two miles north and a little east of the Lafayette well, they are 338 feet below sea level; at Francisville, nineteen miles north of Monticello, they are 200 feet below sea level; at Valparaiso, thirty-six miles north, and a little west of Francisville, they are 602 feet below sea level.

The following table, No. 6, shows the thickness of the strata encountered in wells at each of the points mentioned above, together with the depth of Trenton rock below sea level, and the total depth of well.

TABLE No. VI.

STATIONS.	Drift.	Sub.-Carb.	Devonian Shale.	Corniferous.	Lower Helderberg.	Niagara.	Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.
Bloomington	6	749	155	15	.	240	. .	485	180	626	1,108	2,730
Crawfordsville	140	410	80	55	. . .	380	. .	250	115	69	664	1,49[illegible]
Lafayette, No. 1		100	120	60	. .	100	. .	288	110	72	548	1,20[illegible]
Monticello	205	.	. . . .	. .	40	465	. .	120	170	63	338	1,073
Francisville	8	. . .	. . . .		60	542	. .	235	100	10	200	895
Valparaiso	125	. . .	65	70	80	505	. .	260	195	144	602	1,44[illegible]

From Bloomington to Crawfordsville the Trenton limestones rise at the rate of about 6½ feet to the mile; from Crawfordsville to Lafayette they rise at the rate of about 4 feet to the mile; from Lafayette to Monticello they rise at about the rate of 9½ feet to the mile; from Monticello to Francisville they rise at the rate of a little more than 7 feet to the mile, but from Francisville to Valparaiso they fall at the rate of about 14 feet to the mile. At Francisville the Trenton limestones are 402 feet higher than they are at Valparaiso, a little more than thirty miles north, and 348 feet higher than they are at Lafayette, about the same distance south, and 464 feet higher than they are at Crawfordsville, still farther south. The total elevation of the Wabash Arch in this portion of the State approximates 500 feet, even if it does not exceed that height. Whatever the causes that produced this elevation, and whatever differences of opinion may be entertained concerning its origin, the facts of its existence are absolute. But when the distorted and tilted condition of the exposed rocks throughout this region are considered, together with the continued, and, in many places, the abrupt dip of the strata southward and northward from it, the conclusion is forced that it was produced by the physical forces of nature, at a period infinitely remote.

At Rockville, Parke County, Trenton rock is 1,412 feet below sea level; at Oxford, Benton County, fifty miles north, it is 570 feet below sea level; at Fowler, seven miles north of Oxford, it is 181 feet below sea level; at Kentland, twelve miles northwest of Fowler, it is 370 feet below sea level; at Rensselaer, seventeen miles northeast of Kentland, it is 162 feet below sea level. The dip from Fowler to Kentland, northwest, is a little more than 7 feet to the mile; from Fowler to Oxford, south, it is 58 feet to the mile, and from Oxford to Rockville it is about 17 feet to the mile; from Rensselaer to Kentland, south, it is 6½ feet to the mile.

The following table, No. 7, gives the thickness of the strata encountered in wells at the above mentioned stations, together with depth to Trenton, total depth of wells, etc.:

TABLE No. VII.

STATIONS.	Drift.	Coal Measures.	Sub-Carboniferous.	Devonian Shale.	Corniferous.	Lower Helderberg.	Niagara.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.	Remarks.
Rockville	96	259	689	102	62	. .	370	324	108	10	1,412	2,110	Dry.
Oxford	385	. .	. .	100	45	. .	385	185	188	. .	570		
Fowler	280	. .	. .	92	45	. .	238	185	155	. .	181	995	
Kentland	100	. .	. .	100	45	. .	305	300	210	60	370	1,120	
Rensselaer	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	158	896	

We have no accurate records of any wells due north of Kentland, Ind., showing the thickness of the strata nor the dip of the rocks.

The seven tables given above give a very correct idea of the variations in altitude of the Trenton limestone in a north and south direction through the State. Sections of wells will be given further on, which show more marked irregularities of structure than the foregoing. Great care has been taken to procure the most reliable data concerning the many wells bored for natural gas throughout the State, and the sections given herewith may be regarded as the most reliable that it has been possible to procure.

To more thoroughly show the position of Trenton rock, as regards sea level, the following tables are presented, which show its dip, or variations in elevation on lines running easterly and westerly through the State. These in a number of instances include wells not given in the seven preceding tables.

At Lawrenceburg, Dearborn County, the Trenton limestones are 158 feet above sea level; at North Vernon, fifty miles west, they are 253 feet below sea level; at Seymour, fifteen miles west of North Vernon, they are 472 feet below sea level.

The following table, No. 8, shows the thickness of the strata encountered in the wells at each of the places mentioned, depth of Trenton above or below sea level, etc.:

TABLE No. VIII.

STATIONS.	Drift.	Coal Measures.	Sub-Carboniferous.	Devonian Shale.	Corniferous.	Lower Helderberg.	Niagara.	Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.
Lawrenceburgh	139	. .	. .	. .	. .	. .	. .	. .	185	25	451	*158	840
North Vernon	11	. .	. .	. .	58	. .	222	29	440	220	470	253	1,450
Seymour	75	. .	. .	130	25	. .	190	. .	500	165	94	472	1,194

*Trenton above sea level.

From Lawrenceburg to North Vernon the dip of Trenton rock is a little more than 8 feet to the mile, and from North Vernon to Seymour it is a little more than 14½ feet to the mile.

At Brookville, Franklin County, about thirty miles north of Lawrence burg, the Trenton limestones are 174 feet above sea level; at Greensburg, twenty-six miles west and six miles south of Brookville they are 24 feet above sea level; at Columbus, twenty-two miles west, and about eight miles south of Greensburg they are 325 feet below sea level, and at Bloomington, thirty-three miles west of Columbus, they are 1,108 feet below sea level. From Brookville to Greensburg the dip is at the rate of 6 feet to the mile, from Greensburg to Columbus it is at the rate of 16 feet to the mile, and from Columbus to Bloomington it is at the rate of nearly 24 feet to the mile.

The following table, No. 9, gives the thickness of the strata encountered in drilling wells at Brookville, Greensburg, Columbus and Bloomington, with the distance of Trenton rock above or below sea level, total depth of well, etc.:

TABLE No. IX.

STATIONS.	Drift.	Coal Measures.	Sub-Carboniferous.	Devonian Shale.	Corniferous.	Lower Helderberg.	Niagara.	Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.
Brookville	. .	. .	. . .	. . .	. .	. . .	. .	. .	518	32	120	*174	670
Greensburg	7	. .	. . .	. .	. .	. . .	90	. .	713	110	63	*22	984
Columbus	26	. .	. .	74	21	. . .	259	. .	440	135	155	325	1,110
Bloomington	6	. .	749	155	15	. . .	240	. .	485	180	626	1,108	2,730

*Trenton above sea level.

Connersville, Fayette County, is twenty-five miles north of Brookville. At Connersville the Trenton limestones are 117 feet above sea level; at

Rushville, eighteen miles west of Connersville, they are 124 feet above sea level; at the Muth well, Morristown, fifteen miles west of Rushville, they are 44 below sea level; at Shelbyville, fifteen miles southwest of Morristown, they are 79 feet below sea level: at Martinsville, thirty-six miles west of Shelbyville, they are 780 feet below sea level.

From Connersville to Rushville the Trenton rocks rise at the rate of about one-half foot to the mile; from Rushville to Morristown the dip is at the rate of about 11 feet to the mile; from Morristown to Shelbyville the dip is at the rate of 2½ feet to the mile; from Shelbyville to Martinsville the dip is at the rate of about 19 feet to the mile.

The following table, No. 10, shows the thickness of strata passed through in boring wells at the several places mentioned, the elevation of Trenton rock as compared with sea level, total depth of wells, etc.:

TABLE No. X.

STATIONS.	Drift.	Coal Measures.	Sub-Carboniferous.	Devonian Shale.	Corniferous.	Lower Helderberg.	Niagara.	Clinton.	Hudson River.	Utica.	Trenton.	Trenton below sea level.	Total depth.
Connersville, No. 2	90	..	..	..	..	..	..	...	375	240	61	*117	766
Rushville	60	..	..	..	40	..	180	20	300	260	124	*124	984
Morristown	140	..	..	..	..	..	130	...	450	178	23	44	921
Shelbyville	48	..		..	20	..	202		450	117	86	79	923
Martinsville	85	..	323	120	62	..	216	202	420	131	51	780	1,448

Richmond, Ind., is about twenty miles north of Connersville, and fifteen miles east. At Richmond the Trenton limestone is 79 feet above sea level: at Cambridge City, fifteen miles west, it is 174 feet above sea level; at Knightstown, nineteen miles west of Cambridge City, it is 113 feet above sea level; at Greenfield, thirteen miles west of Knightstown, it is 54 feet below sea level; at Indianapolis, twenty miles west of Greenfield, it is 179 feet below sea level; at Bridgeport, nine miles west of Indianapolis, it is 247 feet below sea level, and at Rockville, fifty miles west of Bridgeport, it is 1,412 feet below sea level.

The dip of rocks from Cambridge City eastward to Richmond is at the rate of about 6 feet to the mile, and from Cambridge City to Knightstown westward, it is at the rate of but little more than 3 feet to the mile. From Knightstown to Greenfield the dip is at the rate of about 13 feet to the mile, but from Greenfield to Indianapolis it is little more than 6 feet to the mile. From Indianapolis to Bridgeport the rocks dip at the rate of 7½ feet to the mile, and from Bridgeport to Rockville at the rate of 23 feet to the mile.

The following table, No. 11, shows the thickness of the various groups of rocks encountered in boring wells at the points named, together with the altitude of Trenton limestone with respect to sea level, total depth of well, etc.:

TABLE No. XI.

STATIONS.	Drift.	Coal Measures.	Sub-Carboniferous.	Devonian Shale.	Corniferous.	Lower Helderberg.	Niagara.	Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.
Richmond	. . .	. .	. .	. .	. .	. .	. . .	. .	500	380	5[illegible]0	*79	1,400
Cambridge City	96	. .	. .	. .	. .	. .	2	. .	400	268	133	*174	900
Knightstown	64	. .	. .	. .	. .	. .	260	. .	300	199	213	*113	1,036
Greenfield	205	. .	.	. .	.		170		400	210	14	54	999
Indianapolis	118	. .	.	. .	68	20	200	20	300	74	620	179	1,520
Bridgeport	140	.	. .	124	20	. .	244	. .	455	55	70	247	1,108
Rockville	96	259	689	102	62		370	. .	324	108	10	1,412	2,110

*Trenton above sea level.

At Winchester the top of Trenton limestone is 43 feet above sea level in well No. 1. From Winchester to Muncie it rises at the rate of nearly 3 feet to the mile, and in well No. 1, at the latter place, it is 97 feet above sea level. From Muncie to Anderson there is a dip of 2 feet to the mile; from Anderson to Noblesville the dip is greater, being at the rate of 7½ feet to the mile. From Noblesville to Lebanon the dip increases to 9 feet to the mile, and from Lebanon to Crawfordsville it is still more rapid, being at the rate of 18 feet to the mile.

The following table, No. 12, gives the records of wells at the points mentioned above, showing thickness of strata, etc.:

TABLE No. XII.

STATIONS.	Drift.	Coal Measures.	Sub-Carboniferous.	Devonian Shale.	Upper Helderberg or Corniferous.	Lower Helderberg.	Niagara and Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.
Winchester, No. 1	147	. .	. . .	. . .	. . .	. . .	71	582	250	90	*43	1,140
Muncie, No. 1	. . .	. .	. . .	. . .	. . .	. . .	265	400	211	22	*97	898
Anderson	114	. .	. . .	. . .	. . .	. . .	206	440	54	24	*66	838
Noblesville, Banner Well	73	. .	. . .	. . .	. .	. .	236	300	76	9	76	853
Lebanon	. . .	. .	. . .	.	. . .	. . .	. . .	. .	. .	. .	302	1,800
Crawfordsville	140	. .	410	80	55	. . .	380	250	115	69	664	1,499

*Trenton abo   sea level.

At Portland, Jay County, the top of Trenton limestone is 90 feet below sea level in well No. 2; at Hartford City, twenty-two miles west, it is 40 feet below sea level, the eastward dip between the two points being at the rate of a little more thon 2 feet to the mile. From Hartford City to Fairmount, twenty miles west, the westward dip is only 1 foot in twenty miles, the top of the limestone being 41 feet below sea level in well No. 1, at the latter point. From Fairmount to Kokomo the dip is at the rate of a little more than 2 feet to the mile; from Kokomo to Lafayette it is at the rate of 10 feet to the mile, and from Lafayette to Oxford, Benton County, it is at the rate of only 1 foot to the mile.

The following table, No. 13, shows the thickness of the various groups of rocks encountered in drilling wells at the points mentioned above, together with depth of Trenton limestone below sea level, etc.:

TABLE No. XIII.

STATIONS.	Drift.	Coal Measures.	Sub-Carboniferous.	Devonian Shale.	Upper Helderberg.	Lower Helderberg.	Niagara and Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.
Portland, No. 2. . . .	58	. .	. .	. . .	. .	.	192	500	240	14	90	1,004
Hartford City	82	. .	. . .	. . .	. . . .	. . .	180	533	140	28	40	963
Fairmount, No. 1. . .	35	. .	. . .	. .	. .	. . .	309	350	240	31	41	965
Kokomo, No 4	61	. .	. . .	. . .	. . .	30	329	265	251	22	97	958
Lafayette, Porter's. .		. .	280	. . .		. . .	350	300	198	20	548	1,148
Oxford	385	. .	. . .	100	50	30	265	255	188	20	570	1,293

At Decatur, Adams County, the top of Trenton limestone is 223 feet below sea level; at Huntington, thirty miles west, it is 247 feet below sea level; at Wabash, nineteen miles west of Huntington, it is 197 feet below; at Logansport, twenty-nine miles west of Wabash, it is 344 feet below; at Monticello, a little more than twenty miles west of Logansport, it is 338 feet below, and at Kentland, about twenty-five miles west of Monticello, it is 379 feet below. The westward dip of the strata from Decatur to Huntington is less than one foot to the mile; from Huntington to Wabash it rises at the rate of about 2½ feet to the mile; from Wabash to Logansport the dip is at the rate of 5 feet to the mile; from Logansport to Monticello it rises at the rate of ¼ foot to the mile, and from Monticello to Kentland falls or dips at the rate of 1½ feet to the mile.

Table No. 14 shows the thickness of strata drilled through in wells at the above named places, the depth of Trenton rock below sea level, etc.:

TABLE No. XIV.

