

REPORT OF THE STATE NATURAL GAS SUPERVISOR.

LETTER OF TRANSMITTAL.

OFFICE OF NATURAL GAS SUPERVISOR, }
KOKOMO, IND., Jan. 13, 1896. }

SIR—I herewith transmit to you my first annual report upon the condition of the natural gas field of Indiana. It is made in obedience to Section 7504 of the Revised Statutes of the State of Indiana, and covers the period from March 16, 1895, to January 1, 1896.

Owing to the short time that I have had charge of this office and the amount of time that it has been necessary for me to spend in the field, it has not been possible for me to make this report as comprehensive as I would like. Now that I am acquainted with the field, I hope that my next report will more nearly represent the magnitude and importance of the Indiana natural gas field.

Believing that the field work of this office is most important, I have spent a large part of my time inspecting gas property. The safety of life and property requires all gas mains, pipes, regulators, etc., to be kept in good condition. Much of the piping and machinery in use at present is old and worn, and the necessity for a careful inspection of the same is apparent. It has not been possible, to the present time, for me to visit the entire field, but my work has been systematic, and I hope soon to report the condition of every gas plant.

Wherever I have been, the owners and managers of gas plants have expressed a willingness to give me all the aid and information possible, thereby making my work pleasant and I trust profitable to the gas interests of the State.

I take pleasure in acknowledging here, the cordial support that I have received from you. Your helpful suggestions and kind aid and encouragement are appreciated.

I respectfully submit this report and remain,

Yours sincerely,

J. C. LEACH,

State Natural Gas Supervisor.

PROF. W. S. BLATCHLEY,

State Geologist.

INTRODUCTION.

The reports from this Department, to be of value, should contain such information as the public desires to know, and discuss such subjects as demand the attention of those who are interested in the natural gas industry of Indiana. They should contain an accurate history of the gas field; a history in which all phases of the subject have been discussed, and in which the condition of the field has been noted from year to year.

In compiling this, my first annual report, I have tried to keep in view its purpose, but of necessity have had to submit to some limitations. The law authorizing an annual report from this division of the Department of Geology and Natural Resources to the State Geologist defines to some extent the nature of the report. The duties of the Natural Gas Supervisor, as defined by law, are not arranged with reference to the compilation of a report, but with sole reference to the needs of the gas industry. This is right. The most important work of the Supervisor is not the making of an annual report, but is the performing of the duties in the field as the law specifies. I would not be understood as underestimating the value of any report in which the scientific or commercial world are interested. The exhaustive reports made by the Departments of Geology of both Pennsylvania and Ohio on the natural gas regions of those States have been of great value to geologists in Indiana, and in fact to every one interested in the natural gas industry. I only wish it were possible for me to compile a report as comprehensive as the subject demands, and one that would fairly represent the magnitude of the Indiana gas field. Taking into consideration the area of the Indiana gas field, and the amount of time that must necessarily be given to the field work, it will be seen at once that an annual report from this office can be little more than a record of the field work.

During the early history of the Indiana field, questions relating to the economic use of gas did not receive much attention. Most people believed that nature had provided for a renewal of the supply. Why give any time to this phase of the question, when the supply was inexhaustible? It was during this period that the scientific phase of the question received most attention. The discussion of the subject was not confined to geologists and chemists alone. Many who did not profess a knowledge of these sciences were able, as they thought, to account for the origin of this new fuel. It was but natural that those who witnessed the power exerted by this gaseous fuel, as it rushed forth from its rocky prison, or who were permitted to enjoy the luxury of its power, when re-imprisoned, should look for a cause for this new phenomenon. But few were able to

account for the origin of gas or its pressure, but many reached the happy conclusion that its life would be equal to all time. This, to the geologist, was not the logical conclusion; a conclusion that the facts involved would substantiate. He claimed that the stock of gas was practically complete; that when once exhausted, there was no provision in nature for its renewal. Experience to date indicates that this is true. If the public mind had been in accord with this idea at the beginning, as it is now, the benefit derived from natural gas in this field would have far exceeded what it has been; for the idea that the supply of gas was good for all time, either by virtue of the enormous amount stored in the rocks, or a provision of nature for the renewal of the present supply, has, to a large degree, been the cause of the extravagant use of gas that has been practiced in the Indiana gas field. Public opinion, however, has changed. The history of other gas fields is finished, and the present condition of the Indiana field indicates that the history of it will be a repetition of the history of every other field.

While the scientific phases of the natural gas question will always be subjects of thought, we have reached that period in the history of the Indiana field when economic measures are of most interest. Methods of economy are more interesting than modes of origin. Instead of spending time and energy inventing and arranging apparatus, by means of which the gas from one or more wells can be made to illuminate the country for miles around, the owners of gas property are interested in scientific burners and devices, invented to protect gas wells and territory, and husband the supply of gas. It is not as difficult to convince the extravagant consumer of gas that the rock pressure is going down; that the salt water is becoming intrusive and that the supply of this new fuel will soon be exhausted, as it once was. The evidence is more convincing now. Statements concerning the gas supply, once labeled as idle assertions made in the interests of gas companies, are now recognized as facts. Any effort to husband the supply of this gaseous fuel meets the public's approval; and while there are but few, comparatively speaking, who practice economy in the use of gas, an examination will reveal the fact that the cause does not lie in the will of the consumer to waste gas, but rather in the kind and arrangement of the devices used in the combustion of this gaseous fuel. The public favors economy in the use of gas. It is late to begin, but not too late. Natural gas is valuable property and a business like economy practiced in the use of it will, even at this late day, materially extend its life.

Questions relating to the origin of rock oil and gas have been discussed by the scientific world for a number of years. Much has been said and many theories advanced. I will not attempt to discuss the many theories that have been proposed to account for the origin, accumulation, or pressure of this hydrocarbon, or to advance any new theory

concerning the same; but, inasmuch as the theoretical views that we hold regarding the subject will influence our judgment as to the supply, I have thought it proper, in a subsequent chapter, to give brief statements of the views most commonly accepted as to the origin and accumulation of natural gas.

The present condition of the Indiana gas field is a matter that interests a large number of people, and a subsequent chapter will be devoted to this subject.

In regard to scientific devices and economic methods of using gas, much investigation has been made during the past year. Especially is this true of manufacturers and gas companies. All realize that natural gas is most valuable as a heating power, and how to get the maximum power from the minimum amount of gas, consistent with the work done, is the question. Upon this subject Prof. Elwood Haynes, of Kokomo, Indiana, has, at my request, prepared a paper for this report. Prof. Haynes is an expert chemist, as well as a natural gas engineer of large experience. He is constantly experimenting along the line of natural gas economy, and his paper will be read with interest, especially by those acquainted with his work in the Indiana gas field.

The past year has witnessed some anxiety and much speculation, on the part of the gas consumer, regarding the schedule of rates for the future. This has not been without cause. In some cities the rates have been materially advanced, while in others there has been much talk and nothing done. Many inquiries come to this office regarding the rates charged in the different cities of the gas belt. Owing to the numerous provisions in the schedules of the various cities using gas, it has not been practical to tabulate them for this report. Those desiring information can obtain it by addressing the gas companies of the State, a list of which is given in this report.

With former reports from this Department, a map of the natural gas area has been given. This has proven very convenient, especially to those who desire to become acquainted with the gas field. I have exerted much care in preparing the map that accompanies this report, and believe it to be practically correct. The outline of the natural gas area is substantially the same as that given on former maps, and is aimed to include all territory that has produced gas in commercially valuable quantities. The pipe lines are located in accordance with maps furnished by the different gas companies, and include all extensions to December 1, 1895. On account of the size of the map, pipe lines tributary to the main lines are not given, and for the same reason it has been impossible, even if desirable, to indicate the location of all the gas wells. Those indicated are but a small per cent. of the total number, but the ratio is intended to be uniform.

Though frequent reference is made to the natural gas law of the State, but few are acquainted with its provisions. The law consists of what may be termed a general law, defining the duties of the Natural Gas Supervisor, and certain special laws enacted to protect the natural gas industry of the State. Its provisions are comprehensive, and it is the duty of the Natural Gas Supervisor to see that they are enforced. But, notwithstanding this, and however broad the law may seem or however ample the authority of the Supervisor may appear, there have been some instances of gross negligence on the part of gas companies and consumers, and flagrant waste by both, that no reasonable construction of the law could prevent. In cases like these, the Supervisor is usually accused of neglecting his duty. In order that those who desire to become acquainted with the law may have the opportunity, and because I believe that the work of this office will become more effective as the public becomes more familiar with its provisions, I have had it printed in a convenient form for general distribution, and will gladly mail one or more copies to those desiring it.

ACKNOWLEDGMENTS.

I take this opportunity to express my indebtedness to all who have rendered me assistance in my work. Without the help that I have received from the officers of the different gas companies, from manufacturers and drillers, my duties would have been much more arduous.

NATURAL GAS.

ITS HISTORY, COMPOSITION, FUEL VALUE, ORIGIN, ACCUMULATION, PRESSURE AND MEASUREMENT.

EARLY HISTORY.

The fact that an inflammable gas escapes more or less freely in every country, from the bottom of ponds and shallow lakes, stagnant water of swamps, springs and crevices in the earth, has been known for a long time. It is frequently found in excavations in recent deposits at the mouths of rivers, and, in fact, wherever the deposit contains organic matter this marsh gas, as it is called, will be found; for the principal conditions upon which its generation depends are a deposit of organic matter and temperature, together with the exclusion of the air from the

decaying substance. This gas is being constantly generated, and there is no doubt but that enormous quantities escape into the atmosphere. It is a compound of carbon and hydrogen, and is the principal constituent of natural gas.

The history of natural gas would require a volume. It has been found in nearly every country and geologic formation. Its presence was known and its power utilized to some extent in China, Japan and in the vicinity of the oil regions near the Caspian Sea many years ago. In China the gas escapes from the borings put down for salt water, and is utilized in boiling down the brine. As might be expected, the tools used in sinking these salt water wells are very crude, and the process of drilling very slow. The wells are cased with wood and the gas transported to the evaporating pans in bamboo pipes. Clay burners are used.

The small quantities of natural gas found in the vicinity of the oil fields of Japan have never been utilized to any extent.

The village of Fredonia, Chautauqua County, New York, used natural gas for illuminating purposes as early as 1821. As far as can be ascertained, this was the first use of natural gas in this country. In 1841 natural gas was used to boil the brine from the salt wells in the Kanawha Valley, West Virginia. A gas well 1,000 feet deep was drilled near the same place in 1843. This well produced "high-pressure" gas, and is the first of its kind on record.

The history of the natural gas industry in Pennsylvania probably dates from the beginning of the drilling for oil in 1859. More or less gas usually accompanied the oil, and at first was allowed to escape into the atmosphere without notice, but later was piped a safe distance from the well and burned. After awhile it was used as fuel under the boilers in drilling and pumping. Natural gas began to be used extensively as a fuel in 1883. It was then that the gas from the Murrysville district was piped to Pittsburgh.

As soon as gas began to be used extensively for manufacturing and domestic purposes in Pennsylvania and its value as a fuel became known, explorations began and have continued ever since. There are but very few States in the Union in which the drill has not penetrated the underlying rocks in search of this gaseous fuel.

In 1884 gas was discovered in the Trenton limestone at Findlay, Ohio. This gave a new impetus to the gas industry. Prior to this time valuable deposits of natural gas had been found in sandstones only; now that a new horizon had been discovered, those whose efforts heretofore had ended in failure took courage. Companies were organized and the drill was sent on its journey of exploration in many localities. In 1886 this limestone was found to be a gas-producing rock in Indiana. The result of this discovery is familiar to a majority of those for whom this report was written. The subject will be mentioned in a subsequent chapter.

Natural gas has been found in a number of States besides those above mentioned. However, outside of Pennsylvania, Ohio and Indiana the supply has not proven very valuable. According to the United States Geological Survey the combined value of the natural gas produced in the United States outside of these three States does not equal one-half the value of the production of either one of these States. It is impossible to calculate the actual value of the natural gas consumed in the State of Indiana during the year 1895, or any previous year.

An approximate value can be given only, and this is very unsatisfactory, from the fact that in many instances it is impossible to obtain the amount or value of the gas used. The volume of Mineral Resources of the United States, 1893, published by the United States Geological Survey, gives a table in which an estimate of the value of the natural gas consumed in the United States from 1885 to 1893 is given. While it can not be claimed that the statements given in this table are more than approximately correct, the author, Mr. Joseph D. Weeks, has used every available means to obtain correct estimates. The basis of the calculations in this table is the value of the fuel displaced by natural gas. Assuming that the statements made are only approximate, a comparison of the various amounts given is interesting. For the benefit of those who have not access to this volume of the Mineral Resources, the table above mentioned is given here.

VALUE OF NATURAL GAS CONSUMED IN THE UNITED STATES, 1885 TO 1893.

