

THE PETROLEUM INDUSTRY IN INDIANA IN 1900.

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TRENTON ROCK PETROLEUM.

The Trenton limestone, which underlies the whole of the State of Indiana, is the source of by far the greater part of the gas and oil produced in the State. The Trenton is one of the lower or older formations of the Lower Silurian System. The upper formation of this system, namely the Hudson River limestones and shales, forms the surface rocks of several counties in the southeastern part of the State. Between the Hudson River limestone and the Trenton limestone is a persistent, fine-grained dark brown or blackish shale, known as the Utica shale. This lies immediately on top of the Trenton limestone and forms the necessary impervious cover over the porous portions of that formation. In these porous portions the oil and gas are stored, and the presence of the overlying close grained Utica shale has, for centuries, kept these stored products from escaping upward, and passing off as volatile products. Trenton limestone does not outcrop or form the surface in any part of the State, and its known closest proximity to the surface is near Lawrenceburg, Dearborn County, where it is 348 feet below.

FORMATION OF POROUS PORTIONS OF TRENTON LIMESTONE.—The Trenton limestone is a sedimentary rock; i. e., one which was laid down in water—the bottom of the sea—ages ago. When first formed it was a nearly pure calcium carbonate or carbonate of lime. In the course of time, certain areas of the sea bottom, covered with the incipient limestone, were slowly raised until they became higher than the others, and formed shallow basins, lagoons or bays. Some of these raised portions covered very large areas. Others were isolated or separated from the main area, sometimes by a distance of 20 to 30 miles. The outline of all was irregular, with many indentations along the margins. In these more shallow portions of the Silurian seas the water became in time very briny and caused a chemical change in the rock. To the lime carbonate was added some magnesia from the brine, and a magnesia-lime carbonate called “dolomite”

resulted. Wherever this change took place—which was only in the shallow, briny areas noted—the resulting *dolomite* was porous. This porous condition was due to the fact that the new crystals of dolomite were smaller than, and never entirely filled the spaces occupied by, the older crystals of lime carbonate. *The larger areas of the Trenton limestone deposit beneath the present bounds of Indiana were either too impure to admit of a change into dolomite, or the conditions of sea level were never such that the change could take place; hence they are non-porous and barren of either oil or gas.*

ORIGIN OF PETROLEUM.—The petroleum of the Trenton limestone was formed in that rock many thousands of years ago. Myriads of animals, as polyps, bryozoans, crinoids, brachiopods, trilobites and fishes, existed in the sea at the time the sediment of the Trenton limestone was being deposited. The presence of such swarms of animal life made necessary the existence of an abundance of plants, since the plant must ever precede the animal and gather for the latter the energy, and form for it the food—the living protoplasm—necessary to its existence. These plants were mostly marine algae or seaweeds and fucoids, though doubtless many other forms existed of which no remains have been preserved in the rocks of that age. As these organisms, both plant and animal, died, their bodies, in vast numbers, were buried in the slowly forming sediment. By the waters above and the ooze around them they were shut off from the free oxygen of the air and the decay ordinarily undergone by dead organisms was thereby prevented. Instead of decaying, their soft parts underwent a *process of slow destructive distillation* which resulted in the petroleum now being brought up from the rocky depths where it has long been stored. The crusts and shells of their bodies went far toward forming the carbonate of lime of the Trenton rock, fully 80 per cent. of which is derived from the remains of their secretions and incrustations. It is a well known fact that if wood, coal or the body of any animal be placed in an air-tight retort and heated, a distillation will occur, and the object will be changed to gaseous, oily and solid matters. In the absence of heat and air a very long period of time will bring about the same results. By this is meant the process of “slow destructive distillation” above mentioned.

ANTICLINES AND SYNCLINES.—The surface of the Trenton limestone is not level as many people suppose, but, like the surface of the earth, is a series of alternating arches and depressions or ridges and valleys. The arches or domes are like inverted troughs and vary much in width and area, as do also the depressions between them. Wherever gas and oil occur they will be found in a porous stratum in

one of the arches, or *anticlines*, as they are called. If a bore happens to be put down and strikes a depression or *syncline* between the arches, salt water will invariably be found. If both gas and oil are present in a certain area, and the bore strikes the flank or side of the arch, oil will result. If the bore strikes the crest or dome of the arch, gas will flow. The cause of this is simple, being due to the arrangement of the three fluids according to their relative weights. When the oil was first formed it was pushed or carried hither and thither by the heavier salt water behind it. Much of it was carried away by the water and lost, but wherever one of the porous areas existed in the side or top of an anticline the oil was carried into it and there remained. During the ages which have elapsed much of the oil was changed into a volatile gas, which rose into the higher porous portions of the anticlines or ridges of the Trenton limestone. As this gas accumulated, it pressed back the remaining oil into the sides or flanks of the arch. The oil being lighter than the water, rested upon the latter and prevented it from rising into the higher porous portions of the limestone. When a bore is put down and strikes gas the latter will flow until the quantity which is stored in the porous area of the anticline is exhausted, when the oil, if any be present on the flanks or lower portions of the porous stratum, will rise in the gas well. It may be that the oil has been carried by the salt water into the porous portions of another anticline, and that only salt water occurs beneath the gas. If this be true, the water will fill the porous reservoir as soon as the gas is exhausted. The anticlines vary much in size, their domes running from scores of miles down to a half mile or less in width. The gas in the higher part of each anticline is, therefore, often shut off from that in a neighboring anticline by the intervening oil or water, or both. In the same way the oil in an anticline which contains oil only may be shut off from that in another anticline by the salt water filling all the porous portions of the syncline between. It often happens that a gas bore is put down which strikes the crest of a narrow anticline or raised portion of Trenton limestone which has not before been pierced. As a result the so-called rock pressure of the gas is at first high, but rapidly declines on account of the small size of the anticline. All the wider and higher anticlines in the main gas field in Indiana in which porous Trenton occurs, have been pierced many times, and the stored gaseous product has become almost exhausted.

ORIGIN OF NATURAL GAS.—From what has been said it will be seen that both natural gas and oil have a common origin; viz., the destructive distillation, carried on through thousands of years, of

the plants and animals which existed in the Trenton Period. The gas is only the lighter and volatile portion of the oil, which has risen into the higher interstices of the limestone. If an open barrel be filled with crude petroleum from the Trenton limestone of Indiana and exposed for a single summer to the air, more than half of the contents will pass away in the form of vapor, and a sticky, tar-like residue will remain. If by some means the escaping vapor could be collected and analyzed it would be found in the main to have the same composition as natural gas. In fact it would be natural gas and would burn as freely as a sample of that valuable fuel, collected in the ordinary way. In the depths of the rock the evaporation of the oil has been extremely slow and the amount has been limited both by the varying pressure of the overlying gas and the underlying water. There is little doubt, however, but that all the natural gas of the Trenton limestone has been so derived. The amount of gas and oil accumulated in any field will depend almost wholly upon the area and height of the anticline, and upon the relative thickness and degree of porosity of the dolomitic portion of the Trenton limestone.

POOLS NOT NECESSARILY CONNECTED.—A fallacy which is held by many would-be operators in the Indiana field is, that oil fields or pools run in lines, and that one field is connected with all others, the oil flowing from one to the other, through a continuous strip of porous rock. This may in part be true in the Pennsylvania oil regions, but it is wholly untrue in the Trenton limestone area of Ohio and Indiana. While all the so-called "pools" of that area are found in the anticlines in the Trenton formation, they are not necessarily connected, nor do the anticlines run in straight lines. From what has been said about the origin of the porous areas of the Trenton limestone it will be seen that a pool may be of any shape, and may lie in any direction from any other pool. Its boundaries may be straight or sinuous; its area one square yard or one thousand square miles. If the conditions necessary for the storing of petroleum, namely, a porous reservoir, located in the flank or dome of an anticline of the Trenton limestone, with an impervious cover above it and a water pressure below it, have been present in the past, the oil will very likely be found, whatever the shape, size or relative location as to other similar reservoirs. If any one of these conditions is lacking or has been lacking, the bore is sure to be a dry hole. Inasmuch as the top of the Trenton limestone in the main Indiana field is everywhere from 700 to 1,000 feet below the surface, it will be seen

that the problem of locating in advance a paying well is a most difficult one.

NO SURFACE INDICATIONS OF OIL.—Samples of oil or of water containing oil are constantly being received at the office of the State Geologist from stations outside of the present producing oil field. For the most part they have been gathered near the surface, and the persons collecting them believe that they are "surface indications" of a large supply of the precious liquid. In this they are mistaken, for the sample collected, if traced to its source, will be found to have exuded from a crevice in some neighboring stratum of rock, or to have come from some large mass of vegetable matter, partially or wholly covered with water or mud. Every shale, sandstone or limestone in the State contains oil in greater or less quantities, and even where the amount is infinitesimally small, enough may collect to exude from a crevice and produce a showing upon some near-by surface of water. In the minutely diffused state in which the oil is originally formed it is wholly without value. Like all other forms of mineral wealth, it must be concentrated into reservoirs, the so-called "pools" of the oil fields, before it can be utilized by man.

Again, many letters are received, asking: "What are the surface indications of gas or oil?" To all such inquiries I reply that in Indiana there is absolutely no such thing as a "surface indication" of either of these fuels. Where they occur in paying quantities in this State, they are found at depths varying from 700 to 1,500 feet below the surface, and no human being can say with certainty that a bore put down, even in the best prospective territory, will yield either in paying quantities. The operator who is thinking of putting down a bore in undeveloped territory, can only sink his drill; he has no way of knowing beforehand what the result will be. He may pierce the center of a reservoir and get a 500 barrel well; he may strike near its outer rim and get a 10 barrel well—he may miss it altogether and get a dry hole. One thing he can rely upon if he strikes a productive well, and that is, that he is drawing upon a stored product which is not now being formed in the rock from which it is drawn, and that, therefore, he must eventually exhaust the stock from the immediate vicinity of his bore.

NECESSITY OF ACCURATE SURFACE LEVELS.—Where a bore for petroleum has resulted in a good producing well, the level of the surface of the Trenton rock below tide should be carefully ascertained. This can be done only by running a transit level from the nearest point where the surface level is known, usually on a railway, to the surface of the bore. By subtracting the surface level of the

bore from the depth at which Trenton limestone is first struck, the surface level of the latter will be obtained. In but few places in the State is Trenton found above sea level. Where so found the depth to Trenton will be less than the surface level of the bore, and should be subtracted accordingly.

The location of the first dozen or more wells in any area a mile or two square must of necessity be largely a matter of guess work, but if the surface level of the Trenton in each bore, productive or dry, be carefully ascertained, the trend of the anticline and the approximate limits of the field or pool can be soon determined. Too much guess work concerning the surface level of the spot on which the well is located has been done in the past. In a broken country it is difficult for any man to guess approximately at the relative levels of two points a quarter of a mile apart, and the new level should always be ascertained with instruments. Of course the surface level of the bore has nothing to do with the absolute height or surface level of the Trenton, or the absence or presence of the petroleum, but it has a great deal to do with the *accurate determination* of the surface level of the Trenton, and therefore with the location of future wells. If a few thousand dollars had been spent in Indiana in past days in the careful determination of surface levels, it would have saved a few hundred thousand which have been sunk in dry holes.

TOPOGRAPHY OF THE MAIN INDIANA OIL FIELD.—The surface of the main area now yielding Trenton Rock oil in Indiana was originally one great plain, with only occasional small undulations to break its monotony. This plain has been eroded in many places by the streams, which in the past have been much larger than at present. Wherever bluffs or hills are found they are but the results of such erosion. But few outcrops of rock occur within the oil field, and they are found only along the streams where the water has eroded deep channels through the drift and bowlder clay, everywhere covering the oil territory to a depth of from 50 to 250 feet. These outcrops belong to the Niagara group of the Upper Silurian Period.

