CHAPTER VI.—MISCELLANEOUS USES OF PETROLEUM AND ITS PRODUCTS.

Petroleum and its products are used for a great variety of purposes that do not fall under the classes previously considered. Commencing with the lightest products, a liquid called cymogene, nearly if not identical with rhigolene, but said to be condensed by pressure, is used in ice-machines with complete success. Gasoline has been proposed as a suitable substance to be used in cleansing raw wool. The following discussion of the use of naphtha (gasoline) for this purpose is introduced here from a circular issued by the Boston Manufacturers' Mutual Fire Insurance Company, with some statements regarding the use of mineral oils for use on wool as the latest information on the subject:

WOOL OILS.

The quality and kind of oil used for preparing wool is a matter of the utmost importance to the underwriter, as it is spontaneous combustion that has caused the record of losses on woolen-mills to be heavier than that on cotton-mills; but in touching upon the subject of wool oils we approach a very "touchy" subject. Many of the methods of treating wool are jealously guarded as trade secrets; the composition of several of the mixtures used on wool has been communicated to us confidentially, and only in order that we may be assured of their safety.

In respect to testimony, we could summon witnesses to prove conclusively that each oil or mixture now used is the very best for its purpose; and conversely that not one of them is really suitable, some difficulty being found either in respect to safety, to the effect on the fiber, or in the removal of every oil used.

All, or nearly all, appear to require a hot solution for their removal, by which the elasticity or luster of the fibers cannot fail to be injured in some degree.

It would appear, according to the evidence and also according to the practice of many of the best manufacturers, that mineral or paraffine oils may be safely and economically used upon wool, either pure or mixed; on other equally competent evidence, that they are utterly unfit to be used and cannot be scoured out, and that nothing but olive, lard, or red oil can be tolerated. The "red oil", so called, is in fact oleic acid, and is subject to impurity if the sulphuric acid used in the process of candle-making (of which "red oil" is a subsidiary product) is not sufficiently removed. When thus impure, we understand it to be peculiarly liable to spontaneous combustion.

The mixed oils, sold under fancy names, of necessity consist of combinations of some of the oils above named, to which the natural yolk or grease of sheep's wool is sometimes added, the latter substance being imported from abroad under the name of "de gras", mostly for the use of curriers.

From the standpoint of the underwriter, the use of mineral oil, mixed to the extent of at least 40 per cent. with animal or olive oil, is to be desired; because in such proportion it abates all danger of spontaneous combustion, and does not in that proportion seriously increase the danger if fire occurs from other causes.

If consideration be given to the work done by the oil, the chief reason why olive, lard, or red oil is preferred, aside from the question of economy, may be that they are a little more viscous than the mineral oils. This may be a point worthy of investigation. If the slight viscosity of fatty oil is desirable, it may be obtained in a mineral oil as well. The substance to be desired is, therefore, one that is not liable to spontaneous combustion; that is not readily ignited by contact with fire; that is readily saponified or reduced to an emulsion, and readily removed from the fiber without the use of any high degree of heat; and that does hold the fibers together in the process of manufacture.

Since none of the oils, greases, or compounds now in use fully meet all these conditions, and since the adverse testimony against them all is stronger than that in favor of any one kind, it follows that both the common practice in scouring all washed or unwashed wool, and the common practice in preparing the wool for carding and spinning, are in some degree bad; that they are not consistent with true economy; that they enhance the difficulties in manufacturing and dyeing, and that if there has been any improvement indicated as being possible by experiments made in a laboratory, from which it is fair to infer that great gain would follow if the theory of the laboratory can be reduced to practice, such experiments deserve the closest attention of all parties in interest.

We therefore beg leave to submit, as the result of our investigation of wool oil, certain propositions. These propositions are submitted only for what they may prove to be worth, and with some hesitation, because none of the officers of the company have ever had any practical experience in the treatment of wool.

Proposition 1. The wool now used in this country will yield 45,000,000 pounds of grease that is now worse than wasted, because it, together with all the alkalies used in the present imperfect method of extracting it, is discharged into ponds and streams, polluting them in a manner most dangerous to health.

2. All this grease can be extracted more perfectly by the use of naphtha than it can be by the use of alkalies, because this grease or yolk does not saponify or yield readily to alkaline treatment until it is in some degree oxidized by age; for which reason the best foreign woolen fabrics are made from wool a year or more old. On the other hand, the newer the clip the more readily the grease is removed by naphtha.

3. The grease and fertilizing material that may be all saved by the naphtha process will more than pay the cost of scouring.

4. This process does not require any heat in the application of the naphtha, and only tepid water for scouring, with a little ammonia in it, it being possible to cleanse a single fleece, by careful manipulation, without disturbing the position of the various portions, thus leaving every fiber in a perfect condition.

5. A portion of the oil thus extracted from the wool itself, after being in some degree refined and mixed with a small portion of mineral oil, makes a viscous emulsion, absolutely free from tendency to spontaneous combustion and in very slight degree inflammable, meeting all the conditions that are required for preparing the wool for carding and spinning.

6. The fiber wool thus cleansed is in much better condition for spinning than when it has been heated and scoured with alkali. Wool and cloth thus treated are in much better condition for the reception of dyes than is possible under any other treatment.

7. This process may be conducted safely in buildings constructed outside mill-yards, at a fair distance away, but not beyond the distance to which the small amount of heat needed may be carried from the main boilers in underground steam-pipes.

In witness of these allegations, we present the report of Mrs. Richards, which was first printed in the *Bulletin of the National Association of Wool Manufacturers*, vol. ix, No. 2.

MRS. RICHARDS' REPORT.

During the progress of the investigation of oil instituted by the Boston Manufacturers' Mutual Fire Insurance Company, for the purpose of abating the danger of fire from spontaneous combustion and other causes, it became expedient to study the natural oil or grease of sheep's wool, which is now saved to a considerable extent in Europe and imported into this country under the name of "de gras", for the use of curriers and for other purposes.

The results of our study of this substance, although not immediately bearing upon the purpose of the inquiry, yet may have an interest to the members of the company, especially those engaged in the manufacture of wool, and are therefore submitted.

The preparation of the raw material is a question of the first importance in any manufacture, and anything which promises to improve the quality of the product, to lessen the labor and cost of preparation, or to lead to the utilization of a hitherto waste product, deserves at least a careful hearing. One of these possibilities seems to be foreshadowed in the wool manufacture.

As is well known, wool, as it is cut from the unwashed sheep, yields from 40 to 75 per cent. of extraneous matter. All this is waste product, and is washed away down our streams to their great damage. Of this large waste, from 12 to 40 per cent., according to the kind of wool, is a grease or oil with valuable properties, and the remainder is largely made up of nitrogenous matters, potash, and phosphates in a very suitable condition to be returned to the soil from whence they were primarily derived. Of course some wools contain sand and mineral dust to the amount of 10 or 20 per cent.

The total amount of washed and unwashed wool used in this country has been estimated at 250,000,000 pounds per year. This will yield approximately 112,000,000 or 115,000,000 pounds of scoured wool, or 45 per cent.; 45,000,000 pounds of grease (18 per cent.); 30,000,000 pounds of fertilizer (12 per cent).

The recovery of a portion of the valuable material has been attempted in France in two ways:

First, by the treatment of the wash-water for the recovery of the grease in a form for gas manufacture, or for the recovery of the potash by the incineration of the evaporated residue, which yields also a very finely divided charcoal, used instead of lampblack. Prussiate of potash has also been manufactured from these residues. By this method, which is an inconvenient one, requiring large tanks and numerous operations, only a portion—about one-third—of the total greasy matter is saved, and none of the nitrogenous matter.

The second method used was the extraction of the grease by means of bisulphide of carbon. The dried wool was then sent to the picking and beating machines before washing, and the wool dust thus obtained was sold for fertilizing purposes. The danger in this process is twofold: the yellowing of the wool by the bisulphide of carbon, and the heat necessary to volatilize the last traces of the solvent (150°–170° F.).

This method, theoretically good, has never been practicable in this country by reason of the cost of bisulphide of carbon. But we have a solvent for grease, in many respects superior to this, which has never yet been applied in this country on a large scale for this purpose, and we have no evidence that, before the present year, any accurate experiments have been made with the best form of this solvent. We have been told of several patent processes for the use of "benzine" for the extraction of the grease; but from the statements as to the results, as well as from a knowledge of the articles sold under the name of "benzine" a few years since, we have no hesitation in saying that the material used was not of proper quality for the purpose or was not carefully applied.

A certain amount of moisture seems necessary to the suppleness of the wool, and any degree of dry heat which takes away this needful moisture renders the wool brittle and harsh. This drying of the fiber is probably the cause of injury in the processes hitherto used.

Our experiments have been made with a quality of naphtha called "gasoline", of about 86°. We have packed the wool in a closed vessel and allowed the naphtha to remain in contact with it for about twenty minutes without any application of heat. The liquid was then drawn off and fresh naphtha run in, the process being repeated three or four times, according to the amount of grease in the wool. "Gasoline" of this quality boils at 90° to 100° F., and air of 50° or 60° F. completely removes it. The naphtha has no affinity for water, and does not, in this cold liquid form, carry away any moisture; very little will be taken out by air at 60° F. before the naphtha is all gone.

In the large way a current of warm air would now be passed through to carry off the absorbed liquid; in our experiments we simply exposed the drained wool to the outdoor air for a few hours. The wool is picked and beaten (the dust being saved), then put into warm water and washed without the aid of any other substance than the soap of potash, which is left on the fiber, untouched, by the naphtha.

The wool thus obtained is very white and soft, and has a "crinkly" appearance.

The objections which have been made to a process of this kind, whether benzine, fusel-oil, or bisulphide of carbon is used, are:

1. That the grease is too completely removed, part being needed to work the fiber.
2. That the grease is also removed from the inner tube of the fiber.
3. That the potash is left in a caustic condition, and hence certain to injure the wool.

In regard to the first objection, Grothe, (*a*) the great German authority, says that the office of the natural grease is so distinct from that of the oil added to facilitate manufacture that this cannot be held valid. The natural grease envelops the fiber as it comes from the hair sack in the skin, making a somewhat stiff coating over it, and only after the removal of this is the wool in the best condition for completely good carding, and also for fulling.

The second objection, that the grease is removed from the tube of the fiber, seems to be founded on earlier ideas. Grothe does not mention this as an objection, and, in the description of the hair, (*b*) says: "In the axis of the hair-shaft is found the pith. This pith is not evident in all wools. In some sorts, viz, Vicuna, it is much developed. The pith-cells contain either liquid or air."

Kölliker (*c*) says that the pith is wanting in colored head-hairs and in most wools: "On treating white hair with caustic soda we get the pith-cells, which do not contain, as was formerly supposed, fat or pigment, but air-bubbles."

It has been stated that washed wool after a time becomes greasy, and it has been supposed that the additional grease came from the pith of the fiber. It is suggested that, as soap can never be entirely washed out of any material, this grease may be derived from the soap used in washing, which is partially decomposed by the cold rinsing-water.

The third objection, that the naphtha or other solvent takes the grease away from the potash on the wool, and thus allows the latter to attack the fiber, seems also derived from a former idea of the nature of the substances under consideration—an idea which is not correct, but which still prevails. The following quotation from an address made in 1872 to a wool manufacturers' association seems to give the prevalent opinion: "In its natural state, as taken from the sheep's back, the whole fleece is filled with a yellowish matter, called by novices grease, but known among dealers as yolk. It is not grease, but a partial soap, being largely composed of alkali, and becoming, if suffered to lie until the volatile oil has dried out, almost a pure soap of itself; hence, as all manufacturers know, old wool scours by ordinary processes much easier than new wool just shorn."

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a Grothe, Wolle, i, 70. Berlin, 1876. *b* *Ibid.*, i, 18. *c* Kölliker, Gewebelehre.

Hartmann, in 1868, showed that this "yolk" is a true grease, containing cholesterine in place of glycerine. (*a*)

Schultze, (*b*) of Zurich, in 1873 and 1874, carried on the research on certain kinds of wool, and it is to his investigation and that of his associates that we owe nearly all of our present knowledge of the composition of the "Wollfett", or grease. He has not only proved the presence of cholesterine, but of isocholesterine and another analogous alcohol. We now know that these substances are in the place of glycerine; hence the far more difficult saponification of this grease than of lard and tallow, which are compounds of glycerine with the fatty acids. Also, the indications are that the wool-fat in the different races of sheep is composed of varying quantities of these cholesterines.

The presence of cholesterine in wool-fat is a very curious fact. Hitherto cholesterine proper has been known chiefly as a product of excretion from the brain, eliminated by the liver; hence its presence in bile. Gautier (*c*) says: "Cholesterine is to the brain what urea is to the blood and other organs."

Why we should find this same substance on the wool of sheep is an unexplained mystery.

The grease is dissolved out by naphtha in the same condition as it is in the wool; a potash soap remains behind untouched.

The proof that the potash is not left caustic is that the concentrated wash-water shows but a very faint alkaline reaction. Only on subjecting it to a high temperature does the reaction become strongly alkaline, showing that a decomposition has taken place.

It may be supposed that because carbonate of potash is made from wool-washings, therefore it exists as such in the wool. It is also obtained from wood ashes, but in neither case does it exist as carbonate before incineration.

The advantages claimed for the naphtha process are the more perfect cleansing of the wool, the better condition of the fiber for taking dyes, etc., the ready recovery of the waste products, hence a prevention of further pollution of streams from wool-washing establishments.

The disadvantage allowed is the inflammable character of the naphtha, rendering a separate building necessary. This is not an insurmountable obstacle, as the use of the substance for several industries has been perfectly successful.

The ultimate cost of the process will depend largely upon the value of the recovered products. This subject has as yet only been touched upon, but we have ascertained that the recovered oil is "equal to the best" for currying leather. It is not liable to spontaneous combustion.

The accompanying table will show the great variation in the wools already tested, the small amount of potash to be obtained, and the necessity of a large number of tests:

	Weight taken in grams.	Per cent. taken out by naphtha.	Per cent. lost on picking.	Per cent. lost on washing in warm water.	Total per cent. lost in cleaning.	Yield of clean wool, per cent	Carbonate of potash in crude wool.	Per cent. of organic matter, dust picking.	Ash of the grease in per cent. of the grease.	COMPOSITION OF THE RESIDUE FROM EVAPORATING THE WASH-WATER.				
										Per cent. of carbonate of potash.	Iron oxide and phosphate of lime.	Lime carbonate and magnesium carbonate.	Sand, etc.	Total volatile organic matter.
No. 1. Victoria. Not liable to moths...	70	21.43	2.0	21.57	45.0	55.0	3.3	.....	0.38	15.4	3.6	(*)	25.8	55.2
No. 2. Cape of Good Hope, Natal. Full of moths.	70	21.70	22.0	15.10	58.8	41.2	1.1	41.45	1.72	7.3	2.7	Like No. 1....	35.3	54.7
No. 3. Buenos Ayres. Full of moths...	70	13.57	15.3	36.13	65.0	35.0	3.1	.....	3.50	10.7	1.5	0.6	34.8	52.4
No. 4. Adelaide. Many moths.....	70	22.86	18.0	19.14	60.0	40.0	1.4	18.00	5.00	7.6	4.3	1.6	40.4	46.1
No. 5. Victoria. Not much injured by moths.	70	18.57	6.7	24.63	49.9	50.1	3.0	.....	1.40	11.7	1.3	0.5	39.0	47.5
No. 6. Cape of Good Hope. Liable to moths.	70	13.57	4.5	38.33	56.4	43.6	4.4	.....	3.80	11.5	3.3	0.8	36.3	48.1
No. 7. Uruguay. Many moths.....	70	12.87	8.0	39.43	60.3	39.7	2.5	.....	3.20	6.5	0.9	0.3 magnesium; Trace only.	46.7	45.9
Vermont wool. Very greasy.....	71	38.50	.....	.....	76.7	23.3	.....	.....	.....	.....	.....	.....	.....	.....
West Virgina wool. Very fine.....	1,088	.....	.....	21.60	.....	.....	4.2	.....	.....	19.5	.....	.....	.....	.....
Mixed wool.....	33,770	25.00	.....	.....	.....	.....	.....	.....	0.80	.....	.....	.....	.....	.....
Mixed wool.....	7,400	.....	.....	9.00	.....	.....	2.5	.....	.....	27.3	.....	.....	.....	.....

* Very little calcium; trace of magnesium.

Naphtha dissolved the grease of all but Nos. 9 and 10 with the greatest facility. These two samples seemed to be older wool, and to have free cholesterine, which was more difficult of solution.

All the samples of wool noticed in the table, except No. 10, were kindly furnished by Mr. George William Bond, to whom we are under great obligation for his interest and co-operation.

No. 10 was furnished by the agent of the Washington mills.

The table will show the small amount of potash which can be obtained, reckoned as percentage on the raw wool. We were surprised at this result, as we had been led to suppose, from various statements, that there was a larger per cent.

The small quantity of ash left by incinerating the grease shows also that it is not a soap of either lime or potash; a portion of this ash was carbon, which is very difficult to burn entirely when derived from cholesterine. It must be remembered also that this was crude grease, which doubtless mechanically carried down some of the other substances.

ELLEN H. S. RICHARDS.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
Boston, May 5, 1879.

We may also cite, in confirmation of these laboratory experiments, the commercial success of the Adamson process of extracting oil by means of naphtha from bone, dead meat, and even in paying quantities from the meat scraps previously treated in the most powerful presses.

a Inaugural Dissertation. Göttingen, 1868. *b Journal für Praktische Chemie.* *c Chimie appliquée à la Physiologie*, ii, 216.

This process is also now being applied commercially to linseed and cottonseed, and, in witness of the great affinity of naphtha for oily matter, it may be stated that Mrs. Richards has lately treated some of the hardest and driest cottonseed-cake from the most powerful steam-press now in use for the extraction of the oil; and we find that, after the utmost quantity of oil had been removed by the press, there still remained a quantity equal to $15\frac{77}{100}$ths per cent. of the weight of the cake.

While the direct result of our investigation of wool oil has therefore only given us the data by which to cause one or two mixtures to be avoided that apparently contained volatile mineral oil, we may yet hope that the final result may be a substantial improvement in the method of scouring wool and woolen fabrics and the saving of a waste substance of great value not only to the woolen manufacturer, but also to the leather-dresser, for whose use large quantities of "de gras" are now imported of a much less pure quality than can be obtained by the naphtha process.

Since naphtha itself is almost a waste product in this country, and is somewhat difficult to obtain in large quantities abroad, owing to the cost and danger attending its transportation, its application to the treatment of wool can be made in this country at much less cost than elsewhere.

The cost of the apparatus would be small, and the waste of material very little, as it can be saved by condensation with very little loss in each treatment.

I am told that the oils that are especially prepared and sold under the name of "wool oils" at the present time are supposed to be in general mixtures of not more than 50 per cent. of mineral oil with either lard, olive, or red oil; and even these mixtures that do not contain more than 50 per cent. of mineral oil are limited in their use to coarse work, it being understood that for fine work the smaller the percentage of mineral oil used the better.

Benzine is equally as useful as benzole for dissolving grease, but it will not dissolve aniline. It is not only used to dissolve grease from cloths, but from animal matter and waste products of any sort from which a refuse fat can be removed. Naphtha of a specific gravity of 62° to 70° B. is used in the manufacture of varnishes, lacquers, and floor-cloths. Rectified anhydrous petroleum spirit (naphtha) of a specific gravity of 0.725 is used to dissolve anhydrous caoutchouc, by which the India-rubber is vulcanized on the addition of chloride of sulphur. (*a*) Naphtha has also been used in air thermometers and for cleaning guns.

Paraffine oil (kerosene) has been recommended to protect seeds from mice, and is said to promote rather than injure vegetation. It has also been successfully used to protect pease from birds, slugs, and caterpillars. Large seeds are soaked in the oil, but it is recommended to sow the ground liberally with sawdust soaked in the oil when smaller seeds are planted. Paraffine oil (lubricating) has been used for saturating gypsum figures and for oiling clocks. Solid paraffine is largely used for stuffing leather, for glazing frescoes and paper, for preserving flowers and wood, and for protecting labels and stoppers of bottles from corrosive liquids.

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a Le Technologiste, xxvi, 126, 312; xxx, 308.

CHAPTER VII.—THE INFLUENCE OF PETROLEUM UPON CIVILIZATION.

In an introductory discourse, delivered before the Literary and Philosophical Society of New York, May 4, 1814, De Witt Clinton remarks:

There is a bituminous spring in Allegany county whence the famous Seneca oil is obtained. * * * At Amiano, in Italy, the petroleum of a spring discovered within a few years is also employed to light their cities. * * * It might be of considerable consequence to discover whether the petroleum of our spring might not be used for like beneficial purposes.

It is, however, only during the last twenty years, and through the production of petroleum in the United States, that this substance has exerted a marked influence on civilization; for while petroleum has been produced and used in Burmah, Japan, the Caucasus, Galicia, and Italy for many centuries, it cannot be claimed that its use was more than local, or that such use exerted any extended influence upon the world. Indeed, for the most part it was confined to such rude mechanisms that, as an illuminating agent in those regions, it was much inferior to the materials employed twenty years ago among highly civilized peoples. The earthen lamps of Burmah, the pastils of dried camels' dung used in Persia, and the rude lamps of Galicia were all of them little better than faggots or pitch knots. It is the advent of refined petroleum at comparatively low prices that has practically lengthened the duration of human life and has added vastly to the social enjoyment of mankind, not only among highly civilized peoples, but among the semi-civilized and barbarous nations; in fact, wherever the white wings of commerce can transport it there it has gone, and, more, its light has penetrated even the solitudes of the eastern deserts and the forests of both hemispheres.