LOCALITIES.	1885.	1886.	1887.	1888.	1889.
Pennsylvania	\$4,500,000	\$9,000,000	\$13,749,500	\$19,282,375	\$11,593,989
New York	196,000	210,000	333,000	332,500	530,026
Ohio	100,000	400,000	1,000,000	1,500,000	5,215,669
West Virginia.....	40,000	60,000	120,000	120,000	12,000
Indiana .....	.....	300,000	600,000	1,320,000	2,075,702
Illinois	1,200	4,000	.....	.....	10,615
Kentucky .....	.....	.....	.....	.....	2,580
Kansas .....	.....	6,000	.....	.....	15,873
Michigan .....	.....	12,000	.....	.....	.....
Missouri .....	.....	.....	.....	.....	35,687
Arkansas .....	.....	.....	.....	.....	375
Texas.....	.....	.....	.....	.....	1,728
Utah.....	.....	.....	.....	.....	150
South Dakota .....	.....	.....	.....	.....	25
California .....	.....	.....	.....	.....	12,680
Elsewhere	20,000	20,000	15,000	15,000	1,000,000
Total	\$4,857,200	\$10,012,000	\$15,817,500	\$22,629,875	\$21,107,099

VALUE OF NATURAL GAS CONSUMED IN THE UNITED STATES, 1885 TO 1893.—
Continued.

LOCALITIES.	1890.	1891.	1892.	1893.
Pennsylvania	\$9,551,025	\$7,834,016	\$7,367,281	\$6,488,000
New York.....	552,000	280,000	216,000	210,000
Ohio.....	4,684,300	3,076,325	2,136,000	1,510,000
West Virginia.....	5,400	35,000	500	123,000
Indiana.....	2,302,500	3,942,500	4,716,000	5,718,000
Illinois.....	6,000	6,000	12,988	14,000
Kentucky.....	30,000	38,993	43,175	68,500
Kansas.....	12,000	3,500	40,795	50,000
Michigan.....				
Missouri.....	10,500	1,500	3,775	2,100
Arkansas.....		250	100	100
Texas.....			100	50
Utah.....	6,000			500
South Dakota.....				
California.....	33,000	30,000	55,000	62,000
Elsewhere.....	1,600,000	250,000	200,000	100,000
Total.....	\$18,792,725	\$15,500,084	\$14,800,714	\$14,346,250

COMPOSITION.

Natural gas is one of a series of the products of the earth's crust, known as bitumens; naphtha, petroleum, maltha, asphaltum, etc., belong to the same list, are found under substantially the same conditions, and doubtless have the same history, consequently whatever is said of natural gas can be applied with equal propriety to petroleum.

Although natural gas is used for lighting purposes to some extent, its chief value is in its heating power. This depends upon its chemic composition, and any change will effect this power. It has not been convenient to analyze a sample of Indiana gas for this report, but a number of analyses of Ohio and Indiana gas, given by Prof. Orton in the Eighth Annual Report of the United States Geological Survey, are used here. They were made in July, 1887, by Prof. C. C. Howard, of Starling Medical College, Columbus, Ohio.

COMPOSITION OF TRENTON LIMESTONE GAS. (Howard.)

CONSTITUENTS.	OHIO.			INDIANA.			
	Fostoria.	Findlay.	St. Mary's.	Muncie.	Anderson.	Kokomo.	Marion.
Hydrogen.....	1.89	1.64	1.74	2.35	1.86	1.42	1.20
Marsh gas.....	92.84	93.55	93.85	92.67	93.07	94.16	93.58
Olefiant gas.....	.20	.35	.20	.25	.49	.30	.15
Carbon monoxide.....	.55	.41	.44	.45	.73	.55	.60
Carbon dioxide.....	.20	.25	.23	.25	.28	.29	.30
Oxygen.....	.35	.39	.35	.35	.42	.30	.55
Nitrogen.....	3.82	3.41	2.98	3.53	3.02	2.80	3.42
Hydrogen sulphide.....	.15	.20	.21	.15	.15	.18	.20
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

NOTE.—The Fostoria gas was taken from the Watertanks wells; the Findlay gas from the six wells of the Findlay Gaslight Company; the St. Mary's gas from the Wilkins well; the Muncie (Ind.) gas from Wells Nos. 1, 2, 3, 4 and 6; the Anderson gas from the McCullough well; the Kokomo gas from wells Nos. 1 and 2, and the Marion gas from well No. 3.

In the Pennsylvania gas it will be observed that there is a notable variation in the proportion of the constituents of the gas from the different fields. The amount of nitrogen varies between 2.02 per cent. and 15.30 per cent., and the paraffins between 84.26 per cent. and 97.70 per cent.

The proportion of carbon to hydrogen in the paraffins also varies, the Speechley gas being richest in carbon. Of sulphuretted hydrogen, a universal element of Trenton limestone gas, there is not a trace found in this gas.

The principal constituent of natural gas is marsh gas or methane (CH_4), a type of a series of hydrocarbons, sometimes called the paraffin series. It burns in the air with a pale, almost non-luminous flame, and when mixed with oxygen explodes violently on the application of a flame or the passage of an electric spark. Perfect combustion of methane requires about ten times its volume of air. This fact should be remembered by the consumer of natural gas, and arrangements should be made to admit the proper amount of air. In the consumption of gas, combustion will be incomplete and the power of the fuel lost in part if it is not mixed with air in the proper proportion. According to Prof. Phillips, marsh gas will be reduced to a liquid under a pressure of 2,700 pounds per square inch at 12° F. or 263° below zero F. , under atmospheric pressure. It will be observed that this is over eight times the pressure found in the most productive gas wells in this field.

Hydrogen, a small per cent. of which is found in its free state in natural gas, is a colorless gas, and when pure has neither taste nor smell. It is combustible and the product of its combustion is water. It is 14.44 times lighter than air and is very diffusible.

Olefiant gas or ethylene (C_2H_4) is a heavy carburetted hydrogen, produced when substances rich in carbon and hydrogen are decomposed by dry distillation. It is a colorless gas, having very little odor and can be condensed to a liquid.

Carbon monoxide (CO) is formed when a carbonaceous substance is burned in a stove or furnace in which the supply of air is not sufficient. It burns with a pale blue flame and is very poisonous when inhaled.

Carbon dioxide (CO_2), the principal compound of carbon and oxygen, is a colorless gas and has a feeble odor. It is found in many natural processes, is always present in the air and soil, and is a universal product of combustion and decay. It is frequently found in old wells and mines and is largely the food of plant life. While it is not poisonous, animals die of suffocation when compelled to breathe it. Carbon dioxide is heavier than air, and for the reason that it holds in combination all the oxygen possible, it is incombustible. Trenton limestone natural gas contains but little more than a trace of this gas.

Oxygen, a tasteless, inodorous, invisible gas, minute traces of which are found in natural gas, is the most widely distributed gas known. It combines with most of the other elements, resulting in the phenomenon of combustion.

Nitrogen, a well known element of natural gas, constitutes about four-fifths of the atmosphere. It does not support combustion and is a diluent of marked influence, thereby reducing the calorific or heat producing power of the gas. Nitrogen is colorless, tasteless, without odor and somewhat lighter than air. It will not support breathing, animals becoming quickly suffocated in an atmosphere of this gas, not on account of its poisonous influence, but from a lack of oxygen.

Hydrogen sulphide (H_2S), known as sulphuretted hydrogen, is a colorless gas, having a penetrating, disagreeable odor. It is formed by the decomposition of organic substances containing sulphur, or by the heating of the same, and is poisonous when inhaled in large quantities for any length of time. Hydrogen sulphide is combustible, and when mixed with one and one-half times its volume of oxygen, will explode upon the application of a flame or the passing of an electric spark.

I have given above a brief description of the chemical constituents of Trenton limestone gas. If it serves to impress upon the consumer the fact that this gaseous fuel contains elements of great danger to life and property, in many ways and under many conditions, and thereby causes him to exercise a due amount of care, not only in supplying safety devices and in the arrangement of burners and mixers, but in the use of gas in general, it will have served its purpose.

FUEL VALUE OF NATURAL GAS.

As I have said, the great value of natural gas lies in its heating power. It possesses many advantages over wood and coal, both for domestic and manufacturing purposes. Whether it be cheaper or not, it is more convenient, and for many kinds of manufacturing it is, on account of the superior quality of the manufactured product, pre-eminently the best fuel.

In volume 6 of the Reports of the Ohio Geological Survey, Prof. Orton gives a comparison between the fuel value of Pittsburgh coal and Pittsburgh and Findlay gas. The data used by Prof. Orton were prepared by Prof. Lesley, of the Pennsylvania Geographical Survey, Mr. S. A. Ford, chemist of the Edgar Steel Works, Pa., and Prof. C. C. Howard. Inasmuch as Indiana and Findlay gas have practically the same composition, this comparison is germane, and is given in this report.

According to the statements referred to above, the theoretical value of 1,000 cubic feet of Pittsburgh gas, weighing thirty-eight pounds avoirdupois, is 210,069,604 heat units. The theoretical value of thirty-eight pounds of pure carbon is 139,398,869 heat units. On the basis of these

figures, the heat units of 1,000 cubic feet of gas will be found to equal 57.25 pounds of carbon; 67.97 pounds of coke; 54.40 pounds of bituminous coal, or 58.40 pounds of anthracite coal. Now, according to these figures, if coke is worth \$2.50 per ton, the fuel value of 1,000 cubic feet of Pittsburgh gas is 7.8 cents, and if Pittsburgh coal is worth \$1.25 per ton, the fuel value of 1,000 cubic feet of Pittsburgh gas is 3.25 cents. One ton of Pittsburgh coal is theoretically equal to 36,764 cubic feet of Pittsburgh gas.

The theoretical value of 1,000 feet of Findlay gas is 228,461,113 heat units, and when Pittsburgh coal is worth \$1.25 per ton the theoretical value of 1,000 feet of Findlay gas is 3.9 cents. One ton of Pittsburgh coal is theoretically equal to 31,085 cubic feet of Findlay gas.

In referring to the above comparisons, Prof. Orton says: "In the preceding calculations it will be observed that the theoretical values only are discussed. The practical advantage in the use of gas is much greater than the figures above given would lead one to suspect. In burning coal, a large part of the possible heat is lost in various ways. In burning gas there is a much greater economy of heat. Theoretically one pound of Pittsburgh coal is equal to 18½ feet of Pittsburgh gas, but it has been determined by carefully conducted experiments that seven and one-half feet of gas are practically equal to one pound of coal. Findlay gas will give somewhat better results than this. Less than seven cubic feet of gas will do the work of one pound of Pittsburgh coal, or less than 14,000 cubic feet of gas are practically equal to one ton of Pittsburgh coal. Trenton limestone gas is thus seen to be one of the most valuable fuels known to man. The reckless use, and especially the wanton waste of it, are little more than a crime against the State."*

What Prof. Orton says regarding the Ohio gas field is equally applicable to the Indiana field. Trenton limestone gas is without a doubt a very valuable fuel, and any effort to husband the supply should receive the hearty co-operation of every person interested in the natural gas industry.

ORIGIN AND ACCUMULATION OF NATURAL GAS.

Questions concerning the origin and accumulation of natural gas have been discussed for a number of years. Much has been said and many theories advanced to account for this hydrocarbon. I will not attempt to discuss these, or to propose anything new on the subject. Our most eminent geologists and chemists have observed, experimented and theorized on the subject, and I could add nothing new, even if I had the time and space at my command. I shall give briefly the views most commonly accepted by those who are seeking knowledge on the subject, and

* Vol. 6, of the Repts. of the Ohio Geol. Survey, 1888, p. 138.

leave the discussion of them to that vast army of scientists who are spending their lives seeking the truth concerning the innumerable phenomena that surround us.

Those who desire an elaborate discussion of the subject will find it in volume 10, of the Reports of the Tenth Census, 1884; volume 6, of the Reports of the Ohio Geological Survey, 1888; in the Eighth and Eleventh Annual Reports of the United States Geological Survey, 1889-90; and the Annual Report of the Geological Survey of Pennsylvania, 1886. These reports have been consulted freely in the preparation of this report, and acknowledgment is hereby made to the authors of the various articles contained therein.

The theories that have been advanced to account for the origin of petroleum and natural gas, as well as the other members of the bitumen series contained in the earth's crust can be divided into two classes, viz., inorganic and organic. The advocates of the former class regard these hydrocarbons as a result of the action of certain chemicals on mineral matter in the interior of the earth, while those of the latter class regard them as the result of the decomposition of organic matter contained in the rocks. Both of these were framed and have been advocated by eminent scientists. The inorganic theory has had but few friends among geologists. It was framed by chemists and chemists have been its chief advocates. The main objection to this theory is that it fails to take into consideration known conditions and characteristics of these products, as well as the geological facts involved, and for these and other reasons it has never received much consideration by the geologists of either continent.