TATIONS.	Drift.	Coal Measures.	Sub-Corbon-iferous.	Devonian Shale.	Upper Helderberg.	Lower Helderberg.	Niagara and Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.
Decatur.	39	. .	. . .	. . .	. . .	40	440	300	211	10	223	1,040
Huntington	. . .	. .	. . .	. . .	. . .	. . .	441	266	315	. .	247	1,022
Wabash, No. 2	28	. .	. . .	. . .	. . .	40	485	160	165	54	198	932
Logansport, No. 1 . .	. . .	. .	. . .	. . .	. .	. .	. .	. .	. .	. .	344	. . .
Monticello	205	. .	. . .	. . .	. . .	. . .	515	170	120	63	338	1,073
Kentland, ...	100	. .	. . .	100	45	. .	305	300	210	60	379	1,120

Ft. Wayne is about fifteen miles north of Decatur, and about eight miles west. At Ft. Wayne, in well No. 2, Trenton rock is about 650 feet below sea level; at Columbia City, twenty miles northwest, it is 545 feet below sea level; at Rochester, about thirty-eight miles west, and a little south of Columbia City, it is 351 feet below sea level; at Kewana, eleven miles west of Rochester, it is 274 feet below sea level; at Francisville, twenty miles west of Kewana, it is 200 feet below sea level; at Renssalaer, eleven miles west of Francisville, it is 158 feet below sea level. It will be noticed that there is an eastward dip of the rocks all the way across the State from Renssalaer to Ft. Wayne, the average dip is about 5 feet to the mile.

The following table, No. 15, shows the thickness of the various strata encountered in drilling wells for gas at the points above mentioned, depth to Trenton rock, altitude of Trenton rock as compared with sea level, etc.:

TABLE No. XV.

STATIONS.	Drift.	Coal Measures.	Sub-Carboniferous.	Devonian Shale.	Upper Helderberg.	Lower Helderberg.	Niagara and Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.
Fort Wayne, No. 2 .	110	. .	. . .	. . .	. . .	34	571	410	312	21	650	1,458
Columbia City . . .	224	. .	. .	. . .	. . .	. . .	526	400	217	39	545	1,407
Rochester	245	. .	.	. . .	40	40	460	260	101	24	351	1,185
Kewana	170	. .	. . .	. . .	.	. .	500	205	175	29	274	1,089
Francisville	8	. .	.	. . .	.	30	512	235	100	10	200	895
Rensselaer	30	. .	. . .	. .	. . .	35	500	225	100	3 0	158	1,275

At Auburn, twenty-two miles north of Ft. Wayne, Trenton rock is 1,069 feet below sea level; at Albion, twenty miles west of Auburn, it is 963 feet below sea level, and at Warsaw, twenty-five miles southwest of Albion, it is 570 feet below sea level. From Warsaw to Albion it dips at the rate of about 8 feet to the mile, and from Albion to Auburn it dips at the rate of about 10 feet to the mile. Throughout this section of the country the dip is either east, northeast or north.

The following table, No. 16, shows the thickness of the strata encountered in drilling wells at the above mentioned places, together with the depth of the Trenton rock, distance of Trenton rock below sea level, etc.:

TABLE No. XVI.

STATIONS.	Drift.	Coal Measures.	Sub-Corboniferous.	Devonian Shale.	Upper Helderberg.	Lower Helderberg.	Niagara and Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.
Auburn.	280	. .	. . .	120	80	40	823	300	268	27	1,069	1,964
Albion	375	. .	. . .	65	65	35	815	285	250	24	973	1,914
Warsaw.	248	. .	. . .	. . .	. . .	60	652	200	287	. .	570	1,464

Goshen, Ind., is twenty-four miles north of Warsaw. At Goshen the top of Trenton rock is 1,076 feet below sea level, which is 506 feet below the top of the same rock at Warsaw; at South Bend, twenty-five miles west of Goshen, the top of Trenton limestone is 855 feet below sea level; at Valparaiso, forty-five miles west by southwest of South Bend, the top of the same rock is 602 feet below sea level. The dip from Valparaiso to South Bend is about 6 feet to the mile, and from South Bend to Goshen, it is about 9 feet to the mile.

The following table, No. 17, shows the thickness of the strata encountered in drilling wells at the above mentioned places, together with the depth to the top of the Trenton limestone, the distance of Trenton below sea level, etc.:

TABLE No. XVII.

STATIONS.	Drift.	Sub-Carboniferous.	Devonian Shale.	Upper Helderberg.	Lower Helderberg.	Niagara and Clinton.	Hudson River.	Utica.	Trenton.	Trenton Below Sea Level.	Total Depth.
Goshen	165	. . .	360	60	32	728	307	215	. . .	1,076	. .
South Bend	160	. . .	220?	60	40	700	200	200	427	855	2,077
Valparaiso	125	. . .	65?	70	80	505	260	195	144	602	1,444

It is easy to discern, after a mere cursory examination of the facts disclosed in the foregoing tables, that there is a general northeasterly dip of the strata in the northern part of the State, and a general southwesterly dip of the strata in the southern part of the State The wide extent of territory included in the Indiana gas area is at the summit of a vast ridge running northwest and southeast, and which slopes off rapidly towards the northeast and the southwest. This ridge extends entirely across the State. The largest accumulations of gas are found along the summit of the ridge, rather than upon the sides. The ridge itself slopes very gradually towards the northwest. A straight line from Cambridge City, where the top of the Trenton limestone reaches its extreme limit of height, 174 feet above sea level, to Renssalaer, Jasper County, also on the summit of the ridge, will pass almost directly through New Castle, Anderson, Tipton, Delphi and Monticello. The following are the elevations of Trenton rock at points named:

Cambridge City	174 ft. above sea level.
New Castle, No. 2	120 ft. above sea level.
Anderson	66 ft. above sea level.
Tipton	127 ft. below sea level.
Delphi, No. 2	350 ft. below sea level.
Monticello	338 ft. below sea level.
Renssalaer	158 ft. below sea level.

The extreme elevations of the ridge, however, do not follow an exact line, but swerve to the north somewhat in the vicinity of the Wabash River. Roughly following the summit of the ridge, as far as facts have been disclosed, the following points would be touched: Renssalaer, Francisville, Royal Center, Peru, and from there to Anderson and the other points occurring on the line given above.

The ridge itself, as before stated, slopes off gradually to the northwest. At Cambridge City its summit is 174 feet above sea level; at Renssalaer it is 158 feet below sea level, a fall of 332 feet in a little more than 150 miles, or a little more than 2 feet to the mile. In the vicinity of the Wabash River, however, there is a slight sag or depression of the summit of the ridge, the top of the Trenton limestones being about 75 feet lower in that vicinity than they are at Renssalaer. In speaking of this vast ridge or anticline it is understood, of course, that reference is made wholly to the elevations of strata and not to the surface nor superficial deposits that are not always conformable.

In every direction from the vast plateau-like elevation that contains the Trenton gas, except to the southeast, there is a more or less rapid dip of the strata. Southeast from the gas area the Trenten limestones rise gradually until finally they appear at the surface in northern Kentucky.

In the search for natural gas wells have been drilled in greater or less numbers in nearly every county in the State, and, so far as it has been possible to do so, complete records of these have been obtained. Following will be found a list showing the records of most of the wells drilled prior to October 1, 1888. In many of the wells referred to below little or no gas was found, but since these wells were drilled others have followed in the same locality with productive results.

The sections given will be found convenient for reference and comparison, and for greater convenience the towns enumerated have been arranged alphabetically.

SECTIONS OF NATURAL GAS WELLS IN INDIANA.

ALBION.

Section of Well No. 1.

Drift	375 feet.
Devonian shale	65 "
Devonian limestone	65 "
Sandstone	5 "
Hydraulic limestone	30 "
Niagara and (Clinton?) limestone and shale	815 "
Hudson River limestone and shale	285 "
Utica shale	250 "
Trenton limestone	24 "
Total depth	1,914 feet.
Trenton below sea level	973 "

Yielded small flow of gas.

ALEXANDRIA.

Section of Well No. 1.

Drift	20 feet.
Niagara limestone	261 "
Hudson River and Utica	611 "
Trenton limestone	5 "
Total depth	897 feet.
Trenton below sea level	40 "

Yielded strong flow of gas.

AMBOY.

Section of Well No. 1.

Drift	35 feet.
Niagara limestone and shale	350 "
Hudson River and Utica	522 "
Trenton limestone	33 "
Total depth	940 feet.

Yielded strong flow of gas.

ANDERSON.

Section of McCullough Well, No. 2.

Drift	114 feet.
Niagara limestone and shale	186 "
Clinton (?)	20 "
Hudson River and Utica	494 "
Trenton limestone	24 "
Total depth	838 feet.
Trenton above sea level	66 "

Yielded very strong flow of gas.

ANDREWS.

Section of Well No. 1.

Drift	70 feet.
Niagara limestone	300 "
Hudson River and Utica	562 "
Trenton limestone	36 "
Total depth	968 feet.

Yielded no gas.

AUBURN.

Section of Well No. 1.

Drift	280 feet.
Black shale	120 "
Corniferous, Water-lime and Niagara	963 "
Hudson River limestone and shale	306 "
Utica shale	268 "
Trenton limestone	27 "
Total depth	1,964 feet.

The pressure of this gas well was 350 pounds in two hours. In five minutes it went to 125 pounds, in 13 minutes to 200 pounds, in 48 minutes to 300 pounds, and in two hours to 350 pounds. The volume of gas is very strong.

BLUFFTON.

Section of Well No. 1.

Drift	12 feet.
Niagara limestone and shale	413 "
Hudson River limestone and shale	340 "
Utica shale	285 "
Trenton limestone	150 "
Total depth	1,200 feet.
Trenton below sea level	213 "

Yielded no gas.

BLUFFTON.

Section of Well No. 2.

Drift	51 feet.
Water lime	30 "
Niagara limestone	479 "
Hudson River limestone and shale	340 "
Utica shale	175 "
Trenton limestone	31 "
Total depth	1,106 feet
Trenton below sea level	238 "

Yielded no gas.

Well No. 2 is located about one-half mile northwest of well No. 1.

BRIDGEPORT.

Section of Well No. 1.

Drift	140 feet.
Devonian shale	124 "
Corniferous limestone	40 "
Niagara limestone	200 "
Hudson River limestone and shale	475 "
Utica shale	55 "
Trenton limestone	74 "
Total depth	1,108 feet.
Trenton below sea level	247 "

Did not yield gas.

BROAD RIPPLE.

Section of Well No. 1.

Drift	55 feet.
Corniferous limestone	48 "
Niagara limestone	257 "
Hudson River and Utica	504 "
Trenton limestone	24 "
Total depth	888 "
Trenton below sea-level	109 "

Yields a small quantity of gas, also a small quantity of oil.

BROOKVILLE.

Section of Well No. 1.

Hudson River and Utica	550 feet.
Trenton limestone	120 "
Total depth	670 "
Trenton above sea-level	174 "

Produces a small quantity of gas

BROWNSTOWN.

Section of Well No. 1.

Drift	43 feet.
Knobstone shale	275 "
Devonian shale	147 "
Corniferous and Niagara limestone	225 "
Hudson River and Utica	658 "
Trenton limestone	100 "
Total depth	1,448 feet.

Yielded no gas, but at a depth of 1,371 feet a slight flow of oil was obtained. The bore was continued to a greater depth after this section was obtained.

BRYAN, OHIO.

Section of Well No. 1.

Drift	176 feet.
Devonian shale	74 "
Corniferous, lower Helderberg and Niagara limestone	1,060 "
Hudson River and Utica	635 "
Trenton limestone	38 "
Total depth	1,983 feet.
Trenton below sea-level	1,180 "

Rock pressure accumulated in ten minutes 185 pounds per square inch.

In well No. 2, at the same place, oil and gas were both found at a depth of 2,035 feet, and salt water at 2,037 feet. In this well Trenton rock was reached at a depth of 1,990 feet, 1,270 feet below sea-level.

BUNKER HILL.

Section of Well No. 1.

Drift	58 feet.
Corniferous and Niagara limestone	503 "
Hudson River and Utica	431 "
Trenton limestone	12 "
Total depth	1,004 feet.
Trenton below sea level	155 "

BUTLER.

Section of Well No. 1.

Drift	378 feet.
Hamilton shale	108 "
Corniferous Water-lime and Niagara	1 064 "
Hudson River and Utica	500 "
Trenton limestone	89 "
Total depth	2,139 feet.
Trenton below sea level	1,187 "

Yielded small flow of gas, which was found at a depth of 27 feet in Trenton rock.

CAMBRIDGE CITY.

Section of Well No. 1.

Drift	96 feet.
Niagara limestone	2 "
Hudson River and Utica	668 "
Trenton limestone	134 "
Total depth	900 feet.
Trenton above sea level	174 ft. 6 in.

Did not yield gas.

CICERO.

Section of Well No. 1.

Drift	161 feet.
Niagara limestone and shale	300 "
Hudson River and Utica	490 "
Trenton limestone	32 "
Total depth	983 feet.

A medium flow of gas was found at a depth of 966 feet, and a considerable flow of oil at $974\frac{5}{10}$ feet, the yield of which is 5 to 20 barrels per day.

COLUMBIA CITY.

Section of Well No. 1.

Drift	224 feet.
Niagara limestone and shale	526 "
Hudson River limestone and shale	400 "
Utica shale	218 "
Trenton limestone	39 "
Total depth	1,407 feet.
Trenton below sea level	545 "

Yielded a trace of gas.

COLUMBUS.

SECTION OF WELL NO. 1.

Drift	26 feet.
Devonian shale	87 "
Corniferous limestone	32 "
Niagara limestone	235 "
Hudson River limestone and shale	440 "
Utica shale	135 "
Trenton limestone	155 "
Total depth	1,110 feet.
Trenton below sea level	311 "

Yielded no gas.

CONNERSVILLE.

SECTION OF WELL NO. 1.

Drift, Hudson River and Utica	712 feet.
Trenton limestone	522 "
Potsdam sandstone	12 "
Total depth	1,246 feet.
Trenton above sea level	120 "

Yielded a small flow of gas.

CONNERSVILLE.

SECTION OF WELL NO. 2.

Drift	90 feet.
Hudson River and Utica	615 "
Trenton limestone	61 "
Total depth	766 feet.
Trenton above sea level	117 "

Yielded small flow of gas.

CRAWFORDSVILLE.

SECTION OF WELL NO. 1.

Drift	140 feet.
Sub-Carboniferous rocks	410 "
Devonian shale	80 "
Corniferous limestones	55 "
Niagara limestones	380 "
Hudson River and Utica	365 "
Trenton limestone	69 "
Total depth	1,499 feet.
Trenton below sea level	664 "

Yielded no gas.

DECATUR.

SECTION OF WELL NO. 1.

Drift	39 feet.
Water-lime and Niagara limestone	480 "
Hudson River and Utica	511 "
Trenton limestone	10 "
Total depth	1,040 feet.
Trenton below sea level	223 "

Yielded no gas.

DELPHI.

SECTION OF WELL NO. 1.

Niagara limestone	587 feet.
Hudson River limestone and shale	220 "
Utica shale	93 "
Trenton limestone	12 "
Total depth	912 feet.
Trenton below sea level	334 "

Yielded no gas.

DELPHI.

SECTION OF WELL NO. 2.

Niagara limestone	565 feet.
Hudson River and Utica shale	351 "
Trenton limestone	434 "
Potsdam sandstone	12 "
Total depth	1,362 feet.
Trenton below sea level	350 "

Yielded no gas.

DELTA, OHIO.

SECTION OF WELL NO. 1.

Drift	117 feet.
Devonian shale	133 "
Devonian limestone	45 "
Water-lime and Niagara limestone	737 "
Hudson River and Utica	1,030 "
Trenton limestone	239 "
Total depth	2,301 feet.
Trenton below sea level	1,241 "

Moderate flow of gas.

DUNKIRK.

Section of Well No. 1.