Speaking of the rise and progress of the trade in petroleum, Mr. E. W. Binney remarks that it is "the most remarkable rise and progress in a trade in modern times. In 1861 the exports from the United States were 1,194,682 gallons; in 1869 it was 99,148,947 gallons". (*a*)

In considering this influence it may be regarded either as of the past or of the future. Dr. Draper, of New York, writing of the influence of petroleum in America, said, in 1864:

The effect that this illuminating agent has produced throughout the country is very striking. It has entirely displaced all other means of lighting except gas, and is used even in cities by many who desire an absolutely steady light. The great desideratum is a perfect chimneyless burner. The petroleum requires a large amount of air for complete combustion of its carbon, and by no other means than a tube 6 or 8 inches long has the supply been rendered sufficient. Although by the substituting of mica for glass the difficulty of breakage has to a certain extent been overcome, there is still great room for improvement. Kerosene has, in one sense, increased the length of life among the agricultural population. Those who, on account of the dearness or inefficiency of whale oil, were accustomed to go to bed soon after sunset and spend almost half their time in sleep, now occupy a portion of the night in reading and other amusements; and this is more particularly true of the winter season. (*b*)

Notwithstanding the desirability of a chimneyless burner which was thus early felt and clearly stated, that want is yet to be supplied, as all attempts to supply such a burner have thus far been only partially successful. In eastern countries, where the compensation of labor is so small, the cost of chimneys, enhanced by long transportation and breakage, is said to seriously interfere with the extended use of kerosene among the poorer classes. Yet the use of refined petroleum in the East has steadily increased, until petroleum is no longer produced in Japan, and the production has little energy in Burmah.

In 1869 M. Félix Foucou published an article in the *Revue des Deux Mondes* that is especially interesting in this connection. He says:

In the domain of the useful arts each age reveals characteristic tendencies. In the last century mankind had need to clothe itself cheaply. It was this that made the fortune of Arkwright and the machine spinners, the sudden prosperity of Manchester and the continental cities which imported the new method of labor. The nineteenth century has wished for light, both in the birch-bark wigwam of the Indian and in the mud cabin of the poor Ruthenian of Galicia. The introduction of the most modest lamp gives activity to family life in prolonging the evening's labors. France has largely contributed to this result. The invention of Argand, which was the first progressive step in advance of the smoky candle-wick of ancient times, arose painfully at the eve of the French revolution; the Carcel lamp and gas are of yesterday. A crowd of obscure inventors have, with unremitting labor, perfected the mechanism of lamps in order to escape the costly necessity of burning vegetable oils. These experiments, many of which were undertaken under the monarchy, prepared the way for the success of petroleum; unfortunately they came at a moment when it was premature to dream that illumination by mineral oil should become universal. The material was at first wanting; chemistry had not furnished a method of extracting those precious substances from the schists with which they were found associated at many points; and science had not yet shown the part that liquid petroleum was destined to play, of which a great many springs were then known. It is to the Americans that the merit belongs of having given this last right of citizenship among the industries. The native talent that led them to regard the useful aspect of everything, above all the feverish but patient activity, seconded so well by a happy temperament, has served them marvelously on this occasion. The French chemist Selligue gave them the first experiments in the basin of Autun, about the year 1832, by distilling on an industrial scale the schists that abound in that part of France. Mr. James Young, of Glasgow, perfected the process, and established in 1847, in Derbyshire, a vast manufactory for treating the English minerals, incomparably richer than those of France, and known under the names of bog-head and cannel coal. In a few years this establishment took on an extraordinary development, and yielded its

a Proc. Lit. and Phil. Soc. of Manchester, viii, 135. *b* *Chem. News*, x, 204.

projectors several hundred thousand francs of revenue. The prospect of such profits so soon realized placed this manufacture in a reputable position. It extended to the United States in 1854, where it was employed upon the Scotch bog-head as well as several other indigenous schists. In 1860 there were in North America 64 manufactories of schist oil. The discovery of abundant reservoirs of petroleum suddenly arrested this growing industry, ruined a large number of manufactories, and led their projectors to change them into refineries of petroleum, that substance being much richer in illuminating material than bog-head or cannel coal. (*a*)

This graphic statement of the manner in which the requirements of the age have been met, and how fully they have been met, is well supplemented and illustrated by chart No. III, page 148, in connection with the statistical statement on page 149 *et seq.* The statement shows that in twenty-two years preceding December 31, 1880, there had been produced 156,890,331 barrels of petroleum, of which amount about 16,000,000 barrels were stored above ground, leaving, in round numbers, 140,000,000 from the Pennsylvania oil regions alone for consumption during twenty-two years, an average of 6,363,636 barrels per year. But the production increased from 500,000 barrels in 1860 to 26,032,421 barrels in 1880. The stocks held in the producing regions did not accumulate in excess of the demand until 1875, when they amounted to 4,250,000 barrels; but the demands of the next two years reduced those stocks, and the price advanced to above $2 50 per barrel. Since February, 1878, stocks in the producing region have constantly accumulated, with a constantly increasing demand, and a tendency, as might be expected, to lower prices. The accumulated stocks, January 1, 1882, had reached nearly 30,000,000 barrels.

The total value of the yearly production, as shown by this statement, has been subject to great fluctuations. For instance, the 4,215,000 barrels produced in 1869 were worth $23,730,450, while the 10,809,852 barrels produced in 1874 were worth only $12,647,526. The most valuable production of any year was that of 1877, when 13,135,771 barrels brought $31,788,565, while the 26,032,421 barrels of 1880 brought only $24,600,637. From these figures it is readily perceived that up to the present time the demands of this century for light have been more than satisfied, and that while new uses and applications for petroleum and its products are being constantly discovered the increasing demand has been more than met by an increasing production.

Looking toward the past, it may be said that petroleum has become the light of the world. It is fast displacing vegetable and animal oils as a lubricator on all classes of bearings, from railroad axles to mule spindles. It is also displacing animal and vegetable oils where such oils are liable to spontaneous combustion; it is becoming one of the most largely used materials for fuel in stoves, both for cooking and for heating purposes; it is very successfully used for steam purposes where other fuel is scarce and petroleum is plenty; it is found to be available in the metallurgy of iron, and is likely to be in demand for the production of pure iron for special purposes; its merits have been long recognized in medicine, and it is rapidly becoming a necessity to the apothecary in the form of petroleum ointment; in fact, petroleum has become one of the indispensable needs of civilized man, and ministers to his wants in such a multitude of forms and under such a multitude of circumstances that it may be safely said that it ameliorates the conditions of his struggle with external nature, adds comfort to health, and soothes in sickness, prolonging his active life by extending the day into the domain of night over all that portion of the earth's surface accessible to commerce.

Looking toward the future, what assurance have we that these varied wants, the wonderful creation of twenty-four years, will be satisfied? In answering this inquiry I wish to emphasize the futility of prophecy and the abundance of the present supply. All through the census year, when each successive month brought an addition to the production without precedent, the entire literature representing the oil interest was each month prophesying that the end was being reached, the Bradford field was outlined, the production next month would surely show a decline, the yield of wells was rapidly running down, and so on. As an illustration I quote from Mr. J. C. Welch's *Views of Future Production* for June, 1879:

Reality has been constantly outrunning estimates on the Bradford production. The subject of the amount of production has been somewhat abandoned recently, in the light of the supply being so greatly in excess of any immediate demand, or of any probable demand in a reasonable time in the future. The May production from the wells will be exceeded, no doubt, by the production of some of the summer months. I think a shut-down movement, on account of depleted bank accounts, lack of credit, and a cash system inaugurated by the well-supply dealers of the Bradford district, will be a very important check on the starting of new wells, and the Bradford production probably is about at its height.

He estimated the total daily production for this month at 58,700 barrels. In his *Views of Future Production* for January, 1880, he says:

While the present situation regarding production is bad, great hopes are that in six months the production will necessarily show a very important falling off.

He estimated the total daily production for this month at more than 65,000 barrels. In his report for June, 1880, he says:

The next point is for the production to show an appreciable falling off. This point has not arrived yet, although producers, on account of the falling off of wells throughout the district, expect it will do so pretty soon.

Total daily production for this month, 80,804 barrels. January, 1881, he says:

Public opinion is very greatly in accord with the following extract from a letter of a producer to me: "In some districts the United lines are cleaning out the tanks. Do you get your statements on stocks at wells from the same parties as the *Era* and *Derrick* get

a Revue des Deux Mondes, April, 1869.

theirs? I sometimes think they back up oil purposely on those who furnish reports. I have interviewed a large number of producers from all sections of the field, and all make the same statement, namely, our production is falling off. I cannot understand, in view of the facts, how there can be an increase in the production, and, in plain words, don't believe it."

Total daily production for this month, 70,427 barrels. In June, 1881, he says:

The sanguine hopes for an important decrease in the production have been postponed for some months at least. Bradford is expected to decline rapidly at some time, and it was confidently hoped the time was near at hand; but the figures on the May production have been disappointing, and any marked decrease in the production is still a matter of the future.

Total daily production for this month, 81,455 barrels. January, 1882, he says:

For the time being the increase at Allegheny equals the loss at Bradford, but this relation is likely to change soon, and not only Bradford will decline, but Allegheny will accelerate the decline by declining itself.

Total daily average production for—

	Barrels.
October, 1881	81,110
November, 1881	80,985
December, 1881	81,462

The following paragraphs were written by an intelligent oil producer of large experience, and express the opinion of conservative operators at the date of their publication, August, 1881:

In the twenty-one years that oil mining has been the chief industry of northwestern Pennsylvania there have been discovered, besides numerous minor deposits, three great basins of petroleum, known among oil men as the Venango, the Butler, and the Bradford districts. The first centers on Oil creek, Venango county; the second on Beaver creek, Butler county; and the third covers an area of about 60,000 acres in the northeastern corner of McKean county, and extends a short distance into the state of New York. The first two named are so far exhausted that a majority of the wells have been abandoned, while those that are still pumped have fallen off until they average less than two barrels each per day. The Bradford district in extent of area and volume of oil exceeds the other two combined. It was discovered in 1875, but it was not until two years later, when its rich character became apparent, that it began to attract the oil men from all other fields. Since then it has been the scene of greatest activity, the magnitude of operations exceeding anything ever known in the business.

In the autumn of 1880, after four years' continuous drilling within and around the Bradford district, the boundaries of this great reservoir were accurately defined; more than 9,000 wells had then been drilled there and were producing oil. These lines being fixed, the producers began to retrace their steps, and to select within these limits such locations as seemed desirable among their old wells and to drill what is technically called the "second crop" of wells. This was the first manifest proof of the limitation of the Bradford district and of its approaching final exhaustion.

The percentage of successful ventures in Bradford surpassed all former experience. Of the whole number of wells drilled in exploring and defining this district about 5 per cent. only were dry or failed to produce oil in paying quantity. In Venango and Butler the average of failure was much larger, and if we except the years when these districts were in their prime, and take those intervening periods in oil mining when the producer had to depend upon the discovery of such minor deposits as lay outside of the great basins, and yet within the oil region proper, it will be found that half of the wells then drilled were failures.

* * * * * * * *

The distinctive features which have marked the development of the Bradford district, and which have given to the Bradford producer advantages over all his predecessors, are: first, the insignificant risk to be taken in drilling; second, the durability of the wells; and third, the expense saved of pumping the wells, which have until recently yielded their oil by flowing. To these natural advantages may be added cheaper machinery and cheaper labor. He has also gained facility by enlarged experience and by his improvements in well machinery. His greatest advantages have no doubt been in the long life of his wells and in the fact that they have been flowing wells; but these conditions have changed. Half of the wells in the Bradford district are now pumped, and the average product per well has fallen to six barrels per day. It is estimated that before the close of the year nearly every well in Bradford must be pumped. They are now passing rapidly from flowing to pumping wells.

The longevity of these wells is accounted for by the thickness of the sand-rock, the natural receptacle of deposit for the oil, which is never found in the Pennsylvania oil region except in this rock. The Bradford rock averages from 50 to 60 feet in thickness, while the Venango and Butler sand-rocks are from 20 to 40 feet. The volume of oil found in any deposit is determined by the extent and porousness of the sand-rock. In one of the minor districts, viz, Triumph, Warren county, the sand-rock was found to be 120 feet thick, and the wells there lasted the longest of any that have been struck; but the area of this deposit was limited to about 1 mile square.

* * * * * * * *

We have seen that the extent of the Bradford basin was ascertained last autumn. Its margin had been previously defined at many points, but it was not until then that the limits of the whole district became known. We can now see that the greater magnitude of this oil-field will not save it from the fate of the fields that preceded it. The same evidences which marked their decline have already appeared here, and we need not doubt that the same results will follow. The 9,000 wells of last autumn have now increased to over 10,000, and a total of 55,000,000 barrels of petroleum has been drawn from them. It is therefore not to be wondered at that the great reservoir begins to show symptoms of exhaustion. True, these symptoms have only passed the premonitory stage, yet they are as real and significant to the oil-producer as his figures of production. They are to him the "handwriting on the wall", for he knows well how insidiously the same symptoms developed in other districts, and with what accelerating speed the decline went on month by month, as his tables of production showed.

Ordinarily these monthly tables of production are a sufficient guide in forming a judgment of the field; but the condition of the Bradford business for many months has been such as to preclude the possibility of accuracy in them. The product of the district rose so rapidly last year above the receiving capacity of the pipe-lines that much of the oil flowed over on the ground and was lost. This waste continued in varying degrees through the greater part of 1880 and into the second quarter of this year. The extreme cold of last winter, and the aptness to congeal of the Bradford oil (which differs widely in this respect from Venango oil, and in a less degree from Butler oil), complicated the working of the pipe-lines, while diminishing their capabilities; so that the waste of oil was estimated to rise sometimes as high as 5,000, 10,000, and even 15,000 barrels per day. This led the producer to suppress the flow of his wells as much as possible, and to increase the wooden tankage which he uses for temporary storage at his wells until the oil can be conveyed into the large iron tanks of the pipe-lines. These iron tanks have a capacity of from 20,000 to 30,000 barrels each, the usual size of a wooden tank being 250 barrels—1,200 being the largest.

In making up the monthly tables of production it has been found that the greatest accuracy is attained by computing the "runs" of oil into the pipe-lines during the month and omitting the oil held at the wells. When the business is moving normally these well stocks remain nearly stationary and average about a hundred barrels per well, and this average does not seem to be much affected by the fluctuations of the market. A measurement taken in the Butler district in 1876 to ascertain this average gave 100 barrels per well, and this at a time when there were five pipe-lines competing for the oil, and when the price was $4 per barrel. When we consider that the average product of the wells is now 6 barrels each per day, that 200 barrels is usually the minimum taken by the pipe-line in one "run", and that there are 10,400 wells in the Bradford district, it will be seen that the time required for oil to gather to make up these "runs" necessarily leaves stock at the wells at all times, and that there must be a point below which this stock cannot sink until the number of wells decreases, when it will gradually decline with the decline of the district, until both are exhausted.

* * * * * * * *

The total marketable stocks of the region at the end of June, 1881, may be estimated as follows:

	Barrels.
Stocks in United Pipe lines	20,641,285
Stocks in Tide-water Pipe line	1,924,658
Stocks in the minor pipe lines	76,222
Stocks in iron tanks of individuals	420,930
Stocks at wells	335,095
	23,398,190

In a less degree perhaps than any other industrial product is the supply of crude petroleum governed by the price. There have been periods in the business when prices have ruled high, and yet production has declined because of the oil-man's inability to find new productive fields to work. On the other hand, production has not infrequently continued to rise long after the price has declined below cost. A powerful incentive to overproduction is found in the mobile quality of petroleum and its tendency to shift its location in the sand-rock, its passage from place to place through the channels of this natural receptacle having been the cause of many an energetic struggle along the dividing lines of adjoining tracts for the possession of the treasure beneath. These subterraneous currents set toward the first drill-hole on any given tract of land, and are not readily diverted toward subsequent openings; so that the chances for a larger share of the oil and for a more lasting well favor the first well drilled. The exceptions to the rule are rare, and arise from conditions that will readily suggest themselves, such as a natural center of deposit, or, still more rarely, a crevice in the oil-rock. As an oil district is always divided among numerous ownerships, the stimulus to excessive drilling pervades the whole field, and when the deposit happens to be large is sure to lead to excessive production.

Another cause of overproduction is found in the tenure, the tracts being mostly held by lease, the land-owner receiving a rent or royalty in oil varying from an eighth to a half of the total product; a bonus in money is often added when the chances of success seem favorable. The lease always stipulates the number of wells to be drilled and limits the time of drilling them, and also contains clauses of forfeiture to enforce execution of the work. The producer is thus compelled to drill wells at times when the market price of oil does not warrant the outlay rather than forfeit a lease on which he may have already made valuable investments, or which he believes will subsequently prove valuable.

Still another agent, acting in the same direction, is the discovery at a time when the supply is already sufficient to fill the market demand of a new oil-field, richer than any then being worked. The yield of the larger wells in the new district makes the cost of production less than in the old districts, the price declines, let us say, until the producer in the older district receives for his product barely enough to pay the cost of lifting it to the surface, though the producer in the new district still has a profit in his products; both continue their work and production is further enlarged. The first man is impelled to pump his well to save his property from destruction; the second is prompted by the profit he makes. The first man cannot shut his wells down and wait for an advance in price until the new district is depleted, for, besides the inconvenience which such stoppage entails in any business, he would risk the ruin of his wells by the clogging with paraffine of the oil-ducts in the sand-rock, or by the diversion of the oil into other channels by the suction of other wells. The first would be more apt to occur in a waning district and the second in a fresh district, but either is likely enough to happen to admonish him against a shut-down.

Since the discovery of Bradford two other districts of minor importance have been opened. One is known as the Wellsville district, and lies north of Bradford, in Allegany and Cattaraugus counties, New York; the other is the Warren district, lying south of Bradford, in Warren and Forest counties, Pennsylvania. The first has been worked for about three years, and yields the heavy oils only, the gravity varying greatly in different wells, being from 36° to 43° B.; the second is two years old, and yields a light-colored oil of 47° to 48° gravity. About two-thirds of the wells drilled in the first district and one-third of those drilled in the second have been failures. The total daily product in the Wellsville district was, at the close of July, 1881, 350 barrels. Neither gives evidence of large capabilities for increasing production, though of the two the Warren is undoubtedly the more promising. Neither can by any known possibility contain what may be termed "a great basin", for the drilling already done is sufficient to establish the character of both fields. These districts are not even pointers to such a deposit, and if they possess any significance in that direction it is rather against than in favor of such a discovery, so that no marks or guide-posts yet exist to point the way to new fields.

In Wellsville a good quality of oil-bearing rock, varying in thickness from 25 to 35 feet, is found in the productive wells, but that it is of a sporadic character is proved by the large percentage of unproductive wells; and this idea is further confirmed by the remarkable variation in the color of the oil obtained, which ranges from the ordinary green to black. Salt water is produced with the oil in all the wells in the Wellsville district, which is another distinguishing feature of heavy-oil districts, the light oils being always found in the sand-rock entirely free from water. Also, the rock here lies at a higher level than the Bradford rock, and therefore belongs to the upper strata, in which the heavy oils are found.

The Warren oil-rock is from 12 to 25 feet thick, and there are two strata about 100 feet apart; but no well has yet found oil in paying quantity in both rocks, where one overlies the other, as occurs in some parts of the district. The drilling here has been so extended as to leave no space sufficient for a new basin of large capacity; and as north of Wellsville the geological formation changes, the metamorphic rock cropping out in the immediate neighborhood, the oil district cannot extend far in that direction, and at all other points it has been thoroughly tested by the drill.

Stimulated by the large prosperity attending the development at Bradford, test drilling advanced in every direction to the extreme limits of what is geologically regarded as the oil region. For a period of nearly three years, ending with 1880, more of this work was done than during the previous seventeen years since oil mining began; but the want of success in finding new oil-fields, and the enhanced cost and diminished price of petroleum, have all contributed to discourage and arrest this pioneer work.

The impression that there are no more great basins like those of Venango, Butler, and Bradford remaining to be discovered is gradually growing into a conviction that Bradford is indeed the last, and that hereafter this region will have to depend entirely upon minor deposits and districts for its supply. This belief is supported both by the practical experience of oil-men and by the observation of geologists. We are satisfied that no one can make a careful survey of the oil region without being impressed by the great amount of test drilling that has been done. This work has been quietly prosecuted in the depths of the forest and other unfrequented places, and is little noticed and little talked about unless oil is found. It is only the successful adventurer who receives public attention; the unsuccessful man is seldom heard of, but the abandoned well, with its dilapidated "rig", everywhere attests his energy.

From the foregoing statement the following deductions may be drawn:

1st. That the Bradford field, from its uniformity and extent, constitutes the true oil center of the whole region, and that it is already declining; that, as all statistics show, the decline of the old wells averages about 150,000 barrels per month; that this decline has hitherto only been overcome by large and continuous drilling; that the field has now reached a condition where the production cannot be maintained by the incoming new wells; that the number of openings in the field has so drawn upon the common reservoir that further drilling is simply subdivision of what is left and will only tend to hasten exhaustion, and that therefore the decline must proceed month by month with increasing rapidity.

2d. That the production to supply hereafter the large demands upon this region (which will amount this year to 19,000,000 or 20,000,000 barrels) must come from minor deposits.

3d. That to supply this production from these minor deposits will be attended with greater uncertainty and a greater degree of cost than heretofore.

4th. That under these circumstances the stock of crude oil in the region will be held more firmly, and that consequently the range of prices must be permanently higher than during the last three years.