The organic theory is accepted by nearly every one that is giving the subject thought at present. According to it, petroleum and natural gas are the result of the decomposition of organic matter, stored in the rocks in which they are found or associated strata. This is the general conclusion to which nearly all agree, but the limitations that have been thrown around it, and the provisions that have been attached to it by those who are seeking to account for the origin and accumulation of these products have been many. In one instance limestone is counted the principal source of natural gas, and in another it is referred to bituminous shales. By some it is claimed that it is indigenous to the rocks in which it is found, and by others it is counted adventitious; or in other words, the advocates of the indigenous origin of natural gas contend that the decomposition was effected in the rocks in which the gas is found, while the advocates of the adventitious origin claim that the gas was generated in the rocks in which the organic matter was deposited, and has been carried by hydrostatic pressure to an overlying stratum that serves as a reservoir. In fact the views of leading geologists are so different in many respects that each may be said to constitute a different

theory, none of which is universally accepted, "and here, as elsewhere, it is no doubt true that theorists are somewhat opposed to one another, because they respectfully regard but one side of a subject which has more than one side."*

As to the general view given above, it has much to commend it and little to condemn it. The arguments in favor of it are both logical and conclusive. That petroleum and natural gas are found and have their origin in the rocks of the earth's crust no one denies. This being admitted, the material from which they are generated is located. The fact that large amounts of animal and vegetable matter were deposited with the material that forms the sedimentary rocks, and that this organic matter contains the elements of oil and gas is never questioned. Why should it be? Proof is abundant and accessible to all. Who has not been a witness to the decomposition of organic matter on the surface. Then it is that the dissolution is perfect and completed quickly; every atom of the body except the mineral matter being resolved into gas, escapes into the air. The organic matter of the earth's crust was deposited under different conditions. There it was soon buried under an accumulation of sediment which prevented both a perfect and a rapid decomposition. The fact that the disintegration was very slow in some of the formations is witnessed by the large number of fossils contained therein. But whether the decomposition was rapid, allowing the resulting products to escape to the atmosphere; or whether (on account of the accumulated overlying deposits of sediment excluding the air, and the proper condition of temperature) this process of decomposition and the consequent evolution of gas has continued for centuries, and will continue as long as undecomposed organic matter remains in the rocks, the result is practically the same, except, in the one case the gas is lost in the atmosphere, and in the other, under certain conditions necessary to gas accumulation, it remains imprisoned in the rocks until it is set free by the drill.

In consideration of the results of the experience and observation of those who have had abundant opportunities for both, I think that it is reasonable to conclude that petroleum and natural gas have their origin through the decomposition of organic matter contained in the rocks. In regard to the various limitations that have been placed against the above conclusions, I think that I am safe in saying that a majority of them are true. I am aware that the fact that some of these views are opposed to each other, renders this statement seemingly inconsistent, but we must remember that this difference in the views of different theorists is largely due to the difference in location. In Indiana the Trenton limestone is the source of large deposits of natural gas, while in Pennsylvania the

*Orton. Eighth Annual Rept. U.S. Geol. Survey, 1889.

supplies are derived from the Devonian shales. Natural gas stored in the limestone is certainly indigenous, while that stored in sandstone is adventitious and can be referred to the underlying shales; and in like manner it is possible to dispose of many of the theories that have been advanced. They have a local application only.

An examination of the geologic and geographic distribution of natural gas will reveal the fact that while it is found in nearly every country and geologic formation, it has been in the Trenton limestone of Indiana, the Berea grit and Trenton limestone of Ohio, and the Devonian, Carboniferous and Catskill sandstones of Pennsylvania that the commercially valuable deposits have been found. It is evident from the above that however important source is to the accumulation of gas or oil, it is not the only condition necessary.

A careful examination of any one of the gas fields mentioned above, and a study of the conditions surrounding it will disclose the fact that there are a number of other conditions that are necessary to gas accumulation, and an examination of other fields will show the same facts. They are universal. These conditions named in the usual order are source, reservoir and cover. In the Indiana gas field the Trenton limestone is both the source and the reservoir. This formation is one of the most widespread formations on the continent. It underlies the entire State and approaches nearest the surface at Lawrenceburg, in the southeastern corner of the State, where it can be found at a depth of 349 feet.

While it is true that the Trenton limestone is a universal formation in this State, and is a reservoir for natural gas and oil, it is equally true that these products occupy but a limited strata of this limestone and a comparatively small area of the State. The cause of this is found in the textural and structural conditions of the gas-producing rock. Trenton limestone is seldom a gas rock below sixty feet from the upper surface, the gas producing stratum ranging from five to twenty feet thick. Observation and the analysis of this rock show that its productiveness is due to its porosity. Wherever the Trenton limestone is a gas or oil rock, it is always substantially a pure dolomite; highly crystalline and of a sufficient porosity to contain large quantities of these hydrocarbons. Its storage capacity is much greater than that of sandstones. Outside of the gas area the conditions are different. There the limestone is nearly pure and non-porous. The dolomitic change has not taken place.

From the above it is plain that the porosity of the Trenton limestone is due to its chemical composition, or at least connected with it. In the oil and gas area this limestone has been transformed in its upper beds; the carbonate of lime giving way in part to carbonate of magnesia.

While it is true that oil and gas deposits are confined to a porous limestone, it is also true that this limestone is not always a productive

gas or oil rock. There are other causes besides the lack of a porous rock to serve as a reservoir that may render limestones unproductive.

Of the necessary conditions for gas production, one of great importance is the reservoir cover. The accumulation of large deposits of gas would be impossible if the reservoir was not protected by a practically impervious cover. In Indiana the Utica shale serves this purpose. Though this formation does not come to the surface in this State, its composition and character are well known. It is impervious to water and gas, and forms a perfect cover for the Trenton limestone.

As has been incidentally mentioned, all the conditions necessary to gas yield have not been given. In order that petroleum and gas may accumulate in valuable quantities it is not only necessary that a rock, the formation of which is suited to the storage of these products, be present and that it be covered with an impervious roof, but it is equally necessary that the rock containing these hydrocarbons possess a structural relief sufficiently elevated to allow the various substances occupying the reservoir to arrange themselves in the order of their specific gravity, that is, the water, the oil (if any) and the gas on top. The required elevation of the relief is relative and not necessarily absolute. The productiveness of the reservoir seems to depend upon its elevation as related to the adjoining territory. The Cincinnati arch meets this requirement in the Indiana field. Its boundaries and structural peculiarities have been practically defined from the records of a number of wells drilled in the territory which it occupies.

In Indiana this arch is a low, broad elevation that crosses the eastern boundary of the State between Lawrenceburg and Liberty and extends in a northwestern direction across the State. Its surface is very uneven in places, consisting of numerous small ridges or folds, with occasional spurs extending at various angles from the main elevation.

A series of maps, prepared by E. P. Cubberly, President of Vincennes University, and designed to show "Indiana's structural features as revealed by the drill,"* illustrates the surface of the Trenton limestone very plainly.

The presence of this arch supplies one of the very necessary conditions for gas yield in this State, for the reason that it acts as a trap in which the gas accumulates. This arch or dome usually contains a number of substances arranged in the order of their specific gravity, the gas being held at the top under an enormous pressure, due to the weight of a column of water back of it. The Trenton limestone which comes to the surface in New York and Pennsylvania on the east, Iowa and Wisconsin on the west, Kentucky on the south and Michigan on the north, forms a

* "Eighteenth Ann. Rept. of the Dept. of Geol. and Nat. Resources of the State of Indiana," 1894.

large basin in which the Cincinnati Arch is located. The water entering at its outcrops flows towards its center and rises in the dome or arch, driving the gas and oil (if any) before it until the resistance of these products is equal to the weight of the column of water. The cause of the pressure of gas is plain. It is the same as that which causes the water to flow from artesian wells.

GAS PRESSURE AND MEASUREMENT.

Rock pressure in gas wells is the pressure exerted by the gas when confined within the well. A vigorous well, the flow of which is not retarded in any manner, will reach its maximum rock pressure almost instantly, while wells of feeble flow sometimes require hours. The open flow pressure of gas is the pressure that it shows when it is allowed to flow freely into the air. To obtain the rock pressure of a well, an ordinary high pressure steam gauge can be used, while to obtain the open pressure it is frequently necessary to use a water gauge, especially if the volume of flow is measured from the casing.

The amount of gas in cubic feet that a well discharges in a given time can be ascertained from the open flow pressure. The method in general use is one devised and given to the public by Prof. S. W. Robinson, of the Ohio State University. This method, which is an application of Pitot's tube, is easy to apply, and by it the strongest well can be measured. To avoid error it is necessary to exercise great care in the measurement of gas wells. A very simple and convenient apparatus is a small thin-walled tube, bent right angled or with an elbow. The open mouth of this tube, to obtain reliable results, should be filed square and reamed out inside to a nearly sharp edge. The joints and connection with the gauge should be air tight. The open mouth of the apparatus should be held in the current of gas at the well head, and the gauge should be held in the same position as when last tested. Usually the Pitot tube is held even with the top of the well tubing, and in the center of the orifice from which the gas is discharged. This will not give reliable results. Numerous experiments have proven beyond a doubt that the velocity of the gas varies at different points between the center and the sides of the orifice.

Dr. Phinney, of Muncie, Ind., in his monograph on "The Natural Gas Field of Indiana,"* reported a number of tests made by Mr. William Moore, of Kokomo, to ascertain the variation in the velocity of gas escaping from an open pipe at the different points between the center and sides of the pipe. For the benefit of those who have not access to this report, the results of these tests are given below:

* Eighth Ann. Rept. of the U. S. Geol. Survey, 1886.

PART OF ESCAPE PIPE.	Flow Pressure, Pounds.	Velocity per Second, Feet.	Capacity.
Center.....	10¾	1,293	5,482,944
One-fifth distance from center to side.....	10½	1,282	5,436,228
Two-fifths distance from center to side.....	9½	1,226	5,198,860
Three-fifths distance from center to side.....	8	1,139	4,829,943
Four-fifths distance from center to side.....	6½	1,049	4,444,076
Side of escape pipe.....	5½	914	3,875,827

Reliable results are obtained only when the average velocity of flow is ascertained. In order to obtain this the tube should be held at about the first fourth of the diameter of the well tubing from the center, and if at the center the registered pressure should be multiplied by .97. Prof. Robinson's method of measuring the volume of flow of natural gas is fully explained in Volume 6, of the Reports of the State Geological Survey of Ohio, 1888; also in a small pamphlet published by him.

THE INDIANA NATURAL GAS FIELD.

The Indiana natural gas field is in the eastern central part of the State and occupies the following counties in whole or in part, viz.: Blackford, Decatur, Delaware, Grant, Hamilton, Hancock, Henry, Howard, Jay, Madison, Miami, Marion, Rush, Shelby, Tipton, Wabash and Wayne. Within the counties named above a number of small areas of barren territory have been found, territory in which the Trenton limestone is very hard and wanting in that condition of porosity that is necessary to gas yield. In some instances only a very small portion of the county is in the gas area, the remainder being barren, either for the want of the proper textural conditions or the necessary elevation of the porous stratum of the limestone. The map that accompanies this report gives the location of the main gas field; that is, the territory that has produced gas in commercially valuable quantities at any time during the history of this field. Owing to the encroachment of salt water, the gas producing territory is becoming smaller. This will continue until finally the salt water will possess the entire reservoir in which the gas is now stored. The main gas field contains an approximate area of 2,500 square miles.

Although wells have been drilled for gas in a number of counties outside of the gas belt, the results have not been satisfactory. In some instances a moderately strong flow of gas was found, but it was usually derived from other horizons than the Trenton limestone, and was soon exhausted. When it became known that within the Trenton limestone in Indiana large quantities of high-pressure gas were stored, companies were organized for the purpose of exploration in many towns and cities of the State, and as a result many deep wells have been drilled. From an economic point of view, much labor and capital were lost by these prospectors, but as a recompense in part for this loss the records of the

wells have furnished a large amount of information regarding the geological structure of the State. The data thus obtained has not only helped to solve the questions concerning the accumulation and distribution of gas, but it has added much information to the geological history of the State.

The surface of Indiana is a broad plain interrupted by the valleys of the water courses; its elevations varying from 378 feet in Vanderburgh county to 1,225 feet in Randolph county. A section of the rock formations of the gas fields as revealed by the drill shows that the great mass of rocks are limestones and shales. A description of the entire series is interesting and those who are seeking knowledge on the subject will find the records of all the deep wells that have been reported and a description of the rock formations of the State in the annual reports previously issued by the State Geologist.

Previous to the drilling of deep wells in Indiana for gas and oil but little was known of the thickness of the drift. The records from these wells have not only given us the vertical range of this formation in nearly every part of the State, but in addition we have obtained data that enables us to trace the history of this deposit. The thickness of the drift relates to natural gas only in so far as it serves to show the character of the surface of the adjacent rock formation. Small pockets of gas are occasionally found in it, but they seldom prove valuable, never indicating gas in the rock beneath, and are soon exhausted. The vast deposit of drift that covers the surface rocks of the entire State varies in thickness from nothing, or a few inches, to 500 feet. It is composed of clay, sand, gravel and boulders, with occasional remains of vegetable life, and in many places shows that it has been assorted by the action of water.