Drift	60 feet.
Niagara limestone	230 "
Hudson River and Utica	640 "
Trenton limestone	25 "
Total depth	955 feet.
Trenton above sea level	39 "

Yielded very strong flow of gas.

In this well gas is found in the shale of a depth of 462 feet, which burns from the well head, making a flame eight feet high.

ELKHART.

Section of Well No. 1.

Drift	122 feet.
Sub-Carboniferous shale (gray shale)	213 "
Hamilton black shale	215 "
Corniferous limestone	65 "

At this depth the well was abandoned, under the erroneous belief that the drill had passed through the Hudson River and Utica shales, and that the Corniferous was Trenton limestone.

ELWOOD.

Section of Well No. 1.

Drift	106 feet.
Limestone and shales	834 "
Trenton limestone	8 "
Total depth	948 feet.

Yielded strong flow of gas.

ELWOOD.

Section of Well No. 2.

Drift	54 feet.
Niagara limestone	270 "
Hudson River limestone and shale	260 "
Utica shale	340 "
Trenton limestone	16 "
Total depth	940 feet.
Trenton below sea level	66 "

Yielded strong flow of gas.

FAIRMONT.

Section of Well No. 1.

Drift	35 feet.
Niagara limestone	309 "
Hudson River and Utica	590 "
Trenton limestone	31 "
Total depth	965 feet.
Trenton below sea level	41 "

Yielded very strong flow of gas.

FAIRMONT.

Section of Well No. 2.

Drift	17 feet.
Niagara limestone and shale	305 "
Hudson River and Utica	588 "
Trenton limestone	54 "
Total depth	964 "
Trenton below sea level	23 "

Yielded very strong flow of gas.

FARMLAND.

Section of Well No. 1.

Drift	55 feet.
Niagara limestone	160 "
Hudson River limestone and shale	585 "
Utica shale	185 "
Trenton limestone	32 "
Total depth	1,017 feet.
Trenton above sea level	55 "

A good flow of gas was found at a depth of 995 feet.

FT. WAYNE.

Section of Well No. 1. Finished Nov. 18, 1886.

Drift	77 feet.
Water-lime	30 "
Niagara	570 "
Hudson River and Utica	751 "
Trenton limestone	15 "
Total depth	1,443 feet.
Trenton below sea level	693 "

Gas with an initial pressure of 160 pounds to the square inch was found upon reaching Trenton rock at a depth of 1,428 feet; at a depth of 1,431 feet a considerable quantity of oil was found.

FT. WAYNE.

Section of Well No. 2.

Drift	110 feet.
Lower Helderberg	34 "
Niagara limestone and shale	571 "
Hudson River limestone and shale	410 "
Utica shale	312 "
Trenton limestone	21 "
Total depth	1,458 feet.
Trenton below sea-level	650 "

Yielded no gas. Salt water, however, was found in considerable quantities.

FT. WAYNE.

Section of Well Bored on Section 4, Township 32, Range 12, Perry Township, Allen County, by Prof. Dryer.

Surface above sea level	844 feet.
Drift	281 "
Limestone	749 "
White shale	430 "
Black shale	240 "
Trenton limestone	52 "
Total depth	1,752 feet.
Trenton below sea level	856 "

Did not strike gas, oil nor salt water.

FOWLER.

Section of Well No. 1.

Drift	280 feet.
Devonian black shale	92 "
Corniferous limestone	40 "
Niagara limestone	328 "
Hudson River and Utica	255 "
Total depth	995 feet.
Trenton below sea level	181 "

Did not yield gas.

FRANCISVILLE.

SECTION OF WELL No. 1.

Drift	8 feet.
Niagara limestone	542 "
Hudson River limestone and shale	235 "
Utica shale	100 "
Trenton limestone	10 "
Total depth	895 feet.
Trenton below sea level	200 "

Yielded a small quantity of gas.

Petroleum was found in the shales at a depth of 630 feet, which accumulated in the bore at the rate of about 25 barrels per day. The oil produced was a heavy grade, and made a fair lubricator upon actual test. Another stratum bearing oil occurred in the Trenton rock at a depth of 885 feet. The yield, however, being less than that from the stratum above.

FRANKFORT.

SECTION OF WELL No. 2.

Drift	278 feet.
Niagara limestone and shale	380 "
Trenton limestone	10 "
Hudson River and Utica	400 "
Trenton limestone	260 "
Total depth	1,328 feet.
Trenton below sea level	227 "

Yielded no gas.

FRANKTON.

SECTION OF WELL No. 1.

Drift	88 feet.
Niagara limestone and shale	272 "
Hudson River and Utica	480 "
Trenton limestone	22 "
Total depth	862 feet.

Yielded good flow of gas.

GALVESTON.

SECTION OF WELL No. 1.

Drift	40 feet.
Corniferous and Niagara limestone	410 "
Hudson River and Utica	480
Trenton limestone	20 "
Total depth	950 feet.

Yielded no gas.

GARRETT.

Section of Well No. 1.

Depth to Trenton	1,980 feet.
Total depth	2,160 "
Trenton below sea level	1,098 "

Yielded small flow of gas.

GOSHEN.

Section of Well No. 2.

Drift	165 feet.
Shale, Sub-Carboniferous and Devonian	308 "
Corniferous limestone	60 "
Water-lime	32 "
Niagara limestone	728 "
Hudson River limestone and shale	307 "
Utica shale	215 "
Trenton limestone	239 "
Total depth	2,054 feet.
Trenton below sea level	1,026 "

Yielded no gas.

GREENFIELD.

Section of Well No. 1.

Drift	205 feet.
Niagara limestone	170 "
Hudson River and Utica	610 "
Trenton limestone	14 ft. 6 in.
Total depth	999 ft. 6 in.
Trenton below sea level	54 feet.

Yielded very strong flow of gas.

GREENSBURG.

Section of Well No. 1.

Drift	7 feet.
Niagara limestone	90 "
Hudson River limestone and shale	713 "
Utica shale	110 "
Trenton limestone	63 "
Total depth	983 feet.
Trenton above sea level	22 "

This well yielded a small flow of gas.

HARTFORD CITY.

SECTION OF WELL No. 1.

Drift	130 feet.
Niagara limestone	350 "
Hudson River and Utica	473 "
Trenton limestone	30 "
Total depth	983 feet
Trenton below sea level	70 "

Yielded strong flow of gas.

HARTFORD CITY.

SECTION OF WELL No. 2.

Drift	82 feet.
Niagara limestone	280 "
Hudson River limestone and shale	433 "
Utica shale	140 "
Trenton limestone	32 "
Total depth	967 feet.
Trenton below sea level	40 "

Yielded very strong flow of gas.

HAUGHVILLE.

SECTION OF WELL No. 1.

Drift	123 feet.
Corniferous and Niagara limestone	300 "
Hudson River and Utica	532 "
Trenton limestone	127 "
Total depth	1,082 feet.
Trenton below sea level	224 "

Yielded no gas.

HICKSVILLE, OHIO.

SECTION OF WELL No. 1.

Drift	142 feet.
Devonian shale	16 "
Devonian and Upper Silurian limestone	802 "
Hudson River and Utica	624 "
Trenton limestone	159 "
Total depth	1,743 feet.
Trenton below sea level	822 "

Yielded good flow of gas.

HUNTINGTON.

SECTION OF WELL No. 1, DRILLED JUST SOUTH OF WABASH RIVER.

Soil	2 feet.
Niagara limestone	398 "
Hudson River limestone and shale	275 "
Utica shale	320 "
Trenton limestone	39 "
Total depth	1,034 feet.
Trenton below sea level	255 "

Yielded no gas.

HUNTINGTON.

SECTION OF WELL No. 2, DRILLED 2½ MILES EAST OF THE CITY, ON THE NORTH SIDE OF THE RIVER.

Niagara limestone and shale	431 feet.
Hudson River limestone and shale	266 "
Utica shale	315 "
Depth to Trenton limestone	1,012 feet.
Altitude of well	765 "
Trenton below sea level	247 "

Yielded no gas.

JEFFERSONVILLE.

SECTION OF WELL No. 1.

Alluvium	45 feet.
Devonian limestone	40 "
Niagara limestone	105 "
Clinton (?) limestone	20 "
Hudson River limestone and shale	646 "
Depth to Trenton	856 feet.
Trenton below sea level	401 "

Yielded small flow of gas.

JONESBORO.

SECTION OF WELL No. 1.

Drift	162 feet.
Niagara limestone	148 "
Hudson River limestone and shale	405 "
Utica shale	197 "
Trenton limestone	23 "
Total depth	935 feet.
Trenton below sea level	72 "

Yielded strong flow of gas.

KENTLAND.

Section of Well No. 1.

Drift	100 feet.
Black shale	100 "
Corniferous	45 "
Niagara limestone	305 "
Hudson River limestone	300 "
Utica shale	210 "
Clinton (?)	60 "
Total depth	1,120 feet.
Trenton below sea level	379 "

Yielded no gas.

KEWANA.

Section of Well No. 1.

Drift	170 feet.
Limestone and shale	879 feet.
Trenton limestone	29 "
Total depth	1,078 feet.
Trenton below sea level	278 "

Did not yield gas nor oil.

KNIGHTSTOWN.

Section of Well No. 1.

Drift	64 feet.
Niagara limestone	200 "
Hudson River limestone and shale	360 "
Utica shale	199 "
Trenton limestone	213 "
Total depth	1,036 feet.
Trenton above sea level	113 "

Well yielded a good flow of gas.

KOKOMO.

Section of Well No. 4.

Drift	61 feet.
Water-lime and Niagara	359 "
Hudson River limestone and shale	265 "
Utica shales	251 "
Trenton limestone	22 "
Total depth	958 feet.
Trenton below sea level	97 "

Yielded strong flow of gas.

LAFOUNTAINE.

Section of Well No. 1.

Drift	300 feet.
Niagara limestone	225 "
Hudson River limestone and shale	175 "
Utica shale	200 "
Trenton limestone	23 "
Total depth	923 feet.
Trenton below sea level	6 "

Yielded very strong flow of gas.

LAWRENCE.

Section of the Dunn Well.

Drift	188 feet.
Niagara limestone	272 "
Hudson River and Utica	455 "
Trenton limestone	40 "
Total depth	955 feet.

Yielded moderate flow of gas.

LAWRENCE.

Section of Kimberly Well.

Drift	161 feet.
Niagara limestone	207 "
Hudson River and Utica	476 "
Trenton limestone	22 "
Total depth	876 feet.

Yielded a good flow of gas.

LAWRENCEBURG.

Section of Well No. 1.

(This well was drilled in the river bottom.)

Alluvium	139 feet.
Hudson River limestone and shale	185 "
Utica shale	25 "
Trenton limestone	451 "
Potsdam sandstone	40 "
Total depth	840 feet.
Trenton above sea level	158 "

Yielded a small quantity of gas.

Well No. 2, drilled in the fair grounds, of which no accurate record was received at this office, yielded when first drilled 1,220,000 cubic feet of gas daily.

LEBANON.

Section of Well No. 1.

Total depth	1,800 feet.
Depth to Trenton	1,227 "
Trenton below sea level	302 "

Yielded no gas.

LOGANSPORT.

Section of Well No. 1.

Depth to Trenton	995 feet.
Trenton below sea level	344 "

Yielded no gas.

MARION.

Section of Well No. 3.

Drift	70 feet.
Niagara limestone	280 "
Hudson River and Utica	528 "
Trenton limestone	22 "
Total depth	900 feet.
Trenton below sea level	67 "

Yielded very strong flow of gas.

MARTINSVILLE.

Section of Well No. 1.

Drift	85 feet.
Sub-Carboniferous rocks	323 "
Hamilton shale	120 "
Corniferous limestone	62 "
Niagara limestone	236 "
Hudson River and Utica	571 "
Trenton limestone	51 "
Total depth	1,448 feet.
Trenton below sea level	780 "

Yielded no gas.

MONTICELLO.

Section of Well No. 1.

Drift	205 feet.
Niagarā limestone	515 "
Hudson River limestone and shale	120 "
Utica shale	170 "
Trenton limestone	63 "
Total depth	1,073 feet.
Trenton below sea level	338 "

Yielded no gas.

MONTPELIER.

SECTION OF WELL NO. 1.

Drift	17 feet.
Niagara limestone and shale	233 "
Hudson River limestone and shale	432 "
Utica shale	280 "
Trenton limestone	19 "
Total depth	981 feet.
Trenton below sea level	110 "

Yielded good flow of gas and about twenty-five barrels of petroleum per day.

MORRISTOWN.

SECTION OF MUTH WELL.

Drift	140 feet.
Niagara limestone	130 "
Hudson River limestone and shale	550 "
Utica shale	78 "
Trenton limestone	23 "
Total depth	921 feet.
Trenton below sea level	44 "

Yielded good flow of gas.

NEW ALBANY.

SECTION OF WELL NO. 1.

Clay and Sub-Carboniferous shale	80 feet.
Devonian shale	104 "
Corniferous limestone	69 "
Niagara limestone	209 "
Hudson River and Utica	545 "
Trenton limestone	500 "
Total depth	1,507 feet.

Yielded no gas.

NEW CASTLE.

SECTION OF WELL NO. 1.

Drift	333 feet.
Hudson River shales	200 "
Utica shale	343 "
Trenton limestone	421 "
Total depth	1,297 feet.
Trenton above sea level	104 "

Yielded a small flow of gas.

NEW CASTLE.

Section of Well No. 2.

Drift	243 feet.
Niagara limestone	5 "
Hudson River limestone and shale	452 "
Utica shale	235 "
Trenton limestone	78 "
Total depth	1,013 feet.
Trenton above sea level	120 "

Yielded medium flow of gas.

NOBLESVILLE.

Section Banner Well.

Drift	73 feet.
Niagara limestone and shale	265 "
Clinton (?) limestone	30 "
Hudson River and Utica	476 "
Trenton limestone	9 "
Total depth	853 feet.
Trenton below sea level	76 "

Yielded strong flow of gas.

NOBLESVILLE.

Section Mallory Well.

Depth of Trenton rock	865 feet.
Trenton below sea level	85 "

Yielded very strong flow of gas.

NORTH MANCHESTER.

Section of Well No. 1.

Drift	274 feet.
Niagara limestone and shale	300 "
Hudson River limestone and shale	250 "
Utica shale	306 "
Trenton limestone	50 "
Total depth	1,180 feet.
Trenton below sea level	355 "

Yielded no gas.

NORTH VERNON.

SECTION OF WELL NO. 1.

Surface clay	11 feet.
Corniferous limestone	28 "
Niagara limestone.	252 "
Clinton (?) limestone	29 "
Hudson River limestone	440 "
Utica shale.	220 "
Trenton limestone.	470 "
Total depth	1,450 feet.
Trenton below sea level	253 "

Yielded medium flow of gas.

OXFORD.

SECTION OF WELL NO. 1.

Drift	385 feet.
Devonian shale	100 "
Limestone	115 "
White shale	100 "
Hard limestone	300 "
Limestone and shale	85 "
Utica shale.	188 "
Depth to Trenton	1,273 feet.
Trenton below sea level	570 "

Yielded no gas.

PERU.

SECTION OF WELL NO. 1.