Artificial conditions and the influence of speculation may for a time interfere with, but cannot prevent this result; indeed, nothing can prevent it save that of which there is now no sign—the discovery of a new, great basin. (a)

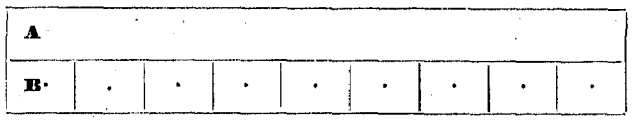
In still further illustration, the following admirable survey of the available resources for future production is quoted from the correspondence of the *Oil and Drug News* for February 28, 1882:

How far off is the date when the production of petroleum will not be in excess of the demand is the great question of the hour to all parties concerned. Daily, monthly, and yearly reports are printed by many parties, a large proportion of which differ one from another. In giving the amount of oil taken from private, wooden, and iron tankage and run into the pipe-lines some reports give the year 1881 credit for the production of the same, when it really was produced in 1879 or 1880. This, of course, would swell the production of 1881 on paper only.

Opperman, a civil engineer and map-maker of this county, and who is good authority, gives the total producing territory in the Bradford field, including Cattaraugus county, New York, at 68,250 acres. February 1, 1882, there were 11,764 wells; and if we estimate 5 acres to the well, 11,764 by 5 gives us 58,820 acres drilled, leaving a balance of 9,430 acres of the lightest territory yet to be drilled, of which from 2,000 to 3,000 can, and probably will, be drilled at present prices, but the balance cannot be operated at less than $1 or $1 25 per barrel.

In November, 1880, there were about 7,000 wells in this field which had been shot with light torpedoes. At this date the large torpedo was found to be more productive, and since this time the greater part of the 7,000 wells have been cleaned out and reshot with the heavy torpedo with good results. (A medium size torpedo nowadays is 60 quarts, which costs, net cash, $290 40.)

Production was further encouraged in 1881 by a great deal of crowding, which I explain as follows:



A wishes to drill one well per month, or wait for higher prices, while B leases his land in small lots. The outcome of this is, a number of wells are drilled along the border of B, which compels A to do the same or lose his oil. This is one of the principal reasons why producers bring their oil to the top of the ground instead of leaving it in the rock at present prices.

The Forest and other large oil companies show by their statements that the cost of production in 1881 was from 30 to 40 cents per barrel more than in 1879 and 1880. This is owing to the pressure of gas and oil upon the rock exhausting, wells ceasing to flow, and pumping resorted to.

The cost per barrel for production in 1879 and 1880 was from 65 to 75 cents, and if the companies are right in their figures the present cost must be considerably above the present market price.

During the six months from July, 1880, to January 1, 1881, the total production of the country was estimated at 90,000 barrels per day, and during much of this time from 3,000 to 6,000 barrels per day was running on the ground in the Bradford field, owing to the inability of the pipe-lines to store and ship the same, and in part owing to the inability of the producers to build private iron and wooden tankage.

During these six months the highest production of the Bradford field was reached, being about 75,000 barrels per day (15,000 being the average production of the other fields). This has gradually declined, until on January 1, 1882, it was about 61,000 barrels per day. This decline includes all drilling of new wells up to that date.

There were more wild cat (or, in other words, prospective) wells put down in 1881 than in all previous years of the oil business, which developed nothing new except the Richburg or Allegany field, in Allegany county, New York. This goes to show that a large territory has been condemned which was counted on as a possible oil-field.

The Allegany field consists of from 7,000 to 8,000 acres, of which about 4,500 is good for 10-barrel wells and upward. The balance from 2- to 10-barrel wells.

On February 1 there were over 600 wells producing from 4,500 acres, and allowing 5 acres to each well, this 4,500 acres will be drilled by April 1, at the present rate of drilling, which is 175 wells per month.

It is estimated that one well to 10 acres is sufficient to drain the land, but where one well is put down to every 5 acres the territory exhausts more rapidly, on the principle of a glass of lemonade exhausting itself sooner when five straws are applied instead of one.

If the Allegheny field is to become a second Bradford, as some seem to say, why is it that the producers have drilled wells so thickly on the 4,500 acres, which is the cream of the territory, and how do they account for the 125 or 130 dry wells immediately surrounding the field? Bradford, in its early development, has scarcely a dry hole in its producing area. In the early days of Bradford torpedoes from

a *Stowell's Petroleum Reporter*, August 23, 1881.

2 to 6 quarts were used, while to-day Allegheny wells are treated to from 40 to 120 quarts, thereby forcing the production to an unnatural large amount for a short time, but the land is being drained correspondingly rapidly.

The following shows the condition of the oil production, etc.:

	Barrels.
Total oil in all pipe-lines, January 1, 1881 (*a*)	16,606,343
Total oil at wells in Bradford field, January, 1881 (*b*)	2,403,500
Total oil in private iron tankage, Bradford field, January 1, 1881 (*c*)	692,750
	19,702,593
Total oil in all pipe-lines, January 1, 1882 (*a*)	25,333,413
Total oil at wells in Bradford and Allegheny fields, January 1, 1882 (*c*)	1,135,848
Total oil at private iron tanks, Bradford and Allegheny fields, January 1, 1882 (*c*)	104,256
	26,573,517
Deduct amount for January 1, 1881	19,702,593
Total net increase of stock in oil regions on January 1, 1882	6,870,924

This amount divided by 365 days gives:

Total net average daily increase in stocks in 1881	18,824
Total net average daily shipments from oil regions in 1881 (*a*)	55,774
Add the daily average increase and shipments for net production	74,598
Add the daily average evaporation and shrinkage (*a*)	2,150
Giving the daily average gross production	76,748
The daily average shipments of 1880 (*a*) were	42,916
The daily average shipments of 1881 (*a*)	55,774
Shows increase in 1881 over 1880 to be per day	12,858

Our export trade has increased nearly every year since 1852. I copy the following from the *American Exporter* for December, 1881:

	Gallons.
Total exports of petroleum and petroleum products for October, 1881	54,244,846
Total exports for same, October, 1880	34,065,254
Increase for October, 1881, over October, 1880	20,179,592
Total for 10 months ending October 31, 1881	422,713,216
Total for 10 months ending October 31, 1880	295,520,798
Increase foreign demand in ten months	127,192,418

The *Oil and Drug News* of January 31, 1882, says:

The total exports of petroleum and petroleum products from the port of New York, in gallons, from January 1 to January 28, 1882, as compared with those of the same period in 1881, are:

	1882.	1881.
Crude, gallons	2,913,442	2,641,430
Refined, gallons	16,556,230	10,035,481
Naphtha, gallons	153,131	541,297
Total	19,622,803	13,218,208
Total increase in foreign demand for the first 28 days of this year, gallons.		6,404,595

Now let us take into consideration the increase in home consumption.

For illuminating purposes it is universally used throughout the country, except where gas exists, and with the wonderful increase in railroads to the far west and south, including all the mining regions, and the increase of population, an unusual increase is sure to follow.

The exact amount of home consumption has never been actually given; it has only been estimated.

In 1880 it was placed at 13,000 barrels per day; in 1881 there were 55,774 barrels (*a*) per day shipped from the oil country, and 40,800 barrels (*b*) per day exported from the United States. The difference between the exports and the shipments from the oil country would show the home consumption to have been 15,000 barrels per day, but there was estimated to have been a large amount of the stocks used, which was stored at the refinery centers and sea-boards, estimated at about 3,000 barrels per day; add this to the 15,000 shows the estimated home consumption for 1881 to have been 18,000 barrels per day, which is an increase over 1880 of 5,000 barrels per day. Owing to the rapid development of the far south and west, and the general prosperity of the country, the home consumption may safely be estimated at 22,000 barrels per day for 1882.

Eight persons out of ten say that Allegheny is at its height, and I have shown where it is probable that the cream of her territory will be drilled by April 1 next, from which time her production will decline. Then consider the number of dry wells which have been drilled in all parts of the country, which shows that the prospects for developing a new oil-field are not very promising.

With Allegheny so near drilled out, the Bradford field declining at from 75,000 to 100,000 barrels per month, and other territory not increasing, is it not natural to predict that the quantities of production and demand must soon come together, at which time prices will naturally advance rapidly? Taking into consideration the reshooting of wells in Bradford field in 1881, the finding of the Allegheny field, the extra amount of crowding lines, etc., after all this the total net increase of stocks in oil regions, January 1, 1882, over January 1, 1881, is only 6,870,923 barrels, while the increase in shipments were 12,858 barrels. Add to this the decrease of stocks at refinery centers, 3,000 barrels, gives 15,858 barrels increase demand per day, or 5,757,510 barrels for the year.

a Official. *b* *Bradford Era.* *c* Producers' report.

The consumptive demand of the world for 1881 was about 21,535,902 barrels, or 59,000 barrels per day, and the demand for 1882 is estimated at, at least, 15 per cent. more (15 per cent. is the average increase the past ten years), which will amount to 24,766,187 barrels for the year, or 67,852 barrels daily average, exclusive of evaporation and shrinkage. The 25,333,413 barrels in pipe-lines seem to lead some people astray.

The above figures show that the entire amount, if drained from the lines, would be only one year's demand, and all know that we could only spare, say, 10,000,000 barrels, as about 15,000,000 is required to carry on the business in the same way as a bank requires capital. Should a few million barrels be taken from the present stock, this, together with the increased consumption, would revolutionize prices.

These illustrations received increased significance when it is understood that within twelve months of the time the first paper was written and immediately following the date of the last the Warren district yielded some of the largest wells on record, and the price of oil tumbled to a still lower figure, instead of being permanently higher.

While it is not probable that the deposits of petroleum within the crust of the earth are being practically increased at the present time, there is reason to believe that the supply is ample for an indefinite period. When prophecy, indulged even by the most sagacious producers of longest experience, proves so futile, I think I am warranted in expressing the opinion that, as regards the future supply of petroleum, the drill alone gives valid testimony. Yet this fact is worthy of the most serious consideration: the production of petroleum as at present conducted is *wasteful in the extreme.* No thoughtful person can escape the conviction that future generations will want what this present generation is destroying to no purpose. "After us the deluge," is written all over the oil region in the destruction of forests and in the waste of the oil itself.

STATISTICS OF THE EXPORTS OF PETROLEUM DURING THE CENSUS YEAR.

The following tables have been prepared for the purpose of showing the relative magnitude of the export trade in petroleum during the census year, the relative amount exported from different ports of the United States during that year, the points to which it was sent, and the relative amount of such export trade in the different manufactured products of petroleum during different years. These tables consist of:

Table I.—Shipments of crude and refined oil out of the producing region to the following points during the census year, by months.

Table II.—Receipts of crude and refined petroleum, etc., at New York, weekly, by routes, during the census year.

Table III.—Exports of petroleum and petroleum products from New York to foreign ports for 1878, 1879, 1880, and the census year; also from Philadelphia for the same time.

Table IV.—The charters reported for crude and refined petroleum, naphtha, and residuum, from New York, Philadelphia, Boston, Baltimore, Richmond, and Portland, to the different ports of the world, exclusive of North America, during the census year.

Table V.—Petroleum and its products exported from the United States during the years ending June 30, 1879 and 1880.

Table VI.—Exports of petroleum and petroleum products from all United States ports to all foreign countries, and the declared value thereof, from 1873 to 1880, inclusive, and the census year, by months.

Table VII.—Quantity of petroleum produced, and the quantity and value of petroleum products exported from the United States during each fiscal year from 1864 to 1880, inclusive.

Table VIII.—New York petroleum market, average prices per year.

Table IX.—Imports of refined petroleum at five principal ports of the United Kingdom, with stocks at the same ports, January 1, 1874, to 1881, inclusive.

Table X.—Imports of petroleum at the undermentioned European ports for seven years ended December 31, from 1874 to 1880, inclusive.

Table XI.—The various products of crude oil, including petroleum, crude oil, refuse oil, and grease, and all products of naphtha exported from Baku, from 1832 to 1879, in poods of 36 pounds each.

Table XII.—Imports of American petroleum (refined) into Japan, from the time of the first importation, in 1872, to the end of 1880.

An inspection of these tables shows a steady increase in the quantity of petroleum and petroleum products exported to the end of 1879; 1880 showed a slight decrease. The months constituting the census year—from June 1, 1879, to May 31, 1880—exhibit an unparalleled activity in almost every item where the statistics were to be found in such form that the months of the census year could be separated from the totals for 1879 and 1880.

Table I shows that the shipments of refined oil from the producing region to New York declined during 1880 more than 1,100,000 barrels, or about 68 per cent. This decline took place mainly after the close of the census year, as the shipments for that year amounted to nearly 85 per cent. of those for 1879. Shipments to both Philadelphia and Baltimore of refined oil were merely nominal both during the census year and during 1880, while there were no shipments in 1879 to either of these points.

The shipments of refined oil to Boston and local points were not materially changed in the aggregate for the two years, but the amount shipped during the census year exceeded that moved during either 1879 or 1880.

The shipments of crude oil out of the producing region to New York, Philadelphia, Cleveland, the Ohio river, and local points show a marked increase in 1880 over 1879, while the shipments to Baltimore, Boston, and Pittsburgh show a considerable decline during the same time; yet to all of the points mentioned above, excepting

the local points, the shipments during the census year were larger than during either of the years of which it forms a part. The total shipments of crude oil out of the producing regions in 1879 to the points above mentioned was 15,987,370 barrels; in 1880, 15,675,492 barrels; and during the census year, 17,769,656 barrels, an amount 11 per cent. greater than the average for the two years.

Table II shows in the totals the same steady increase in the movement of crude oil to New York, and an equally steady decline in the movement of refined oil to the same point. During 1877, 103,662,216 gallons of refined oil entered New York, and by 1880 the receipts had fallen to 42,847,577 gallons, although the amount received during the census year was nearly equal to that received during 1879. During 1877 the receipts of crude oil at New York were 179,214,244 gallons, an amount which was increased to 256,878,660 gallons during 1880, and to 285,839,983 gallons during the census year. These figures indicate a diversion of the product of the refineries located in the interior cities from the export trade and an increase in the proportional supply of that trade by New York city. Table I also shows a similar increase in the consumption of crude oil for Philadelphia and Cleveland, while Boston, Baltimore, and Pittsburgh exhibit a large decline in receipts of crude oil during 1880. It seems, therefore, fair to assume that the manufacture of oils for export has steadily increased in New York, Philadelphia, and Cleveland, and has declined in Baltimore, Boston, and Pittsburgh, notwithstanding the movement of refined oil toward New York has steadily declined, and has been merely nominal toward Philadelphia and Baltimore, while the amount received at Boston has remained practically unchanged.

Table III shows the relative amount of petroleum and petroleum products exported from New York and Philadelphia to different countries during 1878, 1879, 1880, and the census year. The special activity of the export trade during the census year is illustrated by this table, not only in the totals, but also in the items.

Table IV exhibits the destination of the petroleum and petroleum products sent from the country during the census year, the manner in which it was packed, and the kind of material sent to different ports and countries As this table was compiled from the charters reported, some of which were vessels that arrived or were filled after the census year closed, the amounts do not correspond with those given in other tables, which were compiled from the clearances. This discrepancy does not vitiate the statistics of the table for the purpose given above.

The charters for crude oil were for—

	Barrels.	
France	395,560	
Belgium	85,500	
Spain	61,400	191,600 cases.
Bremen	30,800	
Continental ports	18,500	
Mediterranean ports	7,509	
Ireland	5,000	
Total	604,269	191,600 cases.

The charters for refined petroleum were—

For Europe, including the Mediterranean islands:	
Barrels	5,213,081
Cases	1,366,150
Miscellaneous Mediterranean ports, the Levant, Asia Minor, and Syria:	
Barrels	50,800
Cases	874,000
Africa and Mauritius:	
Barrels	2,000
Cases	380,000
Asia, Australia, and the East Indies:	
Cases	6,003,800
South America:	
Cases	17,000

The charters for naphtha were for—

England:	
Barrels	106,050
France:	
Barrels	87,650
Cases	4,900
Belgium:	
Barrels	23,200
Cases	10,000
Sweden:	
Barrels	13,900
Continental ports:	
Barrels	10,300

The charters for residuum were for—

	Barrels.
England	89,900
France	2,000
Antwerp	300

The following-named geographical sections took charters in the census year as given below:

	REFINED.		NAPHTHA.		CRUDE.		RESIDUUM.	
	Barrels.	Cases.	Barrels.	Cases.	Barrels.	Cases.	Barrels.	Cases.
Great Britain	1,218,150		106,050		5,000		89,900	
Sweden and Norway	77,800		13,900					
Denmark	97,300							
Miscellaneous Baltic ports	361,650							
Russia:								
Baltic	13,950							
Black sea		48,000						
Holland	177,300							
Germany	1,594,250				30,800			
Belgium	552,800	1,000	23,200	10,000	85,500		300	
Continental Europe	706,000		10,300		18,500			
France		7,000	87,650	4,900	395,560		2,000	
Spain:								
Outside	15,400	155,700			61,400	191,600		
Inside	12,300	244,250						
Portugal	32,509	17,000						
Sardinia		12,000						
Sicily		113,000						
Italy	76,700	298,000						
Malta		15,000						
Adriatic ports	7,000	102,000						
Trieste	208,966							
Ionian islands and Greece		73,200						
Turkey in Europe		280,000						
Levant		186,000						
Miscellaneous Mediterranean ports	50,800	602,500			7,509			
Syria and Asia Minor		85,500						
Egypt		230,000						
Algiers	1,000	53,000						
Liberia	1,000	21,000						
Zanzibar		45,000						
South Africa		6,000						
Mauritius		25,000						
British India		1,149,800						
Ceylon		95,000						
Rangoon		151,500						
East Indies		153,000						
Java		2,555,000						
Australia		50,000						
New Zealand		20,000						
Manila		17,000						
China		650,500						
Japan		1,028,000						
Singapore		112,000						
Saigon		22,000						
Buenos Ayres		10,000						
Brazil		7,000						

Commencing at the head of the list, it will be observed that 4,799,706 barrels of refined oil were chartered for Great Britain and the continent of Europe north of France. This amount was all chartered in barrels, with the exception of only 1,000 cases, probably of a special brand, which went to Antwerp. In addition to this vast quantity, amounting to nearly 68.5 per cent. of the total charters of refined oil, there were chartered for the same region 153,450 barrels and 10,000 cases of naphtha, 139,800 barrels of crude oil, and 90,200 barrels of residuum, of which latter material all but 300 barrels were for Liverpool and London, England.

There were chartered for France only 7,000 cases of refined oil, which was for the port of Marseilles, and probably consisted of some special brand. The charters for France, however, included 87,650 barrels and 4,900 cases of naphtha, 395,560 barrels of crude and 2,000 barrels of residuum. France has for many years laid an import duty on refined oils and admitted crude oil free, thus fostering the manufacture of refined oils on her own soil. This fact accounts for the heavy charters of crude oil for French ports.

The charters for Spanish ports embraced both refined and crude oil in barrels and cases. There were chartered for Spain 61,400 barrels and 191,600 cases of crude oil. It will be observed that the charters for the inside ports of Spain include a larger proportion of case oil than the outside. Nearly two-thirds of the oil chartered for Portugal is in barrels. With the exception of 7,509 barrels of crude oil chartered for miscellaneous Mediterranean ports, probably Spanish and French, no crude oil, naphtha, or residuum was chartered east of France or south of

the straits of Gibraltar. All of the refined oil chartered for Austria through Trieste was in barrels, besides which 135,500 barrels were chartered for Italy and various Mediterranean and Adriatic ports in barrels. The remainder of the oil chartered for ports between France and Port Said was all case oil, and amounted to 2,098,200 cases. All of the oil chartered for ports south and east of the Mediterranean sea, with the exception of 1,000 barrels for Las Palmas, Canary islands, was case oil. The trade with eastern Asia, including India, the islands, China, and Japan, in case oil is enormous, the charters amounting to 5,933,800 cases for the census year.

Table V shows the relative amounts of the different products of petroleum sent from the different ports, and also gives the amounts and values of lubricating oils exported. In 1879 New York exported of lubricating oils less than one per cent. of the amount of illuminating oils exported, while Boston sent out of lubricating oils nearly 10 per cent. of the amount of illuminating oils exported. The quantity of lubricating oils exported in 1880 was nearly double that of 1879. The total exports of 1880 were more than 45,000,000 gallons in excess of those of 1879, yet their total value was more than $4,000,000 less for the last-named year.

Table VI shows the quantity and value of petroleum and petroleum products exported from the United States from 1873 to 1880, inclusive. This table shows generally a steady increase in the quantity of the different products exported from year to year, but the value of these different quantities varied greatly. For instance, in 1876, 25,343,271 gallons of crude oil were exported, worth $3,343,763, and in 1880, while the quantity was increased to 35,481,168 gallons, the value was decreased to $2,679,193. In 1877, 309,778,832 gallons of refined oil were exported, worth $51,901,106, while the following year, although the amount was lessened only 882,525 gallons, the value was reduced $12,806,655, and in 1879, while the quantity reached 367,321,255 gallons, the value fell to $32,696,713, and in 1880 was still less. The exports of petroleum and its products were valued in 1877 at $57,497,164, a larger amount than has been realized from the same source in any one year prior to January 1, 1881.

Table VII shows the production and quantity and value of exports for seventeen years ending June 30, 1880; that is, for the last seventeen fiscal years prior to and including the census year. (*a*) The fluctuations in relative quantity and value are exhibited in this table.

As an illustration, in round numbers, the 425,000,000 gallons exported in 1880 brought $500,000 less than the 150,000,000 gallons exported in 1871, and about 65 per cent. of the amount obtained for 309,000,000 gallons in 1877. The exports of the fiscal year 1877 were valued at $61,789,438.

The remaining tables need no explanation.

THE CONSUMPTION OF PETROLEUM AND PETROLEUM PRODUCTS IN THE UNITED STATES.

