

ANNUAL REPORT OF THE STATE NATURAL GAS SUPERVISOR.

LETTER OF TRANSMITTAL.

OFFICE OF STATE NATURAL GAS SUPERVISOR,
KOKOMO, IND., January 14, 1901.

Prof. W. S. Blatchley, State Geologist:

Sir—In obedience to the provisions of section 7504 of the Revised Statutes of the State of Indiana, I transmit to you herewith the ninth annual report of the State Natural Gas Supervisor. It is for the year ending December 31, 1900, and is largely confined to the work of this office during that period, and a brief statement of the present condition of the natural gas territory.

Acknowledging the cordial support that I have received from you during the past year, I remain,

Yours respectfully,

J. C. LEACH,
State Natural Gas Supervisor.

ANNUAL REPORT.

DUTIES OF THE STATE NATURAL GAS SUPERVISOR.

Briefly summarized, the duties of the State Natural Gas Supervisor, as defined by sections 7504-5 of the Revised Statutes of the State of Indiana, are as follows:

1. To make a personal inspection, as far as it is practicable, of all the natural gas wells and pipe lines in the State, the latter to be inspected as often as it may be necessary.

2. To see that all the provisions of law pertaining to the drilling of wells and the piping and consumption of natural gas are observed, and that the penalties for the violation of the same are enforced.

3. To make an annual report to the State Geologist in which shall be given certain statistical information regarding the geological formation of the gas field, the rock pressure and production of gas wells, pipe lines used for the transportaton of natural gas, manufacturing industries located on account of natural gas, and such other information as the State Geologist may require.

INSPECTION OF GAS WELLS.

The purpose of an annual inspection of gas wells in this field is to ascertain the rock pressure of the field and the rate of decrease, the production of wells and the condition of the natural gas supply in so far as these tests will reveal it. These are subjects in which all consumers of natural gas are interested and the annual reports from this office regarding the same form an interesting chapter in the history of this field. To secure this information during the early history of the field was not a difficult task. Then, the rock pressure of the entire field tended to equalize during periods of light draught, and it was but necessary to test a few wells located in different sections of the field to ascertain the field pressure. This condition has changed. In some instances a heavy draught on one section of the field does not affect localities near by. The rock pressure of the field no longer equalizes. A large number of wells located in

various sections of the field must be tested to determine the field pressure, if such it can be termed. However much interested the consumers of natural gas are in this subject at the present time, it is of minor importance when compared with that work which has for its purpose the husbanding of the supply of this gaseous fuel, and but little time has been given to it the past year.

PIPE LINE INSPECTION.

The purpose of pipe line inspection is to prevent waste. Natural gas escaping from the many pipe lines, both large and small, that line nearly every road in the gas field, attracts the attention of the public more than any other class of waste. A very small amount of gas whistling from a pipe line near the highway will, often times, attract more attention from those unaccustomed to the work than 100,000 cubic feet of gas escaping from an oil or gas well. I do not underestimate the amount of gas that is wasted from this source; it is large, I know, and there is little excuse for it, but in its proper connection I will speak of another class of natural gas waste that is a much heavier drain upon the resources of the field than that from pipe lines and yet it receives but little attention from those most interested in the future of the gas field, the consumers. Previous to 1899 there was no law prohibiting pipe line waste and at my suggestion the General Assembly that met that year enacted a law authorizing the Natural Gas Supervisor upon the discovery of any leak in any pipe line to notify the owner or superintendent of the same to repair it and in case he does not comply within two days after receiving the said notice, it becomes the duty of the Supervisor, under the law, to make such repairs as may be necessary to stop the leak, and collect the cost of the same from the owner of the line. Though I have not had occasion to enforce the penalty provided for the violation of this law, it has rendered me very effective aid. A large majority of the waste from pipe lines comes from negligence on the part of superintendents of gas plants or field men, and one notice, as provided by law, has, to date, been sufficient. The notice provided in the act should not be necessary. An individual or corporation engaged in selling natural gas or a manufacturer owning his own gas plant should appreciate the value of this fuel enough to keep his lines in repair without notice from the State. The time has come when the law should be more drastic.

Most of the time of two men has been given to the inspection of pipe lines since last June, and, as a result, less gas is being wasted

from this source at present than at any time in the history of the field. The agitation on this subject is doing much good. There was a time when the waste of gas from any source caused but little comment. Now, the vandal-like waste of the past is rehearsed over and over by the manufacturer who finds fresh evidence of a diminishing supply of fuel each day. By some, this office is expected to stop all waste, regardless of the co-operation of the consumer and owner of pipe lines. It would be an easy task, indeed, if every one having an interest in the natural gas industry would do his duty and not permit waste from his own lines.

NATURAL GAS LAWS OF INDIANA.

The laws of the State of Indiana relating to natural gas prohibit—

1. The use of natural gas for illuminating purposes in flambeau lights. (Acts 1891, page 55.)

2. Any person, firm or corporation having possession or control of any natural gas or oil well from allowing the flow of gas or oil from such well to escape into the open air for a longer period than two (2) days next after gas or oil shall have been struck in such well. (Acts 1893, page 300.)

3. The owner or superintendent of any pipe line, machinery, apparatus, appliance or device used in the regulation and distribution of natural gas from permitting the gas in the same to escape into the open air; see "Pipe Line Inspection" above. (Acts 1899, page 83.)

4. The abandoning of oil or gas wells without properly plugging the same. (Acts 1893, page 300.)

5. The piping of natural gas from any point within this State to any point without this State. (Acts 1889, page 369.) It has been found impossible to enforce this statute, the Supreme Court upon two occasions having declared it to be unconstitutional.