TRENTON LIMESTONE.

The Trenton limestone, on account of its being the reservoir for natural gas and oil in Indiana, is the most important formation in the geologic scale. It has a wide range, outcropping in the adjoining States, and throughout this gas field is near 500 feet thick. As has been noted in another section of this report, the upper stratum of this limestone is a dolomite; that is, a limestone in which a chemical change has taken place; in which the carbonate of lime has been partly replaced by carbonate of magnesia. The result of the change is a porous rock suited to the accumulation of large quantities of gas. The relief of the Trenton limestone is its most important feature in this State. This, in the form of a low, broad arch, enters the State at the southeast corner at a depth of 349 feet, 158 feet above sea level, and with a gradual descent, continues in a northeastern direction across the State. The dip of the rock is more rapid to the northeast and southwest. The surface of the ridge, or arch, as it is called, is gently undulating, with occasional domes and transverse ridges. The following table will supplement what has been said regard-

ing the thickness of the drift, and the surface of the Trenton limestone. A careful study of it will reveal the structural peculiarities of the Cincinnati arch.

Tables showing the thickness of the drift, the depth of the Trenton limestone and its altitude with reference to sea level. For much of the data in this table, acknowledgments are due Dr. A. J. Phinney, Prof. E. P. Cubberley, and the Principals and Superintendents of Schools who have rendered me aid in this work.

COUNTY.	TOWN.	Thickness of drift in feet.	Depth to Trenton limestone.	Altitude of Trenton.	
				Feet above sea level.	Feet below sea level.
Adams	Decatur	39	1,020		223
Allen	Fort Wayne	110	1,437		650
Bartholomew	Columbus	26	955		311
Blackford	Hartford City	82	935		40
Blackford	Montpelier	17	958		110
Boone	Lebanon	210	1,518		302
Cass	Galveston	40	920		180(?)
Clinton	Frankfort	278	1,060		227
Dearborn	Lawrenceburg	139	349	158	
Decatur	Greensburg	10	920	22	
Dekalb	Auburn	282	1,941		1,009
Delaware	Muncie		878	67	
Delaware	Eaton		890	5	
Elkhart	Goshen	165	1,815		1,026
Fayette	Connersville	97	705	117	
Franklin	Brookville	157	550	174	
Fulton	Rochester	248	1,161		531
Grant	Fairmount	38	934		41
Grant	Marion	70	877		67
Hamilton	Arcadia	130	960		93
Hamilton	Noblesville	140	844		76
Hancock	Greenfield	215	985		54
Henry	New Castle	500	876	117	
Henry	Spiceland	150	948	85	
Howard	Kokomo	61	944		87
Huntington	Huntington	2	995		255
Jackson	Seymour	72	1,100		472
Jasper	Rensselaer	30	910		158
Jay	Portland	58	990		63
Jay	Red Key	72	980		90
Jay	Dunkirk	60	930	39	
Jennings	North Vernon	11	980		253
Madison	Alexandria	20	897		40
Madison	Anderson	114	814	66	
Madison	Elwood	108	924		66
Marion	Indianapolis	118	900		179
Miami	Amboy	35	907		100(?)
Montgomery	Crawfordsville	140	1,439		664
Morgan	Martinsville	85	1,397		790
Newton	Kentland	100	1,060		379
Park	Rockville	96	2,100		1,412
Porter	Valparaiso	125	1,300		602
Pulaski	Franceville	8	885		200
Randolph	Fairland	58	885	45	
Randolph	Ridgeville	30	981	1	
Randolph	Winchester	147	1,050		42
St. Joseph	South Bend	160	1,600		855
Shelby	Shelbyville	48	837		79
Tipton	Tipton	139	997		129
Wabash	La Fontaine	300	900		6
Wayne	Richmond	5	895		
Wells	Cambridge City	96	767	174	
White	Bluffton	51	1,075		338
White	Monticello	205	1,010		338
Whitley	Columbia City	224	1,369		525

This high-lying area of the Trenton limestone in Indiana furnishes the reservoir for the supply of natural gas. The highest portion of the arch or incline is not a reservoir, for the reason that it does not possess the proper textural condition. It may be said that natural gas in Indiana is stored in the slope of an incline, and that the textural condition of the rock above the reservoir prevents it from escaping at the outcrop.

Around the productive gas area is found the salt water that has accumulated in the porous rock. Being caught at the outcrop of the formation, it has flowed down the incline and occupies the lower portion of the porous rock, the gas, oil and salt water occupying a common reservoir. The salt water is the force back of the gas, and when this hydrocarbon is exhausted it will fill the reservoir. Around this gas field is a line below which salt water is always found. As the supply of gas diminishes, the salt water horizon advances toward the highest point in the reservoir. There is a constant warfare between the salt water and the gas for the possession of the reservoir. The height to which the salt water rises in different fields depends upon the elevation of the source of the water and the reservoir. In this field it is found at a depth of less than 100 feet below sea level, and the upper limit of productive rock will not exceed 90 feet above sea level. It is probable that the total range of productive rock will not exceed 160 feet.

Salt water is the most dangerous and difficult element with which gas companies and owners of gas wells have to contend. They realize this, and are doing all in their power to thwart its progress. While it is true that as the supply of gas diminishes the water rises higher in the reservoir, hermetically sealing all wells in which the pressure of the gas is not strong enough to hold the water back or raise it to the surface, and that the ultimate result is known and certain, it is also true that much can be done to check its progress, thereby extending the life of the present supply. Great care should be exercised in drilling new wells, in order that the productive rock may be penetrated without molesting the salt water. Wells showing signs of water can be made to yield gas for a considerable time with proper care. Like any other class of property, gas wells need constant attention.

There is scarcely a resident of this State that is not familiar with the early history of the Indiana gas field. The fact that Trenton limestone, a universal formation in this State, contained a vast store of this gaseous fuel, awakened an interest that had not been known. Wherever a sufficient amount of money could be raised to put down a well, the drill was started on its journey. Before the gas field was located with any degree of accuracy, vast sums of money were expended by individuals and gas companies. Some were rewarded, but many were doomed to disappointment. Soon the gas field was located, and the success of the drill was seldom questioned.

The Indiana field soon attracted the attention of manufacturers who knew the advantages that natural gas possessed over other fuels. In a short time the manufacturing interests of the gas belt had increased wonderfully, millions of dollars being invested in this industry. The villages and towns have experienced a phenomenal growth, and the wealth of that portion of the State has increased many fold.

In 1880 there were seven States that manufactured more glass than did Indiana; in 1890 there were but three. The value of the glass product in 1880 was \$790,781; in 1890 it was \$2,995,409, being nearly a four-fold increase. In 1880 there were four glass manufactories, valued at \$1,442,000 and employing 862 persons. In 1890 the number of factories had increased to 21; the capital invested to \$3,556,563, and the number of employes to 3,089. The growth of the iron and steel industry has been equally rapid. In 1880 there were nine establishments, valued at \$1,820,000, and employing 1,740 persons, who received \$810,000 annually in wages. In 1890 there were 13 establishments valued at \$3,888,254 and employing 2,644 persons, who received annually \$1,215,702 in wages.

From the above it will be seen that the growth of the manufacturing industries of the Indiana gas field during its early history was phenomenal, but a comparison of its condition in 1890 with 1895 will show a growth even more rapid. There were near 50 glass factories in operation January 1, 1895, the value of which was not far from \$5,000,000. It requires 7,000 employes to operate these factories, and the annual pay-roll amounts to \$3,000,000.

The statistics given above show, in a measure, the growth of the glass and iron industries since the discovery of natural gas. While this gaseous fuel is peculiarly adapted to certain lines of manufacturing, it possesses advantages over wood and coal that are recognized by the manufacturers of all classes of products, and the result is that nearly every class of manufacturing is represented in the Indiana gas field.

The history of one gas field is practically the history of all. Of course each field has its own peculiar limitations. The supply of one field may outlast that of another, but at best they last but a comparatively short time. There was a time in the history of the Indiana field when the only proof of the above was theoretical. Now we have had the practical demonstration. In 1884 natural gas was discovered in the Trenton limestone in Ohio. The supply seemed inexhaustible, and with that idea in mind it was exhausted. The history of that field is practically finished, and the life of the Indiana field will be shorter on that account, for the pipe lines now constructed transport a large amount of gas to Ohio, and will probably continue to do so until this field is exhausted.

That millions of cubic feet of gas have been wasted, either by allowing it to escape into the air or by burning it to show its abundance, no one

will deny. The causes that have led to this wanton waste that has continued for years are numerous. It is not worth the while to enumerate or discuss them here. We are more interested in the effect than the cause.

CONDITION OF THE FIELD.

Manufacturers, gas companies and private consumers are alike interested in the present condition of the gas field. It takes no argument to convince them that gas is failing, and in view of the advantages that are being derived from the use of this fuel, the decline of the rock pressure, the encroachment of the salt water and the increased consumption from year to year are, on account of their relation to the future supply, questions of great importance. The original rock pressure was 325 pounds to the square inch. This pressure was practically uniform throughout the field. Some wells showed the maximum pressure instantly, while others required hours. When a well is closed it forms a part of the gas reservoir, and its pressure will reach the maximum pressure of the immediate neighborhood if allowed to remain closed long enough. The large draught that has been made upon the Indiana field since its discovery has materially reduced the rock pressure. It is admitted by all, I believe, that any material reduction in the rock pressure of a gas field indicates a diminution in the supply.

A comparative statement, giving the rock pressure of a number of wells located in different parts of the field, and taken at intervals of six months or a year, would show the rate of decrease and would be interesting to all who are interested in the natural gas industry. Unfortunately the data is not at hand from which a statement covering the entire field can be made. A record of the pressure of a number of wells located in different sections of the gas field is given below. They were tested during the summer of 1895, and, unless otherwise stated, are located in or near the city named.

The record given was obtained principally from new wells and is the maximum pressure of that section of the field.

ROCK PRESSURE OF THE INDIANA NATURAL GAS FIELD, 1895.

	<i>Pounds Pressure.</i>
Blackford County—	
Hartford City	270
Delaware County—	
Muncie, one mile north of town	200
Muncie, three miles north of town	250
Royerton	250
Daleville, one mile west of town	225

	<i>Pounds Pressure.</i>
Grant County—	
Marion, three miles southwest of town.....	255
Marion, three miles southeast of town.....	260
Jonesboro.....	270
Gas City.....	270
Swayzee.....	250
Hamilton County—	
Noblesville, two miles north of town.....	200
Arcadia, six miles east of town.....	230
Olio.....	200
Hancock County—	
Greenfield, three miles north of town.....	210
Henry County—	
Middletown, three miles north of town.....	220
Howard County—	
Fairfield.....	240
Greentown.....	255
Guy.....	255
Jackson Township.....	250
Jay County—	
Camden.....	150
Dunkirk.....	225
Red Key, four miles southwest of town.....	250
Madison County—	
Alexandria.....	255
Anderson, four miles east of town.....	230
Elwood.....	255
Frankton, four miles south of town.....	245
Chesterfield, three miles north of town.....	235
Orestes.....	255
Lapel.....	220
Perkinsville.....	230
Pendleton.....	225
Rush County—	
Carthage.....	150
Tipton County—	
Prairie Township.....	205
Wild Cat Township.....	250
Hobbs.....	250

The difference in the pressure of wells in different sections of the field is mainly due to the difference in the texture of the Trenton limestone and to consumption. If all the wells in the field were closed, there is little doubt but that the pressure would be uniform throughout the entire field. The initial rock pressure of the Indiana gas territory was 325 pounds. The average rock pressure of the gas producing portion of the original gas area at present is about 230 pounds; a decrease of 95 pounds. There is little doubt but that the pressure of the field will decrease more rapidly in the future than it has in the past.

The supply of gas is diminished by waste and consumption, and while the amount wasted is growing less, the annual consumption is increasing. New pipe-lines are being constructed. The field pressure is being reinforced with pumps and extra inducements are offered to consumers. Factories continue to locate in the gas territory. Some of the largest factories in the gas belt have been built this year. Because of the increased manufacturing interests, the population of many of the towns is increasing rapidly. This all means an increased consumption of gas.

Much has been said of the amount of gas wasted as well as the manner of its use. This is well, for it is a subject that needs attention. That much gas has been wasted in the past, and that it is being wasted in some parts of the field at present, no one will deny. The questions are: how is it wasted and what is the remedy?