The formations passed through by the drill in all parts of the field before the Trenton limestone is reached are, therefore, as follows: Drift; Niagara limestone; Hudson River limestone; Utica shale. In the eastern half of the field an average section showing the thickness of each formation passed through would be about as follows:

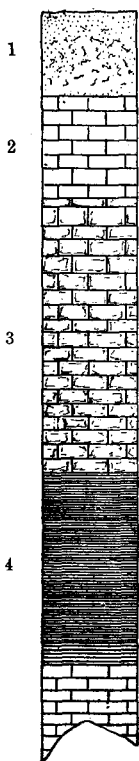


Fig. 73.

- 1. Drift 125 feet.
- 2. Niagara limestone 150 feet.
- 3. Hudson River limestone.. 425 feet.
- 4. Utica shale 300 feet.

In the western portion of the field the average bore shows:

- 1. Drift 175 feet.
- 2. Niagara limestone 225 feet.
- 3. Hudson River limestone.. 380 feet.
- 4. Utica shale 200 feet.

Throughout the Indiana field an eight or ten-inch drive pipe is forced down through the drift to the Niagara limestone. The salt water usually found in the Niagara is cased off by an iron tube $5\frac{5}{8}$ or $6\frac{1}{4}$ inches in diameter, which reaches to the soft blue Hudson River limestone underlying the Niagara. This second limestone and the Utica shale beneath it contain no water. The Trenton is everywhere overlain with the soft, dark colored Utica shale which forms an

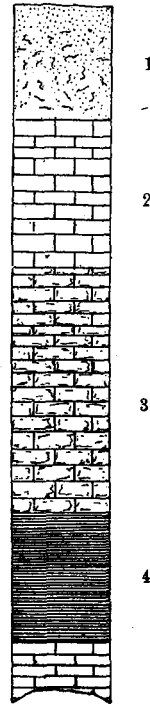


Fig. 74.

impervious cover through which neither gas nor oil can escape. From the bottom of this shale the drill passes at once into the hard crust of the Trenton limestone. Two "pay streaks" or porous layers are usually found in the Trenton, and it is only in them that oil occurs. The first or upper one is usually 15 to 25 feet below the top of the Trenton; the other is 15 to 25 feet below the bottom of the first. While the Trenton rock in Indiana varies in known thickness from 470 to 586 feet the porous portions containing oil are found only in its upper fourth. It has been found useless to drill into the Trenton more than 70 feet, since of the 10,000 and more bores which have been put down in the State, but three or four have found oil or gas below that depth.

SALT WATER.—More or less salt water is always found in the Niagara limestone, and is shut off by the casing put down through that formation. Salt water also occurs in the Trenton rock in all portions of the Indiana field. Usually a difference of only six to 10 feet in the elevation or depression of the surface of the Trenton defines oil and salt water territory. If the well has been located

over a syncline, or trough, in the Trenton, salt water is apt to be found before the drilling has proceeded very far into that formation, and a well yielding only salt water usually results. If, however, the bore pierces the dome or flank of an anticline, either gas or oil will be struck, and the operator is usually careful to see that the drilling is stopped before the level of the water producing rock is reached.

It is now almost universally admitted that the rock pressure in any oil field is nothing more or less than water pressure, as in artesian wells, the water entering the porous stratum at some point where the latter outcrops and so forming a head or source. Hence, the deeper the well the greater the head of water and the higher the rock pressure. The porous rock contains a limited amount of oil, held in place by the overlying shale. The salt water is below this oil, ever pressing it upward into the vent furnished by the drill hole. As the supply of oil is gradually lessened, the water rises to fill the pores, and the rock pressure is lowered. The pressure does not tell us anything about the volume or amount of oil stored in the rock; but the rate of diminution of pressure furnishes an excellent index of the rapidity with which that amount is being lessened. When the supply of oil is exhausted, as it naturally will be in time, there is no source from which it can be renewed. The salt water will rise and occupy the space which formerly held the oil and it will come to stay.

In some cases, however, both water and oil are found together in the same stratum. Some of the best wells in the Indiana field are big salt water wells, pumping from 150 to 700, or even more, barrels of salt water, and 40 to 150 barrels of oil daily. It costs much more to operate a well of this kind, as it has to be pumped with a beam, and, therefore, requires a separate power. Such wells are usually longer lived, as the salt water seems to renew the quantity of oil by bringing it in from quite an area of the porous stratum which the bore has pierced. Moreover, the salt water seems to keep the pores of the oil rock free from paraffine and other materials which have a tendency to clog them up, and a well producing four or five barrels of water a day in connection with the oil, is preferred by many operators to one that produces oil alone.

COST OF A PRODUCING WELL.—According to careful estimates, the average cost of drilling and fitting up the first productive well on a lease, if drilled to a depth of 1,000 feet, was about as follows in the Indiana field on October 15, 1900:

Rig or derrick.....	\$325
Drilling	475
Drive pipe	90
Casing	100
Shooting	110
Tubing and pumping outfit.....	180
Engine and boiler.....	450
Two tanks, at \$90.....	180
Belting and lead lines.....	125
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Total	\$2,035

The second well on the same lease will cost about \$840 less, as the engine and boiler, tanks and rig can be used for both wells, though there will be a loss of about \$125 in tearing down and putting up a new derrick. If natural gas is available and it is so desired, a gas engine, costing from \$325 to \$450, can be substituted for the boiler and engine. With the advanced methods of pumping by which oscillating pull wheels, rods, etc., are used, 20 or more wells can be connected to one power, and the cost of production be thereby greatly decreased.

COST OF OPERATING A LEASE.—The cost of operating an oil lease after the production has been established need not be more than \$75 per month, the salary of the pumper being \$50, and the cost of fuel, if gas, about \$25. A dozen, or even 20 wells can, however, be operated almost as cheaply as one after they have been connected with the power. An extra pumper may have to be employed, but otherwise no additional expense is entailed.

Where the plant has been established, it will pay to pump as low as two or three wells, even if the yield is only three barrels each per day, provided the price of oil is 70 cents or more per barrel.

The estimate of expense and income from two three-barrel wells, after deducting the royalty of one-sixth, is as follows:

Salary of pumper.....	\$50
Cost of fuel.....	25
	<hr/>
	\$75
Income per month:	
150 barrels oil, at 70 cents.....	\$105
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Net income per month.....	\$30

With six three-barrel wells on the lease, the income would be \$315 and the expense \$75; a net gain of \$240 per month.

From what has been written it will be seen that the cost of drilling and operating a lease in any of the Indiana Trenton rock fields is as

low or lower than elsewhere in the eastern United States for the following reasons: (a) The wells are comparatively shallow, the Trenton limestone in most instances being struck at less than 1,000 feet. (b) It is seldom that more than 150 feet of drive pipe and 400 feet of casing are necessary. (c) On account of a comparatively level surface a large number of wells can be connected to and pumped with one power. (d) Gas for fuel or for running gas engines is usually plentiful. (e) Transportation facilities are excellent, a system of pipe lines permeating all parts of the main field.

According to some of the leading operators, it costs 50 cents a barrel to produce oil on the average lease in the main Indiana field. Whatever is received above that sum is net profit. If the lease is small the cost is much greater in proportion. Oil at 90 cents brings a good price and a fair profit. When the price rises above the dollar mark, many operators claim that it increases the cost of production in the following ways: The price of supplies is usually made higher; an increase in the wages of drillers and pumpers is likely to be demanded; there is too much competition and too great a scramble for territory; the land owners demand a higher royalty and, in many instances, a large bonus; too much wild-cattling is done and the percentage of dry holes is thereby greatly increased; the stock of oil in storage is increased too rapidly. All of these things bring in time a reaction which causes the price to fall too low, and for a year or two many of the operators produce at a loss, or a very small profit.

Whatever the price, the profits will depend largely upon the way the property is managed. Success as an oil operator depends upon the same watchful energy as brings success in any other business. One's pumps should be kept at work steadily so as to get all the oil possible. The drilling tools, lead pipes and pumping machinery should be kept in good repair. In average territory the wells should be put down at intervals of 720x680 feet, which will bring eight wells on each 80-acre tract. In exceptionally good territory, 10 bores can, with profit, be sunk on 80 acres, bringing them 551 feet apart each way. Above all, one should be on the lookout for overflow and leakage. Much of what would otherwise be profit in oil property is allowed to go to waste. Finally, if the property is inside the limits of productive territory, the successful oil man is he who lets other people do the wild-cattling, and who follows where they lead.

THE MAIN INDIANA OIL FIELD IN 1900.

No great strikes were made in the main Indiana oil field in 1900, but new developments increased the area of the field so that it now

extends from the Ohio-Indiana State line westward to Marion, Grant County, and from Warren, Huntington County, south to Hartford City, Blackford County. The greatest length of the field is about 45 miles and its extreme width about 20 miles. There are, however, a large number of sections within the area thus bounded which have not been fully tested. A map showing the exact area tested up to January 1st, 1897, with details of the results of the tests to that date, was published in the Twenty-first (1896) report of this Department. This map, enlarged and modified so as to show the field as it was on January 1, 1901, is published in connection with the present paper.

DEVELOPMENTS IN ADAMS COUNTY IN 1900.—During the year a number of good producing wells were drilled in in Wabash, Blue Creek and Jefferson townships, Adams County. These extended the known productive territory from its eastern limit in sections 29 and 32, Wabash Township, as shown on the map of 1896, to the State line.

In the southwest corner of Blue Creek Township and in the adjoining township of Mercer County, Ohio, is the so-called "Dudgeon Pool," which was first opened in the fall of 1899. A number of new bores were put down in 1900, the best of which were on the Fisher lease. Four of them were large salt water wells, each of which, for a time, brought in 50 barrels and more of oil per day. In December there were about 18 wells producing in sections 22, 27 and 34, Blue Creek Township. Some of them were quite small and the total production of the 18 was about 200 barrels daily. In the southwest quarter of section 29 and the northwest of section 32, several small wells have been drilled by the Superior Oil Company. The top of the Trenton is here found at about 1,075 feet. Some of the wells yield gas enough to run boiler and gas engines.

The best wells of the season in Blue Creek Township were on the Rawley & Tumbleson leases in section 31. They were drilled in in October and December. The No. 2 Rawley on the northeast corner of the southwest quarter of the section was finished October 1st, and flowed natural, without shooting, 210 barrels per day for the first five days, and 180 barrels per day for the next week. It yielded no water and just gas enough to cause it to flow. The record of its bore is as follows:

Drive pipe	114 feet.
Casing	370 feet.
Top of Trenton.....	1,059 feet.
Total depth	1,108 feet.

The Tumbleson well, a few hundred feet north, was a big salt

water well when first finished, but in about a week began to produce oil, and made 700 barrels in 27 hours. A bore on the Studebaker farm, 600 feet north and 600 east, of the No. 2 Rawley, was a dry hole. This is a good example of the uncertainty of oil operations in Indiana Trenton rock, even in the best productive territory.

North of New Corydon, in sections 19, 29 and 30, and the north half of sections 31 and 32, Jefferson Township, some wells were sunk in 1900 which started in as fine producers, some of them yielding 80 to 100 barrels daily. In a few of them three pay streaks were found, the first between 18 and 25 feet in Trenton; the second between 30 and 35 feet in, and the third between 40 and 50 feet. The top of Trenton is found in this locality at about 1,080 feet. The wells yield quite a quantity of gas and pump but little water. A dry hole was bored in section 21. The north half of the township has not as yet been tested.

A number of good wells were put down in the spring of 1900 just west of Geneva, in the west half of section 29, Wabash Township. Some of them started in at 150 barrels daily. The so-called "lob-lolly,"* or bed of an old preglacial stream, runs through the center of this section, making necessary 400 feet of drive pipe in some of the bores. The average distance to the top of Trenton is here 987 feet. East of Geneva in section 28 and the west half of section 27, 10 bores had been put down up to November 1st. No dry holes had been found, and the wells were averaging 10 to 12 barrels each per day. In a few of the wells which started at 50 to 60 barrels the pay streaks were very porous and contained much pyrites. In the north-west quarter of section 26, Wabash Township, a bore on the Chrisman farm resulted in much gas and little oil. The top of Trenton was struck at 1,021 feet, while the drift was but 54 feet thick. Some good wells were sunk in the north half of sections 32 and 33, where the "sand" was found at a depth of 989 feet. A small producer in the northeast quarter of section 35 was the only other bore in the south half of the township.