The amount of petroleum and petroleum products consumed in the United States in any given time is a residual quantity consisting of elements very difficult to estimate with absolute accuracy. An approximate estimate, however, has been repeatedly made by subtracting the exports, reduced to crude equivalent from the production, less the accumulated stocks. This method, never of much value, is becoming more unreliable each year as the increasing demand for mineral oil residues increases the production of reduced petroleum, and, consequently, the proportion of illuminating oil manufactured without cracking, and therefore not representing 75 per cent. of the crude oil. The production of oil out of the ground for the census year has been already estimated at 24,354,064 barrels. Of this amount 315,000 barrels were estimated to have been wasted or burned, leaving 24,039,064 barrels as the available production, of which 5,350,863 barrels were added to the stocks already accumulated. Of the remaining 18,688,201 barrels, 17,417,455 barrels were manufactured in this country and 673,763 barrels were exported, leaving 596,983 barrels for consumption in this country.

Of illuminating oils of all grades there were manufactured 11,002,249 barrels, of which 7,346,516 barrels were exported, leaving 3,655,733 barrels for home consumption, an average of about 10,000 barrels per day.

Of lubricating oils there were manufactured of all kinds and grades 380,739 barrels, of which 103,257 barrels were exported, leaving 277,482 barrels for home consumption. Oils consisting in part of crude petroleum are not included in the above amount.

Of naphthas of all grades, including gasoline, there were manufactured 1,508,049 barrels, of which 368,221 barrels were exported, leaving 1,139,828 barrels, of which 57,843 barrels were used as fuel by the manufacturers of petroleum, leaving 1,081,985 barrels for home consumption.

It is impossible to assign any definite amount as representing the consumption of residuum; 229,173 barrels were sold by the manufacturers and 235,314 barrels were burned by them as fuel. Of the 229,173 barrels, 94,141 were exported, leaving a remainder of 135,032 barrels, nearly the whole of which was used as raw material by the manufacturers of lubricating oils. The term "residuum", as it has been used in this report, is probably not properly applied to the whole of the 94,141 barrels reported as exported; but it is impossible to distinguish in the statistics of exports between the different materials, denominated "tar", "pitch," etc., included under the term "residuum."

I have not met with any notice of the export of paraffine wax, but it is not therefore safe to infer that the 7,889,626 pounds manufactured were all consumed in the United States. One firm manufactured 900,000 pounds of candles. While the manufacture of candles represents the largest use for any one purpose, the great number of uses to which it is now applied in the arts represents an enormous consumption of this substance.

a The census year closed May 31. Practically the last fiscal year is the census year.

The actual consumption of crude petroleum represented by these figures is, after all, only an approximation to a correct result. If the illuminating oils are assumed to represent 75 per cent. of the crude oil, the consumption of crude oil as illuminating oil was 4,874,310 barrels, or 13,354 barrels daily; but in reality the illuminating oil, all grades taken together, does not represent 75 per cent. of the crude oil, and I am inclined to think that 15,000 barrels daily is not far from a correct estimate for the consumption of crude petroleum in the United States during the census year.

TABLE I.—SHIPMENTS OF CRUDE AND REFINED OIL OUT OF THE PRODUCING REGION TO THE FOLLOWING POINTS DURING THE CENSUS YEAR.

[Compiled from the reports of the New York Produce Exchange.]

Month and year.	REFINED REDUCED TO CRUDE.					CRUDE.									
	New York.	Philadelphia.	Baltimore.	Boston.	Local points.	New York.	Philadelphia.	Baltimore.	Boston.	Cleveland.	Pittsburgh.	Ohio river.	Local points.	Fire.	Total.
1879.	*Barrels.*	*Barr'ls.*	*Barr'ls.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barr'ls.*	*Barrels.*
June	210,488	.....	.....	37,830	24,984	643,817	29,151	53,957	10,087	114,810	207,697	17,720	18,773	.....	1,369,314
July	240,311	.....	.....	62,493	15,516	465,824	139,968	57,187	23,203	292,924	278,080	20,336	29,243	.....	1,625,095
August	177,407	.....	.....	37,350	25,806	655,416	196,915	57,337	10,178	314,477	284,563	15,214	33,576	.....	1,808,239
September	135,043	.....	.....	26,977	42,468	623,832	169,062	65,459	16,169	296,116	207,863	5,403	38,728	.....	1,627,120
October	169,335	.....	.....	33,942	30,666	502,400	149,349	74,648	10,352	369,779	267,975	5,932	48,791	.....	1,663,169
November	183,386	.....	.....	28,625	55,245	611,630	137,997	56,778	8,428	228,634	193,770	12,597	36,555	.....	1,553,645
December	91,114	.....	.....	55,085	40,267	667,533	221,743	77,310	11,433	242,415	70,072	27,257	28,356	.....	1,532,585
1880.															
January	55,071	99	.....	33,911	49,098	810,131	171,360	78,017	11,541	228,145	152,330	20,254	40,491	.....	1,650,409
February	24,382	.....	.....	18,050	54,100	758,157	179,145	96,146	.....	156,041	53,418	9,850	42,862	.....	1,302,151
March	62,740	.....	.....	23,989	18,269	984,808	220,517	80,045	9,489	151,775	32,590	7,400	21,240	.....	1,613,462
April	19,225	.....	.....	13,502	21,079	385,727	97,147	12,816	5,758	141,197	65,619	62,194	15,004	.....	839,268
May	2,001	175	499	18,940	23,781	513,704	61,503	31,779	4,642	102,358	105,657	3,818	26,402	200,000	1,095,259
Total, census year	1,370,503	265	499	390,094	401,279	7,622,079	1,773,827	742,079	121,280	2,638,671	1,919,584	207,975	380,021	200,000	17,769,056
Total, 1879	1,612,550	.....	.....	379,293	333,446	6,318,532	1,607,998	677,273	120,584	2,502,570	1,901,649	183,131	350,344	.....	15,987,370
Total, 1880	509,769	2,248	7,322	378,035	397,369	6,461,465	1,741,286	604,183	99,819	2,535,216	958,336	206,577	935,810	582,490	15,420,525

PERCENTAGE OF DELIVERIES OF CRUDE AND REFINED OIL AT THE ABOVE NAMED POINTS.

Census year	63.35	0.01	0.03	18.06	18.55	48.85	11.37	4.75	0.78	16.91	12.30	1.33	2.43	1.28	.....
1879	69.35	.....	.....	16.31	14.34	46.25	11.77	4.96	0.88	18.32	13.92	1.34	2.56	.....	.....
1880	39.35	0.17	0.57	29.23	30.68	45.74	12.33	4.28	0.71	17.95	6.78	1.46	6.63	4.12	.....

TABLE II.—RECEIPTS OF CRUDE AND REFINED PETROLEUM, ETC., AT NEW YORK, WEEKLY, BY ROUTES, DURING THE CENSUS YEAR.

[Compiled from the reports of the New York Produce Exchange.]

For week ending—	BY ERIE RAILWAY.			BY HUDSON RIVER RAILROAD.		BY PENNSYLVANIA RAILWAY.			CANAL.	TOTAL.		
	Crude.	Refined.	Naphtha.	Crude.	Refined.	Crude.	Refined.	Naphtha.	Crude.	Crude.	Refined.	Naphtha.
1879.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
June 5	1,641,465	358,093	.....	1,805,265	1,031,321	2,610,193	26,220	.....	567,730	6,633,353	1,409,634	.....
June 12	1,366,605	982,488	.....	1,862,235	699,501	3,227,714	.....	.....	.....	6,456,644	1,681,989	.....
June 19	640,080	378,256	.....	1,780,065	1,273,512	2,765,171	21,798	.....	901,108	6,086,424	1,673,566	.....
June 26	1,730,340	756,606	.....	1,557,630	1,162,451	2,558,377	64,296	.....	250,914	6,097,261	1,983,353	.....
July 3	1,513,080	709,324	.....	1,223,370	1,626,623	2,453,333	144,572	.....	.....	5,189,783	2,480,519	.....
July 10	840,375	818,223	.....	982,215	1,268,483	1,584,893	78,960	.....	.....	3,407,483	2,165,666	.....
July 17	616,770	1,188,630	.....	1,029,420	2,086,612	2,379,670	526,525	.....	48,005	4,073,865	3,795,767	.....
July 24	539,935	931,869	.....	1,407,960	2,170,037	2,207,696	849,901	.....	.....	4,155,611	3,951,807	.....
July 31	1,733,940	1,127,248	.....	1,687,860	1,640,316	2,166,219	885,762	.....	.....	5,588,019	3,659,326	.....
August 7	1,048,095	464,172	.....	1,712,025	2,139,487	2,278,433	957,719	.....	.....	5,038,553	3,561,378	.....
August 14	1,126,575	830,537	.....	2,379,240	2,579,830	2,080,899	1,617,082	.....	.....	5,586,714	5,027,449	.....
August 21	1,570,050	952,925	.....	1,915,200	1,428,236	1,517,964	1,257,156	.....	.....	5,003,214	3,638,317	.....
August 28	1,854,720	771,787	.....	2,420,010	1,496,574	2,161,847	1,530,884	.....	.....	6,445,577	3,799,245	.....
September 4	2,090,880	188,141	.....	2,343,565	923,823	1,744,387	1,210,391	.....	.....	6,178,822	2,322,364	.....
September 11	1,655,460	110,732	.....	2,178,405	684,837	1,544,964	70,359	.....	.....	5,378,829	865,928	.....
September 18	634,545	971,300	.....	2,840,085	1,056,184	2,002,126	782,315	.....	.....	5,476,756	2,209,799	.....
September 25	1,184,185	479,400	.....	977,805	1,435,944	2,973,266	449,367	.....	.....	5,085,296	2,364,711	.....

TABLE II.—RECEIPTS OF CRUDE AND REFINED PETROLEUM—Continued.

For week ending—	BY ERIE RAILWAY.			BY HUDSON RIVER RAILROAD.		BY PENNSYLVANIA RAILWAY.			CANAL.	TOTAL.		
	Crude.	Refined.	Naphtha.	Crude.	Refined.	Crude.	Refined.	Naphtha.	Crude.	Crude.	Refined.	Naphtha.
1879.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
October 2	991,485	564,000	.....	2,601,360	1,404,783	2,388,762	450,100	.....	.....	5,981,607	2,418,883	.....
October 9	535,185	826,730	.....	1,088,325	792,796	2,227,820	402,057	.....	.....	3,851,330	2,021,583	.....
October 16	455,400	1,312,788	.....	280,575	551,733	1,840,110	240,358	.....	.....	2,576,085	2,104,879	.....
October 23	1,297,575	633,090	.....	358,830	689,302	2,516,842	93,718	.....	.....	4,173,247	1,416,110	.....
October 30	1,704,960	593,093	.....	1,019,225	1,226,465	2,916,481	11,938	.....	.....	5,640,666	1,831,496	.....
November 6	1,246,680	84,224	.....	843,210	487,625	2,778,771	34,028	.....	.....	4,868,661	605,877	.....
November 13	1,871,640	745,796	.....	781,920	752,705	2,608,972	74,307	.....	.....	5,262,532	1,527,808	.....
November 20	2,614,590	587,453	.....	683,910	656,138	1,910,763	667,024	.....	.....	5,209,263	1,910,615	.....
November 27	2,166,435	560,522	.....	719,585	596,195	1,781,129	252,531	.....	.....	4,667,049	1,409,248	.....
December 4	1,568,340	629,988	.....	726,930	287,311	3,773,693	736,866	.....	.....	6,068,963	1,654,165	.....
December 11	1,192,230	379,525	.....	1,364,040	402,137	2,365,794	306,205	.....	.....	4,922,064	1,177,867	.....
December 18	1,192,275	379,713	.....	1,235,475	250,510	2,007,899	299,249	.....	.....	4,435,649	929,472	.....
December 25	2,349,360	1,044,105	.....	861,480	623,643	2,154,420	32,900	.....	.....	5,365,260	1,700,648	.....
December 31	2,859,795	1,744,452	.....	887,805	364,062	2,618,748	35,673	.....	.....	6,366,348	2,144,187	.....
1880.												
January 8	2,495,655	1,193,850	.....	1,039,140	794,100	4,051,321	107,771	.....	.....	7,586,116	2,095,721	.....
January 15	3,411,810	963,200	.....	1,158,120	440,950	3,288,166	401,756	.....	.....	7,856,096	1,805,906	.....
January 22	2,306,205	501,250	.....	1,306,170	340,100	1,386,682	438,050	.....	.....	4,999,057	1,279,400	.....
January 29	2,708,460	653,300	66,150	1,369,980	221,800	2,601,312	254,350	.....	.....	6,679,752	1,129,450	66,150
February 5	1,502,805	368,750	.....	1,392,668	156,600	3,683,581	210,200	.....	.....	6,639,054	735,550	.....
February 12	2,336,680	181,300	.....	1,309,065	173,500	3,301,056	89,450	.....	.....	6,946,841	444,250	.....
February 19	2,263,320	51,300	.....	1,786,185	109,500	2,451,109	19,500	.....	.....	6,500,714	180,300	.....
February 26	1,873,170	41,100	.....	1,485,495	136,900	2,453,912	11,600	.....	.....	5,812,577	189,600	.....
March 4	1,482,840	30,000	47,150	1,934,820	96,250	3,663,640	2,500	.....	.....	7,081,000	129,650	47,150
March 11	48,500	2,983,950	89,350	1,886,625	112,750	3,040,501	6,750	.....	.....	4,976,626	3,103,450	89,350
March 18	3,701,520	2,800	59,150	2,088,755	108,600	3,442,571	27,500	.....	.....	9,232,846	138,900	59,150
March 25	3,074,220	2,800	132,850	1,779,345	171,300	3,201,898	5,000	.....	.....	8,055,463	179,100	132,850
April 1	2,834,100	1,302,500	.....	2,066,445	428,100	3,626,020	2,500	.....	.....	8,526,565	1,733,100	.....
April 8	1,124,910	.....	.....	1,310,445	714,700	2,122,824	16,000	.....	.....	4,557,539	730,700	.....
April 15	817,875	2,650	.....	595,620	71,000	411,573	.....	.....	.....	1,825,468	73,650	.....
April 22	1,711,845	.....	.....	444,815	44,000	1,144,611	2,500	.....	.....	3,301,271	46,500	.....
April 29	2,195,280	19,450	.....	716,500	32,000	208,583	5,000	.....	.....	3,120,363	56,450	.....
May 6	1,097,640	38,700	.....	1,727,010	96,000	777,995	2,500	.....	.....	3,602,645	137,200	.....
May 13	2,803,770	.....	.....	1,751,070	140,000	450,614	17,400	.....	.....	5,006,454	157,400	.....
May 20	3,674,385	35,300	.....	1,733,400	108,000	617,924	6,600	.....	.....	6,025,709	149,900	.....
May 27	4,367,835	16,050	.....	1,519,200	78,100	250,314	7,500	.....	.....	6,137,349	101,650	.....
Total, census year	91,675,935	29,894,360	394,650	73,965,518	38,459,426	118,332,563	15,732,688	.....	1,767,757	285,740,033	84,041,483	394,650
Total, 1880	119,842,560	19,271,650	1,061,250	80,825,203	18,439,950	56,210,897	5,135,977	.....	.....	256,878,660	42,847,577	1,553,850
Total, 1879	77,580,610	28,460,996	256,620	68,061,215	43,657,858	98,434,951	15,406,718	394,337	2,830,045	246,906,821	87,525,572	650,957
Total, 1878	67,263,973	26,541,352	664,380	47,579,410	42,389,953	68,110,155	15,873,717	.....	7,103,634	189,708,589	79,600,602	.....
Total, 1877	63,734,244	51,117,982	860,850	36,882,450	45,319,605	78,597,550	7,184,614	.....	.....	179,214,244	103,662,216	.....

TABLE III.—EXPORTS OF PETROLEUM AND PETROLEUM PRODUCTS FROM NEW YORK TO FOREIGN PORTS FOR 1878, 1879, 1880, AND THE CENSUS YEAR.

[From the reports of the New York Petroleum Exchange.]

REFINED PETROLEUM. 1 barrel = 50 gallons.

	1878.		1879.		1880.		Census year.	
	Gallons.	Barrels.	Gallons.	Barrels.	Gallons.	Barrels.	Gallons.	Barrels.
Great Britain:								
London	13, 158, 980	263, 180	21, 192, 079	423, 842	14, 026, 865	280, 537	22, 367, 521	447, 350
Liverpool	5, 013, 377	100, 268	7, 993, 254	159, 865	6, 482, 959	129, 659	8, 943, 434	178, 869
Bristol	2, 537, 886	50, 758	4, 280, 209	85, 604	4, 195, 827	83, 917	3, 299, 266	65, 985
Ireland	5, 444, 392	108, 888	7, 158, 319	143, 166	4, 261, 677	85, 234	6, 967, 157	139, 343
Other ports	3, 277, 117	65, 542	5, 266, 440	105, 329	3, 935, 042	78, 701	4, 639, 210	92, 784
Germany:								
Bremen	28, 279, 351	565, 587	40, 035, 341	800, 707	43, 953, 350	879, 067	47, 494, 457	949, 880
Hamburg	7, 971, 865	159, 437	11, 638, 166	232, 766	15, 344, 524	306, 890	11, 925, 646	238, 513
Königsburg and Stettin	7, 977, 223	159, 544	7, 425, 684	148, 514	3, 430, 726	68, 615	7, 036, 048	140, 721
Dantzic	3, 386, 423	67, 728	1, 874, 059	37, 481	804, 144	16, 083	1, 149, 168	22, 983
Other ports	739, 317	14, 786	1, 949, 384	38, 808	334, 550	6, 691	1, 094, 486	21, 890
Norway and Sweden	3, 928, 374	78, 567	5, 480, 157	109, 603	5, 771, 784	115, 436	5, 704, 219	114, 084
Russia	1, 811, 288	36, 226	2, 670, 900	53, 418	1, 024, 632	20, 493	2, 062, 717	41, 254
Denmark	5, 886, 528	117, 731	5, 809, 642	116, 193	8, 120, 126	162, 403	5, 038, 410	100, 768
Belgium	10, 909, 641	218, 193	16, 150, 629	323, 133	18, 560, 737	371, 215	17, 640, 481	352, 810
Holland	8, 623, 656	172, 473	11, 010, 971	220, 219	11, 858, 877	237, 178	11, 421, 878	228, 438
Spain	6, 658, 785	133, 176	7, 693, 336	153, 867	2, 618, 769	52, 375	7, 163, 521	143, 270
Portugal	1, 356, 800	27, 136	1, 978, 427	39, 469	1, 336, 379	26, 728	1, 735, 029	34, 701
Gibraltar and Malta	2, 480, 342	49, 607	1, 857, 396	37, 148	2, 573, 923	51, 478	1, 746, 220	34, 924
Italy	3, 018, 291	60, 366	2, 331, 628	46, 633	1, 960, 057	39, 201	2, 161, 160	43, 223
Trieste	5, 807, 423	116, 148	9, 787, 224	195, 744	10, 142, 010	202, 840	8, 967, 587	179, 352
Greece	1, 594, 220	31, 884	1, 513, 650	30, 273	334, 310	6, 686	1, 205, 250	24, 105
Turkey in Europe	4, 453, 916	89, 078	3, 605, 440	72, 109	1, 727, 350	34, 547	3, 048, 386	60, 968
Turkey in Asia	2, 803, 850	56, 077	1, 404, 660	28, 093	660, 990	13, 220	1, 331, 160	26, 623
India	.....	.....	7, 588, 460	151, 769	9, 120, 710	182, 414	13, 178, 760	263, 575
China and Japan	24, 271, 545	585, 431	18, 803, 770	376, 075	6, 751, 392	135, 028	17, 021, 352	340, 427
East Indies	8, 861, 345	177, 227	22, 145, 090	442, 902	14, 949, 765	298, 995	26, 926, 105	538, 522
Africa:								
Alexandria	1, 555, 666	31, 113	3, 616, 633	72, 333	2, 203, 620	44, 072	2, 820, 560	56, 501
Canary islands	109, 033	2, 181	72, 976	1, 460	74, 995	1, 482	88, 974	1, 779
Other ports	1, 719, 518	34, 390	2, 359, 170	47, 183	2, 077, 655	41, 553	2, 798, 510	55, 970
Australia	2, 476, 982	49, 540	2, 277, 346	45, 547	1, 910, 324	38, 206	2, 954, 956	59, 099
New Zealand	811, 993	16, 240	352, 260	7, 045	565, 482	11, 310	328, 730	6, 575
Sandwich Islands	32, 000	640	45, 850	917	74, 000	1, 480	64, 000	1, 280
South America:								
Brazil	3, 388, 078	67, 762	4, 215, 973	84, 319	4, 036, 859	80, 737	3, 986, 652	79, 733
Argentine Confederation	1, 632, 985	32, 660	1, 659, 210	33, 184	2, 060, 810	41, 216	1, 705, 210	34, 104
Chili and Peru	1, 062, 115	21, 242	926, 872	18, 537	334, 123	6, 682	638, 993	12, 780
United States of Colombia	2, 640	53	38, 060	761	42, 068	841	42, 946	859
Venezuela	403, 682	8, 074	523, 958	10, 479	672, 162	13, 443	483, 220	9, 664
Other ports	13, 500	270	26, 100	522	31, 496	630	45, 477	910
Central America	162, 244	3, 245	215, 383	4, 308	239, 680	4, 794	232, 355	4, 647
Mexico	532, 921	10, 658	784, 483	15, 690	696, 359	13, 927	735, 613	14, 712
British North America	412, 329	8, 247	237, 054	4, 753	171, 337	3, 427	126, 835	2, 537
Cuba	2, 117, 267	42, 345	703, 186	14, 064	433, 528	8, 671	430, 839	8, 617
British West Indies	1, 222, 602	24, 452	1, 386, 679	27, 734	1, 203, 614	25, 272	1, 339, 438	26, 789
Other West Indies	801, 449	16, 029	968, 776	19, 376	928, 393	18, 568	929, 361	18, 587
Totals	188, 708, 939	3, 774, 179	249, 046, 884	4, 980, 938	212, 097, 089	4, 241, 942	261, 030, 291	5, 220, 606

CRUDE PETROLEUM. 1 barrel = 42 gallons.