By the Act of March 4, 1891 (Acts 1891, page 89) further attempt was made to regulate the production and transportation of natural gas. This act sought to accomplish four prohibitions:

1. The transportation of natural gas through pipes at a pressure exceeding 300 pounds to the square inch.

2. The transportation of natural gas through pipes by any other than natural pressure.

3. The use of any device or artificial process for the purpose of increasing the flow from the wells.

4. The use of any device or artificial process for the purpose of increasing or maintaining the flow of natural gas through pipe lines.

The attempt to enforce this statute has resulted in litigation leading to the overthrow by the Supreme Court of the State of several

features of the act on constitutional grounds. An attempt by the Manufacturers' Natural Gas and Oil Co. et al. (a number of manufacturers in the gas field, interested in the preservation of the supply of gas) to enjoin the Indiana Natural Gas and Oil Company from using artificial devices to increase the flow of gas in pipe lines has been held to be an inhibition against the right of interstate commerce and therefore unconstitutional. In the same series of cases it was further held by the Supreme Court that the attempt to discriminate between artificial and natural pressure in the transportation of natural gas was ineffectual for the same constitutional reasons. The right to prohibit the use of pumps or other devices for the purpose of accelerating the flow from the wells has been upheld as a measure of protection against the improper production of gas. Whether or not the provisions of the Act limiting the pressure to 300 pounds to the square inch in pipe lines can be enforced is not fully settled. An effort to enjoin the transportation of gas at a higher pressure, through a suit instituted by the Manufacturers' Natural Gas and Oil Co. et al., referred to above, failed in the Supreme Court on the grounds that the plaintiffs failed to show such special interest in themselves as warranted the action. The effect of this decision is, that only such persons or corporations as those whose property or persons are exposed to danger or risk incident to such extreme pressure, can be heard to complain of its use.

THE USE OF NATURAL GAS IN FLAMBEAU LIGHTS.

During the early history of the gas field and until 1896, one of the most wasteful uses of natural gas was the flambeau lights that could be seen burning night and day, year in and year out, in every section of the field. An average natural gas flambeau consumes from 150 to 200 cubic feet of gas per hour. Considering the quality of the light, this is certainly a very extravagant use, if not an absolute waste of gas. Though the law was enacted in 1891, but little was done toward enforcing it until 1896, and then much opposition was encountered. At that time, a suit instituted in the Blackford County Circuit Court to enforce it was appealed to the Supreme Court of the State, where its constitutionality was upheld. This did much to quiet the opposition that had been manifested toward it. At present, natural gas flambeaux are used by most drillers and a few manufacturers only. In many cases where they are used during winter there is a defense that would make the enforcement of the law difficult. Also, in localities where public sentiment does not favor

the enforcement of the law as written, it is difficult to secure a conviction. In this I can speak from experience. I have given all the time possible to this subject during the past year and have succeeded in getting the lights in a majority of the factories changed. In some, natural gas for illuminating purposes has given way to electricity. In others, the large lights formerly used have been replaced with more economical lights, though it is difficult to get such a light that is satisfactory for factory purposes. I do not deem it wise for me to give much time to this subject when there are so many other matters of vastly more importance that demand attention.

THE ESCAPE OF NATURAL GAS FROM WELLS.

To enforce the law relating to the escape of natural gas from wells, and thus prevent a wholesale waste of this gaseous fuel in sections of the gas field where oil is found, has consumed most of my time during the past year. What is known as the Indiana oil field is located on the northeastern border of the gas territory and embraces parts of Adams, Grant, Huntington, Jay and Wells counties. This is distinctly oil territory, and while occasionally some gas is found, the amount is insignificant compared with the value of the oil. There is not enough gas in this field for fuel purposes, pipe lines from the main gas field being necessary to supply fuel for drilling and pumping purposes.

This oil territory is contiguous to the gas field, and it is difficult to define a boundary line. Frequently wells drilled near it produce both gas and oil, and to produce the latter without wasting the gas is a difficult task, inasmuch as only a limited pressure can be held in an oil well without very materially reducing the production. If the well has been drilled to test the territory, the incentive to operate it for a short time at least is great. It is sometimes necessary to order what seems to be a productive oil well closed to prevent the waste of the gas.

DEVELOPMENT FOR OIL IN NATURAL GAS TERRITORY.

The idea is entertained by many people that "oil follows gas" and that when the gas is exhausted in this field, that the entire territory will become an oil field. This is an erroneous idea, as any person can ascertain by acquainting himself with the history of other gas fields. While undoubtedly natural gas and oil have the same origin and are stored under practically the same conditions, it does not

follow, nor is it true that the two products are always found associated. Much of the abandoned gas territory of this field does not show any signs of oil whatever, and where oil has been found it is in "sand," below the gas rock, with a hard stratum of nonporous rock between the two. The oil occupies a separate and distinct reservoir from that of the gas, though a small amount of gas is usually found with it. The gas can be produced without wasting the oil, but to produce the oil without wasting the gas is a much more difficult task. To prevent waste from this source, the law was enacted.

Though indications of oil have been present in many localities in the eastern and central part of the gas field for a number of years, no attempt was made to develop for this product in high pressure gas territory prior to 1897. A well drilled in April of that year on the Nimrod Carver farm, about two and one-half miles northeast of Alexandria, Madison County, proved to be a productive oil well, as well as a large gas well. This was the beginning of a period of waste that will never be forgotten by persons interested in the natural gas supply in that section of the field. From April 23, 1897, to March 12, 1898, seventy-five wells were drilled for oil in the vicinity of Alexandria. Of these, forty produced both gas and oil; thirty-three, gas only, and two were "dry," producing neither product. The waste of gas was enormous. To prevent damage to property the escaping gas was burned, and enough was consumed daily for weeks to supply every consumer, both domestic and manufacturing, in the city of Alexandria. At first the citizens of that city and vicinity were indifferent to this waste, and any attempt to enforce the law prohibiting it was looked upon with disfavor. The State acted promptly under the law in force at that time, which involved the infliction of a penalty only, for its violation. As most of the oil operators were nonresidents and but little was known of their responsibility, it was difficult to enforce the law, and when it was, it amounted to little more than a license, and did not stop the waste of gas. What the State wanted was to stop this, and that at once, and the penalty law failed.