In the north half, in sections 8, 9, 16, 17, 20 and 21, the Main Oil Co. has a tract of 1,300 acres under lease on which seven bores were put down in 1900. The average distance to the top of Trenton was 1,035 feet, and the average initial production about 30 barrels per well. One bore, in the north half of section 21, yielded gas only. The northernmost of the productive wells is about one and one-half miles south of Berne. A dry hole in the northeast quarter of section 11 stopped operations to the eastward in this township.

* For an account of this old channel see 21st Ann. Rep. Dep. Geol. and Nat. Res. of Ind., 1896, p. 65.

There is little doubt but that much of the undrilled territory east of Geneva and within the bounds of the field shown on the map will, in the future, be found productive of oil. When it is fairly opened up, the long sought for gap between the Ohio and Indiana Trenton oil fields will have been filled, and the entire producing area of both States will go down in history as one of the largest and most productive oil fields hitherto known to man.

DEVELOPMENTS IN JAY COUNTY IN 1900.—During 1899 and 1900 all the wells east of the G. R. & I. Railway, in Jay County, in the territory marked light producing on the former map, were abandoned. Some fairly productive wells were sunk in the north half of sections 5 and 6, Bear Creek Township, and a number of good ones were drilled in section 7. This section was, however, already considered good territory.

In the northern half of Jackson Township but few new developments are to be noted. A dozen or more good wells have been drilled in each of sections 11 and 12 since the first map was published. This territory has held up well, the annual loss in production being small. The north half of section 8 has recently proven quite productive and a good well or two has been sunk in the southwest quarter of section 10. The whole of section 15 has been abandoned, the few wells therein not paying for pumping. Three fair producing bores were put down in 1899 and 1900, in the northeast quarter of section 33, the Trenton being struck at about 1,000 feet and the production starting out at an average of 50 barrels. A light producer was also sunk near the center of section 35, but, on account of lack of pipe lines, has not been pumped.

In Greene Township, three bores in the north half of section 8 and two in the southeast quarter of section 17, drilled for gas, produced on an average of two barrels of oil per day until they were capped in. The Trenton was struck at about 940 feet, the thickness of drift being about 90 feet. Good gas wells have been sunk in sections 18, 19 and 20 adjoining section 17; also in the northeast quarter of section 26, southeast quarter of section 28, southwest quarter of section 32 and northwest quarter of section 34.

In Penn Township but few changes are necessary in the old map. Several light wells have been sunk in the southwest quarter of section 3. Some dry holes have been drilled in the northeast quarter of section 21, and oil has drowned out the gas in a number of wells in the east half of section 22 and the north half of section 27. In the latter locality the tubing from wells formerly producing one and one-half million cubic feet of gas daily was pulled out and the bores

sunk deeper, when the wells started out at 160 barrels of oil daily. The famous Gardner pool, in sections 24 and 25 Penn and 19 and 30 Jackson townships,* is still producing large quantities of oil.

A small pool which for a short time created much excitement was opened up by the Davenport Oil Co. on the northwest quarter of section 28, Penn Township, in the first half of 1900. Five wells were drilled, the average record of the bores being as follows:

Drive pipe	196 feet.
Casing	315 feet.
Trenton struck at.....	945 feet.
Total depth	1,030 feet.

Bore No. 1 started at 180 barrels daily, but on November 1st had fallen to six barrels. No. 2 made 20 barrels a day for 30 days, then fell to three barrels and was abandoned. No. 3 started at 240 barrels and after yielding 30 tanks became dry. Nos. 4 and 5 were dry holes. The Salamonie Oil Co., in April, 1900, bought the leases on 440 acres adjoining the above pool in sections 28, 29 and 32. Ten wells, making a total of 160 barrels daily, were being operated when the property was bought, the price paid being \$40,000. During the year the new company put down three bores. One, a dry gas well, was on the northeast of section 32. In it Trenton was struck at 927 feet. A dry hole was sunk on the northwest quarter of the southwest quarter of section 28; while the third yielded only a small amount of oil. Between April 1st and November 1st, \$20,000 worth of oil was produced on the lease and the property on November 1st was yielding 75 barrels daily.

Much of the present gas producing territory in Penn, Knox and Greene townships, Jay County, will in future become productive of oil, and a light producing field will result. Where the Trenton lies 10 to 20 feet lower than in the area at present yielding gas, oil will be found in large quantities. Many of the gas wells can, and doubtless will be drilled deeper, a large output of oil resulting.

DEVELOPMENTS IN WELLS COUNTY IN 1900. — In Nottingham Township, where the first paying wells in the Indiana field were sunk in 1891, numerous bores have in recent years been put down on territory already regarded as "good." The productive territory mapped in 1896 has not been enlarged to any extent, but has held up exceedingly well. The Brookhart farm of 160 acres on section 31, of which especial mention was made in the former report, had, up to January 1, 1900, yielded the owner \$18,000 on one-eighth royalty,

* See p. 67, 21st Ann. Rep.

and was still producing about 400 barrels a month. On it 15 wells have been sunk, but one of which has been abandoned. A new bore on the Cory lease in section 27, within 600 feet of the first well, started in May, 1900, at 200 barrels; a bore with an equal initial output was drilled in about the same time on the Scott lease in section 30. In the words of one prominent operator, "Nottingham and Jackson townships, Wells County, have proven the best territory for small operators in the State. They contain a large number of small producing wells which have held out in a remarkable manner."

In Chester Township all of section 5 has developed into fair producing territory, while the north half of section 6 has proven good. Some fair wells have been drilled in the south half of sections 9 and 10. On the M. Quill farm in the southwest of section 10 the record of bore No. 1 was as follows:

Drive pipe	52 feet.
Casing	330 feet.
Top of Trenton.....	998 feet.
Total depth	1,035 feet.

When started it threw a solid stream of oil 40 feet above the derrick, but soon dropped to a five barrel well. No. 2, 600 feet east, started in at 30 barrels; while a bore finished about the same time 600 feet south on the Kennedy farm, section 15, started at 130 barrels. The north half of section 15 and the northeast quarter of section 16 have produced some other good wells, and may now be classed as good territory. Section 28, undeveloped on the former map, has become a fair producer. A number of wells were put down in other sections of Chester Township in 1900, but their output made no necessary change in the map as formerly presented.

In Liberty Township only sections 28, 31, 32 and 33 in the southwest corner have produced oil in commercial quantity. On the southwest quarter of section 32 the Hunt Oil Co. put down six bores, two of which resulted in a good yield, the other four being light. The average record of these bores was about as follows:

Drive pipe	67 feet.
Casing	390 feet.
Top of Trenton.....	1,006 feet.
First pay streak.....	1,015 feet.
Total depth	1,040 feet.

The best of the wells on the Kingan lease started June 28th at 130 barrels, but by October 15th the output had fallen to 30 barrels daily. The top of Trenton in the southeast quarter of the section is

found at about 1,027 feet, and the wells produce much salt water. Bores on the southwest quarter of section 28 and the northwest quarter of section 33 have resulted in a few light producing wells, the initial output running from five to 25 barrels. The south half of section 31 is fair territory but the north half has as yet proven light. It is not likely that much productive territory will be found farther north and east in this township.

Jackson Township, Wells County, has slowly developed into one of the most reliable productive areas of the main Indiana field. More changes are made necessary on the new map in this township than on any other equal area of the field. The north half of section 4 and all of sections 3 and 5 have proven productive, but the yield is, in general, light. The west half of section 14, and sections 15, 16 and 17, have yielded fair producing wells. The undrilled portion of section 24 shown on the other map has proven quite productive and sections 23, 26 and 36 have yielded more oil than the bores put down previous to 1897 promised. The undrilled portions of sections 19, 29 and 30 have also been developed sufficiently to be classified as designated on the map.

One of the best wells of the township is on the Byall farm on the east half of section 28. It is a "crevice" or salt water well put down in 1896 by the Slater Oil Co. The first year it did not pay expenses but since then has averaged 12 barrels a day of oil and 700 barrels of salt water. Experience has well proven that it pays to hold on and keep pumping these big salt water wells, even though the first year or two's output is small. On the whole, the prophecy made in 1896, "that in Jackson Township there was much territory which had been condemned by dry holes, which with a fair test might prove productive," has proven true. The tests were made and the output has well repaid the venture. It is always safer to work the undrilled portions of such a township as Jackson, which lies within the limits of known productive territory, than to "wild-cat" on the outside of such limits.

DEVELOPMENTS IN HUNTINGTON COUNTY IN 1900.—The most important extensions on the north side of the main Indiana field in 1900 were made in the vicinity of Warren, Salamonie Township, Huntington County. One or two bores which developed only salt water were, in the early history of the field, put down to a shallow depth in the Trenton. These stopped the drilling in the southwest corner of the township though the conditions seemed favorable for a fairly productive field and in my report for 1896 it was stated that "there is no reason why oil should not be found in the territory

about Warren." Some of the citizens of that town finally decided to make more thorough tests and, organizing the Warren Oil Co. and securing leases on nearly 2,000 acres, they drilled in their first well in January, 1900, on the Jones farm, south half of section 19, just west of the town limits. The well proved a success, the initial output when put to pumping being 60 barrels daily. As the well was two miles north of known productive territory it created no little excitement. A second bore, 600 feet west, started in at 40 barrels. After the second well came in as a fair producer, the company having accomplished its purpose of proving the presence or absence of oil, sold the two wells and 500 acres of leases west of the Salamonie River to Booth Bros. for \$13,000. During the year the new owners sunk four additional bores, all of which were fairly productive. An average record of the bores was about as follows:

Drive pipe	40 feet.
Casing	415 feet.
Top of Trenton.....	970 feet.
Total depth	1,010 feet.

On October 20 the six wells were averaging about five barrels each.

In addition to the wells on the Jones lease, the Warren Oil Co., during the first half of 1900, put down five bores east of the Salamonie on the northeast quarter of section 19. These proved successful, and they sold the wells and 1,500 acres of territory to McCormick & Co., in August for \$13,500. The wells had an average initial output of about 30 barrels each per day for the first week; and on November 1st the six were making a total of 30 barrels daily. The best of the six was No. 2, J. H. Thompson, in which the Trenton was found at 977 feet. Three other wells were put down by the Plum Tree Oil Co. on section 19, close to the river bank, one of which started at 50 barrels.

The oil bearing Trenton about Warren is said to be rather solid and flinty and is not shattered as much by shooting as is more porous limestone. It is void of gas and, as in most other localities in the Indiana field, bears some pyrite, especially in the upper pay streak. The shooting is done with 80 to 100 quarts of nitroglycerine, a less quantity than is generally used on account of the thinness of the pay streak and the shallow depth (about 35 feet) the bores are sunk into the Trenton.

Besides the wells above mentioned a dry hole was sunk on the S. L. Good farm in the northwest of section 20, and another, one mile south of Plum Tree P. O., in section 9, where the Trenton was

found as low as 1,020 feet. These stopped further search in that direction as a dry hole had also been sunk between the two prior to 1900.

Aside from the developments about Warren, the only portion of Salamonie Township producing oil is comprised in the two southern tiers of sections. Immediately south of Warren, a dry hole was drilled on the northwest quarter of section 29 and another on the north half of 32, which has practically condemned those sections. No drilling has been done on section 30, but the southwest of 31 has produced some fair wells. Several bores in section 28 have proven barren; while 33 is as yet untested. In section 27 some light producing wells have been sunk, while 26, to the east, has some better ones, especially on its eastern half. Sections 25, 35 and 36 can be classed as fair to good. The Jonathan and Adam Faust farm of 110 acres in the southeast quarter of section 35 had yielded, up to October 1, 1900, 65,100 barrels, of which the owners received one-seventh as their royalty. The south half of 34 has also produced some fair wells.