France:								
Havre	5, 862, 304	139, 579	7, 803, 090	185, 788	7, 687, 297	183, 031	7, 994, 545	190, 346
Marseilles	1, 765, 159	42, 028	2, 041, 059	48, 596	2, 116, 256	50, 387	2, 038, 590	48, 538
Bordeaux	1, 449, 115	34, 503	2, 464, 332	58, 675	1, 853, 088	44, 121	2, 208, 468	52, 583
Dunkirk	2, 929, 780	69, 733	2, 704, 475	64, 392	3, 831, 438	91, 225	3, 278, 011	78, 048
Other ports	629, 319	14, 984	2, 752, 155	65, 527	4, 039, 696	96, 183	2, 938, 081	69, 954
Antwerp	170, 320	4, 055	140, 506	3, 345	322, 115	7, 669	140, 506	3, 345
Bremen	1, 102, 060	26, 240	2, 133, 847	50, 806	3, 703, 109	88, 169	2, 773, 370	66, 028
Norway and Sweden	46, 324	1, 103	.....	.....	51, 968	1, 237	.....	.....
Spain	277, 072	6, 597	1, 873, 167	44, 599	8, 694, 381	207, 009	2, 913, 881	69, 378
Cuba	344, 786	8, 209	1, 614, 300	38, 436	1, 610, 710	38, 350	1, 297, 500	30, 893
Other ports	.....	.....	.....	.....	486	12	486	12
Totals	14, 576, 239	347, 053	23, 526, 931	560, 165	33, 910, 544	807, 394	25, 583, 438	609, 130

TABLE III.—EXPORTS OF PETROLEUM AND PETROLEUM PRODUCTS—Continued.

NAPHTHA. 1 barrel = 50 gallons.

	1878.		1879.		1880.		Census year.	
	Gallons.	Barrels.	Gallons.	Barrels.	Gallons.	Barrels.	Gallons.	Barrels.
Great Britain	4, 915, 361	98, 307	7, 497, 559	149, 951	6, 152, 564	123, 051	7, 024, 509	140, 490
France	2, 372, 820	47, 456	4, 864, 165	97, 283	4, 624, 955	92, 499	6, 768, 300	135, 366
Germany	712, 531	14, 251	937, 995	18, 760	781, 566	15, 631	1, 130, 037	22, 601
Other European ports	1, 304, 755	26, 095	1, 800, 010	36, 000	1, 053, 883	21, 078	1, 777, 404	35, 548
Various ports	109, 916	2, 198	81, 567	1, 631	68, 692	1, 374	74, 009	1, 480
Totals	9, 415, 383	188, 308	15, 181, 296	303, 626	12, 681, 660	253, 633	16, 774, 259	335, 485

RESIDUUM. 1 barrel = 50 gallons.

To all ports	2, 617, 039	52, 341	4, 177, 704	83, 554	2, 863, 552	57, 271	4, 135, 260	82, 705

SUMMARY.

Total refined, crude equivalent	251, 611, 919		332, 062, 500		282, 796, 100		348, 040, 400	
Total crude	14, 576, 239		23, 526, 931		33, 910, 544		25, 583, 438	
Total from New York, crude equivalent	266, 188, 158		355, 589, 431		316, 706, 644		373, 623, 838	

EXPORTS OF PETROLEUM AND PETROLEUM PRODUCTS FROM PHILADELPHIA TO FOREIGN PORTS FOR 1877, 1878, 1879, AND 1880.

[From the report of the New York Produce Exchange.]

	1877.	1878.	1879.	1880.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*
United Kingdom	2, 812, 745	4, 340, 407	2, 037, 860	2, 342, 234
Northern Europe	32, 159, 144	47, 539, 068	50, 542, 743	41, 539, 471
Mediterranean ports	13, 728, 475	18, 884, 404	26, 691, 586	8, 703, 135
East Indies	208, 881			204, 500
China and Japan	216, 500	2, 840, 000	1, 855, 250	1, 342, 100
South and Central America	29, 617	29, 815	361, 646	22, 605
West Indies	274, 821	32, 100	58, 448	5, 000
British North America	3, 450	277, 268		
Other countries				454, 901
Totals	49, 433, 633	73, 943, 962	81, 547, 533	54, 673, 946

TABLE IV.—THE CHARTERS REPORTED FOR CRUDE AND REFINED PETROLEUM, NAPHTHA, AND RESIDUUM FROM NEW YORK, PHILADELPHIA, BOSTON, BALTIMORE, RICHMOND, AND PORTLAND TO THE DIFFERENT PORTS OF THE WORLD, EXCLUSIVE OF NORTH AMERICA, DURING THE CENSUS YEAR.

[From the reports of the New York Petroleum Exchange.]

	REFINED.		NAPHTHA.		CRUDE.		RESIDUUM.	
	Barrels.	Cases.	Barrels.	Cases.	Barrels.	Cases.	Barrels.	Cases.
Aarhuus	3, 000							
Adriatic sea	7, 000	102, 000						
Adelaide		5, 000						
Alexandria		209, 000						
Alicante	500	98, 000				13, 600		
Algiers	200	27, 000						
Amsterdam	45, 700							
Ancona	300	25, 000						
Anjier		889, 000						
Antwerp	552, 800	1, 000	23, 500	10, 000	11, 000		300	
Baltic ports	361, 650							
Barcelona					3, 300			
Bari		18, 000						
Belfast	20, 700							
Bergen	8, 800							
Beyrout		12, 000						
Bilboa	7, 600	8, 000			16, 200	158, 000		
Blaye			3, 500		49, 100			
Bombay		627, 800						
Bona		6, 000						

TABLE IV.—THE CHARTERS REPORTED FOR CRUDE AND REFINED PETROLEUM, ETC.—Continued.

	REFINED.		NAPHTHA.		CRUDE.		RESIDUUM.	
	Barrels.	Cases.	Barrels.	Cases.	Barrels.	Cases.	Barrels.	Cases.
Bordeaux			19,550		39,400			
Bremen	1,337,100		23,200		30,800			
Bristol	60,100		18,850					
Cadiz	500	35,800						
Cagliari		12,000						
Calcutta		477,000						
Cartagena		30,000						
Cette					12,400			
China		215,000						
Christiana	15,200							
Civita Vecchia		11,000						
Constantinople		140,000						
Continent of Europe	706,500		10,300		18,500			
Copenhagen	32,200							
Corfu		34,000						
Cork	108,100				5,000			
Coruna		6,000			14,200			
Cronstadt	10,950							
Dantzig	21,700							
Drontheim	2,800							
Drummen	1,500							
Dublin	19,200							
Dunkirk					74,500			
Dutch ports	30,100							
East Indies		153,000						
East Indies, British		25,000						
Elsinore	60,400							
Exeter	9,950		9,800					
Exmouth			1,700					
Flensborg	2,200							
French ports			2,000	4,900	3,500			
Galway	3,000							
Gefle	2,400							
Genoa	26,600	150,000						
German ports	5,500							
Gibraltar		18,500						
Gottenburg	30,700		1,000					
Hamburg	221,750							
Havre			52,800		185,700			
Hiogo		50,000						
Hong-Kong		82,500						
Hull	9,000		3,300					
Ireland, east coast	21,350							
Italian ports	3,000							
Japan		806,000						
Java		1,606,000						
Königsburg	6,000							
Leghorn	10,000	40,000						
Levant		186,000						
Limerick	5,000							
Liston	13,709	6,000						
Liverpool	185,400		19,500				82,400	
London	616,300		50,700				7,500	
Malaga		43,000						
Malino	2,200							
Malta		15,000						
Manila		17,000						
Marseilles		7,000	600		61,560		2,000	
Mauritius		25,000						
Mediterranean ports	50,800	602,500			7,509			
Messina		37,000						
Montevideo		10,000						
Naples	27,600	8,000						
Newcastle	7,600							
New Zealand		20,000						

TABLE IV.—THE CHARTERS REPORTED FOR CRUDE AND REFINED PETROLEUM, ETC.—Continued.

	REFINED.		NAPHTHA.		CRUDE.		RESIDUUM.	
	Barrels.	Cases.	Barrels.	Cases.	Barrels.	Cases.	Barrels.	Cases.
Norway	4,300							
Odessa		48,000						
Oporto	18,800	11,000						
Oran	800	12,000						
Palermo		49,000						
Passages					17,000	2,000		
Piræus		31,000						
Palmas	1,000	21,000						
Penang		20,000						
Phillipsville		8,000						
Plymouth	2,000		2,200					
Port d'Galle		95,000						
Port Philip Head		45,000						
Port Said		21,000						
Rangoon		151,500						
Riga	3,000							
Rivadeo		1,000						
Rostock	2,200							
Rotterdam	101,500							
Rouen			3,000		39,200			
Sables d'Oloun					2,500			
Saigon		22,000						
Salonica		128,000						
Santander	2,100	13,000						
Santos		7,000						
Seville	200	15,900						
Shanghai		353,000						
Sicily		27,000						
Singapore		112,000						
Smyrna		73,500						
South Africa		6,000						
Spanish ports	10,100	53,000			5,500	2,000		
Stockholm	5,000							
Sundsval	2,700							
Swedish ports	2,200							
Tarragona	2,100				5,200	16,000		
Tarranti		8,000						
Toulon					2,200			
Tralee	1,500							
Trieste	268,966							
United Kingdom	148,950							
Valencia	4,600	27,750						
Venice	9,800	38,000						
Vigo		50,000						
Volo		12,000						
Yokohama		172,900						
Zante		8,200						
Zanzibar		45,000						
Totals	5,265,981	8,640,950	245,500	14,900	604,269	191,600	92,200	

	Barrels of 50 gallons each.	Gallons.
Refined:		
In barrels	5,265,981	349,758,550
In cases	1,729,190	
Naphtha:		
In barrels	245,500	12,424,000
In cases	2,980	
Crude:		
In barrels	604,269	32,129,450
In cases	38,320	
Residuum:		
In barrels	92,200	4,610,000
	7,978,440	398,922,000

TABLE V.—PETROLEUM AND ITS PRODUCTS EXPORTED FROM THE UNITED STATES DURING THE YEARS ENDING JUNE 30, 1879 AND 1880.

[From report of Bureau of Statistics.]

	NEW YORK.		PHILADELPHIA.		BALTIMORE.		BOSTON.		OTHER PORTS.		TOTAL.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*
Crude	17,716,883	1,517,701	4,687,786	377,197	1,166,825	98,292	.....	.....	2,302,994	187,223	25,874,488	2,180,413
Naphtha	11,477,029	987,145	2,729,057	207,928	600,782	42,500	52,750	4,623	194,703	16,584	15,054,361	1,258,780
Illuminating	206,520,069	23,088,504	76,307,729	7,795,749	32,662,045	3,231,700	5,090,871	640,553	11,005,788	1,243,356	331,586,442	35,999,862
Lubricating	1,709,556	452,257	7,182	3,367	269,759	56,249	478,998	134,903	22,186	8,692	2,487,681	655,468
Residuum	2,684,052	178,563	144,564	7,952	216,342	12,693	.....	.....	262,080	16,518	3,307,038	210,726
Total, 1879	240,107,529	26,219,170	83,876,298	8,392,193	34,915,753	3,441,434	5,622,619	780,079	13,787,811	1,472,373	378,310,010	40,305,249
Crude	24,034,260	1,652,200	2,730,147	160,549	.....	.....	500	65	1,533,090	114,393	28,297,997	1,927,207
Naphtha	15,257,520	996,398	2,366,622	148,464	682,702	36,200	385	93	103,815	11,074	18,411,044	1,192,229
Illuminating	266,841,227	23,489,496	77,083,630	6,234,608	17,921,548	1,399,975	4,611,433	507,511	867,985	151,985	367,325,823	31,783,575
Lubricating	4,151,597	822,388	34,949	6,980	367,240	68,713	600,837	137,378	8,218	3,605	5,162,835	1,039,124
Residuum	3,885,588	217,677	395,094	28,161	416,430	24,000	.....	.....	69,888	6,652	4,767,000	276,490
Total, 1880	314,170,192	27,178,159	82,610,436	6,578,762	19,387,920	1,528,888	5,213,155	645,047	2,582,996	287,769	423,964,099	36,218,625

TABLE VI.—EXPORTS OF PETROLEUM AND PETROLEUM PRODUCTS FROM ALL UNITED STATES PORTS TO ALL FOREIGN COUNTRIES, AND THE DECLARED VALUE THEREOF, COMPILED FROM RETURNS OF THE UNITED STATES BUREAU OF STATISTICS.

[From the report of the New York Produce Exchange for 1880.]

Year.	CRUDE.		REFINED.		NAPHTHA, ETC.		RESIDUUM.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*
1873	19,643,740	2,665,771	209,021,305	41,854,841	10,250,547	1,264,962	2,060,616	145,398
1874	14,430,851	1,428,494	208,035,382	30,497,191	10,617,268	997,355	2,263,776	167,794
1875	16,536,800	1,738,589	204,616,798	28,417,339	14,048,726	1,392,192	2,655,984	169,671
1876	25,343,271	3,343,763	221,900,446	44,448,361	13,252,751	1,502,798	3,273,024	239,461
1877	28,772,233	3,267,309	309,778,932	51,901,106	19,565,605	1,938,672	4,778,641	390,077
1878	23,883,508	2,150,390	308,896,307	39,094,451	18,431,783	1,077,402	3,145,506	221,019
1879	27,841,900	2,182,573	367,321,255	32,696,713	22,695,223	2,081,210	4,457,486	273,045
1880	35,481,168	2,679,193	284,470,800	29,126,985	22,010,074	2,615,094	3,324,804	204,324
Total	191,933,471	19,456,082	2,114,641,125	298,036,987	125,871,977	12,869,685	25,968,837	1,810,789
Average	23,991,684	2,432,010	264,330,141	37,254,623	15,733,997	1,608,711	3,246,105	226,349
CENSUS YEAR.								
1879.								
June	1,350,713	102,755	30,221,930	2,719,090	1,305,136	129,170	62,664	3,568
July	3,297,347	205,781	44,972,481	3,882,095	1,568,370	136,419	194,082	14,166
August	1,483,108	94,080	41,883,762	3,325,565	2,579,406	207,179	451,500	26,781
September	1,496,109	135,931	40,046,705	3,092,885	2,187,854	168,740	328,272	21,615
October	2,808,561	163,935	42,837,204	3,530,654	3,651,526	296,224	758,478	36,364
November	2,924,488	187,481	32,684,161	2,810,061	2,947,099	175,141	769,062	35,590
December	3,223,457	248,822	37,455,351	3,352,574	3,794,884	305,022	594,258	33,029
1880.								
January	2,299,624	170,399	34,219,503	3,159,460	1,407,958	158,877	495,768	39,334
February	2,756,776	211,236	20,593,427	1,934,975	1,030,129	146,119	582,330	31,035
March	1,945,020	136,152	20,545,746	1,939,466	2,059,438	280,083	410,718	22,641
April	1,745,150	121,418	18,130,976	1,724,732	1,129,941	162,784	2,604	248
May	1,645,181	121,887	13,090,549	1,150,665	897,004	102,064	187,152	10,199
Total	26,975,534	1,899,883	376,681,885	32,622,222	23,658,745	2,267,831	4,836,888	274,510

TABLE VII.—QUANTITY OF PETROLEUM PRODUCED, AND THE QUANTITY AND VALUE OF PETROLEUM PRODUCTS EXPORTED FROM THE UNITED STATES DURING EACH FISCAL YEAR FROM 1864 TO 1880, INCLUSIVE.

[From the report of the New York Produce Exchange for 1880.]

Years ending June 30—	PRODUCTION.*		EXPORTS FROM THE UNITED STATES.										Total.	
	Barrels produced of 42 gallons each.	Gallons produced.	Crude oil, including all natural oils, without regard to gravity.		Mineral, refined or manufactured.						Residuum (tar, pitch, and all other from which the light bodies have been distilled).			
					Naphtha, benzine, gasoline, etc.		Illuminating.		Lubricating (heavy paraffine, etc.).					
			Gallons.	Dollars.	Gallons.	Dollars.	Gallons.	Dollars.	Gallons.	Dollars.	Gallons.	Dollars.	Gallons.	Dollars.
1864	2,478,709	104,105,778	9,980,654	3,864,187	488,197	154,091	12,791,518	6,764,411	.....	.....	.....	.....	23,210,369	10,782,689
1865	2,424,905	101,846,010	12,293,897	6,868,513	480,947	173,943	12,722,005	9,520,957	.....	.....	.....	.....	25,496,849	16,563,413
1866	3,165,700	132,959,400	16,057,943	6,015,921	673,477	188,825	34,255,921	18,626,141	.....	.....	.....	.....	50,987,341	24,830,887
1867	3,591,900	150,859,800	7,344,248	1,864,001	224,576	34,175	62,686,657	22,509,466	.....	.....	.....	.....	70,255,481	24,407,642
1868	3,613,709	151,775,778	10,029,659	1,564,933	1,517,268	267,873	67,909,961	19,977,870	.....	.....	.....	.....	79,456,888	21,810,676
1869	4,046,558	169,955,436	13,425,566	2,994,404	2,673,094	445,770	84,403,492	27,636,137	†134,532	51,122	.....	.....	100,636,684	31,127,433
1870	4,411,016	185,262,672	10,403,314	2,237,292	5,422,604	564,864	97,902,505	29,864,193	†6,871	2,611	.....	.....	113,735,294	32,668,960
1871	5,558,775	233,468,550	9,859,038	1,971,847	7,209,592	746,797	132,608,955	34,138,736	†59,632	22,660	†155,474	14,770	149,892,691	36,894,810
1872	5,842,497	245,384,874	13,559,768	2,807,111	8,092,635	932,160	122,539,575	30,566,108	541,419	211,287	438,186	41,724	145,171,583	34,058,390
1873	7,242,343	304,178,406	18,439,407	3,010,050	9,743,593	1,487,439	158,102,414	37,195,735	748,699	277,966	781,074	79,566	187,815,187	42,050,756
1874	11,188,741	469,927,122	17,776,419	2,099,696	9,737,457	1,038,622	217,220,504	37,566,995	1,244,305	404,243	1,827,798	142,299	247,806,483	41,245,855
1875	10,083,828	423,520,776	14,718,114	1,406,018	11,758,940	1,141,440	191,551,933	27,030,361	1,173,473	313,646	2,752,848	187,103	221,955,308	30,078,568
1876	8,823,142	370,571,964	20,526,397	2,220,268	14,780,236	1,442,811	204,814,673	28,755,638	963,442	303,863	2,581,404	193,206	243,660,152	32,915,786
1877	10,822,871	454,560,582	26,819,202	3,756,729	15,140,183	1,816,682	262,441,844	55,401,132	1,601,065	497,540	3,196,620	317,355	309,198,914	61,789,438
1878	14,738,262	619,007,004	26,936,727	2,694,018	16,416,621	1,411,812	289,214,541	41,513,676	2,304,624	639,381	3,968,700	316,087	338,841,303	46,574,974
1879	16,917,606	710,539,452	25,874,488	2,180,413	15,054,361	1,258,780	331,586,442	35,999,862	2,487,081	655,468	3,307,038	210,726	378,310,010	40,305,240
1880	22,382,509	940,065,378	28,297,997	1,927,207	18,411,044	1,102,220	367,325,823	31,783,575	5,162,835	1,039,124	4,767,000	276,490	423,964,699	36,218,625

* As a given number of gallons of refined petroleum represents the product of a larger number of gallons of crude petroleum, it is necessary to reduce the exports of petroleum to their equivalent in crude oil in order to arrive at a knowledge of the percentage of the total product of mineral oil exported.

† Estimated.

TABLE VIII.—NEW YORK PETROLEUM MARKET.

AVERAGE PRICES PER YEAR.

[From reports of the New York Produce Exchange.]

Year.	CRUDE IN BULK, PER GALLON.		CRUDE IN BARRELS, PER GALLON.		REFINED STANDARD WHITE, PER GALLON.		NAPHTHA IN BARRELS, PER GALLON.	
	Extremes.	Average price.	Extremes.	Average price.	Extremes.	Average price.	Extremes.	Average price.
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
1862	.....	7.62	.....	.....	.....	18.21	.....	11.07
1863	.....	5.92	.....	.....	.....	13.09	.....	9.04
1865	.....	6.52	.....	.....	.....	12.92	.....	9.07
1866	.....	10.53	.....	10.50	.....	19.19	.....	11.36
1867	.....	9.09	.....	9.12	.....	15.72	.....	9.75
1868	.....	6.86	.....	6.37	.....	10.77	.....	7.13
1869	.....	3.62	.....	7.10	.....	8.08	.....	6.40
1870	.....	7.14	.....	7.14	.....	9.12	.....	7.02
CENSUS YEAR, 1879.								
June	.....	3.60	5 to 7¾	6.44	6⅝ to 7⅞	7.23	5 to 8	6.42
July	.....	2.50	5 to 6¼	5.41	6⅝ to 7⅞	6.97	4 to 6	5.14
August	.....	2.38	4⅞ to 6¼	5.42	6½ to 7¼	6.57	4 to 5	4.50
September	.....	2.50	4⅞ to 6⅜	5.50	6¼ to 7½	6.79	4 to 5	4.62
October	.....	3.10	5⅜ to 7½	6.55	7 to 7⅞	7.43	4½ to 6	5.23
November	.....	3.90	6½ to 8½	7.45	7½ to 8⅞	8.03	6 to 6¾	6.27
December	.....	.....	7¼ to 8½	7.92	8¼ to 9	8.56	6½ to 6¾	6.63
1880.								
January	7 1/16 to 8	7.53	7 to 8⅜	7.55	7½ to 8½	7.94	6½ to 7	6.71
February	6⅞ to 7 11/16	7.03	6⅝ to 7¾	7.29	7⅝ to 8	7.81	6¼ to 7	6.05
March	6 9/16 to 7 5/16	6.68	6½ to 7½	6.11	7⅝ to 7⅞	7.75	5¼ to 6¾	6.06
April	6 13/16 to 7⅝	6.97	6⅝ to 7¾	7.22	7½ to 7⅞	7.56	5½ to 5¾	5.63
May	6 7/16 to 7⅝	7.03	6¼ to 7¾	7.03	7⅜ to 7¾	7.56	5½ to 5½	5.50

TABLE IX.—IMPORTS OF REFINED PETROLEUM AT FIVE PRINCIPAL PORTS OF THE UNITED KINGDOM.