But few of the gas plants constructed in the early history of the gas field were planned or "put in" by practical gas engineers. This is especially true of the plants in the small towns and the country. More than this, many of the plants were constructed hurriedly and during the winter season, and in some cases inferior piping and fittings were used. The result of all this is, that many plants are very imperfect in both plan and construction. Wells in which the packers were not properly adjusted; piping too small for the work to be done; worn out regulators that were too small when in repair to properly regulate the pressure of the necessary amount of gas, are frequently found. While conditions such as are stated above have existed and do exist to some extent at present, I am glad to say that a large number of plants have been so thoroughly repaired during the past year that they are practically new; being much better than when first constructed, from the fact that the reconstruction has been made with reference to the work to be done. Larger regulators and piping have been used; the necessary high-lines and reducing stations have been added, and if satisfactory service is not given this winter, the fault will not be with the gas plant. With but few exceptions, the gas companies of the State are better prepared to give satisfactory service this winter than at any time during the history of the field. I do not mean by this that the supply of gas is more abundant, but the facilities to transport and distribute it are much better than they were one year ago. True, there are a few gas companies in the outer zone of the gas field that will not be able to give good service this winter. These towns are fortunate if they are near a pipe-line.

The small pipe lines referred to above, and in a few instances larger pipe lines, have, on account of imperfect fittings and the lack of care, been the source of much waste. It requires perfect joints, gates, valves, etc., to confine gas at well pressure, and the most perfect joint will, from the effect of the contraction and expansion of the pipes, caused by the variations in temperature, become defective, and a very small leak

will cause much waste if allowed to continue. The remedy for this source of waste is plain. Some of the larger pipe-line companies keep men whose sole duty it is to detect and repair leaks in the small tributary lines that thread the gas territory in every direction. These lines should be gone over and repaired at least once a month. The only safe plan is to keep a watch over every avenue of waste. The very few large pipe lines that have caused trouble in the past have been so thoroughly repaired during the past summer that it is not probable that they will cause any more trouble.

Another cause of waste is the crude mixers and burners used by both manufacturers and private consumers. I am satisfied that, with scientific burners and mixers adjusted to the gas pressure, an equal amount of heat could be produced with one-half the amount of gas used in many cases. The full power of natural gas is not realized unless it is mixed with air. As to the proper proportion of air to gas there is a difference of opinion; ten of air to one of gas is not far from correct. If this proportion is to be maintained the pressure of the gas should not vary, for a mixer that will admit gas and air in the correct proportion when the gas is under a twelve-ounce pressure will admit a larger amount of gas if the pressure is increased to sixteen ounces. Ninety-six cubic feet of gas under a pressure of three-tenths of a pound will pass through a No. 7 mixer in one hour, while under one pound pressure one hundred and seventy-nine cubic feet will pass through the same mixer in the same time. It is evident from the above that when a mixer is so adjusted that the gas and air are admitted in the proper proportion, the pressure of the gas should not be changed, unless the amount of air admitted is changed to correspond. To see that the burners and mixers are clean and properly adjusted is the duty of the consumer, and in like manner it rests with the gas company to furnish the gas at a uniform pressure. This can not be done without the necessary high lines, reducing stations and regulators.

Should natural gas be sold by meter measurement or by contract, and what relation does this subject bear to the manner in which gas is used, are questions that have been discussed in the annual reports from this department, in the newspapers and by the consumer. Inasmuch as the subject has received more attention in the past than in all probability it will in the future, it will not be given much space here. Theoretically, there can be no question as to the right in this matter. If natural gas 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 are opposed to the "meter system" contend that the adoption of it means a higher price for gas. While that may be true, it is not necessarily so. I can see no reason why the prices under one system could not be adjusted as fairly and as satisfactorily as under another. A schedule of prices under

which I am compelled to pay for the gas which I use, and no more, is certainly just. If I choose to practice economy, a reduction in the cost of my fuel is the reward; if I use it extravagantly, I pay for what I use and no more.

While the incentives to practice economy in the use of gas are not quite as great under the present system as under the "meter system," the prosperity and general welfare of the gas belt and State should prompt every one to do all in his power to husband the present supply of this gaseous fuel.

NATURAL GAS AS AN ILLUMINANT.

While the chief value of natural gas does not lie in its illuminating power, it has been used for this purpose from the time it was discovered. The flambeau, at first a luxury, by long use has seemingly become a necessity. The time has been when apparently the entire gas field was illuminated with gas torches. In many places they were allowed to burn day and night, year in and year out. A vast amount of gas has been wasted in this way. There are reasons why farmers and villages should use this gaseous fuel as an illuminant in the same manner that any other light is used; that is, burn it when needed and extinguish when not; but why large torches should be allowed to burn day and night in villages and the country, and in the glare of the electric light in cities, I am not able to say.

The General Assembly of 1891 enacted a law prohibiting the use of natural gas in flambeaux, and prescribing how it can be used as an illuminant. This law has encountered much opposition. Those who are opposed to it contend that it abridges their rights as citizens; that natural gas is property and as such the owner has a right to use it as he desires. In opposition to this it is claimed that the enforcement of the law is a judicious exercise of the police powers of the State; that the welfare and prosperity of the public overshadows the good of the individual.

When I took charge of this Department natural gas was used in flambeaux in a majority of the towns and villages of the gas field. In many sections of the field torches could be seen burning in farm yards and gardens day and night. The past year has witnessed a change in public sentiment on the question. The law is looked upon with more favor. Realizing that the use of gas in this manner is extravagant and detrimental to the prosperity of the gas territory, as well as in defiance of the law, a number of villages and towns have either taken down their flambeaux, or ceased to light them. In many instances a single request was sufficient. Farmers have been slower to act. Many own their own wells, and those that do not usually claim the privilege to use gas as they please under the terms of their gas lease.

Recently two suits were brought in Blackford County to enforce the law. In the Circuit Court the defendants entered a motion to quash the affidavit, and by their motion attacked the constitutionality of the law. The Court overruled the motion to quash. The question will soon reach the Supreme Court, and upon its decision will rest the question, as to whether flambeaux will be allowed to burn or not. The object of the law is not to prohibit, but to regulate the use of natural gas as an illuminant. Because its use is prohibited in flambeaux is no reason why villages and towns should be left in darkness, or farm yards without light. The experience of a number of small towns shows that the use of natural gas in "jumbo" burners, or burners of similar character, enclosed in glass lamps, is practical. The light is not the best, but is better than many cities enjoyed prior to the introduction of electricity as a lighting power. Natural gas used in this manner is not wasteful or extravagant.

It is because natural gas possesses superior advantages as a fuel that its waste should be discouraged. When the supply is exhausted some other fuel will be substituted for it, but it is not probable that it will equal it in all respects. We know what it is to enjoy the luxury of its power. Let there be a united effort to use it for those purposes for which it is most valuable, and in the most economical manner possible.

THE FUTURE OF THE INDIANA NATURAL GAS FIELD.

What will be the future history of the Indiana natural gas field? How long will natural gas last? When referring to the natural gas industry, these are the questions most often asked. There was a time in the history of this field when questions like the above did not receive much attention. The seeming abundance of the supply, the power that it exerted as it escaped from its rocky prison, the large area of gas territory, and, in fact, the nature of the product, all seemed to preclude the idea of its exhaustion in the near future. The supply has been equal to the demand since the discovery in 1886, a period of nine years. How long it will continue to honor the enormous draughts that are being made upon it, from year to year, I can not say. The fact that we have entered upon the period of decline, that the supply is failing and will finally be exhausted, is not questioned. Not only is the evidence of such present in the field, but the history of other fields, that were limited by conditions similar to the ones with which this field has to contend, foretells to some degree the future of the Indiana field.

The main fact, settled by the history of the Pennsylvania and Ohio natural gas fields, is that a reservoir of natural gas can be exhausted. However, on account of the difference in the size of the reservoirs and

the amount of gas consumed, no two fields can be compared as to duration. Developments began in the Findlay field in 1884; ten years later it was practically exhausted. The salt water and oil had overrun all portions of the gas rock. We can not compare the Indiana field with the Findlay field, for though alike in a few respects, they differ materially in many. The Findlay and Wood County fields of Ohio, do not include to exceed 100 square miles. The Indiana field does not contain less than twenty times this amount. This does not necessarily indicate that the life of this field will exceed that of the Ohio field, for an increased area affords the opportunity for an increased consumption. While this is true, I have reason to believe that the ratio of the consumption of the Indiana field to that of the Findlay field is not as great as is the ratio of the area of the former to the latter.

Successful explorations began in Indiana in 1886, and after nine years of active operation there remains thousands of acres of good gas territory that is not developed, except an occasional well to supply farmers. A large part of this is owned by pipe-line companies who are holding it in reserve. A number of towns in the interior of the field are drawing their supply from wells drilled within the corporate limits of the town during the early history of the field. In a few instances, this long period of service has not materially reduced the production of the well. The above has especial reference to the smaller towns. As a general rule the larger towns that have succeeded in locating a number of manufactories are widening the horizon of their operations from year to year, piping their gas from three to ten miles.

Another condition that is related to the capacity of the reservoir and consequently has an influence on the duration of the gas field is the vertical range of the gas producing rock. In this, the Findlay field seems to have an advantage over the Indiana field. As to the manner of using gas, the methods, purposes and devices are substantially the same in every field. Natural gas has never been used as economically in any field as its value would suggest. The probable reason for this is that its cost seldom equals its value as a fuel. This is especially true of manufactories, a large majority of which are either using "free gas," as a part of the remuneration for the location of their factory, or are supplied from wells that they have drilled in territory received in the same way. In either case the cost of the fuel is a very small per cent. of its value.

Those manufacturers who measure the gas that they consume, and pay for it accordingly, do not allow fires to burn that are not needed. They use natural gas as they would any other heating or lighting power. Without regard to whether natural gas is bought by meter measurement, by contract or is received as a gratuity, there is no reason why it should not be used with due regard to its value as a heating power. Let us keep in mind that we are drawing on a definite stock of this product; that a

certain amount can be used for a number of years, and when the supply is once exhausted there is no provision for its renewal. It is in the light of the above that the extravagant use and waste of this gaseous fuel should be viewed.

What effect the oil field will have on the natural gas area is difficult to foretell. It depends somewhat upon the future explorations. The present field extends eastward from Marion, around the edge of the gas area to Portland. It includes portions of Grant, Huntington, Wells, Blackford, Adams and Jay counties. Active operations are extending in every direction, and the indications are that this will continue to be a productive field. Any extension of the oil area to the southward will come within the limits of very productive gas territory, and there is no doubt but that the development of oil territory is injurious to the natural gas interests. Indications of oil are sufficient in a number of localities in the interior of the gas field to start prospectors for this product. If this continues, the natural gas industry will soon feel the effect of it.

The gradual decrease of the rock pressure, and the encroachment of the salt water are the most important factors to be taken into consideration when discussing the future of the gas area. If the annual decrease in the rock pressure was unvarying, and the pressure at which the salt water overruns the gas rock was the same throughout the field, predictions concerning the future of the gas field would be of more value.

The initial rock pressure of this field was 325 pounds to the square inch. The average rock pressure of the gas producing portion of the original gas area is about 230 pounds at present. This is a decrease of 95 pounds in nine years or an average decrease of $10\frac{1}{2}$ pounds per year. This decrease, however, has not been uniform. The first three years' consumption effected the rock pressure very slightly, especially in the interior of the field. Since that time, however, the annual decrease has been very noticeable and has increased with the years. I am not prepared to say what the decrease has been during the past year, but with the data at hand, will be able to give the effect of this winter's consumption.

The history of all gas wells in the Indiana field is, that they continue to produce gas until the weight of the salt water overcomes the pressure of the gas. When does this occur, or what pressure is necessary to hold the salt water back, are questions that can not be answered definitely. In some parts of the field the danger point is reached at 200 pounds, while in a few instances, wells in which the pressure has been reduced to 50 pounds are producing gas in commercially valuable quantities. The causes of these conditions are uncertain. The increased consumption of gas is undoubtedly a cause of the increase of the diminution of the rock pressure of the field. Other causes are probably present. As to the pressure at which the salt water overruns the gas rock, it is possibly effected by the textural and structural conditions of the rock, as well as

its elevation. The presence of these conditions precludes anything like an accurate prediction concerning the life of natural gas in this field.

As I have said a comparison between the two fields is not practical. While they are alike in a few particulars, they are so unlike in many respects that the future of the Indiana field does not become much lighter under the rays of the history of the Findlay field. This field is peculiar in many respects, and the outcome and duration of it will depend to a large extent upon the manner in which its product is used.

I have frequently referred to the waste of gas, and the effort that should be made to husband the present supply. The reasons for so doing are obvious. It is the question above all others that should be kept before the public mind. It has much to do with the future of the gas field. A strict enforcement of the law, re-enforced by a strong public sentiment in favor of an economy commensurate with the value of the product, will materially extend its life.

KOKOMO, IND., January 13, 1896.

Prof. J. C. Leach, Kokomo, Indiana:

DEAR SIR—I herewith respectfully submit to you a report on the utilization of natural gas, which I trust may meet with your approval. I have sought to make the article as practical and useful as possible and at the same time intelligible to the thoughtful reader. I have purposely avoided an unnecessary use of scientific terms and have endeavored to make clear the meaning of those I was obliged to employ. I have also avoided any theorizing on the nature and composition of the compounds which compose the combustible portion of the gas; though I must admit this has afforded me some interesting study. I realize that much more could be said, but space and time did not permit it.