In Jefferson Township the limits of the producing territory have not been extended much farther north than shown on the map of 1896, but many of the gaps then undrilled in the two southern tiers of sections have proven productive. Above these tiers the only drilling which has been done is as follows: A dry hole which found top of Trenton at 976 feet was sunk on the J. & W. Brown farm, northeast quarter of section 13. A good strike was made a number of years ago on the Weaver lease* near the center of section 21, but for some reason the surrounding area has not been properly tested. Two bores which resulted only in a showing of oil were sunk on the H. Bowen farm, northeast quarter of section 19, but were soon abandoned. No drilling has been done in the county west of Pleasant Plains. In section 25 drilling has resulted in several dry holes and light wells while the south half of 26 is light. The production in 27 and 28 is only in the south halves and is fair. The south half of section 29 is light to fair producing territory, the top of Trenton running about 1,000 feet.

Only the southeast quarter of section 30 has been drilled, a few fair producing wells resulting. Section 31 remains as before while 32 has proven light over practically all its area. The best section in the township is 33, most of the wells starting at 75 to 100 barrels and falling to 20 barrels in a month, 10 barrels in six months, and

*See p. 80, 21st (1896) Report of this Department.

five barrels in a year. An average record of the bores on this section is about as follows:

Drive pipe	200 feet.
Casing	450 feet.
Top of Trenton.....	1,005 feet.
Total depth	1,055 feet.

The remaining sections of the lower tier run about as marked on the previous map, all being light to fair producers. Southern Wayne Township may produce some fair wells in the future, but the chances are that elsewhere the limits of productive territory in Huntington County have been well defined.

DEVELOPMENTS IN GRANT COUNTY IN 1900.—In Grant County the most important developments in 1900 were just southeast of Marion, where a new pool, seven miles from other producing wells, was opened up in January. This was in gas territory, and some of the wells put down especially for oil have yielded much gas. The first bore to yield oil in quantity was on the J. H. Wigger farm, southeast quarter section 16, which started in at about 60 barrels and on October 15th was still yielding eight barrels daily. No. 2, which started in as a big gas well, was closed down and a separator put on, the gas being piped to the Marion Brick Works. In October this well was producing 12 barrels of oil. Nos. 3 and 4, drilled later, produced much gas and little oil, while No. 5 was a fair oil well.

Two old gas wells on the Van Vactor farm in the north half of the same quarter section were cleaned out and shot, when a good show of oil resulted; the gas yield being only sufficient to furnish fuel for pumping the two wells. The success of these wells on the Van Vactor and Wigger leases caused many new bores to be sunk in the territory from which most of the gas had been drained, and also much activity in real estate transactions. The Ohio Oil Co. paid \$12,000 for 112 acres along the Mississinewa just north of the Van Vactor lease, and a number of gas companies, which held most of the surrounding territory, began to prospect for oil. Two bores on the M. J. Griffith farm, northeast of section 21, just south of Wigger's, came in as dry holes. One on the L. Schwartz farm, southwest of section 15, was a small producer.

One mile south of the Wigger lease on the west side of the County Infirmary and adjacent lands the Ohio Oil Co. drilled seven wells east of the Mississinewa and three west during the summer. Most of these came in as fair producers, starting at 25 to 40 barrels daily.

The record of the No. 1 Jones, on the west bank of the river, in the extreme southwest corner of section 21, was as follows:

Drive pipe	92 feet.
Casing	381 feet.
Top of Trenton.....	883 feet.
Total depth	986 feet.

Eight or ten other wells were, in the autumn, drilled in on the north half of section 28, Mill Township. Several of them produced much salt water with the oil, and were pumped from the beam. Trenton was found in all between 870 and 885 feet. All but one were fair oil producers, but were pumped under difficulty as they had to hold back 30 to 50 pounds pressure of gas in the bores and pump without loss. One or two had to be closed down on account of the large quantity of gas. The two farthest south were on the Winslow farm and started in at about 30 barrels each per day.

On the James Coulter farm, northeast quarter of section 24, about three miles east of the Mississinewa pool, three bores were put down during the year, all of which produced oil. Two previous bores had been sunk for gas. The record of No. 5 was as follows:

Drive pipe	175 feet.
Casing	427 feet.
Top of Trenton.....	1,020 feet.
First pay streak.....	1,040 feet.
Total depth	1,058 feet.
Initial production.....	30 barrels.

On the Nelson farm, just north in the southeast quarter of section 13, two dry holes were drilled. One made a good showing of oil, but soon exhausted when put to pumping. By the first of January, 1901, the daily production of the 35 producing wells southeast of Marion was about 260 barrels; and was slowly increasing. The Indiana Pipe Line Co. had put in a field station on the Wigger lease and had prepared for a much larger output which is sure to come, as soon as the gas pressure lowers sufficiently in the surrounding territory as yet undrilled. The only drilling for oil in Center and Mill townships outside of those mentioned resulted in a dry hole just south of Marion on the northwest quarter of section 20, and two bores on the Neal and Myers farms, sections 11 and 3, in the north part of Center Township, which yielded much gas and a large quantity of oil. Nothing was done toward developing the latter on account of the quantity of gas, but the showing is sufficient to justify the belief

that this portion of the township will also, in the near future, be quite productive of oil.

In Monroe Township, Grant County, just east of the developments above mentioned, an old gas well on the northwest quarter of section 13, which had showed oil for some time, was drilled deeper and began producing about 10 barrels daily. In the southeast quarter of section 25 on the east line of the same township, three or four small producing wells have also been drilled in.

Van Buren Township has heretofore furnished most of the oil produced in Grant County, and the chances are that it will continue to do so for some time to come. Many new bores have been sunk since the former map was issued and while they have not greatly increased the limits of productive territory, they have aided materially in filling up the gaps thereon shown. The drilling in the township in 1900 was especially active.

The north half of section 1 has proven good territory, some of the wells on the Conway and Barnes leases starting in at 80 to 100 barrels daily. Sections 2 and 3 are light throughout, though their north halves have not yet been fairly tested. All of section 4 has become fair territory, while 5 and 6 have remained good. The late bores put down in section 7 have been only fair producers. The northeast quarter of section 9 has developed some fair wells, but otherwise sections 8, 9, 10, 11, 12, 13, 14 and 15 remain as formerly designated. Section 16, which was formerly regarded as barren except on its southeast quarter, has produced some fair wells on the northwest quarter. All of section 17 and most of 18 may now be regarded as fairly productive. In sections 19 and 20 the only new developments are in the southeast quarter of 20, which contains some light wells. The west half of 21 has also become fairly productive; the east half being dry or undrilled. Sections 22 and 23 remain good, the initial yield in the latter being generally much the better. Sections 25, 26 and 27 have developed nothing in their south halves, the north halves remaining light. The north half of section 28 has likewise proven light, while that portion of 29 drilled is light or dry. The remaining sections along the south line of the township have not as yet been tested, but will probably show up as light to fair territory as soon as the gas pressure is sufficiently lowered.

DEVELOPMENTS IN BLACKFORD COUNTY IN 1900.—In Blackford County the developments which have increased the limits of the productive territory have been mainly in Washington and Licking townships. Drilling in Harrison Township since 1897 has made necessary no changes on the map issued in that year.

In Washington Township, the southeast quarter of section 6 has produced some fair wells, the remaining sections of the tier holding up good as formerly designated. The northeast quarter of 7 is good, the southeast quarter fair, the west half light. All of sections 8 and 9 have developed into fair territory. In 9, the record of the average bore on the Kelly and Cunningham leases is about as follows:

Drive pipe.....	185 feet.
Casing	365 feet.
Top of Trenton.....	1,008 feet.
Total depth	1,062 feet.

Two or three big salt water wells have been struck which, at the end of six months, were yielding eight to 10 barrels of oil and 800 barrels of salt water daily.

Sections 10 to 14, inclusive, remain as shown on the former map, with the exception of the north half of 11, which is practically barren. The northeast quarter of 15 is good, the top of Trenton being found at 1,012 feet. The remainder of the section is light. In sections 16, 17, 18 and 19 some important developments were made in 1900. All of 16 and the south half of 17 is light, while the north half of 17 and all of 18 and 19 is fair. Sections 20, 21 and 22 may be classed as light, the wells starting in at five to 30 barrels each. No drilling resulting in oil has been done on 23, 24 and 25 since the former map, while that done on 26, 27 and 28 has resulted only in dry holes or salt water. Section 29 is light to fair territory. The good results of holding on and pumping a salt water well for months are shown in a well on the Isaiah Miller lease, northwest of 29. This was drilled in in April, 1899, and for 15 months yielded 1,600 barrels of salt water daily and but little or no oil. On September 1, 1900, it began to pump oil, and between then and January 1, 1901, yielded an average of seven barrels a day. In this bore the top of Trenton was struck at 1,021 feet, and the total depth was 1,074 feet. Section 30 is light territory, while the sections of the lower tier in the township are as yet undrilled. They will, however, doubtless yield more or less oil in the near future.

Among the new developments in the Indiana Trenton rock oil fields in 1900, those in the vicinity of Hartford City, Licking Township, Blackford County, take a high rank. A good showing of oil had, in 1898 and 1899, made its appearance in several of the gas wells near that city, but the gas pressure was too strong to attempt to develop a paying oil production. By September, 1900, this pressure had decreased so much that, when a well bored for gas near the northwest edge of the city reached the porous limestone it began to

yield oil in large quantity. It was located on the northeast quarter section 10 (23 north, 10 east) and drilled in on September 16. The record of the bore was as follows:

Drive pipe	185 feet.
Casing	300 feet.
Top of Trenton	999 feet.
Total depth	1,044 feet.

The oil bearing stratum was 24 feet below the top of Trenton. The production was about 200 barrels during the first 36 hours. Eight tanks of oil were produced the first month. On October 23, the output was 25 barrels of oil and about 100 barrels of salt water daily.

The usual excitement of a good strike in new territory immediately followed. In a fortnight, seven rigs were up, six of them being within 20 rods of the first producer, while three were on an area 75 feet square. The second well finished was on the Rapp lease, southeast quarter of section 3, one-third of a mile northeast of No. 1. It had an initial output of 200 barrels, and yielded much gas, but was soon down to a 40-barrel producer. The others close to the first well came in as fair producers, yielding from 20 to 100 barrels each and a large supply of gas. In those producing the most gas, the Trenton was struck "high" or at a depth of 990 to 995 feet. Some of the operators had much trouble in securing a market or other lawful use for the gas, and several of the wells were closed for some time on this account. The two pay streaks usually found were, in most of the bores about Hartford City, merged into one, forming a layer 20 or more feet thick of solid oil producing rock. Several of the wells which, when first drilled, promised to be good producers, after shooting yielded gas only. By November 15, eight producing wells were completed, the aggregate yield of which was 250 barrels daily. On December 1st, 15 bores had been finished; all within a radius of one mile of the first well. Six of these had been closed down on account of too strong a gas pressure. The other nine were yielding 325 barrels daily.

By the first of January, 1901, the gas pressure had gone down in a number of the wells and the daily yield had increased to 450 barrels or more. In one well, yielding 40 barrels and much gas, the oil yield was increased to 100 barrels after the gas pressure disappeared. There is little doubt but that the pool will increase in size and gradually connect with that to the north and northeast. In the words of a

prominent operator, "Hundreds of good oil wells are at present shut down as gas wells in the vicinity of Hartford City. They have for two or three years shown much oil and yielded little gas, but nothing has been said about it by the owners of the leases on which they occur. The larger gas companies are quietly leasing all the prospective oil territory they can get, for they know that the days of the gas yield are few, and that the oil is sure to take the place of the more volatile fuel."

ISOLATED TRENTON ROCK OIL PRODUCING AREAS.

Outside of the main oil field there are in Indiana several smaller areas which are producing petroleum in commercial quantities from the Trenton limestone. Some of these, as those near Peru, Broad Ripple and Alexandria have been productive since 1897. Others, as the Parker, Randolph County and Fisher, Hamilton County pools, were developed in 1900.