[From reports of the New York Produce Exchange.]

	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
London	247, 024	169, 394	227, 305	348, 412	261, 385	492, 292	369, 259	.....
Liverpool	157, 700	94, 170	145, 679	144, 000	136, 059	203, 509	163, 800	.....
Bristol	37, 175	36, 460	52, 792	65, 584	54, 267	93, 485	90, 622	.....
Hull	10, 331	6, 902	24, 657	26, 365	25, 420	30, 884	34, 057	.....
Exeter	19, 319	18, 175	7, 598	8, 011	13, 103	10, 789	.....	.....
Total	471, 549	325, 101	458, 031	593, 272	490, 234	830, 950	657, 738	.....

STOCKS AT SAME PORTS, JANUARY 1.

London	.....	117, 345	41, 193	40, 078	94, 326	61, 500	160, 000	99, 518
Liverpool	.....	62, 400	14, 500	22, 880	26, 700	21, 089	48, 000	32, 000
Bristol	.....	8, 000	6, 500	11, 699	14, 000	3, 000	17, 000	20, 000
Hull	.....	5, 444	350	650	4, 050	2, 300	300	1, 300
Exeter	.....	3, 577	2, 200	612	921	1, 300	1, 134	.....
Total	.....	196, 766	64, 743	75, 919	139, 997	89, 189	226, 934	152, 818

TABLE X.—IMPORTS OF PETROLEUM AT THE UNDERMENTIONED EUROPEAN PORTS FOR SEVEN YEARS ENDED DECEMBER 31.

[From reports of the New York Produce Exchange.]

At—	1874.	1875.	1876.	1877.	1878.	1879.	1880.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
Hamburg	.....	154, 581	131, 822	324, 036	203, 600	408, 869	525, 974
Antwerp	617, 338	720, 637	603, 251	840, 086	834, 400	649, 845	719, 017
Rotterdam	1, 885, 260	158, 214	177, 988	229, 258	219, 293	189, 850	212, 433
Amsterdam	110, 198	121, 261	65, 507	65, 026	132, 708	150, 209	217, 046
Bremen	811, 121	1, 043, 137	969, 971	1, 463, 264	1, 165, 746	1, 345, 772	1, 324, 591
Stettin	189, 476	228, 547	211, 875	204, 214	208, 767	249, 469	276, 515
Dantzic	67, 019	101, 848	88, 793	143, 620	111, 422	102, 474	107, 849
Königsburg	85, 937	121, 114	86, 207	116, 455	79, 198	79, 345	72, 223
St. Petersburg (*a*)	105, 399	68, 895	82, 914	121, 451	108, 105	101, 571	69, 652
Trieste (*b*)	113, 523	112, 822	145, 627	254, 044	199, 723	304, 392	273, 459
London	246, 323	169, 834	226, 432	333, 234	275, 707	380, 499	346, 717
Total barrels	4, 231, 594	3, 000, 890	2, 785, 387	4, 096, 188	3, 628, 669	3, 962, 295	4, 139, 476
a Includes 4 cases to barrel ..... cases	59, 421	19, 701	60, 023	183, 160	48, 965	56, 707	33, 195
b Includes Baku ..... barrels	.....	.....	21, 714	34, 517	38, 311	55, 604	52, 174

STOCKS OF PETROLEUM HELD AT THE SAME PLACE AND TIME.

Hamburg	.....	17, 640	9, 072	53, 726	22, 195	27, 749	86, 376
Antwerp	124, 643	109, 477	34, 160	106, 627	126, 894	109, 979	109, 338
Rotterdam	41, 203	15, 801	3, 124	35, 054	21, 954	11, 924	18, 540
Amsterdam	12, 344	10, 305	449	10, 737	32, 329	27, 874	50, 511
Bremen	199, 580	196, 365	42, 281	255, 907	225, 550	343, 738	559, 339
Stettin	20, 064	31, 335	24, 180	11, 598	16, 277	15, 305	42, 832
Dantzic	10, 891	17, 993	7, 118	37, 483	25, 833	20, 189	20, 295
Königsburg	10, 602	21, 341	3, 328	21, 699	16, 160	14, 173	12, 950
St. Petersburg (*a*)	66, 886	41, 398	29, 115	55, 787	69, 786	60, 301	22, 108
Trieste	24, 200	4, 500	6, 350	47, 005	12, 970	37, 500	21, 600
London	117, 347	43, 035	36, 616	80, 481	59, 570	156, 786	99, 188
Total barrels	627, 760	509, 280	195, 793	716, 104	629, 518	825, 518	1, 043, 083
a Includes Baku	.....	.....	11, 782	10, 027	14, 412	18, 856	7, 315

TABLE XI.—THE VARIOUS PRODUCTS OF CRUDE OIL, INCLUDING PETROLEUM, CRUDE OIL, REFUSE OIL, AND GREASE, AND ALL PRODUCTS OF NAPHTHA, EXPORTED FROM BAKU FROM 1832 TO 1879, IN POODS OF 36 POUNDS EACH.

[From report New York Produce Exchange, 1880.]

Year.	Poods.	Year.	Poods.	Year.	Poods.	Year.	Poods.	Year.	Poods.
1832	261, 000	1842	327, 578	1852	No report	1862	No report	1872	1, 535, 000
1833	300, 000	1843	327, 167	1853	do	1863	340, 000	1873	3, 400, 000
1834	346, 100	1844	332, 854	1854	do	1864	538, 066	1874	5, 000, 000
1835	352, 720	1845	31, 685	1855	do	1865	554, 291	1875	3, 462, 382
1836	352, 862	1846	288, 112	1856	do	1866	691, 820	1876	4, 853, 461
1837	344, 147	1847	255, 476	1857	do	1867	998, 905	1877	6, 816, 971
1838	340, 554	1848	327, 802	1858	do	1868	735, 734	1878	9, 931, 644
1839	358, 357	1849	328, 280	1859	do	1869	1, 685, 229	1879	12, 541, 646
1840	337, 010	1850	No report	1860	do	1870	1, 704, 465	1880, to June 1	3, 586, 059
1841	326, 695	1851	do	1861	do	1871	1, 375, 981		

EXPORTED FROM BAKU IN POODS OF 36 POUNDS.

	1875.	1876.	1877.	1878.	1879.	1880, to June 1.
Crude oil	323, 851	323, 561	177, 983	281, 423	436, 673	61, 002
Refined oil	1, 990, 041	3, 325, 233	4, 594, 766	6, 254, 920	6, 562, 140	1, 484, 374
Refuse	1, 131, 725	1, 275, 321	2, 038, 899	3, 382, 859	5, 528, 208	20, 016, 270
Oil and grease	1, 077	1, 095	.....	306	409	23, 503
Asphalt	4, 586	13, 100	723	9, 300	10, 491	.....
Benzine, etc.	11, 102	5, 151	4, 600	3, 130	.....	.....

TABLE XII.—IMPORTS OF AMERICAN PETROLEUM (REFINED) INTO JAPAN.

Year ending June 30—.	Gallons.	Dollars.	Years.	Gallons.	Dollars.	Years.	Gallons.	Dollars.
1872*	41, 470	21, 150	1875	2, 826, 636	573, 071	1878	5, 524, 604	1, 115, 102
1873	1, 000, 959	330, 598	1876	3, 151, 639	520, 387	1879	17, 721, 645	2, 557, 500
1874	1, 291, 180	306, 728	1877	3, 304, 926	599, 966	1880	17, 923, 490	1, 803, 555
						Total	52, 745, 088	7, 807, 571

*First importation.

CHAPTER VIII.—THE BIBLIOGRAPHY OF BITUMEN AND ITS RELATED SUBJECTS.

An examination of the literature of petroleum shows that the subject is properly treated as a portion of the general subject "Bitumen". It is impossible to separate it from asphalt, maltha or mineral tar, rock oil, earth oil (German *Erdöl*), naphtha, coal oil, and paraffine. These several subjects are also treated as pertaining to history, geology, chemistry, technology, commerce, and statistics, and often in such a manner as to render a separation impossible. In ascertaining what articles have appeared in different periodicals, the indices have been searched for "Asphaltum", "Bitumen", "Gas", "Hydrocarbons", "Maltha", "Mineral tar", "Naphtha", "Oils", "Paraffine", and "Petroleum", with their equivalents in other languages.

Two attempts have previously been made to prepare lists of books and of periodical articles relating to this subject. Professor Paul Schweitzer, of the University of Missouri, published his list, in 1879, in connection with his pamphlet on petroleum. Another was prepared in the East Indies, in 1875, by Mr. Benjamin S. Lyman, but was not published. This latter list of titles has been placed in my hands, and has been incorporated with my own work, the 175 titles being distinguished by printing the authors' names preceded by an asterisk. Professor Schweitzer's list was not prepared in such a manner as to admit of such incorporation, but for the most part his titles will be found in the present list.

In submitting this list of titles to my fellow-workers in this field, it is not claimed that it is either complete or free from error. Mr. Lyman's titles were transferred, and many of the others are quoted without being verified; but, so far as has been possible in the time at my command, the work has been proved correct. Only titles to articles of exceptional value have been inserted when the authors are unknown. This, of course, excludes a large number of editorial notices, both good and bad, that are found in reputable scientific journals, as well as in newspapers. I have endeavored, however, to include what is of material value.

So far as I have been able to do it, I have inserted the title to a work in the language in which it was originally written, and I have also endeavored to insert the reference to the work in which the article first appeared, as the first in the list of references. I am aware, however, that in a few instances I have not met the original articles, and that the titles appear translated into other languages. The material was all collected in the course of the preparation of the report, and only required the labor of arrangement to put it in this form.

ABBREVIATIONS.

A. C. et P.	Annales de Chimie et de Physique.
A. C. u. P.	Annalen der Chemie und Pharmacie.
A. der P.	Archiv der Pharmacie.
A. J. Ph.	American Journal of Pharmacy.
A. J. S.	American Journal of Science and Arts (Silliman's Journal).
Am. C.	American Chemist.
Am. J. G. L.	American Journal of Gaslighting.
An. G. C.	Annales du Génie Civil.
An. M.	Annales des Mines.
A. of P.	Annals of Philosophy.
A. S. D.	Annual of Scientific Discovery.
B. D. C. G.	Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
B. I. u. Gbl.	Bayerisches Industrie- u. Gewerbeblatt.
B. N. A. W. M.	Bulletin of the National Association of Wool Manufacturers.
B. S. C. P.	Bulletin de la Société Chimique de Paris.
B. S. d'E.	Bulletin de la Société d'Encouragement.
B. S. G. F.	Bulletin de la Société Géologique de France.
B. u. H. J.	Leobener Berg- und Hütten-Jahrbuch.
B. u. H. Z.	Berg- und Hütten- Zeitung.
Bull. A. I. St. P.	Bulletin de l'Académie Impériale des Sciences de Saint-Péters bourg.
C. Cbl.	Chemisches Centralblatt.
C. Ind. Z.	Chemische Industrie-Zeitung.
C. N.	London Chemical News.
. Nat.	Canadian Naturalist.
C. R.	Comptes-Rendus des Séances de l'Académie Française.
C. Z.	Chemische Zeitung.
D. Ill. G. Z.	Deutsche Illustr. Gewerbe-Zeitung.
D. Ind. Z.	Deutsche Industrie-Zeitung.
Dingler.	Dingler's Polytechnisches Journal.
E. M. W. S.	English Mechanic and World of Science.
Eng.	Engineering.
F. Gztg.	Fürther Gewerbezeitung.
G. Ind.	Génie Industriel.
H. Gbl.	Hessisches Gewerbeblatt.
Hübner's Z.	Hübner's Zeitschrift für die Paraffin-, Mineralöl-, und Braunkohlen-Industrie.
Ind. B.	Industrie-Blätter.
Int. Obs.	Intellectual Observer.
J. A. S. B.	Journal of the Asiatic Society of Bengal.
J. C. S.	Journal Chemical Society of London.
J. F. I.	Journal of the Franklin Institute.
J. f. P. C.	Journal für Praktische Chemie (Erdmann's Journal).
J. G. B.	Journal für Gasbeleuchtung.
J. K. K. G. R.	Jahrbuch der K. K. Geologischen Reichsanstalt.
J. S. A.	Journal of the Society of Arts.
L'A. S. et I.	L'Année Scientifique et Industrielle.
Le Tech.	Le Technologiste.
L. J. G. L.	London Journal of Gas Lighting.
L. u. B. J.	Leonhardt und Bronn Jahrbuch.
Mem. A. A.	Memoirs American Academy of Arts and Sciences, Boston.
M. P. L. S.	Proceedings of the Manchester Philosophical and Literary Society.
M. Sci.	Moniteur Scientifique.
N. E. P. J.	New Edinburgh Philosophical Journal.
N. J. Ph.	Neues Jahrbuch für Pharmacie.
N. Z. R. I.	Neue Zeitschrift für Rübenzucker Industrie.
Oest. Z. f. B. u. H.	Oesterreich. Zeitschrift für Berg- und Hüttenwesen.
P. A. A. A. S.	Proceedings of the American Association for the Advancement of Science.
P. A. Ph. A.	Proceedings of the American Pharmaceutical Association.
P. A. P. S.	Proceedings of the American Philosophical Society, Philadelphia.
P. B. A. A. S.	Proceedings of the British Association for the Advancement of Science.
P. C. A. S.	Proceedings of the California Academy of Science.
P. G. S.	Proceedings of the Geological Society, London.
Pharm. Cbl.	Pharmaceutisches Centralblatt.
Ph. J.	Pharmaceutical Journal, London.
P. I. C. E.	Proceedings of the Institution of Civil Engineers, London.
P. J.	Philosophical Journal.
P. M.	Philosophical Magazine.
Pog. An.	Poggendorf's Annalen der Physik.
Poly. Cbl.	Polytechnisches Centralblatt.
Poly. Nbl.	Polytechnisches Notizblatt.
P. R. I.	Proceedings of the Royal Institution.
P. R. S.	Proceedings of the Royal Society.
P. S. M.	Popular Science Monthly.
P. T.	Philosophical Transactions of the Royal Society.
Q. J. G. S.	Quarterly Journal of the Geological Society of London.
R. C. A.	Repertoire de Chimie Appliquée.
R. I.	Revue Industrielle.
R. U. M.	Revue Universelle des Mines.
Sci. Am.	Scientific American.
S. M. & Sci. P.	San Francisco Mining and Scientific Press.
S. P. Z.	Schweiz. Polytechnische Zeitschrift.
T. A. I. M. E.	Transactions of the American Institute of Mining Engineers.
T. A. Ph. A.	Transactions of the American Pharmaceutical Association.
T. G. S.	Transactions of the Geological Society, London.
T. P. S. E.	Transactions of the Pharmaceutical Society (English).
Trans. Am. P. S.	Transactions of the American Philosophical Society.
Trans. R. S.	Transactions of the Royal Society.
W. B.	Wagner's Berichte.
Z. A. C.	Zeitschrift für Analytische Chemie.
Z. A. O. A.	Zeitschrift des Allgemeinen Oesterreich. Apotheker-Vereins.
Z. C.	Zeitschrift für Chemie.

The few abbreviations of the titles to other journals are extended so as to need no reference.

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Circa 25	*Strabo	vi, 763; xvi, c. 2; c. 12; French translation, 1, xiv, p. 665, Casab.	Translated into French in B. S. G. F., xxiv, 18. Geographie, 1812, iii, 8. B. S. G. F., xxv, 20.
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1865	*Hitchcock, C. H	Albertite of New Brunswick	A. J. S. (2), xxxix, 207.
1865	*Hochstetter, F. v	Erdöl und Erdwachs im Sandecer Kreise in West Galizien.	J. K. K. G. R., xv, 199.
1865	*Hunt, T. Sterry	Petroleum; its geological relations considered with special reference to its occurrence in Gaspé. With a map of Gaspé.	Quebec, G. E. Desbarats, 1865, p. 19.
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1865	Jacinsky, W	Das Vorkommen und die Gewinnung des Bergöles und Bergwachses zu Borislaw bei Drohobicz, in Oest. Galizien.	Oest. Z. f. B. u. H., xiii, 289, 295.
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1865	*Lartet, Louis	Dead Sea asphalt	B. S. G. F., xxii, 437, 444.
1865	Lesley, J. P	On the petroleum of Kentucky and records of borings in Pennsylvania.	P. A. P. S., x, 33.
1865	Lesley, J. P	On popular fallacies respecting petroleum	P. A. P. S., x, 110.
1865	Lesley, J. P	Record of oil borings	P. A. P. S., x, 187.
1865	*Lesley, J. P		Report on lands on Paint Lick Fork of Sandy river in eastern Kentucky, 1865, 8°, pp. 8-32 (2 plates).
1865	*Lesley, J. P		Report on the lands of the Youghiogheny Iron and Coal Company, 1865, 8°, pp. 4, 5 (5 plates).
1865	*Lesley, J. P	Geological report on the Brady's Bend Land and Coal Company's lands in Armstrong county, Pennsylvania.	1865, 8°, pp. 10-15 (3 plates).
1865	*Lesley, J. P	Report on the P. Kerr & Co. coal lands in Washington county, Pennsylvania.	1865, 8°, pp. 5, 6 (3 plates).
1865	Letheby, Dr. Henry	Results of experiments on the carburation of coal gas.	C. N., No. 776; J. F. I., lxxx, 414; R. U. M., xviii, 221.
1865	*Luynes, Duc de	Dead Sea asphalt	Voyage d'exploration à la Mer Morte, 1865, p. 7.
1865	(Lyman)	Petroleum in Archangel Petroleum in Zante	A. J. S., xl; A. J. S., xli, 427; Les Mondes, Dec., 1865. A. J. S., xli, 427.
1865	Monross, N. S	Notes on the coal and iron ore of the state of Guerero, Mexico.	A. J. S. (2), xxxix, 309.
1865	*Medlicott, H. B	Assam oil springs	Memoirs of the geological survey of India, 8°, 1865, iv, 414, 415.
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1865	Nicklès, J	Cire falsifiée par de la paraffine	An. G. C., 1865, p. 781.
1865	Paul, B. H	Use of petroleum as fuel in place of coal	C. N., No. 263; J. F. I., lxxix, 130.
1865	Paul, B. H	On paraffine oil	P. B. A. A. S., 1865, p. 36.
1865	*Poscpny, Fr	Petroleum im Sanoker u. Samborer Kreise, Galizien	J. K. K. G. R., xv, 351; B. u. H. Z., 1865, No. 36-41.
1865	Rand, Theo. D	On the occurrence of petroleum in Canada	J. F. I., lxxx, 59.
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1865	Roy, Alphonse	L'huile de pétrole; connaissance de l'huile de pétrole dans les temps anciens, importance de son exploitation, procédés employés pour l'extraire et la raffiner, applications diverses de ses dérivés.	Paris, 1865, 8°.
1865	Richardson, C. J	On the use of petroleum as steam fuel	C. N., xi, 39; J. F. I., lxxx, 119.
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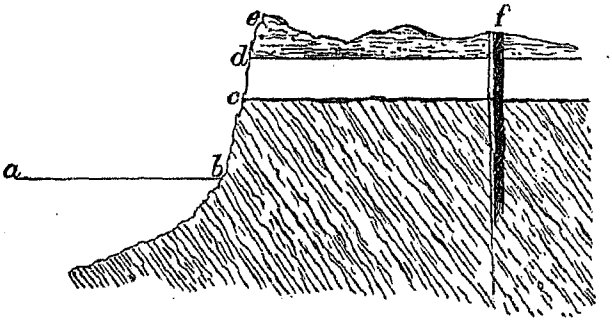
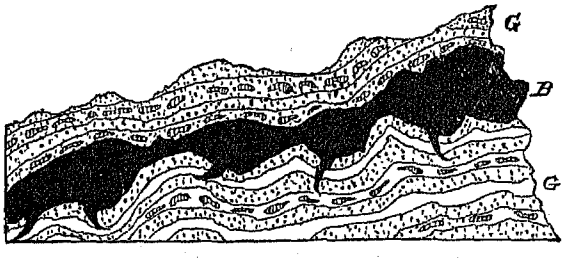


a, b, Sea-level.
b, c, Bituminous shale.
c, d, Unstratified sand saturated with bitumen
d, e, Soil.
f, Well, recently commenced (1866).

[FIG. 1—page 21.]

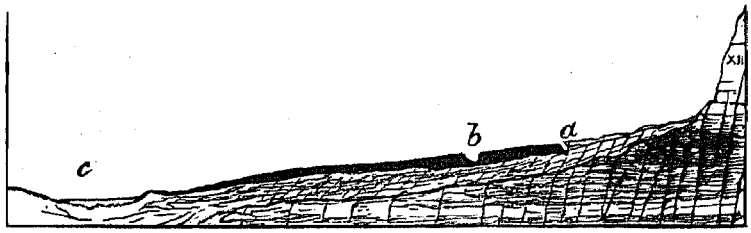
Section of bituminous rocks on Bigg's ranch, Santa Barbara Co., California.