Drift	36 feet.
Niagara (and Clinton ?) limestone	385 "
Hudson River and Utica	454 "
Trenton limestone.	30 "
Total depth.	905 feet.
Trenton below sea level	218 "

A small quantity of oil was found at a depth of 808 feet. Salt water occurred at 900 feet. This well was bored in the Northern part of the city.

PERU.

SECTION OF WELL NO. 2.

Drift	10 feet.
Water-lime and Niagara limestone	455 "
Clinton (?) limestone	15 "
Hudson River and Utica.	449 "
Trenton limestone.	27 "
Total depth.	956 feet.
Trenton below sea level	229 "

Yields a small quantity of gas and oil, but not sufficient for use.

This well was bored a little south of the city limits, about 1¼ miles from well No. 1.

PERU.

SECTION OF WELL NO. 3.

(Situated on Younce farm, 7 miles southeast of Peru.)

Drift	70 feet.
Niagara limestone	490 "
Hudson River and Utica	400 "
Trenton limestone	42 "
Total depth	1,002 feet.

A light flow of gas was obtained from this well.

At a depth of 1,000 feet salt water was struck, which raised to the surface.

PERU.

SECTION OF WELL NO. 4.

(Located on Bearss farm, 2½ miles north of city.)

Drift	324 feet.
Niagara limestone	276 "
Hudson River and Utica	407 "
Trenton limestone	35 "
Total depth	1,042 feet.

Yielded no gas.

Salt water was struck at the depth of 1,042 feet, which raised to within 50 feet of the surface.

PORTER STATION.

SECTION OF WELL NO. 1.

Sub-Carboniferous and Devonian rocks	280 feet.
Niagara limestone and shale	350 "
Hudson River and Utica	498 "
Depth to Trenton	1,128 feet.
Trenton below sea level	548 "

Yielded no gas.

PORTLAND.

The following facts, relating to the Portland gas wells, were obtained from Prof. Elwood Haynes, Superintendent gas company, of Portland:

WELL NO. 2.

Depth to Trenton	982.2 feet.
Altitude of surface	919.9 "
Trenton below sea level	63.3 feet.

WELL NO. 3.

Depth to Trenton	981.3 feet.
Altitude of surface	922 "
Trenton below sea level	59.3 feet.

WELL NO. 4.

Depth to Trenton	986.4 feet.
Altitude of surface	918.8 "
Trenton below sea level	67.6 feet.

WELL NO. 5.

Depth to Trenton	984.8 feet.
Altitude of surface	918.8 "
Trenton below sea level	66 feet.

The following analysis of Trenton limestone, taken from a well at Portland, was made by Prof. Haynes, and kindly furnished this office:

Carbonate magnesia	0.32
Calcium carbonate	0.63
Carbonaceous matter	0.02
Iron	0.01
Aluminum	0.01
Water	0.01
Total	1.00

RED KEY.

SECTION OF WELL NO. 1.

Drift	72 feet.
Niagara limestone	143 "
Hudson River limestone and shale	415 "
Utica shale	350 "
Trenton limestone	48 "
Total depth	1,028 feet.
Trenton below sea level	90 "

Yielded strong flow of gas.

REMINGTON.

SECTION OF WELL NO. 1.

Drift	5 feet.
Devonian shale	85 "
Corniferous limestone	50 "
Niagara limestone	260 "
Hudson River and Utica	570 "
Trenton limestone	295 "
Total depth	1,265 feet.

Yielded no gas.

RICHMOND.

Section of Well No. 1.

Hudson River limestone and shale	500 feet.
Utica shale.	380 "
Trenton limestone	510 "
Potsdam sandstone	10 "
Total depth	1,400 feet.
Altitude of well	959 "
Trenton above sea level	79 "

Yielded no gas.

RIDGEVILLE.

Section of Well No. 1.

Drift.	30 feet.
Niagara limestone.	212 "
Hudson River and Utica.	739 "
Trenton limestone.	167 "
Total depth.	1,148 feet.
Trenton above sea level	1 foot.

Did not yield gas.

ROCHESTER.

Section of Well No. 1.

Drift.	245 feet.
Niagara limestone.	525 "
Hudson River and Utica.	391 "
Trenton limestone.	24 "
Total depth.	1,185 feet.
Trenton below sea level	351 "

Yielded no gas.

ROCKVILLE.

Section of Well No. 1.

Drift.	96 feet.
Gray sandstone	44 "
Brown shale	25 "
White sandstone	110 "
White shale	25 "
Black shale.	105 "
White sandstone	50 "
Limestone	170 "
Gray shale	305 "

ROCKVILLE—SECTION OF WELL NO. 1—Continued.

Sandstone	100 feet.
White shale	114 "
Black shale	102 "
Limestone	118 "
Brown sandstone	46 "
White limestone	135 "
Crystallized limestone	85 "
White shale, like Kaolin	48 "
Limestone	108 "
Dark shale (Utica)	324 "
Total depth to Trenton	2,100 feet.
Altitude of well	688 "
Trenton below sea level	1,412 "

Yielded no gas.

ROYAL CENTRE.

SECTION OF WELL NO. 1.

Drift	109 feet.
Niagara limestone	486 "
Hudson River and Utica	330 "
Trenton limestone	42 "
Total depth	967 feet.
Trenton below sea level	190 "

Yielded small quantity of gas and twenty-five barrels of oil per day.

RUSHVILLE.

SECTION OF WELL NO. 1. RECORD KEPT BY MR. GEO. C. CLARK.

Drift	60 feet.
Chert and cherty limestone (Corniferous)	40 "
Niagara limestone and shale	200 "
Hudson River limestone and shale	200 "
Utica shale	360 "
Total depth to Trenton	860 feet.
Altitude of well, accurately leveled	$948\frac{41}{100}$ feet.
Trenton above sea level	$124\frac{41}{100}$ "

Yielded a small flow of gas.

SALEM.

Section of Well No. 1.

Soil	7 feet.
Keokuk limestone	53 "
Sub-Carboniferous sandstone	567 "
Hamilton shale	103 "
Devonian limestone	40 "
Niagara limestone	215 "
Clinton (?) limestone	30 "
Hudson River limestone and shale	535 "
Utica shale	180 "
Trenton limestone	45 "
Total depth	1,775 feet.
Trenton below sea level	1,000 "

Yielded good flow of gas. The gas was found in the limestone underlying Devonian shale.

SEYMOUR.

Section of Well No. 1.

Drift	75 feet.
Sub-Carboniferous sandstone	15 "
Devonian sandstone	115 "
Corniferous limestone	20 "
Niagara limestone	190 "
Hudson River limestone and shale	520 "
Utica shale	165 "
Trenton limestone	94 "
Total depth	1,194 feet.
Trenton below sea level	472 "

Yielded no gas.

SHELBYVILLE.

Section of Well No. 1.

Drift	48 feet.
Corniferous limestone	30 "
Niagara limestone and shale	102 "
Hudson River limestone and shale	657 "
Trenton limestone	86 "
Total depth	923 feet.
Trenton below sea level	79 "

Yielded small flow of gas.

SHELBYVILLE.

Section of Well No. 2.

Drift	80 feet.
Limestone and shale	769 "
Total depth to Trenton	849 feet.

Yielded small flow of gas.

SOUTH BEND.

Section of the Studebaker Well.

Drift	160 feet.
Sub-Carboniferous and Hamilton shale	220 "
Corniferous limestone	60 "
Lower Helderberg limestone	40 "
Niagara limestone	640 "
Clinton (?) limestone	60 "
Hudson River and Utica	420 "
Trenton limestone	427 "
Total depth	2,027 feet.
Trenton below sea level	855 "

Yielded no gas nor oil.

SPICELAND.

Section of Well No. 1.

Trenton rock reached at a depth of	940 feet
Considerable flow of gas was found at	943 "
Total depth of well	968 "
Trenton above sea level	85 "

A good flow of gas.

SUMMITVILLE.

Section of Well No. 1.

Drift	100 feet
Niagara limestone	236 "
Hudson River limestone and shale	300 "
Utica shale	292 "
Trenton limestone	50 "
Total depth	978 feet
Trenton below sea level	32 "

Yielded very strong flow of gas.

TERRE HAUTE.

Section of White Sulphur, Artesian Well.

Sand and gravel	150 feet.	
Fire-clay	1 "	6 in.
Brown slate	2 "	
Soapstone	11 "	
Coal	4 "	
Fire-clay	3 "	6 in.
Limestone	2 "	1 "
Fire-clay	3 "	2 "
Brown limestone	2 "	
Soapstone	1 "	6 in.
Coal		6 "
Fire-clay	3 feet,	2 "
Limestone	2 "	6 "
Hard-pan	8 "	6 "
Soapstone	10 "	5 "
Coal	2 "	
Fire-clay	3 "	
Sandstone	1 "	
Blue limestone	2 "	4 in.
Dark blue rock	2 "	6 "
White sandstone	3 "	
Fire-clay	5 "	
Shale	2 "	4 in.
Soapstone	2 "	
Blue limestone	5 "	2 in.
Soapstone	5 "	
Black shale	4 "	
Blue sandstone	6 "	
Black shale	2 "	
Fire-clay	5 "	
Gray sandstone	10 "	
Coal		9 in.
Fire-clay	2 feet,	5 "
Blue rock	3 "	4 "
Black shale	3 "	
Fire-clay	2 "	3 in.
Limestone	4 "	
Fire-clay	5 "	10 in.
Limestone	3 "	6 "
Coal	2 "	6 "
Fire-clay	1 "	
Sandstone	28 "	3 in.
Fire-clay	7 "	2 "
Blue sandstone	27 "	
Slate	9 "	
Blue sandstone	29 "	1 in.
White sandstone	8 "	

TERRE HAUTE—SECTION OF WHITE SULPHUR, ARTESIAN WELL—Continued.

Slate	36 feet,	2½ in.
Sandstone	1 "	7½ "
Blue slate	15 "	9 "
White slate	10 "	2 "
White sandstone	35 "	11½ "
Soapstone	43 "	
Blue slate	28 "	7½ in.
White slate	7 "	7 "
Hard sandstone	23 "	9 "
Hard black stone	9 "	6 "
White slate	12 "	
Hard sand rock	127 "	
White limestone	4 "	4 in.
White fire-clay	3 "	3 "
White limestone	30 "	
Hard gray sandstone	10 "	
Blue limestone	6 "	11 in.
Hard white sandstone		9 "
Hard blue sandstone	3 feet,	6 "
Blue clay	3 "	
Hard gray sandstone	2 "	3½ in.
Hard blue sandstone	3 "	3 "
Hard sandstone	110 "	5 "
Soft sandstone	7 "	3 "
Blue slate	5 "	
Blue hard sandstone	411 "	2 in.
Blue soapstone	34 "	10 "
White grit sandstone	117 "	2 "
Hard blue slate	48 "	
Brown sandstone	89 "	11 in.
Coarse white sandstone	6 "	9 "
Yellow sandstone	44 "	2 "
Hard flint	15 "	8 "
Clay, limestone and shale	70 "	2 "

At a depth of 840 feet, a show of oil was found; at a depth of 1,296 feet 9 inches, lubricating oil was found; at a depth of 1,335 feet, a vein of fresh water was found; at a depth of 1,620 feet 10 inches, a vein of oil was found; at a depth of 1,658 feet, blue sulphur water was found; at a depth of 1,710 feet, white sulphur water was found; at a depth of 1,768 feet, more white sulphur water was found; at a depth of 1,785 feet, a large flow of white sulphur water, yielding at the rate of 6,000 gallons per hour, was found.

THORNTOWN.

Section of Well No. 1.

Drift	65 feet.
Sub-carboniferous limestone and shale	238 "
Hamilton shale	87 "
Corniferous limestone	37 "
Niagara limestone	407 "
Hudson River and Utica	373 "
Trenton limestone	80 "
Total depth	1,287 feet.
Trenton below sea level	394 "

Yielded no gas.

TOBACCO LANDING.

Section of Well No. 1.

Keokuk limestone	15 feet.
Knobstone	390 "
Depth to Devonian shale	405 feet.

A good flow of gas was found in Devonian shale.

UNION CITY.

Section of Well No 1.

Drift	98 feet.
Niagara limestone	250 "
Hudson River and Utica	800 "
Trenton limestone	540 "
Total depth	1,688 feet.
Trenton below sea level	40 "

Traces of gas were observed from a depth of 1,155 to 1,162 feet.

UNION CITY.

Section of Well No. 2.

Drift	70 feet.
Niagara limestone and shale	210 "
Clinton (?) limestone	10 "
Hudson River limestone and shale	510 "
Utica shale	340 "
Total depth	1,140 feet.

At the time this record was obtained the well was not yet completed.

VALPARAISO.

SECTION OF WELL No. 1.

Drift	125 feet.
Hamilton shale	65 "
Corniferous limestone	55 "
Niagara limestone	565 "
Clinton (?) limestone	10 "
Hudson River limestone and shale	185 "
Utica shale	295 "
Trenton limestone	144 "
Total depth	1,444 feet.
Trenton below sea level	602 "

Did not yield gas.

VINCENNES ARTESIAN SALT WELL.

Sand and gravel	80 feet.
Sandstone	18 "
Soapstone	100 "
Hard pebble rock	10 "
Sandy shale	15 "
Soapstone	32 "
Blue sandstone	35 "
Sandy shale	20 "
Soapstone	10 "
Coal	3 "
Soapstone	18 "
Coal	5 "
Soapstone	18 "
Black shale	41 "
Soapstone	138 "
Coal	5 "
Limestone	10 "
Blue shale	47 "
Black slate	30 "
Soapstone and shale	80 "
Sandstone	15 "
Slate and soapstone	75 "
Sandstone and salt water	25 "
Slate and shale	95 "
Sandstone	175 "
Shale and black slate	140 "
Sandstone	96 "
Total depth	1,336 feet.

WABASH.

SECTION OF WELL NO. 2, FROM RECORD KEPT BY DR. FORD, OF WABASH.

Drift	28 feet.
Niagara limestone and shale	525 "
Hudson River and Utica	325 "
Trenton limestone	54 "
Total depth	932 feet.
Trenton below sea level	198 "

Did not yield gas nor oil.

WARSAW.

SECTION OF WELL NO. 1.

Drift	248 feet.
Niagara limestone	652 "
Hudson River and Utica	487 "
Trenton limestone	77 "
Total depth	1,464 feet.
Trenton below sea level	570 "

Yielded no gas.

WINCHESTER.

SECTION OF WELL NO. 1.

Drift	147 feet.
Niagara limestone	71 "
Hudson River limestone and shale	582 "
Utica shale	250 "
Trenton limestone	90 "
Total depth	1,140 feet.
Trenton above sea level	43 "

Gas is found in Hudson River shales at a depth of 730 feet, and also in Trenton limestone, the yield in each instance, however, being small.

Petroleum is found in Trenton limestone, which accumulated in the well at a rate of about four barrels per day.

WINCHESTER.

SECTION OF WELL NO. 2.

Drift	131 feet.
Niagara limestone	69 "
Hudson River limestone and shale	575 "
Utica shale	240 "
Trenton limestone	95 "
Total depth	1,110 feet.
Altitude of the surface at the well, leveled	$1,068\frac{5}{10}$ "
Depth to Trenton	1,015 "
Trenton above sea level	$53\frac{5}{10}$ feet.