March, 1898, the Supreme Court of the State decided the anti-waste law constitutional, and also that the State, or an individual interested in the supply of gas, could stop the waste of this fuel by injunction. This closed the oil wells and stopped the waste of gas in this territory for the time. These cases were affirmed by the Supreme Court of the United States, and the question was settled. In the meantime the citizens of Alexandria and the entire gas belt had awoke to the true condition, and since, the State has had their cooperation in every effort to husband the supply of this fuel.

From the time the oil wells at Alexandria were closed until the latter part of the year 1899, the oil industry in the gas field was quiet. At that time the Ohio Oil Company cleaned and started to operate five wells located on the Blake lease, about two and one-half miles northeast of Alexandria, that had been closed by injunction less than two years previous to prevent the waste of gas. On this lease it was found that the pressure of the gas had decreased until it did not seriously interfere with the production of the oil, and that the volume was not more than enough to operate the wells. This encouraged others in that locality, and at present all the wells that were closed in 1898 to prevent the waste of gas are either being operated for oil or have been abandoned. Some of the largest producers, when closed, are in the latter class. During the past year a number of wells have been drilled for oil. In cases where they produce more gas than is necessary to operate them and are not located near a large pipe line having consumers near by, sufficient to reduce the pressure in the line to a very low point, they have been closed.

Since January 1, 1900, in this locality of the gas field there have been twenty-eight old wells operated for oil. Over one-half of these are being operated at present, though the production is small. During the same period, thirty-three new wells have been drilled. Of the entire number, sixty-one, forty-five showed both gas and oil when drilled. Twelve wells produced gas only, and four did not show either product in valuable quantities. Fifteen of these wells have been closed to prevent the waste of gas, and ten are remaining closed to date. In nearly all of these wells being operated, the pressure of the gas reduces the oil production.

About three miles southeast of Marion, Grant County, is another small area of gas territory where oil is being found. In June, 1899, a "wild cat" well drilled on the B. F. Van Vactor farm, Section 15, Center Township, showed both oil and gas in large quantities. This was promptly closed by the State to prevent the waste of gas. Though all the available territory in that locality was soon under lease for oil, the closing of the Van Vactor well discouraged further drilling in that territory that year. Early in the year 1900 an old gas well located a short distance southwest of the Van Vactor well was cleaned and started to pump for oil. It showed but little gas, and a profitable oil production from the beginning. This encouraged others to drill in that vicinity. During the year 1900, fifty-five wells have been drilled for oil. Eight of these were old gas wells. Of the entire number of wells, three produce gas only, and two show neither product. The most productive wells are located in sections 15, 16, 21 and

24 of Center Township, and sections 28 and 29 of Mill Township. Twelve oil wells have been closed to prevent the waste of gas, and eight are remaining closed to date. While none of these wells are large producers, a majority are profitable, and are maintaining a fairly uniform output. The territory should not be judged by these wells, as but few show a natural production on account of the gas pressure. Though there is comparatively little gas in this field, and the companies operating it have made provision to care for any surplus that they may have, there is some difficulty in reducing the pressure in the lines to a point low enough to entirely relieve the wells.

Recently a few wells have been drilled for oil in the territory south-east of Muncie, Delaware County. Enough oil has been found to warrant further development of the territory. There is but little gas and there is no manifested disposition to waste it.

What seems to be the most productive "oil pool" that has been found in the gas belt this year is near Hartford City, Blackford County. Within the past three months twenty-three wells have been drilled, most of which are within the city limits. A few of these are very large oil wells and all produce more or less gas. Nine companies are operating in this small territory, and it has required constant work to prevent a large waste of gas, as no preparation was made to care for it at the beginning. However, large pipe lines have been laid from this territory to the factories near by, and with proper care there should be little trouble in the future. Of the twenty-three wells drilled, sixteen produce both gas and oil and seven produce gas only. Four wells have been closed to prevent the waste of gas and two are remaining closed to date.

A brief summary of the oil operations in the gas field during the past year shows that the drilling has been confined principally to four localities, to wit: Alexandria, the vicinity of Marion, Hartford City and the territory southeast of Muncie; that aside from the Hartford City "pool" no large wells have been found; that the pressure and volume of the gas, in many instances, seriously interferes with the operation of the wells, and that the natural production of the territory can not be ascertained until the gas is practically exhausted. During the year 1900, one hundred and thirty-nine wells have been drilled for oil in the gas field. This includes the old gas wells that were drilled deeper. Of these, one hundred and ten wells showed both gas and oil when drilled. Twenty produced gas only, and seven were "dry," producing neither gas nor oil. It has been necessary to close thirty-one oil wells to prevent the waste of gas, and of these, twenty are closed at present. Twenty-one wells drilled for oil have

been abandoned. It should be understood that it was not necessary for the State to institute suit to close all of these wells, but it should be equally well understood that they were closed in most cases because it is a violation of law to permit natural gas to escape into the open air from wells, and it is known that the State is compelling a strict observance of the law.