THE PERU FIELD IN 1900.—But two or three bores were put down in 1900 in the Peru field proper as mapped in the 1897 report. They were small producers, starting in at 10 to 15 barrels. Many of the old wells sunk on town lots have been abandoned. Much more money was expended in this field than was ever gotten out of it. The rock was more porous than at any other locality in the State where the Trenton has produced oil. As a result the stored product was much sooner exhausted, the production quickly dropping from 100 to 200 barrels down to five or 10. The outcome of the Peru field has proven the fallacy of many small companies attempting to operate successfully in a limited area. The expenses are bound to exceed the profits unless the output is phenomenal.

A new pool was opened up in Erie Township, Miami County, on October 13, 1898. The first well was sunk about two and a half miles east of Peru in the angle north of the main line of the Wabash railway, and east of the Chili branch of the Detroit Division of the Wabash. The center of the field is about one-third of a mile from each line and one-half mile north of the Wabash River. A part of it lies in the Richardsville Reserve, Peru Township. The wells are on the bluffs of the river, 75 to 90 feet above low water.

In 1899 12 or 15 wells were completed, but three of which were dry, the average initial production being about 22 barrels. In 1900 drilling was more active, and on October 15 there were 35 producing wells in the field. Of these, 23 were owned by the Crawford Oil Co., while the Wabash Labor Co. and the St. Charles Oil Co. owned six

each. The first well in the field on the Baker lease, section 18, found the Trenton at 960 feet, had an initial production of 50 barrels, and at the end of two years was making four barrels daily.

On the E. Butts lease, 20 wells were in operation on October 15, 1900. Of these 11 produced 4,200 barrels of oil from September 15 to October 15. Mr. Butts receives one-fourth royalty and leases locations 500 feet apart each way instead of definite tracts of land, as is usually the custom. In this way he is getting his just proportion of the riches underlying his land. The average record of the bores put down on the Butts leases was about as follows:

Drive pipe	70 feet.
Casing	505 feet.
Top of Trenton.....	940 feet.

But one pay streak is said to occur in this field and that is usually 10 to 15 feet below the top of Trenton, the wells being sunk about 25 feet in. But about one-half the wells are shot, and the quantity of nitro-glycerine used is small, being but about 60 quarts. The drift is deeper farther east, being in a few of the wells more than 200 feet. No gas occurs in the field, that used as fuel being piped from a distance. During the winter of 1900-1901, this supply was cut off and coal and wood took its place. The oil produced is piped eastward to Rich Valley, thence to Laketon, and finally to Whiting, where it is refined.

At Kellar's or Rich Valley, in the edge of Wabash County, a few miles east of the above pool, but three new wells were drilled in 1900. One of these was dry, the other two small producers.

The following is the output by months of the Peru and Rich Valley fields for the year 1900:

PRODUCTION OF THE PERU AND RICH VALLEY, INDIANA, OIL FIELD BY MONTHS
FOR THE YEAR 1900.

January	16,883 97
February	13,665 11
March	16,206 53
April	19,395 33
May	21,683 41
June	25,307 46
July	23,931 61
August	23,839 73
September	19,727 83
October	21,145 07
November	17,834 04
December	17,668 76
Total	237,288 85

THE ALEXANDRIA FIELD IN 1900.—Oil operations about Alexandria, Madison County, were at a standstill from the spring of 1898 to April 1, 1900, on account of the anti-waste gas law. At the latter date an old gas well on the Armstrong lease, northwest quarter section 6 (20 north, 7 east), three and a half miles south of the town, which for some time had been showing oil, was drilled deeper, cleaned out and shot. The depth of the well was increased from 963 to 1,014 feet, a little too deep, as it proved, for it began to yield about 300 barrels of salt water and 35 barrels of oil a day, and kept up this yield throughout the year. In addition it produced at a low pressure about one million cubic feet of gas a day which was separated through the casing and piped to Alexandria. A second gas well, one-third of a mile northeast, was drilled down to a depth of 1,005 feet, but when shot produced, in addition to much oil, four million cubic feet of gas, and was not pumped. No. 3, 10 rods west of No. 1, was a failure. It produced only a trace of oil and quite a supply of gas, and was plugged. No. 4, 10 rods east of No. 1, completed October 18, proved a fair oil well and a small gas producer. The record of its bore was as follows:

Drive pipe	174 feet.
Casing	400 feet.
Top of Trenton.....	923 feet.
Total depth	998½ feet.*

Four other bores were drilled for oil on the Brunk lease, one-third of a mile northeast of the No. 2 Armstrong. In them Trenton was struck at 913, 908, 914 and 906 feet, respectively. Two were drilled in 85 feet, but all produced much gas and little oil.

In the west part of Alexandria near the Big Four railway station five wells which had been closed since 1898 were put to pumping in August and made about 15 barrels each. One and a quarter miles east of the town on the S. H. Buck lease, northwest quarter of section 20 (21 north, 8 east), a well completed September 13 started in at about 50 barrels daily. The record of the bore was as follows:

Drive pipe	110 feet.
Casing	385 feet.
Top of Trenton.....	924 feet.
First pay streak.....	967 feet.
Total depth	1,018 feet.

* This well was plugged about the close of the year, as the oil produced was not sufficient to pay for operating.

But little gas was found, and only 20 to 30 barrels of salt water was produced daily. Several other small producers were drilled in the immediate vicinity later in the season.

The strike of the year which created the most excitement in the Alexandria field was the J. E. Lippincott well on the Heritage lease, northeast quarter of section 7 (21 north, 7 east), one and one-half miles northeast of Alexandria. It came in the middle of June as a good gas well, having been bored 27 feet into Trenton. It was closed and the derrick taken down, but as soon as the gas was turned into the pipe line it ceased flowing and the well filled with oil. The derrick was rebuilt and the well drilled 85 feet into "sand," and after shooting produced at the rate of 1,200 barrels of oil a day for a few days. It soon dropped to 200 barrels, and on October 15 was down to about 65 barrels daily. The well showed much gas at times, and was closed down on several occasions. A special gas line was laid to it and the gas piped to several factories. The oil was readily pumped when the gas pressure was kept below 25 pounds. A second well on the same lease, one location south, produced much gas and no oil, while a third one, put down by a rival company, just 50 feet west of No. 1, produced a large amount of gas and about 40 barrels of oil daily. When shot, it was claimed that the space between the two bores was broken through, and when one well was pumped the other showed no oil. A fourth bore, 15 rods north of No. 1, produced only gas.

On the W. P. Blake lease, northwest quarter of section 16 (20 north, 8 east), five wells sunk in 1898 and closed by injunction till June, 1900, were producing in October a total of about 500 barrels per week. The average depth of the Trenton was 916 feet, and each well was drilled in about 100 feet, the first pay streak being found at 35 and the second at 65 to 70 feet in. Not enough gas was produced for fuel. On the S. E. Peck farm, southwest quarter of section 9 (20 north, 8 east), were two other wells closed in 1898 which became good producers in 1900. A well starting in at 200 barrels daily was completed on the Nicson lease, section 23, Monroe Township, in November. A former bore on the same lease had produced gas only.

Near Gaston, Washington Township, Delaware County, about seven miles northeast of Alexandria, three wells were drilled in on the W. H. Broyles lease, northeast quarter of section 36 (22 north, 8 east), in the fall of 1897. They produced large quantities of both gas and oil, and were closed by injunction on March 12, 1898. Four wells, located on adjoining farms to the south, were closed at the same time. The three wells on the Broyles lease struck Trenton at 940, 935 and 933 feet, respectively. In October, 1900, Howland &

Co. put down a fourth well, 24 rods north of No. 2, striking Trenton at 937 feet. In order to shut off the gas they used 10-inch drive pipe and 6¼-inch casing. Inside of the latter 5½-inch casing was used clear down to the oil. Two pay streaks yielding gas were found; the first 25 to 45 feet, the second 65 to 80 feet in. The inner casing was sunk to a depth of 1,019 feet, or below the gas "pay." A packer was put in below the gas and one above. Below the gas 18 feet of oil rock was found, the oil being raised through 2-inch tubing without waste of gas. The outfit was quite expensive, but was fairly successful, the output of the well being about 40 barrels daily, which flowed by heads. An arrangement was utilized by which enough gas for running the engines was secured from the supply held between the packers. A second well, using the same process, was being drilled on the lease at the close of the year. It is thought by some operators that after these wells have been pumped a while and the oil has become partially exhausted for a distance around the foot of the bore, the gas will find its way down and up inside of the tubing, the experiment thereby proving a failure. Mr. Broyles received from Howland & Co. \$2,000 bonus and one-sixth royalty for 82 acres of his farm, and the same amount for a second 80 acres, from the American Window Glass Co., the latter company agreeing to pay also \$100. per year for each gas well drilled, from which the gas was piped away for use.

All together, the operations in and about Alexandria during the year were very successful and the chances are that much good oil territory will be opened up in the near future. The growth will be gradually toward the northeast until the main petroleum field is reached. The results of the past few years have shown that the oil will remain until the gas is practically exhausted, when it can be secured without loss of the more volatile fuel. It is worse than folly to waste the gas in an attempt to prematurely secure the oil. Whenever possible separators can be used and the gas piped to some main where it can be utilized. By such means only can these two fuels be properly conserved and made to be of the greatest and most lasting utility to the people of the State.

In the following table is shown the output of oil from the Alexandria field by months for the year 1900:

PRODUCTION OF THE ALEXANDRIA, INDIANA, OIL FIELD BY MONTHS FOR THE
YEAR 1900.

January .....	.....
February	859 59
March	2,423 16
April	3,613 89
May	4,995 72
June	6,006 19
July	6,134 83
August	6,723 62
September	4,686 90
October	5,372 13
November	10,277 41
December	8,800 94
Total	59,894 38

THE PARKER, INDIANA, OIL FIELD IN 1900.—Near Parker, Monroe Township, Randolph County, four bores were sunk for oil in the first half of 1900, all of which were small producers, starting in at five to 35 barrels each. There was no gas to deter operations and the output held up well, averaging 10 barrels per well at the end of two months. Experienced operators could probably have opened up quite a strip of territory, but two or three dry holes in the latter part of the season stopped the drilling.

A few miles east of the Parker pool, near Selma, Liberty Township, Delaware County, a gas well was cleaned out, drilled deeper and shot in July. A strong flow of gas resulted for a few days and then it began producing oil at the rate of 35 barrels daily and also a large amount of water. A second gas well which was likewise cleaned and shot started at five barrels, but no successful drilling resulted during the year.

Near Smithfield a well on the G. H. Canady farm, northeast quarter of section 27, Liberty Township, started in August at 40 barrels and was producing the same amount on October 15th. A second bore on the same lease produced only gas. On the W. Lewis farm, same section, another bore started at 20 barrels. In section 23, Liberty Township, a wildcat bore on the M. Dunkin farm proved a dry hole, while another on the J. Dunkin lease yielded gas only, as did another bore on the Cecil farm in section 24.

East of Muncie five miles, on the Delaware County Infirmary farm, section 8, Liberty Township, an old gas well was cleaned out and shot, when it began producing 50 barrels; and when two months old was yielding 30 barrels. A second bore started in at 15 barrels. By the last of November there were nine producing wells in the Parker and

Smithfield pools which were yielding a total of 120 barrels a day. They were scattered over a large area which promises to develop into fair producing territory before the close of another year.

THE FISHER, HAMILTON COUNTY, POOL IN 1900.—Near Fisher, Hamilton County, the Indianapolis Gas Co. completed a well in May, 1900, which had an initial production of 60 barrels. It was on the Wiseman lease, section 25, Fall Creek Township, a mile and a half northeast of the Kincaid well which the year before had produced quite an amount of oil. The new well was shut down for some time on account of lack of tankage, pipe line connections, etc., but when put to regular pumping in July it produced 50 barrels a day for a month or so. A second well on the Hartly lease near-by was a small producer, starting in at 15 barrels. A bore on the Wyant farm, same section, proved a dry hole, as did also one on the Thatcher farm, section 26. Four other bores finished later in the season on the Booth and Kinnerman leases, section 24, and the Brandon and Wilson leases, section 25, proved dry, practically putting an end to the hopes of finding good producing territory of any size in that vicinity.