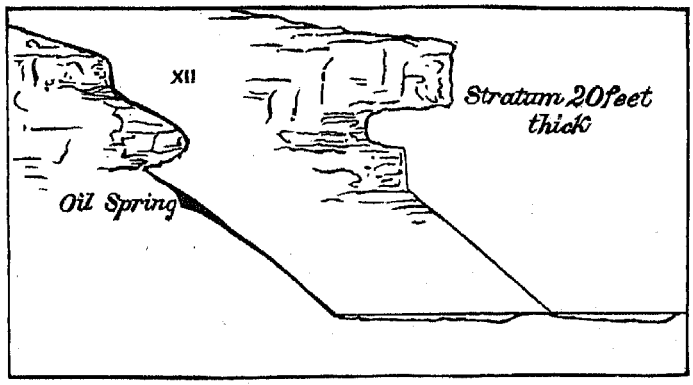
B, Solid bitumen. G, Sandstones and conglomerates.

[FIG. 2—page 32.]

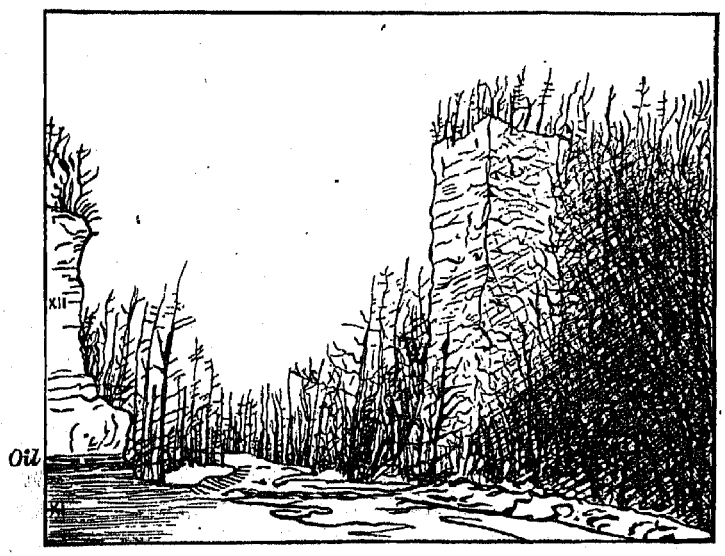
Bitumen at Selenitza, Albania.



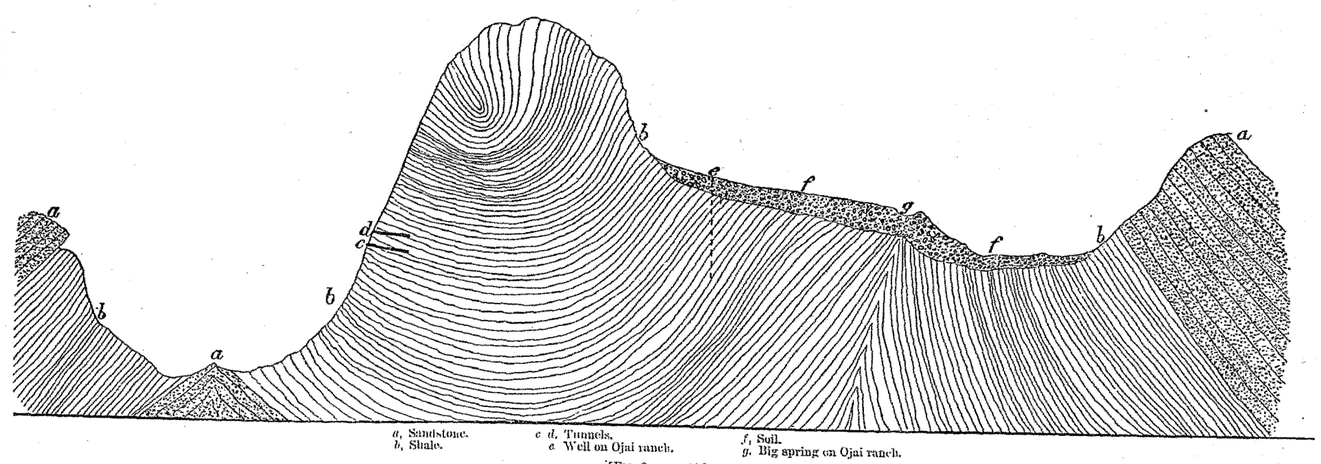
[FIG. 3—page 63.]
Old oil springs, Paint creek, Johnson Co., Ky.



[FIG. 4—page 63.]
Section on Little Paint creek, Johnson Co., Ky.



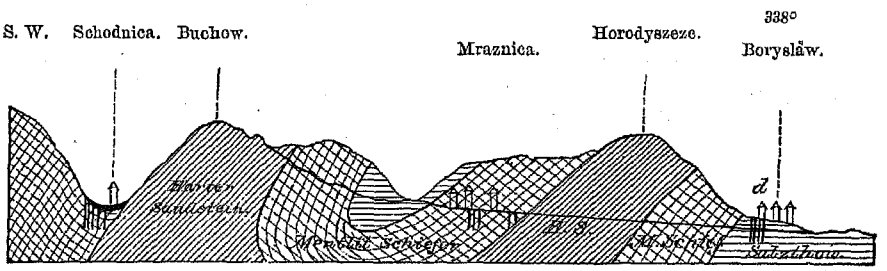
[FIG. 5—page 63.]
Crows' Nest, on Paint creek, Johnson Co., Ky.



a, Sandstone.
b, Shale.
c d, Tunnels.
e Well on Ojai ranch.
f, Soil.
g, Big spring on Ojai ranch.

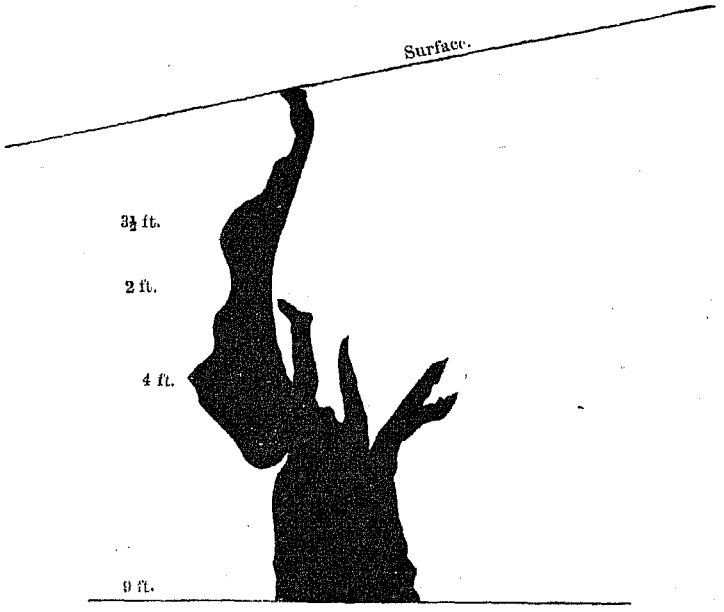
[FIG. 6—page 68.]

Section through Sulphur mountain and Ojai plateau, Ventura county, California.



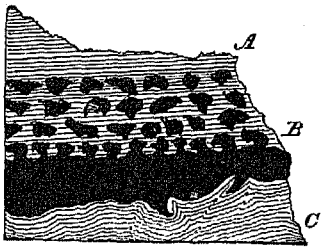
[FIG. 7—page 72.]

Section from Boryslaw to Schodnica, East Galicia.



[FIG. 8—page 72.]

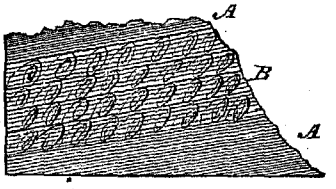
Section of vein of asphaltum near Havana, Cuba.



A, Slates. B, Asphalt. C, Breccia.

[FIG. 9—page 73.]

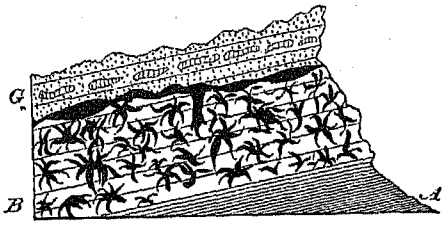
Bitumen in Albania.



A, Slates. B, Pisolithic bitumen.

[FIG. 10—page 73.]

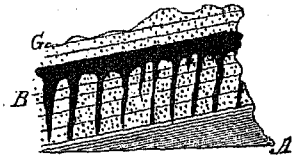
Bitumen in Albania.



A, Slates. B, Reticulated bitumen.
G, Sandstones and conglomerates.

[FIG. 11—page 73.]

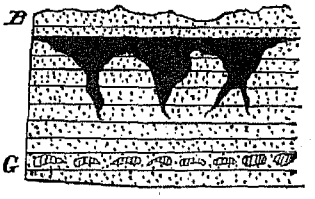
Bitumen in Albania.



A, Slates. B, Bitumen.
G, Sandstones.

[FIG. 12—page 73.]

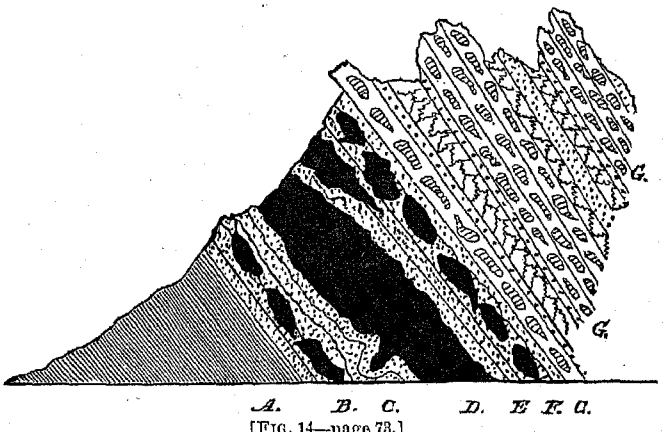
Bitumen in Albania.



B, Bitumen.
G, Conglomerate.

[FIG. 13—page 73.]

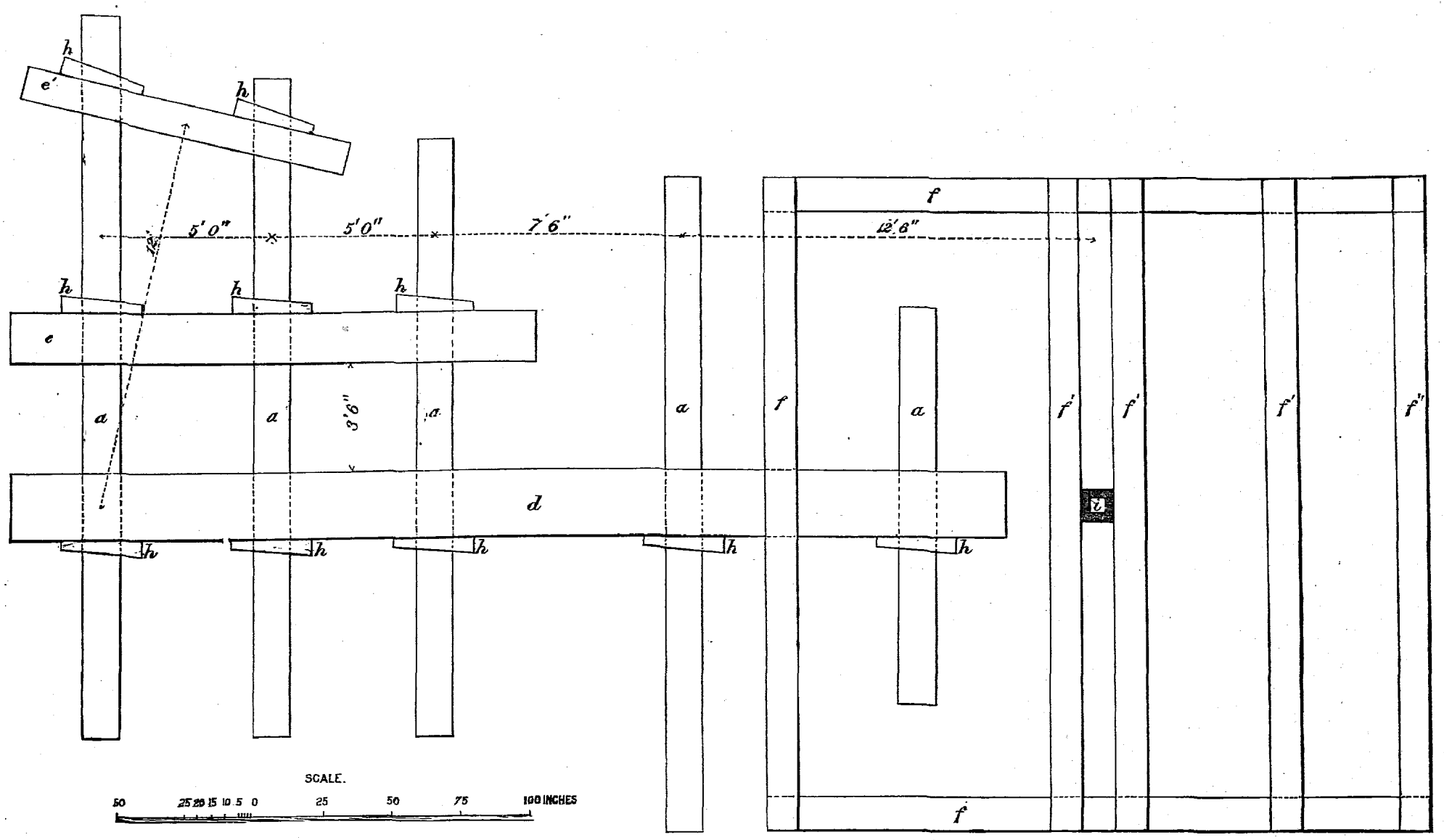
Bitumen in Albania.



[FIG. 14—page 73.]

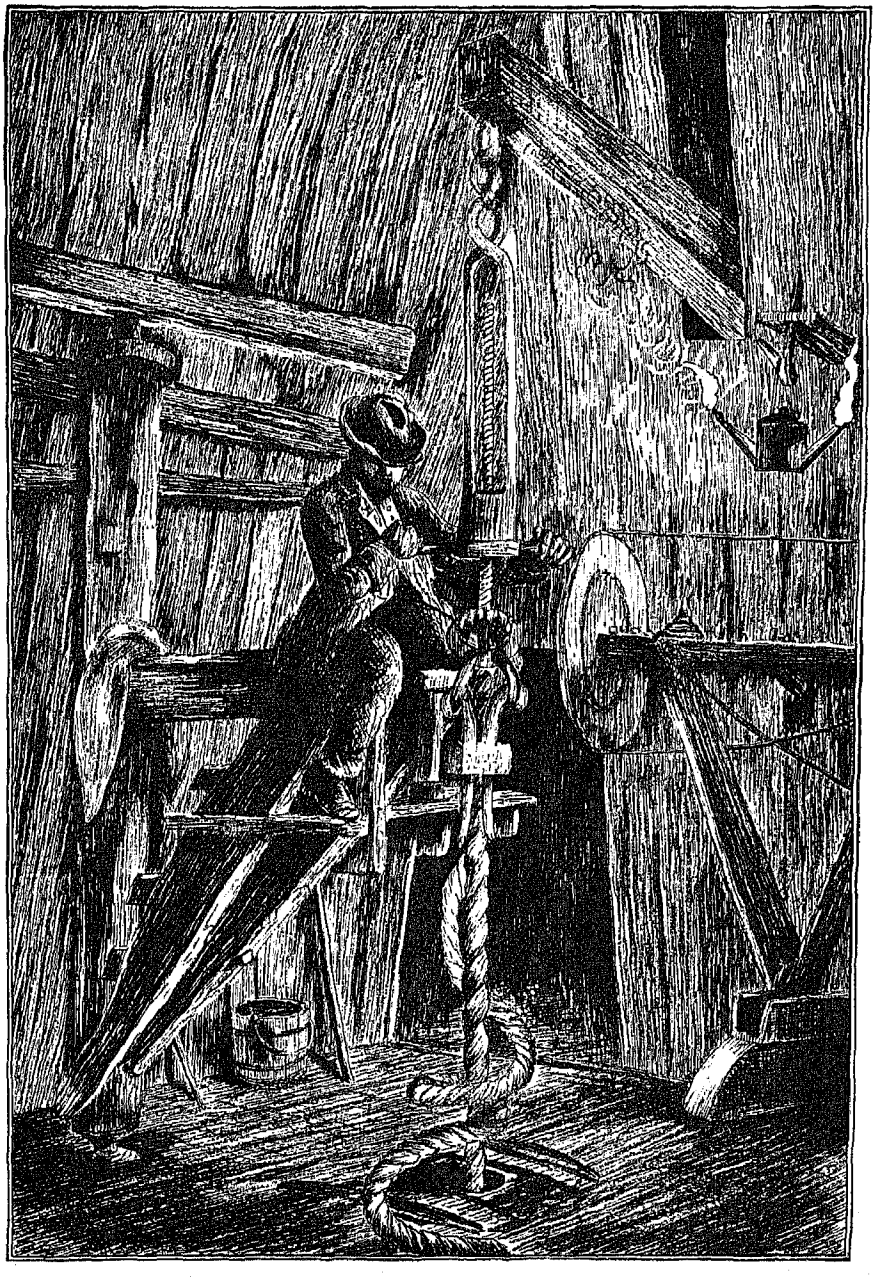
1. A, Slates, 90 meters.
2. B, Conglomerate, with balls of bitumen, 3 meters.
3. C, Yellow sandstone, with bivalves, 2 meters.
4. D, The great mass of bitumen, 45 meters.
5. E, Yellow sandstone with cardium edule, 2.5 meters.
6. F, Alternating sandstones and conglomerates, with balls of bitumen, 3.6 meters.
7. G, Conglomerates and sandstones, 60 meters.

Bitumen in Albania.



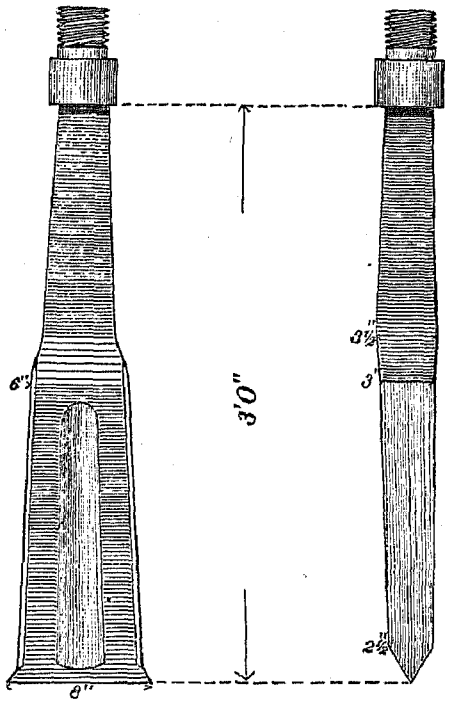
[Fig. 15—page 79.]

Foundation timbers for rig.

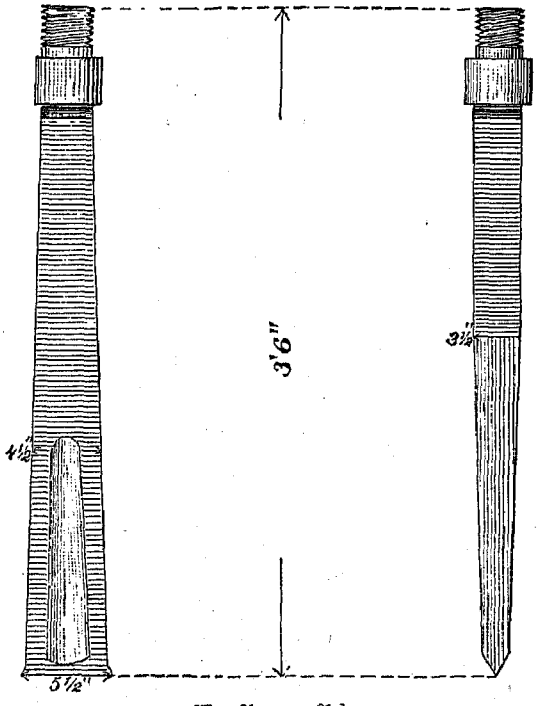


[FIG. 19—page 81.]

Inside view of derrick at night, showing use of temper-screw and derrick light.



[FIG. 20—page 81.]
Eight-inch bit, 1-12 natural size.