A good flow of gas was found at a depth of 1,029 feet. A cartridge of nitro-glycerine was exploded in the well, which increased the flow of gas materially, after which several barrels of oil were taken from the well.

WINCHESTER.

SECTION OF WELL NO. 3.

Drift	116	feet.
Niagara limestone	76	"
Hudson River and Utica	816	"
Trenton limestone	120	"
Total depth	1,128	feet.
Altitude of well	$1,076\frac{5}{10}$	"
Depth to Trenton	1,008	"
Trenton above sea level	$68\frac{5}{10}$	feet.

Gas was found at a depth of 1,036 feet. Oil in considerable quantities after "shooting" the well.

XENIA.

SECTION OF WELL NO. 1.

Drift	50	feet.
Water-lime	31	"
Niagara limestone	238	"
Hudson River and Utica	587	"
Trenton limestone	31	"
Total depth	937	feet.
Trenton below sea level	91	"

Yields a good flow of gas, though volume not ascertained.

The wells described above are scattered pretty generally over the State. There are several counties, however, where no deep wells have yet been drilled, or if they have been, no information has reached the State Geologist concerning them. In a considerable number of counties only one or two wells have been drilled.

Prospectors for gas, oil or other substances frequently write the State Geologist asking for information as to the probable depth to Trenton limestone in a particular locality. For general information upon that subject, the following estimate of the approximate altitude of Trenton limestone, as compared with sea level, is inserted. By finding the altitude of the surface at the well, it will be a matter of small difficulty to determine to within a short distance the depth to Trenton rock in any county in the State. To further aid in forming a conclusion in this matter, a table of altitudes is given, showing the height above the sea of all the important points in the State of which we have data. The altitude of the surface at the well in any part of the State may be ascertained by taking the nearest point given in the table of altitudes, and leveling from that point to the location of the proposed well. When the altitude is known it is easy to estimate the approximate depth of Trenton limestone.

Approximate depth, above or below sea level, of the Trenton limestones in the different counties of Indiana:

Counties.	Sea Level.	Feet.
Adams	Below	200 to 400
Allen	Below	400 to 800
Bartholomew	Below	300 to 350
Benton	Below	350 to 600
Blackford	Below	40 to 120
Boone	Below	350 to 500
Brown	Below	600 to 800
Carroll	Below	225 to 300
Cass	Below	150 to 300
Clark	Below	500 to 600
Clay	Below	1,300 to 1,400
Clinton	Below	300 to 500
Crawford	Below	750 to 850
Daviess	Below	1,200 to 1,300
Dearborn	Above	150 to 175
Decatur	Above	10 to 100
Dekalb	Below	1,000 to 1,200
Delaware	Above	0 to 75
Dubois	Below	850 to 1,000
Elkhart	Below	1,150 to 1,350
Fayette	Above	100 to 150
Floyd	Below	600 to 750
Fountain	Below	600 to 800
Franklin	Above	125 to 175
Fulton	Below	400 to 700
Gibson	Below	1,400 to 1,600
Grant	Below	50 to 100
Greene	Below	1,100 to 1,200
Hamilton	Below	50 to 100
Hancock	Below	20 to 80
Harrison	Below	750 to 800
Hendricks	Below	350 to 500
Henry	Above	0 to 125
Howard	Below	40 to 150
Huntington	Below	200 to 400
Jackson	Below	300 to 350
Jasper	Below	150 to 250
Jay	Below	0 to 100
Jefferson	Below	250 to 500
Jennings	Below	150 to 300
Johnson	Below	350 to 600
Knox	Below	1,300 to 1,600
Kosciusko	Below	1,000 to 1,350
Lagrange	Below	1,250 to 1,400
Lake	Below	300 to 400
Laporte	Below	400 to 500
Lawrence	Below	700 to 850

Counties.	Sea Level.	Feet
Madison	Above, 65 feet, to 50 feet below.	
Marion	Below	110 to 450
Marshall	Below	700 to 1,100
Martin	Below	850 to 1,200
Miami	Below	100 to 350
Monroe	Below	1,000 to 1,150
Montgomery	Below	600 to 700
Morgan	Below	750 to 900
Newton	Below	200 to 300
Noble	Below	1,200 to 1,300
Ohio	Above	100 to 150
Orange	Below	750 to 850
Owen	Below	900 to 1,000
Parke	Below	1,400 to 1,500
Perry	Below	850 to 950
Pike	Below	1,250 to 1,350
Porter	Below	400 to 600
Posey	Below	1,500 to 1,700
Pulaski	Below	200 to 450
Putnam	Below	500 to 800
Randolph	Above	0 to 100
Ripley	Above, 50 feet, to 100 feet below.	
Rush	Above, 125, to 0 feet below.	
Scott	Below	350 to 500
Shelby	Below	50 to 300
Spencer	Below	950 to 1,200
Starke	Below	350 to 700
Steuben	Below	1,400 to 1,500
Sullivan	Below	1,300 to 1,600
Switzerland	Above	0 to 75
Tippecanoe	Below	500 to 600
Tipton	Below	75 to 180
Union	Above	100 to 150
Vanderburgh	Below	1,300 to 1,500
Vermillion	Below	1,400 to 1,600
Vigo	Below	1,400 to 1,600
Wabash	Below	10 to 350
Warren	Below	600 to 750
Warrick	Below	1,200 to 1,350
Washington	Below	500 to 750
Wayne	Above	75 to 175
Wells	Below	200 to 400
White	Below	200 to 350
Whitley	Below	400 to 800

TABLE OF ALTITUDES IN INDIANA.

	Authority.	Altitude.
Adams County—		
Decatur	C., R. & Ft. W. R. R	807 feet.
Allen County—		
Arcola	P., Ft. W. & C. R. R	833 feet.
Fort Wayne	G. R. & Ind. R. R	752 "
"	P., Ft. W. & C. R. R	775 "
"	City datum, City Engineer	762 "
Huntertown	G. R. & Ind. R. R.	827 "
New Haven.	T., W. & W. R. R	753 "
Wallen.	G. R. & Ind. R. R	839 "
Woodburn	T., W. & W. R. R	750 "
Bartholomew County—		
Clifford.	J., M. & I. R. R	664 feet.
Columbus.	J., M. & I. R. R	630 "
Elizabethtown	J., M. & I. R. R	646 "
Jonesville	J., M. & I. R. R	595 "
St. Louis Crossing	J., M. & I. R. R	683 "
Taylorsville	J., M. & I. R. R	656 "
Wailesborough	J., M. & I. R. R	613 "
Waynesville	J., M. & I. R. R	607 "
Benton County—		
Ambia	L. E. & W. R. R.	710 feet.
Boswell.	L. E. & W. R. R.	734 "
Chase	L. E. & W. R. R.	719 "
Earl Park	C., I., St. L. & C. R. R	814 "
Fowler	C., I., St. L. & C. R. R	823 "
Gravel Hill	Surface of Hill	857 "
Mt. Gilboa	Prof. Owen	815 "
Otterbein	L. E. & W. R. R.	785 "
Oxford	L. E. & W. R. R.	703 "
Raub.	C., I., St. L. & C. R. R	731 "
Talbot	L. E. & W. R. R.	710 "
Templeton	L. E. & W. R. R.	675 "
Blackford County—		
Hartford City.	Ft. W., M. & C. R. R.	895 feet.
Montpelier	Ft. W., M. & C. R. R.	867 "

Boone County—	*Authority.*	*Altitude.*
Lebanon	C., I., St. L. & C. R. R	925 feet.
Thorntown	C., I., St. L. & C. R. R	813 "
Cass County—		
Adamsboro	Eel River R. R	665 feet.
Anoka	Pan Handle R. R	696 "
Curveton	T., P. & W. R. R	671 "
Lake Cicott	T., P. & W. R. R.	703 "
Logansport	W., St. L. & P. R. R	606 "
Onward	Pan Handle R. R	763 "
Royal Centre	Pan Handle R. R	735 "
Clark County—		
Charleston	O. & M. R. R	589 feet.
Henryville	J., M. & I. R. R	479 "
Jeffersonville	O. & M. R. R.	455 "
Memphis	J., M. & I. R. R	490 "
New Providence	L., N. A. & C. R. R	551 "
Sellersburg	J., M. & I. R. R	478 "
Clay County—		
Brazil	T. H. & I. R. R	643 feet.
Clay City	T. H. & S. E. R. R	584 "
Cloverland	T. H. & I. R. R	577 "
Cory	T. H. & S. E. R. R	625 "
Harmony	T. H. & I. R. R.	672 "
Saline City	T. H. & S. E. R. R	555 "
Staunton	T. H. & I. R. R	643 "
Clinton County—		
Boyleston	L. E. & W. R. R.	896 feet.
Colfax	C., I., St. L. & C. R. R.	825 "
Frankfort	L. E. & W. R. R.	841 "
Hillsburg	L. E. & W. R. R.	910 "
Jefferson	L. E. & W. R. R	827 "
Mulberry	L. E. & W. R. R.	754 "
Daviess County—		
Washington	O. & M. R. R	484 feet.
Dearborn County—		
Aurora	O. & M. R. R	493 feet.
Cochran	O. & M. R. R	493 "
Guilford	C., I., St. L. & C. R. R	508 "
Lawrenceburgh	O. & M. R. R	479 "
Mooreshill	O. & M. R. R	916 "
Weisburg	C., I., St. L. & C	929 "
Decatur County—		
Adams	C., I., St. L. & C. R. R	880 feet.
Greensburg	C., I., St. L. & C. R. R	942 "
New Point	C., I., St. L. & C. R. R	981 "
St. Paul	C., I., St. L. & C. R. R	852 "

	Authority.	Altitude.
DEKALB COUNTY—		
Auburn	Ft. W., J. & S. R. R	872 feet.
"	Ft. W., J. & S. R. R. Junction	868 "
Butler	L. S. & M. S. R. R	863 "
Cedar Creek	Eel River R. R	861 "
Corunna	L. S. & M. S. R. R	937 "
New Era	Ft. W., J. & S. R. R	859 "
Summit	Ft. W., J. & S. R. R	1,001 "
Waterloo	Ft. W., J. & S. R. R	914 "
DELAWARE COUNTY—		
Daleville	C., C., C. & I. R. R	910 feet.
Eaton	Ft. W., M. & C. R. R. Track at Bridge	910 "
Muncie	C., C., C. & I. R. R	948 "
Reed	L. E. & W. R. R	936 "
Selma	C., C., C. & I. R. R	1,005 "
Yorktown	C., C., C. & I. R. R	924 "
ELKHART COUNTY—		
Bristol	L. S. & M. S. R. R	786 feet.
Elkhart	L. S. & M. S. R. R	755 "
"	C., W. & M. R. R	741 "
Goshen	L. S. & M. S. R. R	789 "
Millersburg	L. S. & M. S	886 "
New Paris	C., W. & M. R. R	828 "
Vistula	L. S. & M. S. R. R	809 "
FAYETTE COUNTY—		
Bentonville	J., M. & I. R. R	1,056 feet.
Connersville	C., H. & D. R. R	832 "
Glenwood	C., H. & D. R. R	1,092 "
Longwood	C., H. & D. R. R	1,111 "
Salter's Switch	C., H. & D. R. R	919 "
Lyons	C., H. & D. R. R	896 "
FLOYD COUNTY—		
New Albany	J., M. & I. R. R	438 feet.
"	Low Water, Ohio River	362 "
Galena		958 "
FOUNTAIN COUNTY—		
Attica	W., St. L. & P. R. R	540 feet.
"	T., W. & W. R. R	556 "
"	Low Water, Wabash River	516 "
GIBSON COUNTY—		
Princeton	E. & T. H. R. R	483 feet.
GRANT COUNTY—		
Fairmont	C., W. & M. R. R	893 feet.
Jonesboro	Panhandle R. R	846 "
Marion	Panhandle R. R	811 "
Mier	Panhandle R. R	816 "
Van Buren		950 "

	Authority.	Altitude.
Greene County—		
Dixon	Indianapolis & Vincennes R. R	530 feet.
Lyons	Indianapolis & Vincennes R. R	509 "
Marco	Indianapolis & Vincennes R. R	482 "
Switz City	Indianapolis & Vincennes R. R	526 "
Worthington	Indianapolis & Vincennes R. R	522 "
Hamilton County—		
Noblesville		770 feet.
Westfield	L., N. A. & C. R. R	786 "
Hancock County—		
Fortville	C., C., C. & I. R. R.	857 feet.
Greenfield	Panhandle R. R	906 "
McCordsville	C., C., C. & I. R. R.	854 "
Maxwells	I., B. & W. R. R	920 "
Mount Comfort	I., B. & W. R. R.	870 "
Sugar Creek	I., B. & W. R. R	855 "
Warrington	I., B. & W. R. R	1,020 "
Willow Branch	I., B. & W. R. R.	950 "
Hendricks County—		
Clayton	T. H. & I. R. R	890 feet.
Coatsville	T. H. & I. R. R	878 "
Danville	T. H. & I. R. R	613 "
Friendsville	Indianapolis & Vincennes R. R	738 "
Maplewood	I., D. & S. R. R	842 "
Montclair	I., D. & S. R. R	759 "
North Salem	I., D. & S. R. R	888 "
Plainfield	T. H. & I. R. R	742 "
Henry County—		
Kennard	I., B. & W. R. R	1,057 feet.
Messick	I., B. & W. R. R.	1,030 "
New Castle	I., B. & W. R. R.	1,075 "
New Lisbon	Ft. W., M. & C. R. R.	1,098 "
Spiceland		1,025 "
Howard County—		
Cassville	Panhandle R. R	648 feet.
Kokomo	Panhandle R. R	839 "
Huntington County—		
Huntington	T., W. & W. R. R	734 feet.
"	Court House Square	741 "
Jackson County—		
Chestnut Ridge	J., M. & I. R. R	553 feet.
Crothersville	J., M. & I. R. R	562 "
Rockford	J., M. & I. R. R	585 "
Seymour	J., M. & I. R. R	605 "
"	Crossing O. & M. R. R	608 "

	Authority.	Altitude.
JASPER COUNTY—		
Remington	L., P. & W. R. R	732 feet.
JAY COUNTY—		
Dunkirk	Panhandle R. R	969 feet.
Portland	C., R. & Ft. W. R. R	904 "
Red Key	C., R. & Ft. W. R. R	890 "
JEFFERSON COUNTY—		
Dupont	J., M. & I. R. R	783 feet.
Madison	J., M. & I. R. R	451 "
"	Foot Incline Plane	772 "
North Madison	J., M. & I. R. R	878 "
"	Top of Inclined Plane	876 "
"	Summit Line	880 "
JENNINGS COUNTY—		
Butler's Switch	J., M. & I. R. R	941 feet
North Vernon	J., M. & I. R. R	727 "
Scipio	J., M. & I. R. R	680 "
Vernon	J., M. & I. R. R	686 "
"	Muscatatuck Bridge	669 "
JOHNSON COUNTY—		
Amity	J., M. & I. R. R	693 feet.
Edinburgh	J., M. & I. R. R	694 "
Franklin	J., M. & I. R. R	732 "
"	C., I., St. L. & C. Crossing	736 "
Whiteland	J., M. & I. R. R	805 "
KNOX COUNTY—		
Bruceville	Indianapolis & Vincennes R. R	515 feet
Edwardsport	Indianapolis & Vincennes R. R	460 "
Sanborn	Indianapolis & Vincennes R. R	472 "
Vincennes	E., L. & H. R. R.	463 "
"	C. & V. R. R	417 "
"	Bench mark on Court House	435 "
Westphalia	Indianapolis & Vincennes R. R	456 "
KOSCIUSKO COUNTY—		
Claypool	C., W. & M. R. R	902 feet.
Milford	C., W. & M. R. R	850 "
Silver Lake	C., W. & M. R. R	927 "
Syracuse	B. & O. R. R.	870 "
Warsaw	Crossing L. S. & M. S. R. R	839 "
"	C., W. & M. R. R	824 "
LAGRANGE COUNTY—		
Lagrange	G. R. & Ind. R. R	915 feet
Lima	G. R. & Ind. R. R	882 "
Valentine	G. R. & Ind. R. R	952 "
Wolcottsville	G. R. & Ind. R. R	938 "