THE BROAD RIPPLE FIELD IN 1900.—No extensions of importance were made in the Broad Ripple, Marion County, oil field in 1900. But eight wells were completed. Of these two, located on the Gardner and McCormick leases, were dry. The others were mostly small, the total initial production of the six being only 95 barrels, or an average of 16 barrels per well. The total production of the Broad Ripple field in 1900 was 30,194 barrels, as against 51,000 in 1899, a loss of nearly 41 per cent. The yield in 1900 was less than one-third what it was in 1898, when the field produced 102,087 barrels.

The following table shows the production by months in 1900:

PRODUCTION OF THE BROAD RIPPLE, INDIANA, OIL FIELD BY MONTHS FOR THE YEAR 1900.

January	2,942 68
February	1,489 21
March	3,449 72
April	3,106 96
May	2,874 52
June	4,399 22
July	1,779 71
August	2,374 62
September	2,342 38
October	2,082 83
November	1,444 81
December	1,907 69
Total	30,194 35

STATISTICS OF THE INDIANA TRENTON ROCK PETROLEUM
FIELDS IN 1900.

While the year 1900 was not characterized by any great strikes or notable extensions of productive territory in the Trenton limestone field of Indiana, it was nevertheless the banner year in the oil industry of the State. The price of iron pipe and other supplies which had risen rapidly during the year previous, declined materially, so that the cost of a productive well was much less.

The price of oil, while much lower at the end of the year than at the beginning, averaged for the year 9 cents more per barrel than in 1899. The price at the beginning of the year was \$1.12. By February 26 it reached the maximum of \$1.21, which it held until April 2, when it began to decline. On May 21 it had fallen to \$1.00, and by June 6 to 90 cents. It held this price until August 9, when it began to slowly go down again, reaching 74 cents, the minimum price, on November 13. At the close of the year it was selling at 78 cents, with a tendency toward a further rise. The average price for the year was 96½ cents as against 87½ in 1899.

The total production of Trenton rock petroleum in Indiana in 1900 was 4,912,675 barrels which, at the average price of 96½ cents, amounted to \$4,740,731. Compared with 1899, this was an increase in production of 1,104,961 barrels, or 29 per cent. Owing, however, to the higher average price, the amount received by the producers was \$1,408,981, or 42 per cent. more than in 1899.

The first of the following tables gives a complete record of the monthly production of petroleum from the Trenton limestone fields of Indiana for the 10 years beginning January 1, 1891, and ending December 31, 1900. The second table shows the annual production, the average yearly price, and the total value by years for the same period:

TOTAL PRODUCTION OF TRENTON LIMESTONE PETROLEUM IN INDIANA FROM 1891 TO 1901, BY MONTHS.

[Barrels.]

MONTH.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
January	6,171	15,841	111,824	259,000	300,568	365,582	290,746	317,014	297,291	353,451
February	5,981	18,946	96,025	232,107	230,559	241,743	309,922	272,780	220,440	302,493
March	5,159	24,794	134,549	282,376	310,303	386,586	341,961	325,301	290,257	364,590
April	4,973	26,184	146,493	287,330	352,077	395,032	328,779	310,034	325,774	381,804
May	5,757	31,033	186,939	321,502	397,001	417,963	340,023	311,208	344,831	426,363
June	8,136	40,888	209,616	333,479	403,569	434,167	369,803	320,477	334,282	446,492
July	10,809	49,203	221,666	327,349	434,376	422,968	375,249	314,861	329,086	437,087
August	11,603	56,109	248,353	345,031	420,132	407,238	371,921	332,777	347,621	466,427
September	16,500	66,634	245,615	319,588	409,169	415,675	362,528	326,264	332,283	418,716
October	19,029	95,699	252,568	339,424	393,153	394,283	408,179	319,490	326,781	467,521
November	20,801	129,270	245,607	304,030	373,789	337,331	430,958	200,644	326,802	406,684
December	21,715	144,067	236,038	337,450	361,436	362,164	423,069	300,457	332,266	441,347
Total	136,634	698,068	2,335,293	3,688,666	4,386,132	4,680,732	4,353,138	3,751,307	3,807,714*	4,912,675

PRODUCTION OF TRENTON ROCK PETROLEUM IN INDIANA FROM 1891 TO 1901, WITH VALUE.

	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
Total production (barrels of 42 gallons)	136,634	698,068	2,335,293	3,688,666	4,386,132	4,680,732	4,353,138	3,751,307	3,807,714	4,912,675
Total value at wells of all oils produced, excluding pipeage	\$54,787	\$260,620	\$1,050,882	\$1,774,260	\$2,807,124	\$2,954,411	\$1,871,849	\$2,228,276	\$3,331,750	\$4,740,731
Value per barrel	\$0 40	\$0 37	\$0 45	\$0 48	\$0 64	\$0 63	\$0 43	\$0 59½	\$0 87½	\$0 96½

* This sum in the table on page 12, Report of this Department for 1899, was 11,000 barrels greater, that being the amount of Corniferous rock petroleum produced at Terre Haute in that year and included in the monthly production of Trenton rock oil.

From the above tables it will be seen that the largest production in any one month was in October, 1900, when 467,521 barrels were produced. The total production for the ten years reached the enormous amount of 32,750,359 barrels, for which was received \$21,074,690, or an average of more than \$2,100,000 per year. This did not include the amount used for fuel and other purposes in the field.

In the following table there is shown the number of wells put down in the Trenton limestone fields of Indiana for petroleum in each month since June, 1891:

NUMBER OF WELLS COMPLETED IN THE INDIANA TRENTON LIMESTONE OIL FIELDS FROM 1891 TO 1901, BY MONTHS.

YEAR.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1891.....							6	6	15	15	15	8	65
1892.....	11	13	18	13	17	19	17	30	25	52	33	47	295
1893.....	20	30	31	36	45	47	47	55	27	72	58	76	542
1894.....	90	103	108	80	110	107	84	123	100	107	97	85	1,189
1895.....	61	45	81	111	122	153	132	140	129	106	102	85	1,267
1896.....	76	90	86	136	148	150	113	121	70	58	66	66	1,180
1897.....	41	35	40	47	49	52	60	45	55	89	119	54	686
1898.....	41	23	29	43	38	55	53	80	72	82	92	86	694
1899.....	75	48	68	64	87	99	77	104	106	120	106	106	1,060
1900.....	112	66	97	143	162	164	159	149	135	151	114	104	1,556
Total.....													8,534

From the above table we learn that 289 more bores were sunk for oil in the Trenton rock oil fields of Indiana in 1900 than in any preceding year. The high price of the product was the leading factor in causing this increase of activity. Whenever petroleum sells close to the dollar mark or above, the profit of production is sufficient to keep the drills steadily at work. On January 1, 1901, there were 5,480 wells producing oil in the State, as against 4,336 on January 1, 1900—a gain of 1,144 for the year. The table also shows that up to January 1, 1901, 8,534 bores had been sunk to Trenton rock within the State for petroleum, so that 3,054 had either proven dry or were abandoned previous to the date mentioned. The number abandoned in 1900 was 197, or just 50 less than in 1899, while the number of dry holes drilled during the year was 215, or 110 more than in 1899. Of the total number of bores drilled, 13.8 per cent., or 3.8 per cent. more than in 1899, were dry.

The following table gives the

TOTAL NUMBER OF DRY HOLES DRILLED IN THE INDIANA TRENTON LIMESTONE OIL FIELDS FROM 1891 TO 1901, BY MONTHS.

YEAR.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
1891.....								2	5	4	3	1	15
1892.....	2	6	6	2	3	4	2	3	3	18	6	21	76
1893.....	7	10	10	6	14	6	11	9	5	14	10	9	111
1894.....	19	14	24	14	13	13	9	21	15	14	8	17	181
1895.....	7	4	13	16	22	20	15	23	12	12	9	13	166
1896.....	10	13	6	28	26	20	14	19	4	4	6	8	158
1897.....	8	9	7	12	5	16	11	9	16	11	18	8	130
1898.....	14	4	2	13	9	6	7	10	12	8	13	16	114
1899.....	5	9	14	5	5	7	12	9	12	14	8	5	105
1900.....	10	6	15	16	25	21	31	21	15	20	22	13	215

The final table shows the

NUMBER OF PRODUCING WELLS AND NUMBER OF DRY HOLES DRILLED IN EACH OF THE TRENTON OIL PRODUCING COUNTIES OF INDIANA IN 1900.

COUNTY.	Producing Wells.	DryHoles*	Total.	Percentage of Dry Holes.
Wells.....	543	37	579	6.4
Blackford.....	166	36	202	17.8
Jay.....	64	41	105	39
Adams.....	120	13	133	9.8
Grant.....	227	13	240	5.4
Huntington.....	134	13	147	8.8
Madison.....	17	38	55	69
Miami.....	45	4	49	8.2
Marion.....	7	3	10	30
Wabash.....	2	3	5	60
Delaware.....	9	4	13	31
Hamilton.....	2	7	9	77.7
Randolph.....	5	3	8	37.5
Total.....	1,341	215	1,556	
Average.....				13.8

*This column includes bores sunk for oil which yielded gas.

From the statistics given it will be seen that the year 1900 was by far the best in the history of the Trenton rock oil fields of Indiana. Drilling was more active, there being 289 more bores sunk than in any preceding year. The percentage of dry holes was greater than in 1899, but this was due mainly to the active wildcatting in prospective territory outside the known limits of the main field. The average price of the product was high enough to keep the drill going,

and yet not too high as compared with its real value. The initial production was, on the average, much less than in previous years. This goes to prove that the days of the gusher are practically over in the older portions of the main field where most of the bores were sunk. It is better for the practical producer that this is true. A well starting at 200 barrels or more a day creates an excitement and a rush for territory that in the end proves harmful to all concerned. Large bonuses are paid out and big risks taken which are foreign to territory whose wells are small but sure producers. As has been stated in my former reports, one large well will not make any man a fortune; twenty small ones may in time. The yield of the large producer will quickly grow much less; that of the twenty small ones will hold out for a long time. There is yet room for thousands of wells in the known productive territory. At present prices eight to ten wells pumped by one power and yielding on an average but two or three barrels each per day, will prove a paying investment.

. It is a good omen for the future of the oil industry in Indiana that so many bores are being sunk each year in the old producing territory of Wells, Adams and other counties. The risks of the operator are much fewer. Moreover the chances that the greater portion of the stored product will eventually be brought to the surface are much greater where a bore is sunk on every 10 acres than where only one is sunk on each 40 or 80-acre tract. Were a bore sunk at regular intervals on each 8 or 10 acres of productive territory the profits in the end would be more sure and much greater than where the present haphazard method of drilling is followed.

CORNIFEROUS ROCK PETROLEUM.

Petroleum in commercial quantities has been found in the Corniferous rocks of Indiana in three different and widely separated localities, namely: at Loogootee, Martin County; Terre Haute, Vigo County, and west and northwest of Medarysville, Jasper County. At Terre Haute this petroleum has been produced since 1889. At the other points the first production was in 1899.

The Corniferous formation is the lowest or oldest division of the Devonian system in Indiana, being represented in the State by sandstones with a maximum thickness of 20 feet, which are thought to correlate with the Schoharie group of New York, or by limestones five to 65 feet in thickness correlated with the Upper Helderberg. At Loogootee the oil bearing rock is a sandstone; at the other localities, limestone. Above the oil bearing rocks of this formation will always be found a deposit of brown and black shales, varying in thickness from 90 to 160 feet. These are the Hamilton and New

Albany or Genesee shales. They not only form the close grained cover which has prevented the total evaporation of the volatile portions of the petroleum, but they are undoubtedly the original source of the petroleum itself.

These shales, when first deposited, were largely composed of the remains of plants and animals, which, by the action of slow destructive distillation mentioned on a preceding page, were changed into bitumens. The Genesee shale is rich in these bitumens,* and when set on fire will burn until they are consumed. Where the underlying rock is a porous limestone or sandstone, the oil and gas, which have been separated from the shale during the thousands of years which have elapsed since its formation, have accumulated. It is these accumulations or reservoirs which have been struck at the points above mentioned. Similar reservoirs doubtless occur in many portions of the area which the black shale underlies, but they will be found only where the Corniferous limestone or sandstone is porous enough to retain in large quantities the gaseous and liquid bitumens.† The gas at Petersburg and Loogootee is only the more volatile part of the oil which has arisen into the higher portions or anticlines of the porous rocks. Where these rocks are found low, the oil or salt water will occur, but there is much less likelihood of salt water being found in quantity than in the Trenton limestone of the main Indiana oil field.