Wherever oil wells are being operated in gas territory there is more or less complaint about the waste of gas. In some cases there is just cause for this, but in many there is not. While there is always more or less waste on an oil lease where the gas pressure is high, it is not always in a manner that can be prevented by law. Many times natural gas is used so extravagantly by oil operators that its use is not less than waste, but it is not just to confine this charge to the oil field alone, for extravagance in the use of this fuel in a dwelling house or factory is just as wasteful as it is in an oil field. One of the most wasteful uses of natural gas that has come under my observation, and one that should be prohibited by law, is the use of it in steam engines instead of steam, to supply pumping power. This is one means of using the surplus gas on an oil lease. The amount of gas necessary to supply power by this means is governed by the condition of the engine, and it can not be good, after being operated with gas for a short time. Both the opportunity and incentive to use natural gas extravagantly, and even waste it where it interferes with the production of oil, is great, and in endeavoring to prevent this I have given nearly all of my time during the past year. The brief report given above suggests the results of my work. It has been my aim to enforce the provisions of the law strictly, and if I have failed in any degree I trust that the amount of work that I have tried to do will be considered.

PLUGGING OF ABANDONED GAS AND OIL WELLS.

There has been little done the past year to enforce the law regarding the plugging of abandoned gas and oil wells. This is not because the subject does not need attention, for it is a matter of vast importance to both the gas and oil industry, but because the law is defective. Attempts to enforce its provisions have proven fruitless. The present law stipulates the manner of plugging wells and provides an adequate penalty for its violation, but there is no way to ascertain when a well is to be plugged, and if so, whether according to law. Complaint is made to me that a well has been abandoned and not properly plugged. The person making the complaint was not present when

the tubing and casing were taken from the well and, in all probability, can not cite any person that was. At least it is seldom that a person can be found that can testify as to the manner that the well was plugged. The only evidence that the well is not properly plugged is the condition of the oil and gas rock in the vicinity of the well. A large number of wells have been abandoned the past year, and the annual number will increase. There is no doubt but that many of these have been left practically open, thus allowing the water to rush in and occupy the surrounding gas rock. This is very damaging to the oil and gas territory, and is a subject of much complaint from oil operators, gas companies and manufacturers. A bill will be submitted to the Legislature in session now that seeks to remedy the defects in the law in force at this time, making it possible for the State to ascertain when and how abandoned wells are plugged.

PRESSURE MAINTAINED IN PIPE LINES.

Late in October, 1900, a number of manufacturers of Muncie, Marion and Alexandria made formal complaint to this office, charging the Indiana Natural Gas and Oil Company, known as the Chicago Gas Company, with maintaining a pressure exceeding 300 pounds in its lines. The same charges were made against the Red Key Transportation Company and the Ohio and Indiana Consolidated Natural and Illuminating Gas Company. The charges against the Chicago Gas Company were especially plain and emphatic. Extravagant statements were made, some claiming that the pressure in these lines reached 1,500 pounds at times. It was not claimed by any one that these charges were based upon facts ascertained by actual tests, but upon the fact that it is *impossible* to pipe natural gas to Chicago from the Indiana field with 300 pounds pressure. The fact that former tests of the pressure in these lines had not revealed a pressure exceeding 300 pounds was given but little consideration.

The Indiana Natural Gas and Oil Company transports natural gas from this field to Chicago through two eight-inch lines and one ten-inch line. Three compressing stations are used—one near Greentown, Howard County; another near Fairmount, Grant County, and a third near Fowlerton in the same county. Each of these lines were tapped below each compressing station. Beginning November 28th, a number of tests were made, covering a period of six days, and during that time the pressure in these lines varied from 276 pounds to 295 pounds. Each test was witnessed by a number of representative citizens of the locality in which the test was made.

The fact that Chicago is a large city and could consume an enormous amount of gas accounts, in no small degree, for the current ideas in the gas field regarding the pressure in these lines. It is doubtful if the capacity of the lines or the number of wells in service has ever been considered by those making complaint. Compressing stations can not make natural gas. The Chicago Gas Company has about enough gas wells to supply, in the ordinary way, a city of 20,000 inhabitants. The product of these wells is taken to Kokomo, Indiana, and Chicago. The pipe line capacity to Chicago is four times that of any other gas company in the State having the same number of wells. It will be admitted by every one at all acquainted with the subject, that natural gas can be transported to Chicago in pipe lines at a pressure much below 300 pounds, the pressure necessary to move gas any distance being governed by the consumption. Also, it is true that the pipe line capacity of a gas plant has much to do with the amount of gas that can be carried a given distance at a given pressure. The question with a majority of manufacturers and gas companies in this field at this time is, whether to enlarge their lines or build a compressing station. I make these statements regarding the Chicago Gas Company because the complaints filed at this office made special reference to this company, and further, because there is a disposition manifested on the part of those manufacturers complaining, to discredit the tests made by this office. The tests that I have made may not furnish conclusive evidence that this company does not at times maintain an unlawful pressure in their pipe lines, but it *does* furnish conclusive evidence that natural gas can be transported to Chicago from this field for at least six days at a pressure not exceeding 300 pounds.

The Red Key Transportation Company has an eight-inch pipe line extending from the territory west of Eaton, Delaware County, to Dayton, Ohio. Three compressing stations are in use—one near Eaton, another near Red Key and a third near North Star, Ohio. This line was tested December 7th, and the highest pressure found was 210 pounds.

The Ohio and Indiana Consolidated Natural and Illuminating Gas Company has an eight-inch line extending from the north central part of Delaware County to Lima, Ohio. This line has three compressing stations—one near Eaton, another near Red Key, and a third near St. Marys, Ohio. The maximum pressure, December 7th, was 255 pounds. The pressure in the various pipe lines in the State will be tested in the future as frequently as the duties of the office will permit.

ANNUAL REPORTS.