Station	*Authority.*	*Altitude.*
LAKE COUNTY—		
Crown Point Station	Pan Handle R. R	714 feet.
Gibson	M. C. R. R	600 "
Hobart	P., Ft. W. & C. R. R	623 "
Lake Station	J. & N. R. R	613 "
Lowell		636
Millers	L. S. & M. S. R. R	625 "
Ross	J. & N. R. R	636 "
Tolleston	M. C. R. R	607 "
Whiting	L. S. & M. S. R. R	606 "
LAPORTE COUNTY—		
Holmesville	L. S. & M. S. R. R	800 feet.
Kingsburg	Peninsula R. R	742 "
Lacrosse	Pan Handle R. R	675 "
Michigan City	M. C. R. R	603 "
Michigan Lake	U. S. Lake Survey	582 "
Otis	L. S. & M. S. R. R	765 "
Rolling Prairie	L. S. & M. S. R. R	821 "
Wanatah	P., Ft. W. & C. R. R	731 "
Westville	L., N. A. & C. R. R	786 "
LAWRENCE COUNTY—		
Bedford	L., N. A & C. R. R.	679 feet.
Mitchell	O. & M. R. R	676 "
MADISON COUNTY—		
Alexandria	L. E. & W. R. R	857 feet.
"	Crossing C., W. & M. R. R	872 "
Anderson	C., C., C. & I. R. R	880 "
"	P., C. & St. L. Crossing	900 "
"	C., C., C. & I. Crossing	894 "
"	C., W. & M. Junction	894 "
Chesterfield	C., C., C. & I. R. R	907 "
Elwood	L. E. & W. R. R.	858 "
Gillman	L. E. & W. R. R.	852 "
Pendleton	C., C., C. & I. R. R	847 "
Summitville	C., W. & M. R. R	1,001 "
MARION COUNTY—		
Acton	C., I., St. L. & C. R. R	792 feet.
Bridgeport	T. H. & I. R. R	748 "
Brightwood	C., C., C. & I. R. R	791 "
Galaudet	C., I., St. L. & C. R. R	852 "
Indianapolis	City datum, City Engineer	676 "
"	Belt R. R. Crossing J., M. & I	722 "
"	Signal Station U. S. Signal Office	753 "
"	Union Depot	721 "
Lawrence	C., C., C. & I. R. R	872 "
Maywood	Indianapolis & Vincennes R. R	695 "
Southport	J., M. & I. R. R	761 "
Valley Mills	Indianapolis & Vincennes R. R	759 "
West Newton	Indianapolis & Vincennes R. R	779 "

	Authority.	Altitude.
Marshall County—		
Plymouth	P., Ft. W. & W. R. R	781 feet.
"	P., K. & P. R. R	769 "
"	Surface Yellow River	760 "
Teegarden	B., P. & C. R. R	794 "
Martin County—		
Loogootee	O. & M. R. R	532 feet.
Shoals	O. & M. R. R	480 "
West Shoals	Center Stone, Cross of Cap on Basement Window W. S. C. H	523 "
Miami County—		
Amboy	Pan Handle R. R	810 feet.
Bunker Hill	Pan Handle R. R	800 "
Chili	Eel River R. R	725 "
Mexico	Eel River R. R	700 "
Peru	W., St. L. & P. R. R	655 "
"	Court House Square	
	W. & E. Canal	657 "
Monroe County—		
Bloomington	L., N. A. & C. R. R	742 feet.
Ellettsville	L., N. A. & C. R. R	682 "
Harrodsburgh	L., N. A. & C. R. R	506 "
Smithville	L., N. A. & C. R. R	717 "
Montgomery County—		
Crawfordsville	L., N. A. & C. R. R	741 feet.
Whitesville	L., N. A. & C. R. R	874 "
Morgan County—		
Brooklyn	Indianapolis & Vincennes R. R	659 feet.
Martinsville	Indianapolis & Vincennes R. R	598 "
Mooresville	Indianapolis & Vincennes R. R	685 "
Paragon	Indianapolis & Vincennes R. R	577 "
Newton County—		
Goodland	T., P. & W. R. R	718 feet.
Kentland	T., P. & W. R. R	681 "
Noble County—		
Albion	B., P. & C. R. R	927 feet.
Avilla	G. R. & Ind. R. R	969 "
"	Summit. B., P. & C. R. R	1,015 "
Brimfield	L. S. & M. S. R. R	945 "
Kendallville	L. S. & M. S. R. R	974 "
Ligonier	L. S. & M. S. R. R	886 "
Rome City	G. R. & Ind. R. R	920 "
Wawaka	L. S. & M. S. R. R	896 "
Orange County—		
Orleans	L., N. A. & C. R. R	633 feet.

Owen County—	*Authority.*	*Altitude.*
Coal City	T. H. & S. E. R. R	651 feet.
Farmer	Indianapolis & Vincennes R. R	528 "
Freedom	Indianapolis & Vincennes R. R	538 "
Gosport	Indianapolis & Vincennes R. R	595 "
Quincy	L., N. A. & C. R. R.	749 "
Spencer	Indianapolis & Vincennes R. R	557 "

Parke County—		
Bloomingdale	I., D. & S. R. R	642 feet.
Guion	I., D. & S. R. R	630 "
Leatherwood	I., D. & S. R. R	572 "
Marshall	I., D. & S. R. R	700 "
Montezuma	I., D. & S. R. R	494 "
Rockville	Gas Well, John T. Campbell, C. E.	688 "

Porter County—		
Chesterton	L. S. & M. S. R. R	660 feet.
Furnesville	M. C. R. R	669 "
Hebron	Panhandle R. R	714 "
Kout	Panhandle R. R	688 "
Porter	M. C. R. R	647 "
Valparaiso	P., Ft. W. & C. R. R	738 "
"	Peninsular R. R	801 "
Wheeler	P., Ft. W. & C. R. R	666 "

Posey County—		
Mount Vernon	St. L. & S. E. R. R.	407 feet.

Pulaski County—		
Francesvile	L., N. A. & C. R. R	685 feet.
Gundrum	Panhandle R. R	710 "
Star City	Panhandle R. R	706 "
Winamac	Panhandle R. R	713 "

Putnam County—		
Bainbridge	L., N. A. & C. R. R	936 feet.
Barnard	I., D. & S. R. R	902 "
Cloverdale	L., N. A. & C. R. R	782 "
Fillmore	T. H. & I. R. R	844 "
Greencastle	T. H. & I. R. R	834 "
"	Junction L., N. A. & C. R. R	773 "
Hamrick	T. H. & I. R. R.	703 "
Putnamville	L., N. A. & C. R. R	687 "
Raccoon	I., D. & S. R. R	745 "
Reelsville	T. H. & I. R. R	638 "
Roachdale	I., D. & S. R. R	839 "
Russelville	I., D. & S. R. R	828 "

Randolph County—	Authority.	Altitude.
Bloomingsport	I., B. & W. R. R.	1,225 feet.
Farmland	C., C., C. & I. R. R	1,037 "
Harrisville	C., C., C. & I. R. R	1,101 "
Losantville	I., B. & W. R. R.	1,140 "
Lynn	Crossing I., B. & W. and G. R. & Ind. R. R.,	1,174 "
Parker	C., C., C. & I. R. R.	1,023 "
Ridgeville	Pan Handle R. R	994 "
Union City	C., C., C. & I. R. R	1,108 "
Winchester	C., C., C. & I. R. R	1,089 "
Ripley County—		
Batesville	C., I., St. L. & C. R. R	968 feet.
Milan	O. & M. R. R	985 "
Morris	C., I., St. L. & C. R. R	982 "
Osgood	O. & M. R. R	950 "
Pierceville	O. & M. R. R	1,010 "
Spades	C., I., St. L. & C. R. R	1,013 "
Sunman	C., I., St. L. & C. R. R.	1,015 "
Rush County—		
Falmouth	J., M. & I. R. R	1,048 feet.
Homer	J., M. & I. R. R	913 "
Manilla	J., M. & I. R. R	896 "
Rushville	J., M. & I. R. R	964 "
"	Crossing C., H. & I. R. R	972 "
St. Joseph County—		
Mishawaka	L. S. & M. S. R. R	722 feet.
New Carlisle	L. S. & M. S. R. R	772 "
Osceola	L. S. & M. S. R. R	737 "
South Bend	L. S. & M. S. R. R	725 "
"	Mid. A. L. R. R	679 "
"	Crossing Penn. R. R	733 "
"	St. Joe River, Peninsula R. R	699 "
Terre Coupee	L. S. & M. S. R. R	760 "
Scott County—		
Austin	J., M. & I. R. R	549 feet.
Lexington	O. & M. R. R	626 "
Scottsburgh	J., M. & I. R. R	570 "
Vienna	J., M. & I. R. R	566 "
Shelby County—		
Fairland	C., I., St. L. & C. R. R	774 feet.
Flat Rock	J., M. & I. R. R	695 "
Lewis Creek	J., M. & I. R. R	713 "
London	C., I., St. L. & C. R. R	775 "
Morristown	C., H. & I. R. R	842 "
Prescott	C., I., St. L. & C. R. R	792 "
Shelbyville	J., M. & I. R. R	769 "
"	Crossing C., I., St. L. & C. R. R	768 "
Waldron	C., I., St. L. & C. R. R.	819 "

	Authority.	Altitude.
Starke County—		
English Lake	P., Ft. W. & C. R. R	660 feet.
Hamlet	P., Ft. W. & C. R. R	698 "
North Judson	P., K. & P. R. R	681 "
San Pierre	P., K. & P. R. R.	689 "
Steuben County—		
Angola	Ft. W., J. & S. R. R	1,052 feet.
Freemont	Ft. W., J. & S. R. R	1,055 "
"	Geodetic Station U. S. L. Survey	1,142 "
Pleasant Lake	Ft. W., J. & S. R. R	975 "
Sullivan County—		
Sullivan	E. & T. H. R. R	538 feet.
Tippecanoe County—		
Clark's Hill	C., I., St. L. & C. R. R	782 feet.
Dayton	L. E. & W. R. R	648 "
Lafayette	T., W. & W. R. R	595 "
Montmorenci	L. E. & W. R. R	672 "
Tipton County—		
Goldsmith	L. E. & W. R. R	903 feet.
Hobbs	L. E. & W. R. R	867 "
Kempton	L. E. & W. R. R	920 "
Tipton	L. E. & W. R. R	868 "
Union County—		
Brownsville	C., H. & I. R. R	793 feet.
Liberty	C., H. & I. R. R	979 "
Vanderburgh County—		
Evansville	L., E., E. & S. W. R. R	378 feet.
"	Low Water, Ohio River	326 "
Vermillion County—		
Clinton	E., T. H. & C. R. R	494 feet.
Dana	I., D. & S. R. R	643 "
Eugene	E., T. H. & C. R. R	507 "
Gessie	E., T. H. & C. R. R	616 "
Hillsdale	I., D. & S. R. R	452 "
Newport	E., T. H. & C. R. R	494 "
Perrysville	E., T. H. & C. R. R	582 "
Summit Grove	E., T. H. & C. R. R	520 "
Vigo County—		
Atherton	E., T. H. & C. R. R	522 feet.
Riley	T. H. & S. E. R. R	569 "
Seelyville	T. H. & I. R. R	585 "
Terre Haute	E., T. H. & C. R. R	492 "
	7th Street Crossing T. H. & I. R. R	496 "

	Authority.	Altitude.
Wabash County—		
La Fontaine	C., W. & M. R. R	894 feet.
La Gro	T., W. & W. R. R	698 "
Laketon	Eel River R. R	762 "
Liberty Mills	Eel River R. R	773 "
North Manchester	Eel River R. R	775 "
Roann	Eel River R. R	750 "
Urbana	C., W. & M. R. R	815 "
Wabash	W., St. L. & P. R. R	735 "
"	C. H. Sq., W. & E. Canal	730 "
"	W., St. L. & P. Crossing over C., W. & M. R. R	742 "
Warren County—		
Marshfield	T., W. & W. R. R	721 feet.
West Lebanon	T., W. & W. R. R	720 "
Williamsport	T., W. & W. R. R	619 "
Warrick County—		
Boonville	L., E., E. & S. W. R. R	391 feet.
Chandler	L., E., E. & S. W. R. R	406 "
De Forest	L., E., E. & S. W. R. R	406 "
Washington County—		
Harristown	L., N. A. & C. R. R	872 feet.
Salem	L., N. A. & C. R. R	714 "
Wayne County—		
Beesons	Ft. W., M. & C. R. R	875 feet.
Cambridge City	J., M. & I. R. R	941 "
Green's Fork	I., B. & W. R. R	1,120 "
Richmond	C., R. & Ft. W. R. R	969 "
"	Low Water, Whitewater River	885 "
Wells County—		
Bluffton	Ft. W., M. & C. R. R	837 feet.
Keystone	Ft. W., M. & C. R. R	871 "
Ossian	Ft. W., M. & C. R. R	831 "
White County—		
Chalmers	L., N. A. & C. R. R	707 feet.
Idaville	T., P. & W. R. R	712 "
Monticello	T., P. & W. R. R	672 "
Reynolds	T., P. & W. R. R	692 "
Whitley County—		
Cherubusco	Eel River R. R	725 feet.
Collamer	Eel River R. R	795 "
Collins	Eel River R. R	870 "
Columbia City	P., Ft. W. & C. R. R	836 "
South Whitley	Eel River R. R	808 "

ECONOMIC USE OF NATURAL GAS.

Natural gas is used for two purposes, heating and lighting. It produces intense heat, and may be used in the reduction of the most refractory metals; in the manufacture of brick, tile, porcelain and glass; for producing steam, and for all domestic purposes. It is comparatively free from sulphuric and other deleterious acids, which makes it particularly valuable in foundries, machine shops, and in all manufactories which manufacture metal goods. It is greatly superior to all other fuels used in the manufacture of glass.

It is most important in building up the manufacturing interests of any locality producing it. Its appreciation as a fuel by manufacturers may be better understood by a review of the manufacturing industries located within the gas area of Indiana within the past year. These embrace manufactories engaged in the manufacture of straw board, straw paper, wood pulp and wood paper, steel works, foundries, nail mills, bar and bolt works, and bell foundries; plate glass, window glass, fruit cans, and bottle factories; crayon factories, fruit-canning factories, excelsior mills, saw-mills and flouring mills; brick and tile factories, and many other industries, in which several million dollars are invested and hundreds of hands employed.