The Genesee shale, and its underlying oil bearing rocks, occur only in the western half of the State. Here it has been recognized in all the deep bores drilled west of its eastern outcrop. This outcrop extends from the Ohio near New Albany in a northeasterly direction through Floyd, Clark, Scott, Jefferson and Jennings counties, then northwesterly through Bartholomew, Johnson, Marion, Boone, Clinton, Carroll and White counties. The shale forms the surface rock of an area eight to 15 miles wide in these counties or those adjacent on the west. It is also known to be the formation immediately underlying the drift over quite a large area of the two northern

*A paper treating of the bitumens of this shale was published in the report of this department for 1896, pp. 108-119. As a result of numerous experiments, the author found that 8.5 pounds of the black shale yielded by distillation 45 gallons of gas, which, when burned as an illuminant, proved to be 22 candle power in quality. In Scotland 60,000,000 gallons of crude oil are annually produced by distilling a similar shale, while at the same time 25,000 tons of sulphate of ammonia, a valuable fertilizer, is formed as a by-product.

†As in the Trenton rock oil fields, there are absolutely no surface indications by which one can locate, with any degree of certainty, productive wells. The only thing to do is to sink a bore through the black shale to the underlying Corniferous rocks. If accurate surface levels of the first dozen or more producing wells are determined, one can readily ascertain the dip of the oil-bearing stratum, and thereby lessen the chances of failure in future bores.

tiers of counties in the State. At Loogootee the Corniferous oil bearing rock is about 500 feet below the surface. At Terre Haute, which is much farther west of its outcrop, the oil occurs 1,630 feet below; while at Medarysville, near the eastern outcrop, the depth to the oil bearing stratum is only 100 to 110 feet.

THE TERRE HAUTE POOL IN 1900.—The Phoenix well at Terre Haute is the oldest and the best oil well in the State of Indiana. For 12 years it has yielded an average of more than 1,000 barrels per month. When the drill first struck the oil bearing stratum on the night of May 6th, 1889, the flow was so great that quite a lake of oil accumulated around the derrick, and there was some alarm lest a destructive fire should result. The drill was then pulled out of the well, and as soon as the end left the mouth of the drive pipe, a solid stream of oil four and a half inches in diameter shot into the air a distance of forty or fifty feet. While running at this rate there was probably a little over a barrel a minute pouring from the well, and when the pressure decreased from the first spurt, which lasted only fifteen minutes, the flow steadied down to a four and a half inch stream spurting about three feet above the mouth of the well. A tank with a capacity of twenty barrels was put under the pipe, and it was filled to overflowing in just twenty-two minutes. This great flow soon began to decrease, and in a few months had reached an average of 35 barrels per day, which it has since maintained. The output of the well in 1900 was 12,090 barrels, or 1,015 barrels per month, except in April, when a few days were spent in cleaning out the well, the production for the month being thereby reduced to 925 barrels.

Previous to the sinking of the Phoenix well, three or four bores had been put down at Terre Haute, one to a depth of 2,400 feet. In two of these oil in small quantity had been found. The result of the Phoenix strike was like that of every other similar one in the history of the petroleum industry. Hundreds of oil operators from far and near flocked to Terre Haute. Real estate almost doubled in price. Twenty-four new companies were formed, eighteen of which made locations. A dozen or more bores were put down to the required depth within three miles radius of the first gusher, struck the proper stratum, and for the most part found—nothing. Two, within a short distance of the original well, yielded oil in small quantity. The yield of one was soon overcome by salt water. The other continued to produce for five or six years, but was finally abandoned.

No further prospecting was done until 1899, when two bores were completed. One of these, about two miles north and one-half mile west of the Phoenix, was a dry hole. In the other, about 40 rods northeast of the Phoenix, oil was found, which partially filled the bore. Owing to litigation, this well was not pumped until 1900, the output for that year being a little less than 1,000 barrels.

The oil from the Corniferous at Terre Haute is darker colored, more ill smelling and of a greater weight and density than the Trenton rock oil from the main Indiana field. An examination and comparison of samples of the two were made by Dr. Noyes, who reported on them as follows:*

	TERRE HAUTE.				VAN BUREN.			
	Per Cent.	Specific Gravity.	Degrees, Beaumé.	Flashing Point.	Per Cent.	Specific Gravity.	Degrees, Beaumé.	Flashing Point.
Original oil .....	.....	0.879	30°	.....	.....	0.853	35°	.....
Below 150° C .....	.....	.....	.....	.....	7.2	0.719	.....	Below 26° C
150°-200° C	12.0	0.793	48°	38° C	10.2	0.759	56°	Below 20° C
200°-250° C	14.0	0.825	41°	65° C	10.2	0.799	47°	60° C
250°-300° C	13.6	0.847	36.5°	85° C	12.2	0.826	41°	82° C
300°-350° C	14.8	0.867	32.5°	97° C	14.8	0.844	37°	96° C
350°-390° C	40.6	0.879	30°	45° C	41.8	0.860	34°	38° C
Total distillate	95.0	.....	.....	.....	96.4	.....	.....	.....
Residue by weight	6.2 per cent.				4.5 per cent.			
Sulphur .....	.72 per cent.				.83 per cent.			

"The oils were distilled rather slowly from flasks with the thermometer in the vapor only. A thermometer filled with nitrogen and graduated to 460° C. was used.

"The oils appear to be quite similar in general character, but there is less of the low boiling products in the Terre Haute oil, and the specific gravity of the oil and of the various distillates is higher. The portion of the Terre Haute oil boiling at 350°-390° deposits considerable amounts of solid paraffines at 15° C. The low flashing point of the high boiling oil must be due to a partial 'cracking' of

* The sample of Trenton rock oil was obtained at Van Buren, Grant County,

the oil. From the results, I calculate the following percentage of naphtha and kerosene contained in the petroleum:

	Terre Haute.	Van Buren.
Naphtha below specific gravity 0.73	None.	10%
Kerosene between specific gravity 0.73-0.83	30%	33%

There is little doubt but that a large quantity of oil occurs in the Corniferous rocks beneath the city of Terre Haute and vicinity, else the yield of the Phoenix well could not have been so uniform and long continued. The porous area or reservoir containing the oil must, however, be narrow, and this bore probably struck it at just the right point to get the best results. Some people who know little or nothing of the geology of Indiana believe that the Phoenix well struck a crevice, which extends to the main oil field of the State. Such belief is, of course, preposterous, as the Corniferous rock which contains the oil at Terre Haute, outcrops before the main oil field is reached, and is not pierced by any bore sunk in that field. Moreover, it is a younger and much thinner formation than the Trenton limestone, and for that reason there is little chance of developing an oil output near Terre Haute in any way comparing to that of the main Indiana field.

THE LOOGOOTEE OIL FIELD IN 1900.—In the spring of 1897 a well was drilled into the Corniferous sandstone at Petersburg, Pike County, 25 miles southwest of Loogootee, which resulted in a good gas producer, having since supplied most of the citizens of Petersburg with fuel. Six other bores were soon afterward sunk in that vicinity, in all of which either oil or gas was found in small but not commercial quantities. These bores led to the organization of the Loogootee Prospecting Co. at Loogootee, Martin County, which proposed to prospect for oil or gas in the vicinity of that town. Their first bore, a short distance south of the town, was intended to reach Trenton limestone, but at a depth of 1,682 feet drilling was for some reason stopped near the base of the Hudson River limestone, or in the top of the Utica shale. The well should have been drilled to a depth of 2,000 feet, in order to have reached and thoroughly tested the Trenton rock. At a depth of 478 feet a good showing of both oil and gas were found in a thin stratum of Corniferous sandstone. About 15 gallons of oil a day were produced. On April 2, 1900, 100 feet or more of oil was standing in the bore.

The showing made by this first bore was deemed sufficient to justify the drilling of another well about one-quarter of a mile east of No. 1. In this gas was struck at a depth of 505 feet, the stratum of sand being three feet thick. The output of gas was about 400,000 cubic feet per day. The third bore, a quarter of a mile east of the second, was on a ridge whose surface level was 32 feet higher than that of the second bore. In it the gas bearing sand was struck at 527 feet, and was eight feet in thickness. About one half million cubic feet of gas daily resulted, but no oil.

In the fourth bore, put down on the Larkin lease, 1,500 feet east of No. 3, the surface level was 15 feet lower. The productive sand was 16 feet thick, its top being 513 feet below the surface. When finished, on November 13, 1899, it began flowing water, gas and oil, yielding about 250,000 cubic feet of gas and 12 barrels of oil per day. On April 12, 1900, it was yielding about six barrels per day, natural flow. No. 5, sunk 700 feet east from No. 4, at the same level, was dry, none of the productive sandstone having been found at 562 feet when the bore was abandoned. This completed the results of the first season's work.

In 1900 the first well completed was a dry hole on the Fields farm, a mile northeast of No. 4 above mentioned, no sign of the productive stratum of sandstone being encountered. The second was on the Cannon lease, and was distant about one-quarter of a mile southeast of the gas well (No. 3) last drilled. It was finished February 18, the sandstone being 17 feet thick and struck at a depth of 478 feet. Its initial output, when pumped, was four barrels. It was shot with 10 quarts of nitro-glycerine, being the first of the wells so treated. After shooting, it flowed 30 barrels of oil a day for 10 days, then fell to 20 barrels, which it was yielding on April 12. A small quantity of gas was escaping on that date. The flow of the oil was natural and by heads at intervals of 10 to 12 minutes. The striking of this second productive well created much excitement and an active scramble for territory by oil men from widely different localities. A number of rigs were at once erected and drilling began in earnest.

Three miles east of the No. 4, or first oil producing well, a bore on the O'Brien lease, section 17, Perry Township, found the sand at 390 feet, but only Blue Lick water was produced. A second bore on the Cannon lease, 600 feet south of the new oil producer, was dry. The sandstone, struck at 483 feet, was only two feet thick, dense and very hard. Another bore on the Larkin lease, only 500 feet northeast from No. 4, was drilled in on April 10. Fourteen

feet of sand was found at 527 feet below the surface and the bore developed a 10-barrel producer. Still another bore, sunk between the Larkin and Cannon wells, had an initial production of 50 barrels. This, the fourth oil well in the field, was the last one drilled in 1900, all the others yielding either Blue Lick water or gas or being wholly dry.

Those of which we have an account in this office are as follows:

Thos. Mehan lease, section 18, Perry Township, three-quarters of a mile north of producing wells; sand struck at 501 feet, white, thin; well dry, though afterward filled up with Blue Lick water struck at 445 feet.

Chas. Gootee lease, section 1, Perry Township, two and a fourth miles south of the Larkin wells, developed 10 feet of close grained sandstone and was dry.

O. J. Clark lease, one-third of a mile south of Larkin wells, two bores sunk, each producing a million cubic feet of gas but no oil.

J. M. Hall lease, section 35, Barr Township, Daviess County, three miles southwest of Loogootee; first sand 30 feet thick, close grained, dry; second sand, at 493 feet, yielded two and a half million cubic feet of gas.

J. Dible lease, section 2, Barr Township, Daviess County, one million cubic feet of gas.

S. Smith lease, section 3, Barr Township, Daviess County; dry hole.

J. McCord lease, section 26, Barr Township, Daviess County; sand eight feet thick, large gas well.

John Graham lease, near Glendale, Harrison Township, Daviess County, 13 miles southwest of Loogootee; sand found at a depth of 950 feet. Good showing of oil, no gas.

M. E. Haggerty lease, five miles south of Loogootee; dry hole.

McBride Bros. lease, four miles east of Loogootee; dry hole.