But little time is given to the annual reports from this office. To give a full and complete report on the condition of the field would mean the neglect of much field work. These reports are published by the State and are supposed to give such information as will be most beneficial to manufacturers, gas companies and others interested in the natural gas supply. The time is here when the field work must be neglected if any time be given to reports. Those most interested in the subject ask that first consideration be given to the former and it should be, for anything that the State can do to husband this, its most valuable fuel resource, and thereby assist in more firmly establishing the many manufacturing industries that have located here to secure the advantage of using this gaseous fuel, should be done. Then, if some of the work of this office is left undone it is because all could not be done, and that which was most needed to conserve the supply of gas was given first attention. In all of my work during the past year, the one and principal object has been the husbanding of the natural gas supply of the State.

ASSISTANTS NEEDED.

It is hardly necessary for me to say, especially to those acquainted with the conditions in the gas field, that it is impossible for one man to do all the work of this office in an acceptable manner. This was probably not true when the law was enacted, 1891, but conditions have changed. At that time comparatively few wells had been drilled and but little pipe had been laid in gas territory. Most of the wells were in the vicinity of cities and towns and near the edge of the gas field. Not only has the past ten years wrought a wonderful change in the amount of natural gas property in the field, as well as in the condition of the field, but it has wrought an equal change in the work of the Natural Gas Supervisor. The increase in the number of wells and in the amount of pipe line has increased the avenues of waste, and the diminution in the supply has brought a consideration to the subject unknown in the past. Although the waste that characterized the early history of the field is no longer found, to prevent waste and the useless extravagance in the use of this valuable fuel requires a constant and vigilant watch. The entire time of one man could be given with profit to any one of the four principal gas producing counties (Blackford, Delaware, Grant and Madison) in the

gas belt. I am warranted in saying that every manufacturer and gas company in the gas belt will indorse this statement.

A number of manufacturers in Alexandria, Marion and Hartford City, and gas companies interested in the preservation of the gas supply, knowing the conditions and realizing the importance of the work, have, at their own suggestion, paid the expense of two assistants since last June. These men have worked under my directions, and the condition of the pipe lines, etc., throughout the field shows the results of their work. It should not be necessary for this expense to be paid by private individuals and corporations. Most manufacturers and gas companies are large taxpayers, and whatever benefits them benefits the entire State. Any expense necessary to carry on the work of this office should be paid by the State. I trust that the Legislature in session at this time will give this subject consideration and appropriate funds sufficient to pay the necessary expense of the office.

THE INDIANA NATURAL GAS FIELD.

It would probably be a waste of time to give any space in this report to a description of the Indiana Natural Gas Field or its history. These are subjects that have claimed considerable attention in earlier reports, and only such reference is made to them at this time as is necessary to a proper understanding of the present condition of the field; for in this, consumers of natural gas at present are more interested than in past history. It is not what the resources of the field have been, but what they are at present that interests us.

Some facts regarding this field are apparently settled in the public mind. For many years it was almost impossible to get the consumer who knew nothing about his fuel supply except what he saw at the point of consumption to face the true conditions. From actual observation he knew nothing about the decrease in the rock pressure of the wells and their volume of flow; the advance of the salt water horizon and the abandonment of wells; the necessary annual increase in the number of wells and the extension of pipe lines. To him the supply of this gaseous fuel was apparently inexhaustible. Time and changed conditions have wrought a change in the public mind. In most cases a shortage of gas has brought about an investigation of the condition of the supply, and in every case the result has been the same. When the true condition is known the necessity for husbanding the supply of this fuel resource is appreciated. On account of the mistaken ideas entertained by a majority of natural

gas consumers regarding the generation of this fuel and the stability of the supply, this gas field has suffered much. From the beginning until within the past three years, public sentiment was not only indifferent to the extravagant use and willful waste of this fuel that characterized nearly every section of this field during that period, but in many localities was positively opposed to the enforcement of laws enacted to prevent it. Strange as it may seem to those who know the conditions, it is true that in some sections of the field this spirit of indifference is still present. Where natural gas is wasted it is not often in a willful or unlawful manner, but by extravagance in its use, which, in most cases, is the result of crude appliances used in consuming it.

As I have said, the willful waste that characterized this field for so many years is fast becoming a thing of the past, though only after millions of cubic feet of this valuable fuel has been lost. Much of the waste that is found now is the result of negligence on the part of field men and those intrusted with the fuel department in factories. But it will avail but little to rehearse the mistakes of the past unless it aids us in meeting the responsibilities of the future.

DEVELOPMENT OF THE GAS FIELD, 1900.

In my last annual report I located the center of the gas field, that point toward which the principal pipe lines are being extended, a little north of the northwest corner of Delaware County. Embraced in this area were parts of Fairmount and Jefferson townships, Grant County; Washington Township, Delaware County, and Van Buren Township, Madison County. Of course there were numerous small areas of gas territory in various parts of the field, held by local gas companies and manufacturers, that had not been systematically drilled. Though this be true, these areas could not be considered as undeveloped territory, as wells drilled in it the past year show a rock pressure and production but little above those wells near by that have been in service for years. Wells drilled under these conditions are usually short lived.

Of the territory spoken of as the center of the field, about fifty square miles have not been drilled. This territory is composed of different areas, irregular in shape, and largely controlled by the principal pipe line companies. It is being rapidly and systematically drilled, and from present indications there will be but few locations left by the time this report is published.

GAS WELLS.

The condition of a gas field must be judged by the condition of the wells. More gas wells have been drilled in this field during the past year by both gas companies and manufacturers than any year previous. This does not mean that the amount of gas consumed annually is increasing, but rather that an increased number of wells is being abandoned each year and that new wells are becoming less productive. The salt water horizon in the most productive parts of the field is advancing rapidly, and in some localities has completely taken possession of the rock. Not unfrequently do seemingly productive gas wells succumb to it within six months after they are drilled. The condition of the gas rock can only be ascertained by the drill, and the result is a large increase in the number of failures. The time was when all new wells were fairly uniform in production and but few failures were recorded. Time has wrought a wonderful change in this condition, as well as others in the gas field.