At Anderson, Madison County, are located a number of large concerns, which have changed the city from a quiet commercial place to a bustling manufacturing center. The following named manufactories are already located at Anderson, and capitalists are almost daily visiting that place, as well as all the other more important points, with a view of locating manufacturing enterprises.

UNION STRAWBOARD WORKS.

Incorporated.
Capital invested, $200,000.
Number of employes, 150.
Wages of unskilled laborers, 75 cents to $1.25 per day.
Wages of skilled laborers, $1.50 to $2.50 per day.
Capacity of the works, 30 tons per day.
Price of product to consumers, 42½ cents per ton.
Principal raw materials used, straw and lime.
Raw material all obtained in Indiana.

Horse-power of engines, 800.

Horse-power of boilers, 1,200.

The principal uses of the product are in the manufacture of paper boxes, car wheels, house lining, egg cases, berry baskets, carpet lining, etc.

ANDERSON BOLT WORKS.

Incorporated in New York.

Cost of plant and working capital, $250,000.

Number of employes, 100.

Wages of unskilled laborers, $1.00 per day.

Wages of skilled laborers, $2.50 per day.

Manufacture bolts, nuts, leg screws, etc.

Daily capacity, 15,000 pounds.

The raw material is all procured from the Mahoning Valley, Ohio.

Power of boiler, 80-horse.

Power of engine, 80-horse.

ANDERSON KNIFE AND BAR WORKS.

Silas E. Famen, Superintendent.

Manufacture machine knives of all kinds, etc.

Cost of plant and working capital, $50,000.

Value of annual product, $100,000.

Number of employes, 50.

Wages of unskilled laborers, $1.25 to $1.50 per day.

Wages of skilled laborers, $2.00 to $3.00 per day.

Power of engine, 150-horse.

Their grindstones are procured from Marietta and Cleveland, Ohio. Their high grade steel is obtained from England and their low grade steel from Pittsburg.

BUTLER GLASS COMPANY, OF ANDERSON, INDIANA.

Incorporated.

Cost of plant and working capital, $33,000.

Number of men employed, 30.

Number of boys employed, 40.

Wages of skilled men, $4.00 to $6.00 per day.

Wages of unskilled men, $1.75 per day.

Wages of boys, 50 cents per day.

Value of annual product, $60,000.

Manufacture flint bottles.

Their sand is procured at Pendleton, Indiana, their ground limestone from Cleveland, Ohio, and their soda ash from England.

THE AMERICAN WIRE NAIL COMPANY, OF COVINGTON, KENTUCKY.

Incorporated.
Cost of plant and working capital, $500,000.
Manufacture steel rods, steel wire and wire nails.
Capacity of steel rod mill, 100 tons per day.
Capacity of steel wire mill, 75 tons per day.
Capacity of nail mill, 1,500 kegs per day.
Number of hands employed, 300.
Wages of skilled men, $3.00 to $5.00 per day.
Wages of unskilled men, $1.50 per day.
Power of engine, 2,000-horse.
Raw material, steel billets, imported from England and bought in Pittsburg.

SEFTON MANUFACTURING COMPANY.

Manufacture paper pails, etc.
Will employ between 200 to 300 hands.
This concern is located, but has not yet begun work.

JONES & CLEMENT'S BRICK YARD.

Manufacture machine pressed brick.
Capital invested, $25,000.
Number of employes, 30.
Wages of employes, $1.50 per day.
Daily product, 25,000 brick.
Steam power used, 40-horse.
The bricks are dried with hot air, burned with natural gas, and the work is continued the year round.
The brick-sand is obtained from Sandusky, Ohio.

MANUFACTORIES AT DUNKIRK.

Dunkirk is a small town in the southwestern part of Jay County. The Chicago, St. Louis & Pittsburg Railroad passes through it. In 1880 the population was 662. The following important manufacturing establishments have been located there and are in active operation:

THE DUNKIRK WINDOW GLASS COMPANY.

J. F. Wilcox, President.
C. P. Cole, Secretary and Treasury.
John Ames, Superintendent.
Incorporated.

Capital stock, $25,000.
Cost of plant and working capital, $40,000.
Number of furnaces, 2.
Number of pots, 12.
Number of employes, 65.
Average weekly pay-roll, $900.
Engine power, 15-horse.
The sand used is obtained from Millington, Illinois.
The salt cake and soda ash used are obtained from England.
The daily product of the factory is 225 boxes of window glass of 50 feet each.

THE DUNKIRK EXCELSIOR WORKS.

Charles A. Maish & Co., Cincinnati, proprietors.
Capital invested, $9,000.
Number of employes, 10.
Weekly pay-roll, $80.
Daily product, 5 tons.
Boiler power, 50-horse.
Engine power, 45-horse.
The raw material is all procured in Indiana.

MANUFACTORIES AT EATON.

Eaton is the pioneer of natural gas towns in Indiana. The first natural gas in the present broad gas field of this State was found here. An account of the pioneer work done at Eaton is given in the fifteenth annual report of the Department of Geology and Natural History.

One excelsior manufactory is located here. Ames & Carter, proprietors.
Number of employes, 14.
Wages of employes, $1.25 to $1.50 per day.
Capacity of works, 6 to 8 tons per day.
Power of engine, 60-horse.
The raw material is all obtained in the vicinity of Eaton.

MANUFACTORIES AT ELWOOD.

At Elwood, a thriving town in the northwestern part of Madison County, on the Lake Erie & Western Railroad, are located the following factories:

LEESON & MARSH EXCELSIOR COMPANY.

Capital invested, $4,000.
Number of employes, 12.
Wages of employes, $1.25 to $1.50 per day.

ELWOOD PLANING MILL COMPANY.

Capital invested, $8,000.
Employes, 12.
Wages of employes, $1.25 to $1.50 per day.
Raw material for both concerns is all obtained in Indiana.

MANUFACTORIES AT FAIRMONT

FLOURING MILL.

Capital employed, $8,000.
Capacity, 100 barrels per day.
Number of employes, 7.
Average wages of employes, $1.50 per day.
Raw material obtained in Indiana.

HOOP MANUFACTORY.

Capital invested, $6,500.
Number of employes, 20.
Average wages of employes, $1.25 per day.
Product amounts to $1,200 per month.
Raw material obtained in the vicinity of the town

EXCELSIOR MANUFACTURING COMPANY.

Capital invested, $2,500.
Number of employes, 15.
Average wages of employes, $1.25 per day.
Value of product, $1,500 per month.
Raw material all obtained in the vicinity of Fairmont

ROLLER MILL REDUCTION MACHINERY MANUFACTURING COMPANY.

Capital invested, $20,000.
Will employ from 25 to 50 hands.

SAW AND PLANING MILL.*

Capital invested, $10,000.
Number of employes, 30.
Wages of employes, $1.25 to $1.50 per day.
Raw material obtained in Indiana.

* Has been destroyed by fire.

MANUFACTORIES AT HARTFORD CITY.

HARTFORD PULP COMPANY.

A. Reynalds, President.
ncorporated.
Capital, $30,000.
Manufacture wood pulp.
Number of employes, 20.
Weekly pay-roll, $220.
Capacity of works, 4 tons, dry, per day.
Power of engine, 550-horse.
Power of boiler, 700-horse.
Raw material all obtained in Indiana.

HARTFORD CITY EXCELSIOR WORKS.

Capital invested, $3,000.
Number of employes, 10.
Average wages of employes, $1.25 per day.
Power of engine, 16-horse.
Will soon put in a 60-horse power engine.

CHICAGO STEEL ROLLING MILL COMPANY.

Incorporated.
Capital stock, $200,000.
Number of employes, 100.
Not yet in operation, but guaranteed to run 300 days in the year.

MANUFACTORIES AT KOKOMO.

KOKOMO STRAW BOARD COMPANY.

Incorporated.
Capital stock, $200,000.
Number of employes, 80.
Wages of unskilled laborers, $1.50 per day.
Wages of skilled workmen, $2.25 per day.
Number of boilers, 8.
Total boiler capacity, 1,100-horse power.
One engine of 250-horse power.
One engine of 80-horse power.
One engine of 60-horse power.
Total horse-power, 390.

Manufacture the finest quality of straw-board, or what is commonly termed "paste-board."

Lime obtained from Marion, Ohio.

Straw obtained in Indiana.

Capacity, 18 tons per day.

THE NEWMAN PAPER COMPANY.

Manufacture of wood pulp.

Incorporated.

Capital stock, $50,000.

Number of employes, 20.

Average wages of unskilled hands, $1.25 per day.

Average wages of skilled men, $2.00.

Capacity of works, 15 tons per day.

Value of product, $40 to $50 per ton.

Engine power, 150-horse.

Boiler power, 240-horse.

Raw material obtained from the Kokomo wood pulp mill.

ROCKFORD BIT WORKS.

Incorporated.

Capital stock, $40,000.

Manufacture augurs and bits of all kinds.

Number of employes, 75.

Wages of skilled workmen, $2.25 per day.

Wages of unskilled workmen, $1.00 per day.

Raw material all of domestic production.

Capacity of works, 1,000 bits per day.

Boiler power, 65-horse.

Engine power, 50-horse.

HOWARD GLASS COMPANY.

Capital invested, $6,500.

Tank factory, with 10-pot capacity.

Employes, 40.

Wages of skilled men, $4.00 to $6.00 per day.

Wages of unskilled men, $1.25 per day.

ROCK ISLAND KNIFE AND SHEAR WORKS.

Incorporated.
Capital, $33,000.
Number of employes, 30.
Wages of skilled workmen, $3.00 per day.
Wages of unskilled laborers, $1.00 per day.
Capacity of works, thirty dozen pairs per day.
American iron and steel used exclusively.
Boiler, 30-horse power capacity.
Engine, 25-horse power capacity.

OPALESCENT GLASS WORKS.

Capital invested, $10,000.
Number of pots, 7.
Number of employes, 50.
Wages of skilled men, $3.00 to $5.00 per day.
Wages of unskilled men, $1.50 per day.
Manufacture colored and ornamental glassware.
Sand obtained from Millington, Illinois.
Soda, ash and potash, imported.

DIAMOND PLATE GLASS WORKS.

Incorporated.
Capital stock, $500,000.
Manufacture plate glass.
Number of employes, 400 to 500.
Average wages of skilled workmen, $4.00 per day.
Average wages of unskilled workmen, $1.50 per day.
Number of pots, 40.
Capacity of pots, 100 to 125 square feet of glass each.
Daily capacity of works, 4,500 square feet.
One engine, of 600-horse power.
Fifteen engines, of 60-horse power each.
Glass sand obtained from Millington, Illinois
Grinding sand obtained from local deposits.
Lime obtained, probably, from Depauw, at New Albany, Indiana.

This institution is not yet in operation, but is rapidly approaching completion.

KOKOMO GLASS WORKS.

Manufacture window glass.
Incorporated.
Capital stock, $50,000.
Number of employes, 65.
Average wages of employes, $100 per month.
One 10-pot furnace.
Capacity of works, 4,000 50-feet boxes of glass per month.
Sand obtained from Millington, Illinois.
Salt cake imported from England.
Lime obtained from Depauw, at New Albany, Indiana.
This concern was moved to Kokomo from Ithaca, New York.

KOKOMO MACHINE BRICK AND TILE MANUFACTORY.

Capital invested, $20,000.
Number of hands employed, 35.
Average wages of hands, $1.40 per day.
Value of annual product, $25,000.
Power of engine, 40-horse.
Clay obtained at Kokomo.

GERMAN & TEEGARDIN.

Manufacture threshers and grain weighers.
Capital invested, $12,000.
Number of employes, 12.
Average wages of employes, $2.00 per day.
Power of engine, 40-horse.
The iron used is obtained from Indianapolis.
The wood used is obtained in Indiana.

CHARLES & MARTZ, CANNING MANUFACTORY.

Cost of plant, $20,000.
Working capital, $20,000.
Number of employes, 400.
Wages of employes, $3.00 to $6.00 per week.
Boiler power, 160-horse.
Engine power, 120-horse.
Number of regular hands, 25.
Wages of regular hands, $900 per week.

Fruits and vegetables used in the works all produced in the vicinity of Kokomo.

Besides the above, the following named firms have located and will soon be in operation:

Kokomo Boiler Manufactory.

Kokomo Pulp Company.

Kokomo Planing Mill.

MANUFACTORIES AT MARION.

MARION PULP CO.

Incorporated.

Capital stock, $25,000.

Cost of plant and working capital, $60,000.

Number of employes, 100.

Wages of skilled laborers, $2.00 per day.

Wages of unskilled laborers, $1.35 per day.

Capacity of works, 40 tons per day.

It is sold at $10.00 per ton.

Five boilers of 200-horse power each.

Two engines of 500-horse power each.

The product is used for book and newspapers. The pulp is made o buckeye, cottonwood, spruce and quaking ash, all of which grow in Indiana. Works run day and night.

MARION BRICK WORKS.

Incorporated.

Capital stock, $50,000.

Manufacture machine pressed bricks.

Cost of plant, $42,000.

Working capital, $8,000.

Number of employes, 60.

Annual capacity, 12,000,000 bricks.

Average wages of employes, $1.62½ per day.

Twenty per cent. of the employes are boys.

Wages vary from 60c. to $4.00 per day.

Value of annual output, $120,000.

MARION WINDOW GLASS WORKS.

Incorporated.

Capital stock, $30,000.

Cost of plant, $26,000.

Working capital, $10,000.

Manufacture window glass.
Number of pots, 10.
Capacity of works, 800 boxes of glass of 50 feet each per week.
Number of employes, 75.
Average wages of skilled laborers, $5.00 per day.
Average wages of unskilled laborers, $2.00 per day.
Sand obtained from Illinois and Michigan, soda ash from England.

MARION FLINT GLASS COMPANY.

Incorporated.
Capital stock, paid up, $25,000.
Cost of plant, $20,000.
Working capital, $13,000.
Number of men employed, 72.
Number of boys employed, 44.
Wages of blowers, $5.00 per day.
Wages of packers, $2.50 to $3.00 per day.
Wages of unskilled men, $2.00 per day.
Wages of boys, 50c. per day.
Average age of boys employed, 13 years.
Value of monthly output, $10,000.
Number of pots, 12.
Sand is obtained from Chicago; soda ash all comes from England; lime from Indiana.

SWEAZY & JOHNSON.

Manufacture butchers' skewers.
Cost of plant, $25,000.
Working capital employed, $10,000.
Number of employes, 62.
Number of skilled laborers, 15.
Number of unskilled men, 32.
Number of girls, 15.
Wages of skilled men, $1.50 per day.
Wages of unskilled men and girls, $1.00 per day.
Value of annual product, $50,000.
Power furnished by two 14x20 (200-horse power) engines.
Raw material all obtained in Indiana.

PARMENTER CRAYON COMPANY.

Cost of plant, $7,000.
Number of men employed, 5.
Number of boys employed, 7.

Daily average wages of men, $2.00.

Daily average wages of boys, 75 cents.

Engine power, 10-horse.

Raw material, clay and plaster, imported from Germany and Nova Scotia.

BARTON BELL COMPANY.