Yours respectfully,

ELWOOD HAYNES.

UTILIZATION OF NATURAL GAS.

BY ELWOOD HAYNES.

Fuel is one of the necessary and fundamental elements of modern civilization. It not only contributes to the comfort of man, but it has enabled him to leave the genial climate near the equator and force his way into more rigorous latitudes farther northward, and rendered existence there not only possible but pleasant. It is the key that unlocks the great resources of nature and enables man to fashion them to his own use.

The three most important forms of fuel are wood, coal and gas. The former was probably first utilized by man for this purpose on account of the ease with which it could be procured and its low kindling temperature. It is also highly probable that charcoal made from wood, formed the "entering wedge" which opened up the vast treasures of the iron mine.

It is to mineral coal, however, that we are indebted for by far the greater portion of man's progress in the industrial arts of the present century. The use of gaseous fuel on an extensive scale is of very recent origin. It is true the Chinese have used natural gas in a very crude way in connection with salt production, but this was so limited that it is of little interest, except from an historical standpoint.

Another form of fuel, which is now utilized to a considerable extent, is crude oil, which has the advantage of being easily transported either by pipe line or by freight. We then have fuel in the solid, liquid or gaseous form. If we examine these fuels from an analytical standpoint we find that they are all composed of carbon and hydrogen united in different proportions. Every one who has witnessed the combustion of coal, wood, oil or gas has noticed at times a black deposit of soot on objects in contact with the flame. This black deposit consists of nearly pure carbon, which is one of the main constituents of all the fuels mentioned above.

The other constituent—hydrogen—when in the pure state is a very light, colorless, odorless and invisible gas. It may, however, combine with carbon to form a solid, a liquid or a gas, as we have seen.

There is another element in nature which is necessary to combustion, which exists in the free state in the atmosphere. This is oxygen, and it must be present in sufficient quantity if perfect combustion is to be secured.

When combustion is taking place, or as we usually term it, "the fire is burning," the oxygen from the atmosphere is quietly uniting with the carbon and hydrogen of the fuel. When it unites with the carbon it forms an invisible gas called carbonic acid, which is the same gas that forms the bubbles that rise from a glass of soda-water when it is just drawn from the fountain.

The hydrogen of the fuel unites with the oxygen of the air to form water, which, of course, passes up the flue in the form of steam. In very cold weather the steam can be seen issuing from the chimney tops.

There is besides oxygen in the atmosphere another gas termed nitrogen which constitutes about four-fifths of its volume. This gas takes no part in combustion, but merely passes through the fire unchanged. It is evident, however, that a much larger volume of air is required to burn a given quantity of gas than would be necessary if the atmosphere consisted entirely of oxygen. It has been found that a given weight

of hydrogen requires 8 times its weight of oxygen to burn it. A given weight of carbon requires $2\frac{2}{3}$ times its weight of oxygen in order to burn it to carbonic acid gas. We thus see that a given weight of fuel requires a weight of oxygen equal to 8 times the weight of hydrogen it contains plus $2\frac{2}{3}$ times the weight of the carbon it contains.

Or since the atmosphere is only about 23 per cent. by weight oxygen, we find that it would require about forty-four times as much air. Let H equal the weight of hydrogen, and C equal the weight of carbon in any given fuel, and W the weight of the air required for its combustion. Then

$$W = 4.4 \frac{(8C+8H)}{3}.$$

In order to obtain the value of W it is only necessary to analyze the fuel and the weight of the air necessary to burn a given weight of it can then be computed from the above equation.

The first step in the analysis of a gas should be to obtain its specific gravity or the weight of a given volume, as compared with that of an equal volume of air.

This is best accomplished by weighing a given volume of each in a thin glass globe, and comparing the weights thus obtained. The weight of a given volume of air has been accurately determined, and thus the weight of a given volume of gas can be closely ascertained. It is evident that the sum of the weights of the constituents of the gas as shown by the analyses should equal the weight of the gas, which was taken for experiment. The composition of natural gas by weight has been found by analysis to be substantially as follows:

Carbon	70.25
Hydrogen.....	21.45
Sulphuretted hydrogen.....	.17
Carbonic acid.....	.02
Nitrogen (by difference).....	7.93
Total	100.00

It would be interesting from a scientific standpoint to determine, if possible, the nature and composition of the mixed hydro-carbons which compose the combustible portion of the gas, but practically it is only necessary to know the weight of the carbon and hydrogen, in order to gain an accurate knowledge of its heating power.

It may be added, however, that as much as 85 per cent. of natural gas consists of marsh gas, which is composed of seventy-five parts by weight carbon and twenty five parts of hydrogen.

It is evident, however, that the hydrocarbons can not consist entirely of marsh gas, as the carbon and hydrogen are not in the proper proportions, as shown by the following analyses.

COMPOSITION OF THE HYDROCARBONS IN NATURAL GAS.

<i>Analysis Made in 1894.</i>		<i>Analysis Made in 1896.</i>	
Carbon	76.4	Carbon	76.8
Hydrogen	23.6	Hydrogen.....	23.2

The analyses indicate that the gas is nearly or quite constant in its composition. Substituting the values given in the complete analysis in the formula, we find that $W=4.4 \left(\frac{562}{3} + 171.6 \right) = 1,579.3$ lbs., the weight of air necessary to burn 100 pounds of natural gas.

Since the specific gravity of natural gas is .634, the volume of air required to burn 100 cubic feet of the gas is 1,001.27, or almost exactly ten times the volume of the gas consumed. In practice, however, it is advisable to use a little more air than is called for by the formula, in order to insure perfect combustion. If, however, the mixture can be made perfect it is not advisable to admit too much air, as all surplus air tends to carry away heat which might otherwise be utilized. A good method of regulating the "quality" of a gas flame is to adjust the air supply at the mixer in such a manner that there is just a slight white tip occasionally visible at the end of the flame, and then turn on enough air to cause this to disappear. It is not the purpose of this article to treat of the utilization of heat, but it will perhaps be in order to say something of the subject as it is of such great importance.

The appliances in most common use in the utilization of natural gas are: 1. Stoves. 2. Furnaces. 3. Grates. 4. Boilers.

The burner in a stove used for heating should be set as near the bottom of the stove as possible, and the flame of the gas should issue horizontally so that the tip should just reach the iron of the stove. This arrangement carries the hot gases upward in close contact with the interior wall of the stove, and thus enables the heat to penetrate the iron and pass into the room. There should also be a damper in the stove pipe to prevent too rapid escape of the hot gases from the stove.

The furnace is perhaps the most economical appliance for the utilization of heat for warming rooms. It is, moreover, when properly constructed, healthful and pleasant. But if not properly constructed, or if proper attention be not given to it, it may become the source of great annoyance and even danger to health. Placed as it usually is, in the basement, it renders certain the introduction of all the burnt gas, resulting from leakage, into the rooms above.

The carbonic acid and steam thus finding their way into the rooms are comparatively harmless; but there is another gas called carbonous oxide which is often produced from "smothered" combustion that is extremely poisonous. It is not advisable to sit or stand near a furnace register if there is the slightest odor of "burnt gas" perceptible, as the carbonous

oxide here forms the highest per cent. of the air in the room. The remedy for the above is to have the furnace thoroughly inspected by a competent person who will see :

1. That the chimney draft is clear.
2. That the burner is clean.
3. That the air and gas are admitted in the proper proportions through the mixer.
4. That the pipes admitting air to the registers are tight.

Carbonous oxide is odorless and invisible, but its presence is manifested by causing a dizzy sensation often accompanied by headache.

The heat supplied to a room is of two kinds :

1. That supplied by direct radiation or radiant heat.
2. Heat by convection or that supplied directly from the stove to the air of the room. When we approach a very hot stove or an open fire we feel the effect of the direct radiation. This form of heat can pass readily through a vacuum, and does not depend upon air for conveying it from one object to another.

The stove heats both by direct radiation and by convection.

The furnace heats by convection only ; as the air acts as a carrier for all the heat it supplies to the rooms. The grate or open fire, if built into the chimney, supplies heat by direct radiation only. It is a pleasant fire, but a very wasteful one. In very cold weather it is almost impossible to warm a room of any considerable size by a grate.

There are two reasons for this :

1. The heat being radiant can only warm the room by directly radiating against the floor, walls and furniture, and as its intensity diminishes with the square of the distance the amount of heat supplied to the room is limited to a small area very near the fire.
2. The draft created in the flue is strong in cold weather and the cold air rushes into the room at every crack and crevice, thus robbing the room of a great deal of heat. The best that can be said for the grate is that it is a cheerful fire and insures good ventilation if properly constructed. The remark that Benjamin Franklin satirically made of the old-fashioned fire-place can be applied with equal force to the modern grate: "It is the thing to use if one wishes to obtain the least amount of heat from the greatest amount of fuel." There is some hope just now, however, that a stove will come into use which will have all the cheerfulness of the grate and an economy equal to the best stove. Whether a stove, furnace or grate is used it should have sufficient radiating surface to allow the heat to pass so rapidly into the room that the temperature of the gases in the stove pipe shall be reduced as far as possible before they pass out into the air. Notwithstanding the fact that considerable quantities of steam are carried out through the chimney it is not necessary that the temperature of these gases should be above the boiling

point of water. The writer has tested the temperature of these gases, by inserting a thermometer in the stove pipe, and in some cases found it to be as low as 90° Centigrade, and there were no signs of condensation.

It should be remembered that air heated to this temperature may carry as much as one-third of an ounce of water to the cubic foot without precipitating any moisture. It should be added that the test referred to above was made on a stove pipe about thirty feet in length, just before it entered the flue. The gases when they leave the stove are much hotter than boiling water, but if the stove pipe is long they give up a great deal of heat before reaching the flue. When possible it is a good plan to place a drum in the room directly above the stove and allow hot gases to go through it before entering the flue.

In order to utilize the gas to the best advantage it is then necessary: 1. To burn it perfectly. 2. To reduce the temperature of the burned gases to the lowest possible degree consistent with a perfect draft. If the precautions in setting the burner and properly regulating the air supply and draft are carefully observed there will be no difficulty in securing nearly perfect combustion.

It should be remembered, however, that imperfect combustion is almost certain to result in the formation of carbonous oxide, which is extremely poisonous. The draft should be properly looked after when the stove is put in place, and care should be taken that the stove pipe should not extend far enough into the chimney to interfere with the draft, as this will produce "smothered combustion," and noxious gases are almost certain to escape into the room in large quantities. The steam boiler is used in producing steam for heat or power. When for the former purpose the pressure is usually low, and "stack temperature" can be reduced to quite a low point without interfering with the boiler pressure. It is evident, however, that if steam is to be generated, the temperature of the stack gases must be above the boiling point of water.

This form of heating is economical and healthful if but little ventilation is required. For crowded rooms, however, it should not be used unless extra ventilation is provided from a separate source. When steam is used for power purposes the stack gases must, of course, be hotter than if it is to be used for heating; since the pressure is higher in the boiler and its temperature correspondingly higher.

It is possible, however, to obtain good service from a steam boiler, and yet keep the temperature of the stack gases surprisingly near to that of the boiler.

In some experiments made by the writer it was found possible to keep the temperature of the stack gases as low as 330° Fahrenheit, and at the same time carry a pressure of 95 pounds in the boiler. The temperature of the stack gases in this case was only about 10° F. above that of the

water in the boiler. The boiler readily gave steam to its rated capacity under the above tests.

The main trouble in keeping down the stack temperature is a desire on the part of the owner to force the combustion and get as much steam as possible from the boiler. This is poor economy, as it not only results in imperfect combustion and requires vastly more gas, but materially shortens the life of the boiler. Care should also be taken that no soot shall be deposited either on the boiler or in the flues. It is a well-known fact that carbon, in the form of a light, flaky soot, is a very poor conductor of heat, and even a slight deposit of it will materially lessen the efficiency of the boiler. The writer has found that a slight deposit of soot may reduce the evaporation from 10 to 20 per cent., under given conditions, according to the thickness of the deposit.

Owing to the lack of space the gas engine can not be given the credit it deserves in this article. It may be stated, however, that all who have used it thus far testify to its great economy.

GAS COMPANIES.

The following list of natural gas companies, with a few exceptions, was compiled by the county assessors of the various counties. While every effort has been made to make the list as reliable as possible, doubtless mistakes will be found. As a general rule wells owned by individuals for their own use are not included in the list.

LIST OF NATURAL GAS COMPANIES.