The presence of the salt water in the upper strata of the gas rock can be accounted for when its structural condition and the source of the gas pressure is considered. In this field the gas rock is in the upper part of the Trenton limestone. It is here that the carbonate of lime has given way in part to carbonate of magnesia. The result is a highly crystalline limestone of sufficient porosity to contain a large amount of gas. The gas rock is not equally porous throughout, and not of a uniform thickness. It seldom comes to the surface of the limestone, from one to fifteen feet of the uppermost portion usually being hard and nonporous. As the upper surface of the gas rock is undulating, it is plain that the salt water advancing will meet the lower portions of the upper strata of hard limestone first, and thus different localities in the field will become hermetically sealed, one from the other. If the drill strikes the point in the gas rock where the salt water completely occupies it the result is evident. Also, as the volume of gas diminishes and the rock pressure gets lower, the tendency on the part of the former to move in the rock and the latter to equalize during periods of light draught becomes less. Viewed in the light of the above facts, the reason for the great difference in the volume of gas wells located in the same section of the field and their rock pressure is plain. Records of the rock pressure of this field at this time appear more like that of a number of small gas fields, wholly disconnected, than of one gas area. This condition is becoming more marked each year.

The structural condition of the gas rock, as well as the draught, has much to do with the aggressiveness of the salt water. It ap-

peared in the western part of the field and in wells that had been drilled an extra depth, and those that were subject to overdraught first. Very productive wells, with a rock pressure of 260 pounds, succumbed to this agent here before it was known to be a destructive agent in some other localities. Finally, as the draught throughout the field began to show in the diminished volume of the wells and a material decrease in the rock pressure of the field, the influence of the salt water became more pronounced, and now it is the most dangerous and difficult element with which gas companies and manufacturers have to contend. It is necessary to exercise the greatest care in drilling gas wells at this time that the gas rock may be penetrated without molesting the salt water. What can be done to counteract the influence of the salt water and thereby render the gas that is left in the rock available? If the pressure of the gas is sufficient to raise it through the tubing the task is an easy one. The water can be separated from the gas and kept out of the line. If the pressure of the gas is not strong enough to raise it through the well tubing, then the only thing to do is to reduce the well tubing to a point where the gas will lift the salt water. It is not advisable to place a small pipe within the well for the purpose of lifting the water, and permit it to remain open, as the water will be raised but the gas will be wasted. By re-tubing with small pipe and using a separator the same object will be gained without the waste of the gas. Like any other class of property, gas wells need constant attention.

PIPE LINE EXTENSIONS.

An increase in the number of wells drilled in a given year usually means an increase in the amount of pipe line laid, though for various reasons main lines are frequently extended farther into new territory than is necessary for the wells to be drilled at the time. In this manner territory is sometimes held for a time, for after a certain area has been penetrated by large lines by any one company, other companies are slow to enter it. In case they do it is usually from extreme necessity. A large amount of main line was laid in 1899, and a majority of the lines laid the past year are feeders, though in some cases they are as large as the main lines. There is a disposition at present founded upon necessity, to enlarge all gas lines. In constructing the gas plants in this field, if present conditions could have been anticipated, much labor and capital could have been saved; for, as the field pressure decreases it becomes absolutely necessary to enlarge field lines or increase the pressure by artificial means.

COMPRESSING STATIONS.

With the decrease in the rock pressure of this field came the necessity for using compressors on pipe lines. I repeat that the pressure required to transport natural gas any distance depends primarily upon the consumption. With no consumption and the pipe line perfectly tight the pressure at the outlet of the line must be the same as that at the wells, and with the line wide open at the point of consumption the loss of pressure is at a maximum. The amount of natural gas that can be transported in pipe lines a given distance depends upon the size of the line and the pressure in the same, the former governing the volume of gas and the latter its velocity. Thus as the field pressure decreases, the question presented to both gas companies and manufacturers is, whether to build compressing stations or increase their pipe line capacity. Some have adopted the former, others the latter, while occasionally it has been necessary to resort to both. The following companies have stations as indicated below in this field:

<i>Company.</i>	<i>Number of Stations.</i>
1. Indianapolis Gas Company, Indianapolis.....	2
2. Consumers' Gas Trust Company, Indianapolis.....	2
3. Manufacturers' Natural Gas Company, Indianapolis....	1
4. Indiana Natural and Illuminating Gas Company, Lebanon, Frankfort and Crawfordsville.....	2
5. Lafayette Gas Company, Lafayette.....	2
6. Logansport and Wabash Valley Gas Company, Logans- port, Peru, Wabash and Decatur.....	4
7. Fort Wayne Gas Company, Bluffton and Fort Wayne..	3
8. Portland Natural Gas and Oil Company.....	1
9. The Ohio and Indiana Consolidated Natural and Illu- minating Gas Company, Lima, Ohio.....	2
10. The Red Key Transportation Company, Dayton, Ohio..	2
11. Richmond Natural Gas Company, Richmond.....	1
12. Indiana Natural Gas and Oil Company, Kokomo, Ind., and Chicago, Ill.....	3
13. The Muncie Glass Company, Muncie.....	1
14. Pittsburg Plate Glass Company, Elwood and Kokomo..	1
15. The Anderson Fuel Supply Company, Manufacturers in Anderson	1
16. The J. M. Leach Gas Company, Manufacturers at Kokomo	1
17. American Sheet Steel Company, Muncie.....	1
Total	30

It will be noticed that manufacturers in Muncie, Elwood, Anderson and Kokomo have been compelled to build compressing stations to maintain their fuel supply. This is but a beginning. The indications are that all the larger gas companies within the gas field, whether supplying gas for domestic or manufacturing purposes, will be compelled to build compressing stations this year if they are to have satisfactory service.