In all 26 bores were put down in the Loogootee field during 1900. Of these three produced oil, 10, gas, the remaining 13 being dry. The results show that the productive stratum of sandstone is not to be relied upon. It does not appear to be continuous but is in pockets. It varies much in thickness and also in closeness of texture, in some places being soft, quite porous and productive; in others, hard, close grained and barren. On account of its pocket nature and thinness, the supply of oil from any given area of this Corniferous sandstone will never equal that from any similar area of the main Trenton limestone field of northeastern Indiana.

The Loogootee Prospecting Company, to whom all credit is due for bringing about the development of the field, have done well with

their venture. They owned, at the close of the year, the four producing oil wells and four of the gas wells, besides having control of much of the best prospective undrilled territory. Their stock, of which 1,200 shares were issued at \$10 each, was selling at \$60 per share when any was on the market.

The oil produced at Loogootee is very similar to that found at Terre Haute, being ill smelling, dark in color, and possessing a specific gravity of 32° Beaumé. It is shipped by the Indiana Pipe Line Co. to Jeffersonville, Indiana, and Louisville, Kentucky, where it is used mainly for fuel. The output of the producing wells by months for the year was as follows:

PRODUCTION OF THE LOOGOOTEE, INDIANA, OIL FIELD BY MONTHS IN 1900.

January.....	142.20	August.....	769.08
February.....	144.42	September.....	701.08
March.....	713.67	October.....	759.08
April.....	544.89	November.....	827.59
May.....	843.42	December.....	800.00
June.....	1,129.91		
July.....	561.45	Total.....	7,936.79

THE JASPER COUNTY OIL FIELD IN 1900.*—During the past two years active development has been carried on in Jasper County, Indiana, with the result that a considerable area of valuable oil territory has been disclosed. The oil is found in a limestone which, without doubt, is a continuation of the Corniferous limestone formations at present producing oil in the Canadian fields, and at Terre Haute in Vigo County, Indiana; the limestone being easily recognized throughout a large area of southern Michigan and western Indiana, but being entirely absent in the eastern and central portions of the latter State. The formation is nearest the surface in the section of Indiana which has since developed into the Jasper County oil field and is found in the most productive portions of this field at approximately 100 feet below the surface.

The history of the Jasper County field dates from 1865, when a company was organized in New York to exploit certain oil territory, supposed to exist in the Kankakee swamps of Indiana. This company was organized during the great oil excitement in Pennsylvania and adjoining states, but no records remain of any active development

* Mr. C. K. MacFadden, of Geneva, Indiana, to whom much of the credit is due for the opening up of the Jasper County field, furnished most of the data for this report on that field. I have re-arranged his paper and have added to it in places additional data which I gathered when I last visited the field. For the most part, however, the wording is his own.

undertaken by this original company. The next interest shown in this section was in 1893, when a well drilled on the W. J. Swisher farm, six miles west of Medarysville, southeast quarter section 33 (31 north, 5 west), Gillam Township, was completed, which produced a considerable amount of oil. This well was drilled by the owner of the farm to provide water for his stock. Not finding water at the usual depth the well was continued to a depth of about 85 feet, when a flow of oil was encountered which, according to reports, flowed intermittently, its production at certain periods ranging as high as 10 barrels daily. The oil was found to be a good lubricant, and for a number of years the owner of the well obtained a fair income from the sale of it at approximately \$10 per barrel. Shortly after the Swisher well was completed a number of test wells were drilled in the immediate neighborhood, but in the light of present development it would seem that none of them penetrated the Corniferous limestone to a sufficient depth to obtain oil in any quantity.

The recent history of the field began in July, 1899, when a company, composed of a number of practical oil producers and known as the Interstate Oil Company, commenced active work. They leased approximately 36,000 acres of land, 26,000 of which they obtained from B. J. Gifford at one-eighth royalty, the only condition being that they put down a bore to the oil producing rock on each section of land, one well to be sunk every 60 days, until the tract was drilled over. After purchasing the oil right on the original Swisher farm, the company sunk a bore 700 feet northwest of the first well, which resulted in a two-barrel producer. Additional wells were completed in section 33 until by the end of the year 1899 a considerable acreage had been proven to be productive territory. About this time the development of the district was brought to the attention of a number of English capitalists known as the Byrd Syndicate, Lmt., of London. That syndicate made a careful investigation of the property of the Interstate Oil Company, and finally purchased the leases and 19 producing wells, paying therefor the sum of \$150,000. The new company immediately began extensive operations, and by the close of 1900 had more than 100 producing wells in operation. Several other companies were formed soon after the Interstate Company sold its territory and most of the unleased land near by was quickly taken up, either by lease or direct sale.

In eastern Jasper, western Pulaski and the counties to the northward, the New Albany or Genesee brown and black shales immediately underly the drift and are encountered in sinking wells for water. As already noted, these shales are rich in bitumens, both

oily and gaseous. In the yard of J. P. De Selmes, on the northwest of the northeast quarter of section 34 (31 north, 5 west), about a mile northeast of the Swisher well, a bore sunk for water in 1893 a few feet into the shale produced gas enough to supply several stoves. It was used in the cooking stove for six months, but as no separator was put on to shut off the water the latter finally found its way into the stove. In April, 1900, the well, after being primed and pumped a few strokes, would flow water for 10 or 15 minutes and at the same time allow a large amount of gas to escape. This when set on fire would burn with a flame several feet high as long as the water flowed.

The Corniferous limestone or oil bearing rock underlying this shale in the productive area of Jasper County is a hard gray limestone which, in a number of test wells which have been drilled through the formation, has been found to be approximately 40 feet in thickness. The upper 20 feet, however, constitutes the oil producing portion of the limestone, and in this 20 feet are found several bands or pay streaks of porous rock which enlarge into crevices with considerable regularity. These crevices are often lined with pyrites of iron and lime crystals. Crevices have been found in quite a number of the producing wells which were two or three feet in thickness. In case a well, while being drilled, encounters one of these crevices, it will often produce a considerable quantity of oil without a shot of nitro-glycerine, but almost without exception it has been found desirable to place a torpedo of about 20 quarts in such position in the formation as to cover 10 or 12 feet of rock, the result invariably being to greatly increase the well's production. One of the large glycerine companies has a magazine in this district and provides the Jasper County producer with the necessary explosive.

The usual formation encountered in drilling a Jasper County well is as follows: Drift, consisting of sand, clay and loam, 50 feet, under which is encountered a bed, 45 to 55 feet in thickness, of close grained black shale which forms an impervious cover for the Corniferous limestone reservoir. This black shale or slate does not cave in drilling, it thus being necessary to use but a short length of drive pipe to shut off the drift formation. The operators use for this purpose 5½ inch casing, and by driving it a sufficient distance into the black shale shut off the surface water. With the usual form of portable drilling machine employed in the Jasper County district, an expert crew has completed a bore in the remarkably short time of 23 hours actual drilling time, it thus being evident that the cost of a well is a very small sum.

The oil obtained is unlike any other product found in the Ohio and Indiana oil districts, it being of a black or very dark green color and of a gravity which ranges from 17 to 21. Its thickness and low gravity is without doubt largely due to the shallow depth at which it is found, the more volatile portions having long since escaped through their overlying formations. The oil on examination is found to have a cold test of about zero F. and a fire test of over 300°. It has a good viscosity test and is universally used throughout the Jasper County district for lubricating purposes. It is associated with a strong sulphur water of which a large amount is usually encountered whenever a crevice is penetrated. There is usually but little gas found in the district except immediately upon the completion of a new well, when, for several days following, a considerable quantity of gas is often discharged. Further development may disclose an area in which gas will be found in larger quantity and several wells which are expected to be finished to the Trenton limestone during the summer of 1901 may develop gas or oil horizons in the two producing formations lying under the Corniferous limestone, namely: the Clinton formation, producing oil in small quantities, 10 miles southwest of the Jasper County development, and the Trenton limestone.

There has been but little excitement shown in the development of the Jasper County field, due to the fact that the territory is controlled in large blocks, thus largely eliminating rivalry between owners of the adjacent properties such as furnishes the activity so noticeable in the Trenton limestone areas of Indiana. Moreover, the wells are generally small producers, running only from two to five barrels each. This, however, is not always the case, as several wells drilled on the Syndicate's properties in section 28 (31 north, 5 west), Walker Township, and in section 33 (31 north, 5 west), Gillam Township, having resulted in producers whose first day's output ranged from 10 to 100 barrels or more. The largest well completed in the district is on the south half of the southwest quarter section 28, Walker Township. This well, when completed, without a shot, gave a yield of approximately 200 barrels in 24 hours when pumped in a rather primitive manner with one of the drilling machines. It is quite possible that this well would have yielded a much larger amount had it been pumped with a standard pumping rig such as is used in the deeper territory of the State.

Outside of the immediate vicinity of the first producing well, other drilling has been done as follows: On the W. Austin farm, one and a quarter miles southwest of Wheatfield, northeast quarter section

35 (32 north, 6 west) a bore was sunk to a depth of 203 feet in January, 1900. It is claimed that no black shale was encountered and only a strong flow of sulphur water resulted, the vein of which was struck in limestone at a depth of 185 feet.

On the John Perry farm, two miles southeast of Wheatfield, a bore found the oil bearing stratum at a depth of 105 feet, and a fair producing well resulted. A bore which produced gas only was sunk on the J. A. Campbell farm, northeast quarter of section 33 (31 north, 5 west).

Three and a half miles west of San Pierre, on the banks of the Kankakee River, two or three light producing wells have been developed on the farm of M. S. Rogers. The oil from these wells has the lowest gravity of any in the field, and the color is dark green rather than black.

In Railroad Township, Starke County, two or three bores were sunk which produced only a showing of oil. A bore with similar results was drilled a mile south of Medarysville on the land of E. C. Williams.

Three and a half miles southeast of the main producing area, on the land of James A. Low, section 11 (30 north, 5 west), a bore was drilled in June, 1900, to a depth of 700 feet. The oil producing rock was struck at 125 feet, but was barren.

In the immediate vicinity of San Pierre several fairly productive wells have been completed. The first one sunk was on section 9 (32 north, 4 west). In it considerable gas with traces of oil was found, but at a depth of about 125 feet a strong vein of sulphur water was encountered which produced a flowing well. In a second bore in section 18, one and a half miles southwest of No. 1, oil was struck at 122 feet, a small producing well resulting. Two or three other bores were put down in the vicinity of San Pierre which produced oil, but no accurate record of them has been secured.

According to Mr. MacFadden, the total estimated daily production of Jasper County at the close of the year 1900, was approximately 400 barrels. The actual daily production possible is unknown, due to the fact that a market for the oil is as yet wanting, although pipe line service will be installed during the summer of 1901. It is doubtful, however, if the oil can ever be freely moved by means of pipe lines on account of its thickness and heavy weight. What has been sold was hauled in barrels to the railway stations and is said to have brought \$5.00 to \$5.50 a barrel for lubricating purposes. After the sediment is removed but little difference is said to exist between it and the Mecca, Trumbull Co., Ohio, lubricating oil which brings \$10

per barrel on the market. It is claimed that a St. Louis firm has purchased a quantity of the Jasper County product for making an artificial rubber compound, the oil being exceedingly rich in asphaltum and paraffine bases.

There is probably no oil field in the world in which the expense of development is as low as in the Jasper County district. The oil formation lies at an extremely shallow depth and the area which has been found to be petroliferous seems to be fairly uniform in character, resulting in few wells which will not make paying producers. Notwithstanding the small output of the average well, the cheapness with which the territory may be operated, together with the value of the product, makes it possible to operate at a profit wells which produce but one or two barrels daily and it may be confidently expected that the life of the wells will compare favorably with the development in the Corniferous limestone formation in the Canadian oil fields, where many wells have produced oil in paying quantities for the past 25 years. There is little doubt but that the productive territory will eventually be found to extend over a large area to the north and northwestward of present development. In many localities to the southward, a little west of the line of outcrop of the black Genesee shale, the porous Corniferous limestone doubtless occurs. The chances are that in these localities wells producing oil similar to that of the Jasper County field will be drilled in the future but their output will never be large.

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