COMPANY.	PRES. OR SECY.	P. O. ADDRESS.
ALLEN COUNTY.		
Ft. Wayne Natural Gas Co.....	Henry C. Paul.....	Ft. Wayne.
BLACKFORD COUNTY.		
Bailey Natural Gas Co.....	S. A. Mills.....	Hartford City.
Blackford County Natural Gas Co.....		Montpelier.
Blackford and Grant County Natural Gas Co.....		Hartford City.
Citizens' Natural Gas Co.....	Amer Boid.....	Montpelier.
E. C. Storms Natural Gas Co.....	E. C. Storms.....	Roll.
Hartford City Glass Co.....	R. Hagany.....	Hartford City.
Hartford City Natural Gas and Oil Co.....	John Lenox.....	Hartford City.
Jones & Dowell Gas Well.....	J. H. Dowell.....	Hartford City.
Linbark Gas and Oil Co.....	C. Whitson.....	Dunkirk.
Marion Creek Natural Gas Co.....	Marion Creek.....	Priam.
Millgrove Natural Gas Co.....	Theo. Fugua.....	Millgrove.
Montpelier Natural Gas, Oil and Mining Co.....		Montpelier.
Peck Natural Gas Co.....	Sam. Peck.....	Hartford City.
Peoples' Natural Gas Co.....	H. H. Robbins.....	Hartford City.
Renner Natural Gas Co.....	J. E. Green.....	Hartford City.
Smith Natural Gas Co.....	Hiram Smith.....	Hartford City.
Trenton Natural Gas Co.....	Tom Armstrong.....	Priam.
Walnut Street Natural Gas Co.....		Hartford City.
BOONE COUNTY.		
Big Spring Natural Gas Co.....	M. F. Billings.....	Big Springs.
Elizabethville Natural Gas Co.....	A. C. Campbell.....	Elizabethville.
Indiana Natural and Illuminating Gas Co.....	John H. Dilkes.....	Indianapolis.
Little Eagle Natural Gas Co.....	Rufus Cowrer.....	Northfield.
Northwestern Natural Gas Co.....	George Stultz.....	Zionsville.

LIST OF NATURAL GAS COMPANIES—Continued.

COMPANY.	PRRS. OR SECY.	P. O. ADDRESS.
CLINTON COUNTY.		
Terhune & Kirkland Natural Gas Co	G. M. Kutz	Kirkland.
DECATUR COUNTY.		
Benj. Jenkins Gas Co	Benjamin Jenkins	St. Paul.
Bracken & Hamilton Gas Co	Dr. Wm. Bracken	Greensburg.
Citizens' Gas Co	George Ewing	Greensburg.
Consumers' Natural Gas Co	George M. Kline	St. Paul.
Fourth Ward Natural Gas Co	Putt Ewing	Greensburg.
Greensburg Natural Gas, Oil and Water Co	Charles Porter	Greensburg.
Hamilton Natural Gas Co	Brutus Hamilton	Greensburg.
Hollensby Natural Gas Co	Jud Hollensby	Greensburg.
Muddy Fork Natural Gas Co	Hubert Eich	Greensburg.
Slippery Natural Gas Well Co	Oliver Hunter	Greensburg.
Stevenson & Emmeret Gas Co	Thom. Stevenson	Greensburg.
St. Paul Gas, Oil and Water Co	E. L. Floyd	St. Paul.
Thomas Healtou Natural Gas Co	Thomas Healtou	St. Paul.
Newton Natural Gas Co	Dallie Tilton	Greensburg.
DELAWARE COUNTY.		
Buck Creek Natural Gas Co	A. W. Ross	Muncie.
Cammack Natural Gas and Mining Co	W. F. McKinley	Cammack.
Central Cooperative Fuel, Gas and Light Co	J. W. Ream	Muncie.
Citizens' Cooperative Natural Gas Co	C. S. Watchell	Muncie.
Compromise Natural Gas Co	L. O. Swingley	New Burlington.
Cleveland Gas Co		DeSoto.
Cooperative Gas Light and Fuel Co	L. H. Greer	Yorktown.
Cooperative Fuel and Gas Light Co	J. F. Broyles	Gaston.
Cooperative Natural Gas Co	J. M. Hancock	Daleville.
Cowan Exploring and Gas Co	W. H. Neff	Cowan.
Cross Roads Natural Gas Co	W. L. Swanger	Cross Roads.
Delaware Natural Gas and Mining Co	D. A. Black	Albany.
DeSoto Natural Gas and Mining Co	Eli Ogle	DeSoto.
Eaton Mining and Gas Co	C. K. VanBuskirk	Eaton.
Economy Natural Gas Co	F. J. Claypool	Muncie.
Farmers' Non-transferable Gas Co	A. D. Gray	Muncie.
Farmers' Natural Gas and Petroleum Oil Co	M. C. Ratcliff	Yorktown.
Farmers' Natural Gas and Oil Co	D. A. Funkhouser	Cross Roads.
Farmers' Natural Gas and Oil Co	Newton Weaver	Albany.
Forest Park Gas Co	W. H. Reed	Muncie.
Granville Citizens' Natural Gas Co	L. W. Davis	Granville.
Gaston Gas and Mining Co	L. F. Miller	Gaston.
Greenstreet Gas Co	G. A. Buckles	Albany.
Harrison Tp. Natural Gas Co	S. H. Jackson	Stout.
Jake's Creek Valley Gas Co	H. J. McClellan	Muncie.
Manufacturers' Fuel Gas Co	Bert Whitely	Muncie.
Manufacturers' Natural Gas Co	Frank Ball	Muncie.
Maple Grove Natural Gas Co	R. L. Brent	Eaton.
Manufacturers' Cooperative Natural Gas Co	L. N. Dixon	Daleville.
Mt. Pleasant Natural Gas and Oil Co	Henry Slagel	Daleville.
Muncie Cooperative Gas Co	John C. Eiler	Muncie.
New Burlington Natural Gas Co	J. B. Jackson	New Burlington.
Niles Natural Gas Co	D. B. Moore	Dunkirk.
No Name Natural Gas Co	W. T. Clark	Cowan.
North Muncie Farmers' Natural Gas Co	J. L. Powers	Muncie.
Oakville Natural Gas Co	Henry Weber	Oakville.
Pikes' Peak Natural Gas Co	W. H. Shoemaker	Daleville.
Reed Station Natural Gas Co	Chas. Fuson	Reed Station.
Richmond Farmers' Natural Gas Co	Perry V. Stewart	Muncie.
Ross & Fullheart Gas Co	W. W. Ross	Muncie.
Royerton Natural Gas Co	Lee Scott	Royerton.
Selma Natural Gas Co	N. E. Black	Selma.
Sugar Creek Natural Gas Co	Frank Pittenger	Selma.
The Cooperative Fuel and Gas Light Co	G. W. Whiteman	Albany.
The Mutual Natural Gas Co	S. F. McNett	Gaston.
The Petroleum, Natural Gas and Exploring Co	J. R. Stafford	Albany.
Walker Natural Gas and Oil Co	Jos. Dillow	Gilman.
Washington Tp. Farmers' Cooperative Fuel and Gas Light Co		
Washington Tp. Farmers' Cooperative Fuel and Gas Light Co	J. W. Lambert	Gaston.
York Prairie Natural Gas and Mining Co	J. S. Buckles	Yorktown.
Yorktown Natural Gas and Oil Co	Thos. Allen	Yorktown.

LIST OF NATURAL GAS COMPANIES—Continued.

COMPANY.	PRES. OR SECY.	P. O. ADDRESS.
FAYETTE COUNTY.		
Connersville Natural Gas Co	C. E. J. McFarland	Connersville.
GRANT COUNTY.		
Arcana Gas Co	Joshua Strange	Arcana.
Barron Creek Gas Co	John H. Caskey	Fairmount.
Cart Creek Gas Co	O. J. Simmons	Jalapa.
Citizens' Gas Co	Will C. Jay	Gas City.
Citizens' Gas Co	B. F. Carpenter	Fairmount.
Citizens' Gas Co	B. F. Thompson	Swayzee.
Deer Creek Mining Co	Chas. E. Coffin	Marion.
Dry Fork Gas Co	C. E. Carey	Hackleman.
Fairmount Mining Co	Con. L. Shugart	Marion.
Fowler Gas Co	C. R. Small	Fairmount.
Farmington Mining Co	J. S. Fowler	Fowler.
Hackleman Mining Co	Cary Carroll	Farmington.
Haw Run Gas Co	Eli Goodwin	Marion.
Herbst Natural Gas and Mining Co	Abraham Small	Roseburg.
Jadden Gas Co	T. J. Thompson	Herbst.
Jonesboro Mining Co	Isaiah Wall	Jadden.
Lake Branch Mining Co	R. M. Johnson	Jonesboro.
Landesville Gas Co	Timothy Forehand	Upland.
Michaels' Natural Gas Co	W. W. Sandess	Landesville.
Mississinewa Mining Co	Robert L. Smith	Michaels.
New Cumberland Mining and Gas Co	James F. Gabby	Marion.
North Marion Gas Co	Michael Cory	New Cumberl'nd.
Peoples' Gas Co	Geo. B. Winchel	Marion.
Pipe Creek Natural Gas Co	James F. Gabby	Marion.
Roseburg Natural Gas Co	Jos. W. Farley	Roseburg.
Swayzee Mining Co	M. Drukemiller	Roseburg.
Sweetser Mining Co	John Reed	Swayzee.
Triumph Gas Co	Geo. Williamson	Sweetser.
Sweetser Natural Gas Co	J. W. Cox	Fairmount.
The Upland Mining Co	Frank W. Chase	Sweetser.
West Marion Citizens' Gas Co	Jacob Bugher	Upland.
.....	Jonathan Mills	Marion.
HANCOCK COUNTY.		
California Natural Gas Co	J. M. Henry	Maxwell.
Charlottesville Natural Gas Co	W. H. H. Rock	Charlottesville.
Citizens' Natural Gas Co	J. L. Fry	Greenfield.
Cleveland Natural Gas Co	Isaiah Manden	Cleveland.
Cushman Natural Gas Co	J. F. Cushman	Fortville.
Don's Natural Gas Co	H. C. Davis	Fortville.
Farmers' Natural Gas Co	John D. Cory	McCordsville.
Fortville Natural Gas Co	W. C. VanLaningham	Fortville.
Gilboa Natural Gas Co	J. E. Sample	Cleveland.
Greenfield Natural Gas Co	J. H. Can	Greenfield.
Haskett Ford Natural Gas Co .....	.....	Carthage.
Independence Natural Gas Co	H. N. Bennett	Greenfield.
Maxwell Natural Gas Co	J. H. Mugg	Maxwell.
McCordsville Natural Gas Co	J. P. McCord	McCordsville.
Mohawk Natural Gas Co	A. O. Steele	Mohawk.
Morristown Natural Gas Co	L. E. McDonald	Morristown.
Mutual Natural Gas Co	D. B. Cooper	Greenfield.
Nameless Creek Natural Gas Co	C. M. Vanderbark	Cleveland.
National Natural Gas Co	M. T. Duncan	Greenfield.
Pigeon Roost Natural Gas Co	J. M. McKown	Charlottesville.
Pleasant Hill Natural Gas Co	E. Tijner	Greenfield.
Scrabbletown Natural Gas Co	Moses Bates	Wilkinson.
Stringtown Natural Gas Co	George W. Crider	Greenfield.
Sugar Creek Natural Gas Co	J. C. Webber	Greenfield.
T. J. Hannah Natural Gas Co	T. J. Hanna	McCordsville.
Vernon Natural Gas Co	G. S. Williams	Fortville.
Westerngrove Natural Gas Co	Joseph L. Binford	Westland.
Westland Natural Gas Co	L. Wiggins	Westland.
Wilkinson Natural Gas Co	Benjamin H. Cook	Wilkinson.
Willow Branch Natural Gas Co	Henry Marsh	Willow.

LIST OF NATURAL GAS COMPANIES—Continued.