ROCK PRESSURE.

As the conditions of a natural gas field must be judged by the wells, so the wells must be judged by the volume of flow, the rock pressure, etc. A diminution in the supply of gas will show in a decreased volume of flow of the wells, and in a general way, in a decrease in the rock pressure. If oil is present or salt water is invading the rock the wells will show it when open. Also, any statement regarding the condition of the wells or field, to be of value, must not only be based upon the conditions stated above, but must be comparative; that is, the conditions at present must be compared with conditions as shown by former tests.

Referring to the rock pressure of the field and its relation to the supply of gas, I quote from my last annual report: "When speaking of the condition of a natural gas field, reference is usually made to the rock or closed pressure of the wells, it being the impression of many people that, accordingly as this is high or low, so are the wells large or small. This is not true in every instance, and as the supply of gas becomes more nearly exhausted this becomes a more uncertain index of the capacity of the wells. A decrease in the rock pressure of a given area of the gas field indicates a general diminution in the supply of gas in that area, but two wells on the same farm may have the same rock pressure and be very unequal in production. The velocity of the gas at the well mouth is the only true index of the capacity of the well." The original rock pressure of the Indiana natural gas field was 325 pounds. The heavy consumption of gas by all classes of consumers, from the beginning, soon became apparent in the decline of the volume of flow and the rock pressure of wells in those localities of largest draught. This was in the zone occupied by pipe lines and in the vicinity of cities and towns, though it was not long before the decline could be noticed in all parts of the field.

At first the decline of the rock pressure throughout the field was gradual and fairly uniform, showing greatest, of course, during

periods of heavy consumption. During the summer season, when the consumption was light, the gas seemed to move freely through the rock and the pressure equalized to a certain extent. As the supply of gas has decreased the pressure has become less uniform. As has been stated, the gas rock is not uniform in thickness, both the lower and upper surfaces being more or less undulating. As the salt water raises, it may reach the upper surface of the gas rock at points and hermetically seal the gas in the more elevated portions of the same; and thus, as the field progresses, it is possible that the entire gas territory will become divided and subdivided into numerous small gas areas, varying in rock pressure, the draught on one not affecting others. To a certain extent this condition exists at this time. The draught on the wells is becoming less uniform as the rock pressure decreases. Those pipe lines connected with compressors maintain a pressure above that of the wells located below the compressing station, and as a consequence these wells are useless, a part of the time, at least. The difficulty in ascertaining the average rock pressure of the entire gas area is plain, and when found it does not give much information regarding the condition of the gas supply. The rock pressure of the territory south of an east and west line parallel with the south boundary of Hamilton County, and touching the same, is not included in the pressures given in this report. This is not because this territory does not produce gas sufficient to warrant a consideration, but because it supplies but little gas other than what is used for local domestic consumption within the territory. Regarding this part of the gas field I quote from my last annual report: "In much of this section the gas rock is thin and hard, lacking the degree of porosity found in the northern section. The gas passes slowly from the rock to the wells, and, as a consequence, they are small and seldom overworked. Pipe lines from this part of the field supply Connersville, Shelbyville and Hope. Aside from these cities the draught is largely for local domestic consumption."*

When reference is made to the Indiana Natural Gas Field, that part of the field north of the line indicated above is usually in mind. The original area of this section of the field contains approximately 2,850 square miles. As has been stated in former reports, it presents three well defined divisions. First, an outer zone surrounding the entire section. This zone varies greatly in width and has been abandoned for pipe line purposes. A part of it supplies local domestic consumption.

* Annual report of State Natural Gas Supervisor, 1899, page 208.

Second, a middle zone, which is the territory supplying pipe lines and a large majority of the factories. It varies in productiveness and has in most localities been systematically drilled. In December, 1899, this zone contained approximately 1,350 square miles. It has decreased in area very materially during the past year.

Third, the center of production, or that part of the field not invaded by pipe lines. This is a very small area located in the vicinity of the northwest corner of Delaware County. It is being very rapidly drilled. It is very difficult to ascertain the exact area of these divisions. Regarding the productive area, it is probably sufficient to say that the south two-thirds of Grant County, the south half of Blackford County, and the north half of Madison and Delaware counties supply a large per cent. of the natural gas consumed from this field.

The pressures given in this report were taken from wells located in the middle and center zones only, and are the averages of a large number of tests made in various localities. On account of the presence of the salt water it is very difficult to ascertain the exact rock pressure in many instances, but the results given here were secured under the most favorable conditions possible. This territory or zone of the gas field is decreasing annually in area and the average pressure given for each year is made from tests of the territory as it was at that time.

Tests made in this territory in November, 1897, showed an average rock pressure of 197 pounds. The same territory in 1898 showed 173 pounds rock pressure. In December, 1899, this had decreased to 155 pounds, and at present the pressure varies from 75 to 160 pounds, and the average is about 115 pounds.

CONSUMPTION AND WASTE.

Ordinarily, in referring to natural gas waste, we have in mind the escape of gas from wells, pipe lines, etc. Reference has been made to this class of waste in former sections of this report. The subject will be mentioned here only as it is involved in the consumption of this fuel. If natural gas is used extravagantly, or in heating appliances from which its full heating power is not available, it is waste, and that it is so used throughout the gas and oil field is well known. Laws have been enacted to prevent the escape of natural gas from wells, pipe lines, appliances, etc., and the enforcement of the same has reduced this class of waste to a minimum, the amount being very little compared with the same during the early history of the field. Without trying to apologize for the extravagant use of this

fuel by consumers in general, it is but fair to say that more care is being exercised in its use than formerly, though it is usually made necessary by a shortage in the supply. The fact is that but few consumers exercise that degree of economy in the use of this gaseous fuel that its value warrants or that they would were it measured to them and they were compelled to pay for what they use. The waste of natural gas that is involved in its consumption presents many difficult questions, and at present it seems that additional legislation will be required to in any measure prevent it.