Incorporated.

Capital stock, $30,000.

Number of employes, 40.

Wages of skilled men, $2.00 per day.

Wages of unskilled men, $1.20 per day.

Value of annual product, $40,000.

Power of engine, 25-horse.

Manufacture small bells. Copper and tin obtained from New York and Baltimore.

STUDEBAKER & VON BEHREN MANUFACTURING COMPANY.

Incorporated.

Capital stock, $15,000.

Manufacture hardwood wagon stuff.

Product per month, 600,000 feet.

Number of employes, 70.

Seven skilled workmen earn each $2.50 per day.

Sixty-three unskilled workmen, each earns $1.35 per day.

Engine power, 140-horse.

Raw material all obtained in Indiana.

AMERICAN SOAP COMPANY.

Incorporated.

Capital, $6,000.

Cost of plant, $6,000.

Working capital, $10,000.

SWEET & CLARK MANUFACTURING COMPANY, OF TROY, NEW YORK.

Cost of plant, $60,000.

Working capital, $150,000.

Will employ about 600 men.

Will manufacture malleable iron goods.

These works are not yet in operation, but they are rapidly approaching completion.

CROSBY PAPER COMPANY.

Incorporated.
Capital stock, ———.
Number of employes, 36.
Men employed, 30.
Women employed, 6.
Average wages of men, $1.66⅔ per day.
Average wages of women, 83⅓ cents per day.
Number of rotarys, 2.
One 40-horse power engine, one 160-horse power engine.
One 175-horse power boiler.

M'CULLOUGH & WILLSON, MARION FRUIT JAR AND BOTTLE COMPANY.

Capital invested, $40,000.
Men employed, 40.
Boys employed, 60.
Number of pots, 8.
Product, 75 gross of jars per day.

STEWART, ESTEP & CO.

Manufacture window glass.
Cost of plant and working capital, $50,000.
Number of employes, 125.
Wages of skilled laborers, $5.00 to $6.00 per day.
Wages of unskilled men, $1.75 to $2.00 per day.
Number of pots, 26.
Daily capacity of works, 400 fifty-foot boxes of glass.
Sand obtained from Garden City, Illinois, 70 miles west of Chicago.
Use salt cake and soda ash; part imported and part domestic.

WISE & NELSON.

Manufacture lumber, patent coiled hoops and chair stuff.
Cost of plant and working capital, $20,000.
Number of employes, 56.
Number of men employed, 39.
Number of boys employed, 17.
Average wages of skilled men, $2.00 per day.
Average wages of unskilled men, $1.25 per day
Average wages of boys, 75 cents per day.
Lumber manufactured, per day, 8,000 feet.
Hoops manufactured, per day, 32,000.

Chair stuff, made of beech, oak, sugar and hickory, manufactured, per week, 2 car loads.

Engine power, 100 horse.

Raw material all obtained in Indiana.

MARION EXCELSIOR WORKS.

George S. Landes, Manager.

Capital invested, $8,000.

Number of employes, 15.

Average wages of employes, $1.25 per day.

Daily product in 10 hours, 65 bales of 115 pounds each.

Daily product, night and day work, 130 bales.

Power of engine, 40-horse.

Raw material all obtained in Indiana.

Excelsior is used by mattress and carriage makers, for packing, etc.

MARION STOVE COMPANY.

Manufacture stoves and hollow ware.

Number of employes, 50.

Averages of employes, $10 per week.

Product amounts to $50,000 annually.

Iron obtained from Lake Superior and Southern Ohio.

This concern was formerly the Sidney Manufacturing Company, of Sidney, Ohio.

MANUFACTORIES AT MUNCIE.

MUNCIE PULP COMPANY.

Incorporated.

Capital stock, $150,000.

Manufacture wood pulp.

Number of employes, 80.

Capacity of works, 20 tons per day.

Engine power, 400-horse.

Boiler power, 800-horse.

Raw material all obtained in Indiana.

MUNCIE COMBINATION MANUFACTURING COMPANY.

Incorporated.

Capital stock, $25,000.

Number of employes, 25.

Average daily wages of hands, $1.50.

Power of engine, 25-horse.

Raw material all obtained in Indiana.

BALL GLASS WORKS.

Incorporated.
Capital stock, $40,000.
Manufacture fruit jars, green and amber bottles.
Number of furnaces, 2.
Number of pots, 9.
Number of employes, 125.
Weekly pay-roll, $1,200.
Value of daily product, $700.
Power of engine, 12-horse.
Sand obtained from Millington, Ill.
Lime obtained from Fostoria, Ohio.
Soda ash obtained from England.

HEMINGRAY GLASS COMPANY.

Incorporated.
Capital stock, $250,000.
Number of employes, 100.
Average weekly pay-roll, $800.
Number of furnaces, 1.
Number of pots, 14.
Sand obtained from Millington, Ill.
Use domestic soda ash.
Manufacture all kinds of bottles.
This concern also has large glass works at Covington, Ky.

C. H. OVER, WINDOW GLASS WORKS.

Capital invested, $45,000.
Number of employes, 84.
Average weekly pay-roll, $1,400.
Number of furnaces, 2.
Number of pots, 16.
Sand obtained from Millington, Ill.
Lime obtained from Kelly Island.
Use foreign and imported salt cake and soda ash.
Weekly capacity, 1,400 boxes of glass.

MUNCIE NAIL COMPANY.

Incorporated.
Capital stock, $200,000.
Manufacture steel and iron nails, and all kind of cut nails.
Number of employes, 200.
Monthly pay-roll, $10,000.

Daily capacity, 500 kegs of nails.
One engine of 300-horse power.
One engine of 150-horse power.
Three engines of 50-horse power each.
Use American iron, principally from Alabama.
Steel used comes principally from Mingo Junction, Ohio.
This concern was formerly located at Greencastle, Ind., and known as the Greencastle Nail Company.

MARING, HART & CO.

Manufacture window glass.
Cost of plant, $30,000.
Working capital, $70,000.
Total invested, $100,000.
Number of employes, 120.
Average wages of skilled men, $4.00 per day.
Wages of unskilled men, $9.00 to $12.60 per week.
Number of furnaces, 2.
Number of pots, 20.
Capacity of works, 7,680 fifty feet boxes of glass per month.
Sand obtained from Millington, Ill.
Soda ash obtained from England.
Use domestic salt cake.

Other manufactories for which no statistics were obtained:
Muncie Veneering Works.
Washing Machine Manufactory.
Muncie Rubber Mill.

MANUFACTORIES AT NOBLESVILLE.

NOBLESVILLE FOUNDRY AND MACHINE WORKS.

Incorporated.
Capital stock, $35,000.
Do general foundry and machine work.
Number of employes, 40.
Daily wages of skilled men, $2.00.
Daily wages of unskilled men, $1.25.
Value of annual product, $20,000.
Engine power, 50-horse.
Boiler power, 40-horse.
Use Ohio iron and Pittsburgh American steel.

NOBLESVILLE NOVELTY WORKS.

Manufacture hardware novelties.
Capital invested, $26,000.
Number of employes, 50.
Average wages of employes, $2.00 per day.
Boiler and engine power, 35-horse.

NOBLESVILLE MANUFACTURING COMPANY.

Manufacture chemical straw and wood paper.
Incorporated.
Capital stock, $150,000.
Employes, 75.
Capacity of works, 15 to 20 tons per day.
Boiler power, 800-horse.
One engine of 350-horse power.
Two engines of 75-horse power each.
Raw material consisting of buckeye, white beech, "quaking ash," wood and straw is procured in Indiana.

NORDYKE & MORMON.

Flouring mill.

MANUFACTORIES AT PENDLETON.

PENDLETON WINDOW GLASS WORKS.

Incorporated.
Capital stock, $50,000.
Number of employes, 75.
Average wages of skilled employes, $5.00 per day.
Average wages of unskilled men, $1.50 per day.
Number of pots, 12.

MANUFACTORIES AT PORTLAND.

H. C. VAUGHT & SONS.

Manufacture furniture.
Capital invested, $10,000.
Number of employes, 15.
Average daily wages, $1.30.
Power of engine, 35-horse.
Raw material all obtained in Indiana.

PORTLAND HANDLE MANUFACTURING COMPANY.

Number of employes, 30.
Average wages of hands, $1.50 per day.
Capacity of works, 3,000 handles per day.
One engine of 35-horse power.
One engine of 30-horse power.

The foregoing extensive list of manufacturing concerns embraces those only that have been located in Indiana since the discovery of natural gas. The list is not complete, for the reason that since the facts presented above were obtained, there have been other enterprises located at a number of points.

Many of the concerns named in the list are those that have been moved from localities where no natural gas can be procured, others are from localities where gas is furnished in sufficient quantities, but the prices are so high that from an economical stand-point, natural gas possesses no advantage over coal or other fuel. For instance, at Pittsburg the price of gas to glass manufacturers is $50 to $60 per pot. In Indiana, so far, gas is furnished free to glass manufacturers, and other concerns, also. Glass works are run about ten months in the year. A 26-pot factory, therefore, at Pittsburg is required to pay $13,000 to $15,600 per year for fuel, all of which is saved in Indiana. Even if gas is not furnished absolutely free, as an inducement for a manufacturer to locate in the Indiana field, he can secure it comparatively without cost by boring his own well upon his own land, and immediately adjoining his works, where the piping will not add materially to the price of a well. The cost of drilling a well in the Indiana gas field at this time, is from $850 to $1,000.

A fair proportion of the manufactories located in the Indiana gas area are enterprises that are wholly new. They have all undoubtedly been drawn to this region on account of the cheapness and convenience of the fuel. Without natural gas it is not likely that any new factories would have been located throughout all this wide extent of territory except such lumber and grist mills as were required to supply the local demand for their product.

During the brief period of time that has elapsed since gas was discovered, eastern Indiana has become fairly a manufacturing region, giving employment to thousands of persons, directly and indirectly, and producing annually a vast and varied amount of manufactured goods. The prospects for the immediate future are flattering in the extreme.

A summary of the manufacturing establishments located in the gas area of Indiana is given below:

GLASS MANUFACTORIES.

Number of window glass manufactories	7
Capital invested in window glass factories	$327,500
Number of pots in window glass factories	104
Number of employes in window glass factories	579
Total number of plate glass manufactories	1
Capital invested in plate glass works	$500,000
Number of employes in plate glass works	500
Number of pots in plate glass works	40
Number of fruit jar, bottle and opalescent glass factories	6
Capital invested in fruit jar, bottle and opalescent glass factories	$206,000
Number of pots in same	62
Number of employes in same	551
Total number of glass factories	14
Total capital invested in glass factories	$1,033,500
Total number of employes in glass factories	1,630
Total number of pots in glass factories	206

IRON MANUFACTORIES.

Number of nail mills	2
Capital invested in nail mills	$700,000
Number of employes	750
Daily capacity of nail mills, kegs	2,000
Number of foundries	3
Capital invested in foundries	$75,000
Number of employes in foundries	102
Value of annual product	$85,000
Knife and bar works	1
Capital invested in bar works	$50,000
Hands employed in bar works	50
Value of annual product	$100,000
Bolt works	1
Capital invested in bolt works	$250,000
Hands employed in bolt works	100
Amount of daily product, pounds	15,000

Rolling mills	1
Capital invested	$200,000
Number of employes	100
Estimated value of product annually	$500,000
Knife and shear works	1
Capital invested	$33,000
Hands employed	30
Amount of daily product, dozens	15
Bit works	1
Capital invested	$40,000
Number of employes	75
Daily product, bits	1,000
Novelty hardware works	1
Capital invested	$26,000
Number of hands employed	50
Estimated value of annual product	$100,000
Malleable iron works	1
Capital invested	$210,000
Number of employes	600
Estimated value of product annually	$1,200,000
Total number of iron manufactories	12
Total amount invested	$1,634,000
Total number of employes	1,907
Estimated value of product annually	$4,200,000

BELL FOUNDRIES.

Total number of factories	1
Capital invested	$30,000
Number of employes	40
Value of annual product	$40,000

STRAW BOARD AND PAPER MANUFACTORIES.

Total number of factories	4
Total capital invested	$650,000
Total number of employes	341
Daily product, tons	78
Value of annual product	$1,000,000

WOOD PULP WORKS.

Total number of factories	4
Total capital invested	$290,000
Total number of employes	213
Daily product, tons	75
Value of annual product	$300,000

BRICK AND TILE MANUFACTORIES.

Total number of factories	9
Capital invested	$295,000
Number of employes	245
Annual product	*41,750,000

WOOD WORKING MANUFACTORIES.

These include wagon factories, skewer factories, hoop factories, handle factories, planing and saw mills, etc.

Total number of factories	13
Total capital invested	$159,500
Total number of employes	394
Value of annual product	$482,000

EXCELSIOR MANUFACTORIES.

Total number of factories	6
Total amount invested	$38,500
Total number of employes	75
Total daily product, tons	45

FLOURING MILLS.

Total number of mills	4
Total amount invested	$66,000
Total number of employes	162
Total daily product, barrels	350

MISCELLANEOUS MANUFACTORIES.

Total number of factories	12
Total capital invested	$266,000
Total number employes	727
Amount of annual product	$500,000

The miscellaneous factories include crayon factories, fruit canning establishments and other industries.

*Brick. The amount of tile not ascertained.

The facts given above will not be complete of course when this report goes to press because new concerns are being located almost daily. The amount of capital drawn to the Indiana gas field on acconnt of the cheapness and superiority of the fuel, and other advantages, is not less than $300,000 per moth.

RECAPITULATION.

Total number of manufactories	79
Total capital invested	$4,462,500
Total number of hands employed	5,734

Aside from its great value for manufacturing purposes, natural gas is superior in every respect for domestic purposes. It saves the expense of coal and wood sheds, the inconvenience of handling the fuel, of kindling fires and removing the ashes and other waste or refuse matter from the stove or grate. Its combustion is not accompanied with volumes of smoke nor accumulations of soot.

Almost every town or hamlet, if not all, throughout the gas area, now has one or more gas wells. Pipes have been laid and gas has wholly supplanted wood and coal for fuel. All shops, stores and other business houses have adopted the use of the new fuel, and in nearly every instance the residences and business houses are lighted as well as heated with natural gas. In addition to this many of the farmers throughout the gas area have piped gas to their residences, or have drilled wells of their own, and are now using gas for heat and light.

The outlay of money by the various corporations, local organizations and individuals, in boring for gas and laying mains throughout the gas area, is enormous, amounting to several millions of dollars.

Among the facts presented above, concerning the manufactories in the State, the point from which the raw material used in the various factories is given. In many instances it will be noticed that all the raw material is produced in this State. In some cases this material is found in the immediate vicinity of the factory, and in other cases it is obtained from other parts of the State. The introduction of new factories has thus afforded a market for quite a number of the State's products that were hitherto unmarketable on account of the distance they had to be transported.

In many instances a large part of the raw material used in some factories is brought from neighboring States that might just as well be furnished by our own people at just as reasonable prices as are paid for it elsewhere. It requires only a little energy, sometimes, to place an article upon the market that has all along been regarded as of little value, but, when once introduced, will be the source of a steady and satisfactory income. The clays and sands of many localities of this State are well adapted to use in many different ways, and our woods—those that have been assumed to have little value—are likely to prove the source of great profit.