COMPANY.	PRES. OR SECY.	P. O. ADDRESS.
HAMILTON COUNTY.		
Atlanta Natural Gas Co.....	J. M. Whistler.....	Atlanta.
Bakers' Corner Natural Gas Co.....	J. B. Foulk.....	Bakers' Corner.
Bethlehem Natural Gas and Oil Co.....	H. L. Dick.....	Cicero.
Big Springs Natural Gas Co.....	W. T. Billings.....	Big Springs.
Buffalo Corner Natural Gas Co.....	Henry Sowers.....	Arcadia.
Carmel Natural Gas Co.....	L. G. Small.....	Carmel.
Central Gas Co.....	S. M. Smith.....	Westfield.
Cicero Natural Gas Co.....	Wm. Z. Colling.....	Cicero.
Citizens' Natural Gas Co.....	Z. T. Hobbs.....	Atlanta.
Citizens' Natural Gas and Oil Co.....	S. D. Stultz.....	Jolietville.
Clay Center Natural Gas Co.....	O. C. Elliott.....	Carmel.
Clarksville Natural Gas Co.....	John Passwater.....	Clarkville.
County Line Gas and Oil Co.....	Cal Faussett.....	Fortville.
Eagletown Pioneer Gas Co.....	P. F. Brunson.....	Eagletown.
Eureka Natural Gas and Oil Co.....	T. A. Stephens.....	Eagletown.
Fall Creek Township Natural Gas Co.....	Gus Brooks.....	Fishers' Switch.
Farmer's Natural Gas Co.....	R. M. Johnson.....	Arcadia.
Federal Hill Natural Gas Co.....	Calvin Keesling.....	Noblesville.
Fisher's Switch Natural Gas Co.....	I. P. Heath.....	Fishers' Switch.
Hortonville Natural Gas Co.....	J. A. Aldred.....	Hortonville.
John Harrison Natural Gas Co.....	John Harrison.....	Noblesville.
Keck Natural Gas Co.....	W. A. Hill.....	Omega.
Little Eagle Natural Gas Co.....	M. Stultz.....	Eagletown.
Noblesville Gas and Improvement Co.....	C. R. Davis.....	Noblesville.
Nora Natural Gas Co.....	R. Moffitt.....	Nora.
Northwestern Natural Gas Co.....	Geo. Stultz.....	Zionsville.
Ohio Natural Gas and Oil Co.....	W. A. Young.....	Ohio.
Pleasant Valley Natural Gas Co.....	N. C. Shaw.....	Fortville.
Poplar Ridge Natural Gas Co.....	J. H. Harvey.....	Carmel.
Sheridan Natural Gas Co.....	H. J. Thistlewait.....	Sheridan.
Slabtown Natural Gas Co.....	J. E. West.....	Waugh.
Spicewood Natural Gas Co.....	O. C. Lindley.....	Sheridan.
Stoney Creek Natural Gas Co.....	T. A. Rambo.....	Noblesville.
Stoney Creek Natural Gas Co. No. 2.....	Marion Smith.....	Clarksville.
Strawtown Natural Gas Co.....	W. W. Morris.....	Strawtown.
Tile Factory Corner Natural Gas Co.....	A. H. Bray.....	Noblesville.
Westfield Gas and Milling Co.....	A. L. Binford.....	Westfield.
White River Natural Gas Co.....	C. D. Zimmer.....	Strawtown.
HENRY COUNTY.		
Cadiz Natural Gas Co.....	A. L. Alshouse.....	Cadiz.
Central Natural Gas Co.....	W. W. Horston.....	Cadiz.
Citizens' Natural Gas Co.....	A. E. Sample.....	Knightstown.
Citizens' Natural Gas Co.....	G. L. Swan.....	Middletown.
Dunreith Natural Gas Co.....	J. W. Hayes.....	Dunreith.
Enterprise Natural Gas Co.....	J. I. Morris.....	New Castle.
Farmers' Free Gas Co.....	J. L. Hartly.....	Mt. Summit.
Farmers' Natural Gas Co.....	John Wilkinson.....	Middletown.
Farmers' Natural Gas Co.....	E. B. Raddiff.....	Spiceland.
Gronendyke Gas Co.....	James Gronendyke.....	Middletown.
Honey Creek Natural Gas Co.....	John Starkey.....	Honey Creek.
Kennard Natural Gas Co.....	A. J. Daniels.....	Kennard.
Knightstown Natural Gas Co.....	Thomas B. Deem.....	Knightstown.
Mechanicsburg Natural Gas Co.....	S. M. Keesling.....	Mechanicsburg.
Montgomery Creek Natural Gas Co.....	J. B. Modlin.....	Greensboro.
Moreland Natural Gas Co.....	A. B. Shepherd.....	Moreland.
Ogden Natural Gas Co.....	J. A. Moffette.....	Ogden.
Painters Plain Natural Gas Co.....	Cyrus Vanmeter.....	Middletown.
Spiceland Natural Gas Co.....	E. A. Bogue.....	Spiceland.
Stone Quarry Natural Gas Co.....	S. J. Tright.....	Greensboro.
Sulphur Springs Natural Gas Co.....	Jacob Good.....	Sulphur Springs.
Walnut Level Natural Gas Co.....	Samuel Bowers.....	Cadiz.
Welcome Natural Gas Co.....	Edward Lewis.....	Knightstown.
HOWARD COUNTY.		
Pittsburgh Plate Glass Co.....	H. G. Chisnell.....	Kokomo.
Flabby Natural Gas Co.....	John W. Phares.....	Plevna.
Greentown Natural Gas Co.....	H. A. Covalt.....	Greentown.
Howard Natural Gas, Oil, Mining and Pipe Line Co.....	J. K. Saul.....	Sycamore.
Liberty Natural Gas Co.....	C. E. Leeson.....	Plevna.
Manufacturers' Pipe Line Co.....	J. M. Leach.....	Kokom.
Sycamore Natural Gas Co.....	Abe Garr.....	Sycamore.
Kokomo Natural Gas and Oil Co.....	G. W. Landon.....	Kokomo.

LIST OF NATURAL GAS COMPANIES—Continued.

COMPANY.	PRES. OR SECRY.	P. O. ADDRESS.
HUNTINGTON COUNTY.		
Huntington Light and Fuel Co	F. D. Townsend	Huntington.
Warren Natural Gas Co.....	C. H. Good.....	Warren.
JAY COUNTY.		
Citizens' Natural Gas and Oil Co.....	J. L. Fulton	Portland.
Dunkirk Natural Gas and Oil Co	C. W. Smalley	Dunkirk.
Pennville Natural Gas and Oil Co.....	Samuel Mason	Pennville.
Portland Natural Gas and Oil Co.....	J. G. Crowell	Portland.
Red Key Natural Gas Co.....	J. D. S. Neeley	Lima, Ohio.
Richmond Natural Gas and Oil Co	Edgar Fishback.....	Redkey.
MADISON COUNTY.		
Adams Township Natural Gas and Oil Co.....	J. M. Tomlinson.....	Markleville.
Alexandria Mining and Exploring Co .....	.....	Alexandria.
Alfont Natural Gas and Oil Co .....	.....	Alfont.
Anderson Fuel and Supply Co.	G. C. Forry	Anderson.
Bear Creek Natural Gas Co.....	I. C. Peck	Perkinsville.
Canal Natural Gas Co.....	.....	Alexandria.
Citizens' Natural Gas Co.....	J. H. Millsbaugh.....	Anderson.
Citizens' Natural Gas and Mining Co.....	Bert Carpenter	Elwood.
Citizens' Natural Gas Co	Cyrus Spears.....	Summitville.
County Line Gas Co.....	.....	Pendleton.
County Line Natural Gas and Oil Co.....	.....	Ingalls.
Depauw Plate Glass Co	J. F. Merker.....	Alexandria.
Dyars Creek Gas and Oil Co	G. B. Carpenter	Lapel.
Elwood Natural Gas and Oil Co	W. G. Curtis	Elwood.
Fall Creek Gas Co.....	W. W. Williams.....	Pendleton.
Farmers' Mutual Natural Gas Co .....	.....	Summitville.
Fosters Branch Natural Gas Co	A. C. Anderson	Pendleton.
Green Township Natural Gas Co.....	.....	Pendleton.
Gilman Natural Gas Co.....	.....	Gilman.
Hardman Natural Gas and Oil Co.....	Frank Mosely	Markleville.
Jacobs Natural Gas Co.....	.....	Pendleton.
Lapel Natural Gas and Oil Co.....	J. R. Woodard.....	Lapel.
Markleville Natural Gas and Oil Co	W. H. Hardy.....	Markleville.
Mendon Natural Gas Co .....	.....	Mendon.
Pendleton Natural Gas Co.....	O. W. Brownback	Pendleton.
Perkinsville Natural Gas and Oil Co	J. B. Applegate.....	Perkinsville.
Philips Land and Gas Co	V. C. Quick.....	Alexandria.
Pleasant Valley Natural Gas Co.....	T. A. Baker.....	Pendleton.
Riverside Natural Gas Co.....	.....	Alexandria.
Ryan Valley Natural Gas and Oil Co.....	.....	Perkinsville.
Scatterfield Natural Gas and Oil Co.....	.....	Anderson.
Spring Valley Natural Gas Co.....	Liba Darlington.....	Pendleton.
Summitville Mining Co.....	O. E. Gordon	Summitville.
Victory Natural Gas and Oil Co.....	T. M. Moore	Summitville.
West Alexandria Natural Gas Co	S. C. Dalrymple	Alexandria.
MARION COUNTY.		
Consumers' Gas Trust Co	Bement Lyman	Indianapolis.
Indianapolis and Broad Ripple Natural Gas Co.....	R. C. Light	Indianapolis.
Indianapolis Natural Gas Co	J. R. Pearson.....	Indianapolis.
Manufacturers' Natural Gas Co.....	H. McK. Landon	Indianapolis.
United States Encaustic Tile Natural Gas Co.....	John Pickens.....	Indianapolis.
MIAMI COUNTY.		
Amboy Natural Gas Co.....	C. P. Baldwin.....	Amboy.
Citizens' Gas and Pipe Line Co	H. Bouslog.....	Peru.
North Grove Natural Gas Co.....	J. E. Marsh.....	Peru.
West Xenia Real Estate, Gas and Pipe Line Co.....	A. C. Smith.....	Converse.
Xenia Natural Gas and Pipe Line Co	Aaron Michaels.....	Converse.

LIST OF NATURAL GAS COMPANIES—Continued.

COMPANY.	PRES. OR SECY.	P. O. ADDRESS.
RANDOLPH COUNTY.		
Citizens' Natural Gas Co.....	I. C. Mills.....	Parker.
Eastern Indiana Oil and Gas Co.....	Ed. Goodrich.....	Union City.
Elkborn Natural Gas Co.....	John Nixon.....	Farmland.
Farmland Natural Gas Co.....	J. H. Thornburgh.....	Farmland.
Green Township Natural Gas Co.....	Jacob Life.....	Shedville.
Lynn Natural Gas Co.....	J. S. Blair.....	Lynn.
Parker Natural Gas Co.....	L. A. Botkin.....	Parker.
Rock Oil Co.....	E. F. Kitselman.....	Winchester.
Windsor Natural Gas Co.....	Milo Davidson.....	Windsor.
Ridgeville Natural Gas Co.....		Ridgeville.
RUSH COUNTY.		
Big Four Natural Gas Co.....		Carthage.
Carthage Natural Gas Co.....	O. S. Hill.....	Carthage.
Citizens' Natural Gas Co.....		Manilla.
Cream Ridge Natural Gas Co.....		Carthage.
Farmers' Natural Gas Co.....		Mays.
Five Points Natural Gas Co.....		Sexton.
Hackleman Natural Gas Co.....		Mays.
Homer Natural Gas Co.....		Homer.
J. B. Kirkpatrick Natural Gas Co.....		Sexton.
Manilla Natural Gas Co.....		Manilla.
Mays Station Natural Gas Co.....		Mays.
People's Natural Gas Co.....	J. Q. Thomas.....	Rushville.
Riverside Natural Gas Co.....	John White.....	Rushville.
Rushville Natural Gas Co.....	Wm. J. Henley.....	Rushville.
Sexton Natural Gas Co.....		Sexton.
Walnut Ridge Natural Gas Co.....		Carthage.
Walnut Street Natural Gas Co.....		Carthage.
W. L. Walker Natural Gas Co.....		Carthage.
SHELBY COUNTY.		
Citizens Natural Gas Co.....	J. L. Showers.....	Shelbyville.
Fountaintown Natural Gas Co.....	H. M. Inlow.....	Fountaintown.
Morristown Natural Gas Co.....	L. E. McDonald.....	Morristown.
Southern Indiana Natural Gas Co.....	P. G. Kamp.....	Shelbyville.
Waldron Natural Gas Co.....		Waldron.
TIPPECANOE COUNTY.		
Lafayette Natural Gas and Oil Co.....	S. T. Murdock.....	Lafayette.
TIPTON COUNTY.		
Citizens' Natural Gas Co.....	J. C. Urnston.....	Tipton.
Citizens' Natural Gas Co.....	J. R. Hildrup.....	Windfall.
Lutz Natural Gas Co.....	J. C. Lutz.....	Goldsmith.
Tipton Line and Improvement Co.....	John Kemp.....	Tipton.
Tipton Light, Heat and Power Co.....	Peter McArdle.....	Tipton.
Vanbrigue Natural Gas Co.....	Peter Vanbrigue.....	Groomsville.
Windfall Natural Gas, Oil and Mining Co.....	B. F. Legg.....	Windfall.
WABASH COUNTY.		
LaFontaine Natural Gas and Oil Co.....	O. H. Mason.....	LaFontaine.
Somerset Natural Gas Co.....	C. E. Henley.....	Wabash.
Wabash Fuel Co.....	M. H. Mendenhall.....	Wabash.
WAYNE COUNTY.		
Hagerstown Natural Gas Co.....	J. M. Hartley.....	Hagerstown.
Richmond Natural Gas Co.....	E. G. Hibbard.....	Richmond.
MISCELLANEOUS.		
Central Contract & Finance Co.....	J. D. S. Neely.....	Lima, Ohio.
Indiana Natural Gas and Oil Co.....	J. S. Smith.....	Chicago, Ill.
Logansport & Wabash Valley Natural Gas Co.....	S. T. Murdock.....	Lafayette.