THE CONSUMPTION OF GAS.

Natural gas has fulfilled its highest purpose when it has been used for the comfort and benefit of mankind. To secure this end the entire stock of gas must be consumed in such manner that the greatest possible amount of heat will be obtained and utilized. In other words, the appliances used to consume natural gas should be such as will permit a complete combustion of the gas and supply the heat to its proper purpose. Incomplete combustion not only involves waste, but fails to give the most satisfactory service. Natural gas, when used under proper conditions, is a most satisfactory fuel, a large per cent. of its heating value being attainable.

At this time when much complaint is being heard regarding the natural gas service, especially from pipe line cities, much is being said about economical appliances and methods of using gas. To those who have an opportunity to become acquainted with the usual methods of burning natural gas and utilizing its heat that are practiced throughout the gas field, this is not surprising. If the agitation had come sooner and proper methods of sale and consumption had been adopted at the beginning, the condition of the field would doubtless be different at this time.

While attending the duties of this office I have examined a large number of gas fires, both in factories and private houses, and in but few instances have I found the results of the gas consumed in the private houses to be what they should be. From incomplete combustion, which is usually the result of the use of appliances not adapted to the fuel, the domestic consumer suffers most. Not only is much of the heating power of the gas lost, but it is sure to result in the formation of carbonous oxide gas, which is extremely poisonous. To attempt to describe the various methods of using natural gas by domestic consumers would be an endless task. Generally speaking, there is not so much difference in the amount of gas used where the supply is ample as there is in the results, the latter depending entirely upon

the way it is used. In the consumption of natural gas the principal end to be attained is complete combustion, whereby all of the heating power of the gas is realized and the supplying of the heat to the room or to the purpose for which it is generated. To realize the full heating power of natural gas or to secure complete combustion it is necessary to mix it with air. The volume of air required to burn a given amount of gas is about ten times the volume of gas consumed. Too much air will tend to carry away heat through the chimney that might otherwise be utilized. In regulating a gas fire, a good method is to adjust the air supply at the mixer in such a manner that a slight white tip can be occasionally seen at the end of the flame and then turn on enough air to cause this to disappear. The supply of gas may be ample and the combustion complete, and if the heat is permitted to pass out through the chimney instead of being supplied to the room the service can not be good. Much depends, then, upon the construction of the stove or grate and the regulation of the draught. I have seen gas stoves consuming not to exceed twenty cubic feet of gas per hour giving out more heat than grates consuming two hundred cubic feet per hour. Generally speaking, a grate is very wasteful, and the best that can be said is that it makes a cheerful fire and usually insures good ventilation.

Natural gas from this field has been used for domestic purposes since 1886. During that time, comparatively little attention has been given to methods of consumption. In cases where it has, it has been caused by a shortage in the supply rather than a desire to husband it. Some reasons can be given why this condition exists and many why it should not. At the time that natural gas was discovered, wood and coal were the universal fuels. The heating apparatus in every house was arranged with especial reference to the use of one or the other, or both of these fuels. Most people began the use of natural gas with but little knowledge of how it should be used. Generally speaking, the grates, stoves, chimneys, etc., were ill adapted to the new fuel, but without any material change except a burner its use was begun. The "contract system" of selling gas was adopted by all gas companies at the beginning, and with it there is but little incentive for the consumer to exercise economy. The schedule of rates was arranged with reference to the number of fires or rooms; in some towns an annual charge was made for a residence, regardless of the amount of gas consumed. It is true, as I think, that most natural gas consumers will admit that the "contract system" of selling gas is largely responsible for the indifference manifested by the average consumer towards methods of consumption and amount of gas consumed, and but little improvement can be expected until it is forced

by a shortage in the supply or until the present system of selling is changed to one whereby the consumer is required to pay for the gas used only. Under the contract or flat rate system of selling gas the charges are the same regardless of the amount of gas used. In some cities where the supply is short at times, the consumer pays for fuel that he does not get. The system is wrong in principle and would not be considered in any other business.

There can be no question as to the just method of selling natural gas. If it is property and can be transferred as other property is, it will harm no one to pay for it as he pays for other property. Those who oppose the "meter system" contend that its adoption means a higher price for gas. This may be true, but not necessarily so. I can see no reason why the rates can not be adjusted as equitably under one system as the other. A schedule of prices under which I am compelled to pay for the gas that I use and no more is certainly just. If I choose to adopt economical appliances and practice economy, a reduction in my gas bill will follow. If I use the gas extravagantly I pay for what I use and no more. The introduction of meters at this late day would not only improve the service in many localities, but would undoubtedly prolong the life of the field. I am sure that the result would be ample recompense for the trouble and expense.

In a majority of factories natural gas is used more economically than in private residences. The reasons are plain. Most manufacturers own their fuel plant. The increasing annual expense that is necessary to maintain it has led many to investigate the subject of natural gas consumption. The result is that a majority have adopted improved appliances and are using less gas and having better service. The American Window Glass Company have placed meters in each of their thirty-six factories in this field. They own their fuel plants, and propose to practice the same economy in the use of their fuel as they do in the use of any other constituent of their product. The American Plate Glass Company keeps an accurate daily record of gas consumed. I do not want to be understood as saying that all manufacturers have adopted approved appliances for using gas or make an effort toward economy in the use of this fuel. A few adhere to old methods and use the gas in a manner that would indicate their belief in an inexhaustible supply. I find many cases of absolute waste that the law does not prohibit. Manufacturers, however, usually comply with any reasonable request that has for its object the husbanding of the natural gas supply. Such waste is frequently the result of negligence on the part of employes, rather than a disposition to waste the gas.