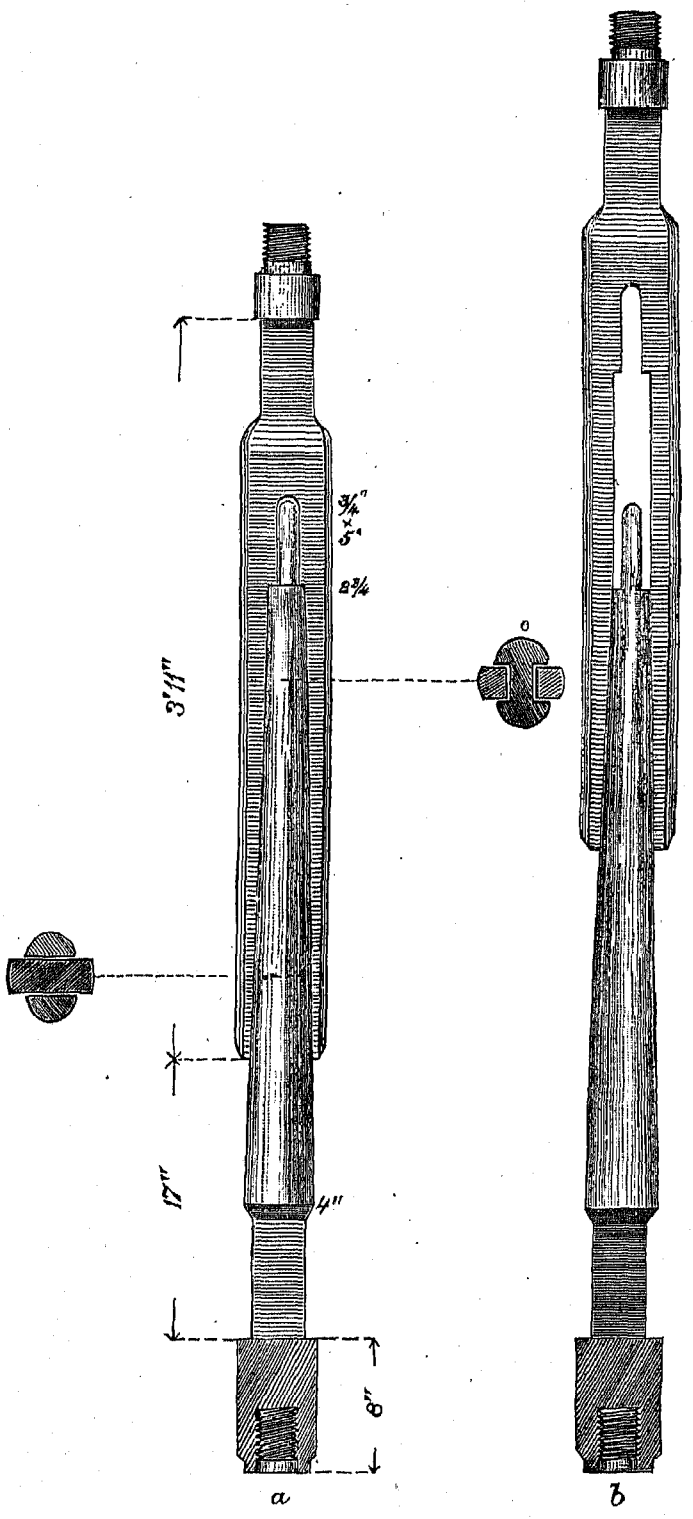


[FIG. 21—page 81.]
Five-and-one-half-inch bit, 1-12 natural size.

[FIG. 22—page 81.]
Auger stem.

[FIG. 24—page 81.]
Sinker bar.

1-12 natural size.

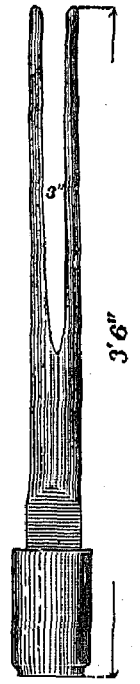


Closed. Open.

c and d, cross-sections

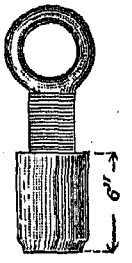
[FIG. 23—page 81.]

Jars, 1-12 natural size.



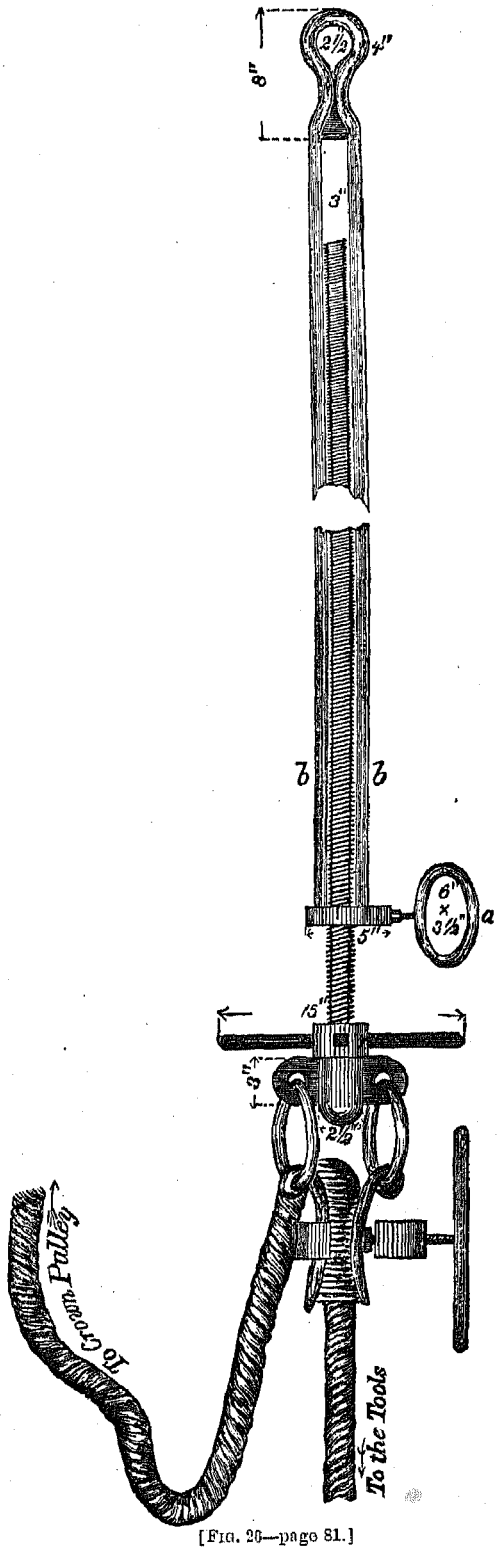
[FIG. 25—page 81.]

Rope socket, 1-12 natural size.

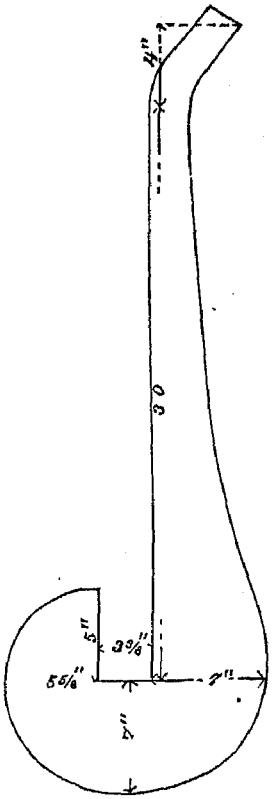


[FIG. 27—page 81.]

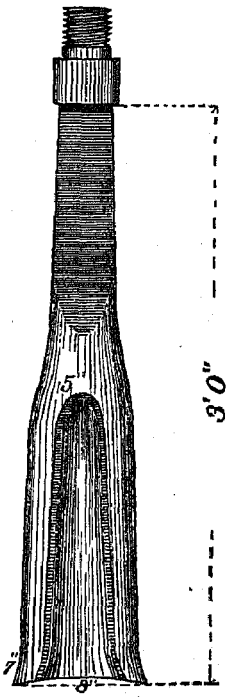
Ring socket, 1-12 natural size.



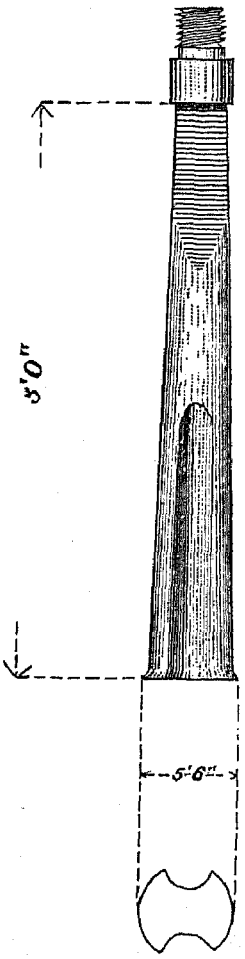
[Fig. 26—page 81.]
Temper-screw.



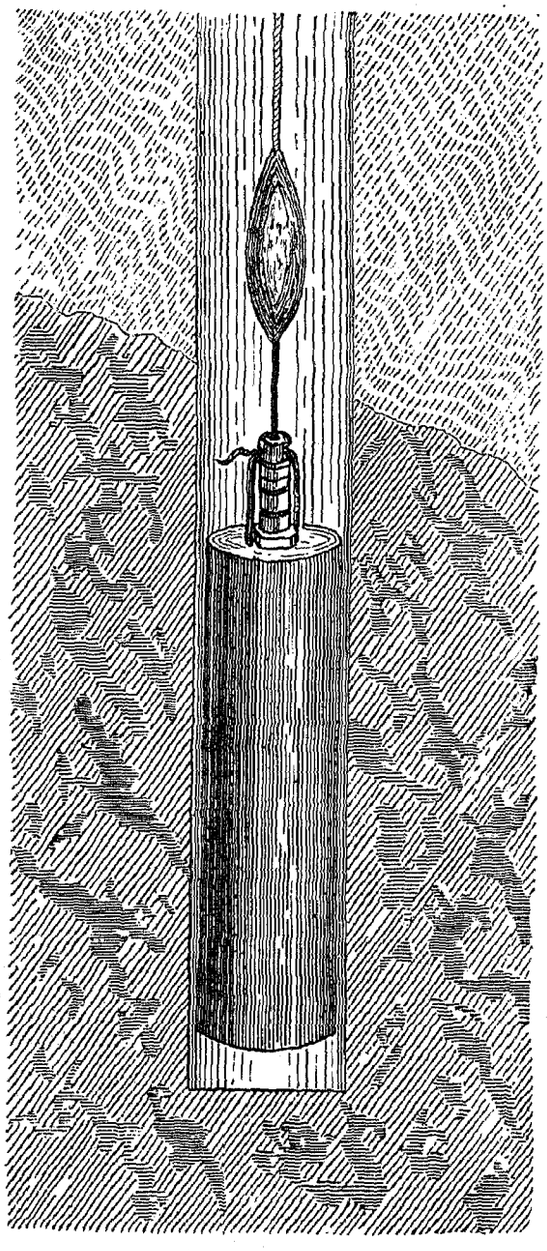
[Fig. 28—page 81.]
Wrench, 1-12 natural size.



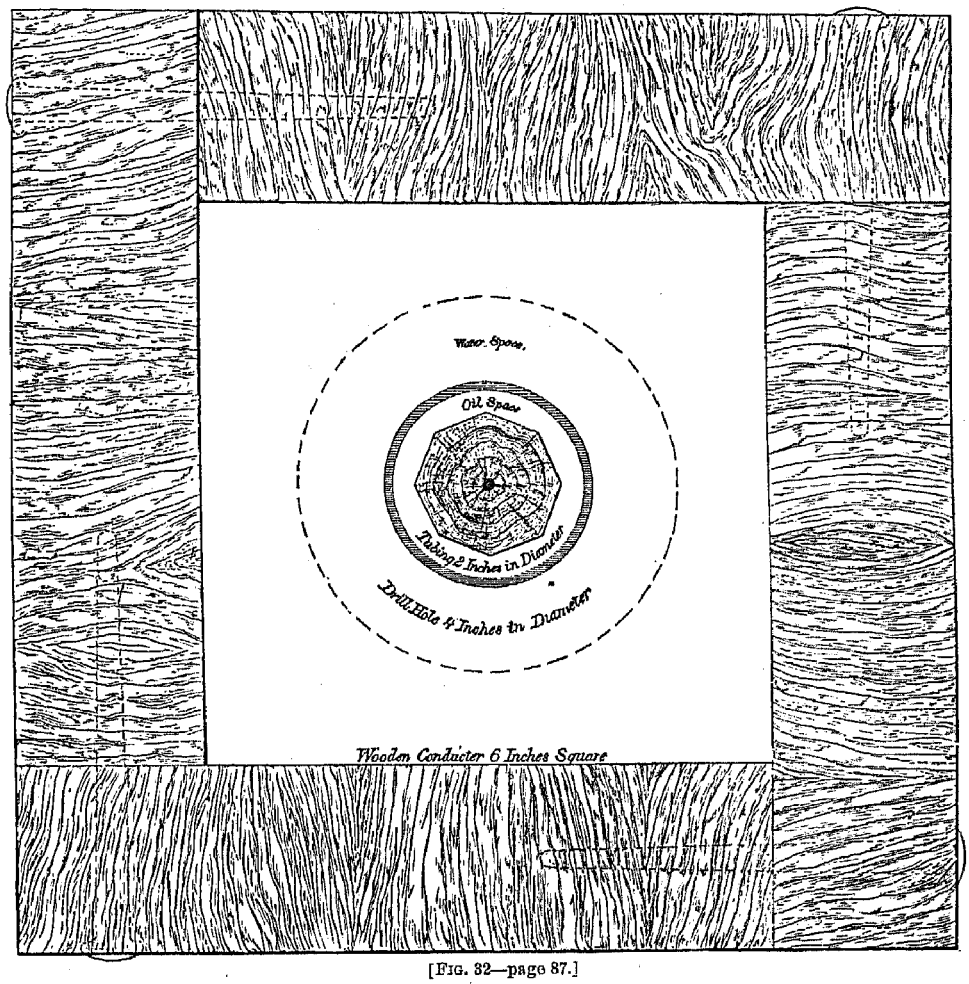
[Fig. 30—page 81.]
Eight-inch reamer.



[Fig. 29—page 81.]
Five-and-one-half-inch reamer, 1-12 natural size.

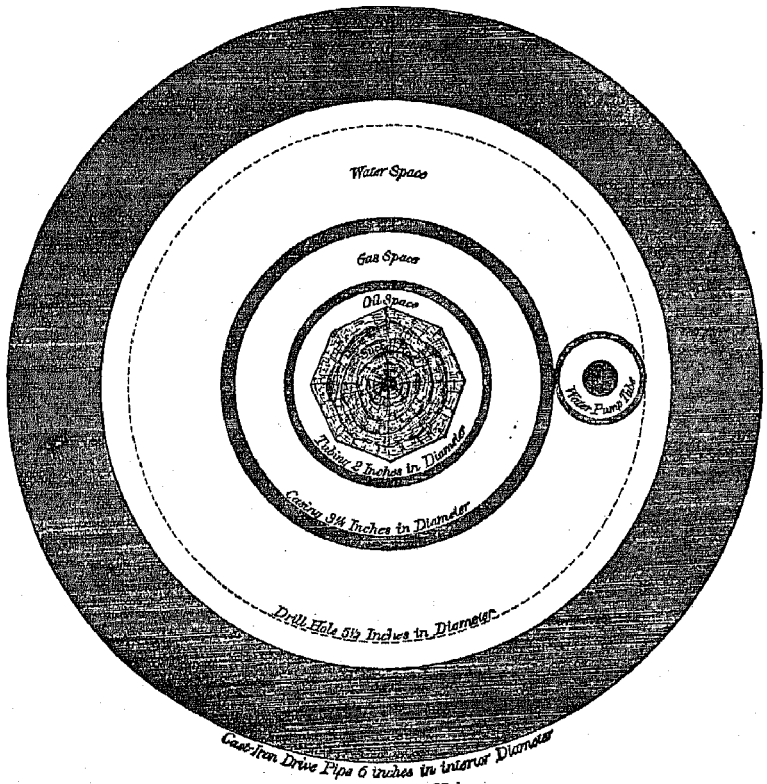


[Fig. 31—page 85.]
Torpedo before explosion.



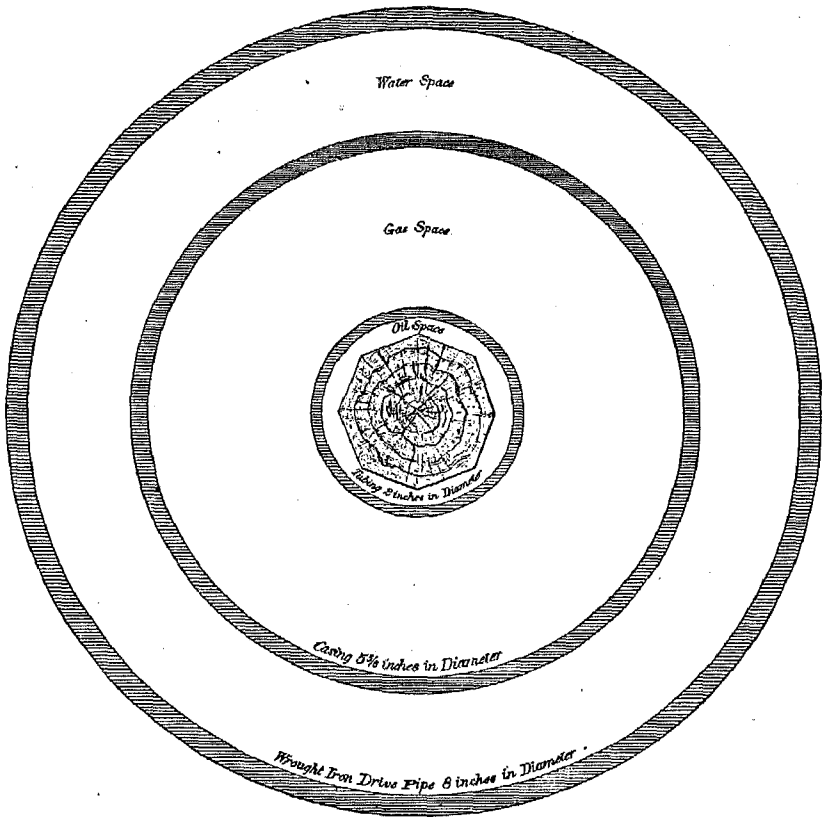
[Fig. 32—page 87.]

Cross-section of pumping well, 1861—wooden conductor.



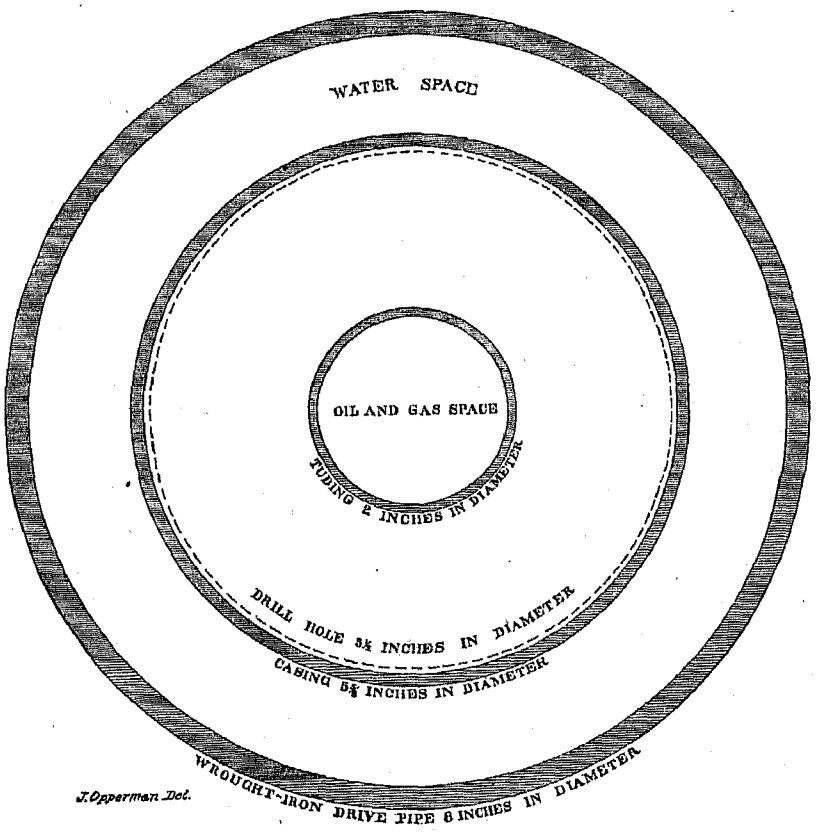
[Fig. 33—page 87.]

Cross-section of pumping well, 1868—cast-iron drive-pipe.



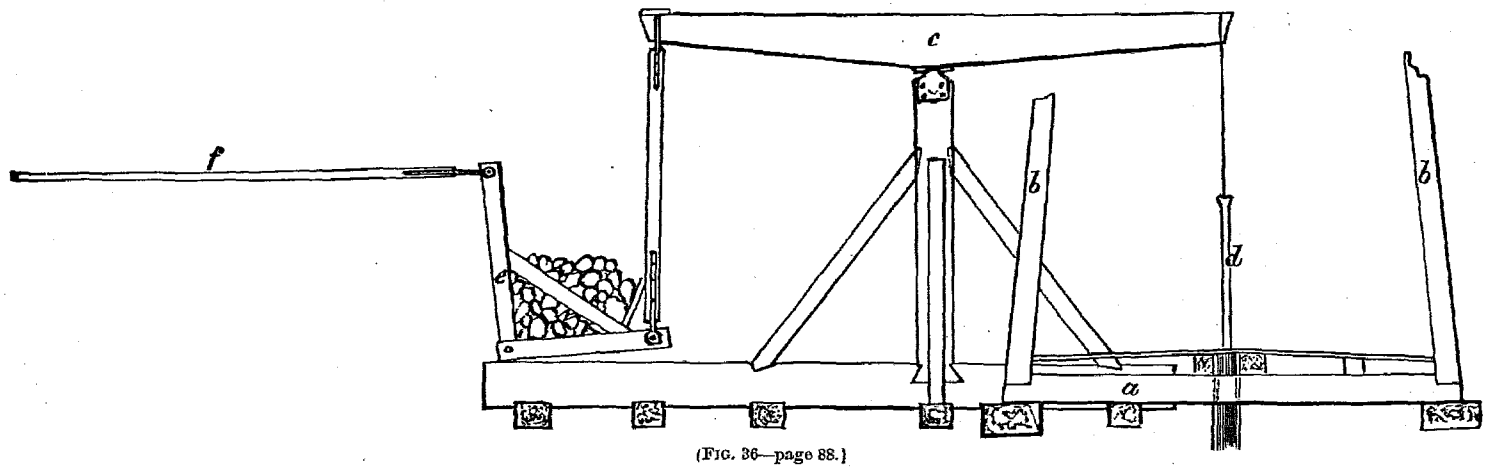
[Fig. 34—page 87.]

Cross-section of pumping well, wrought-iron drive-pipe, 1878.



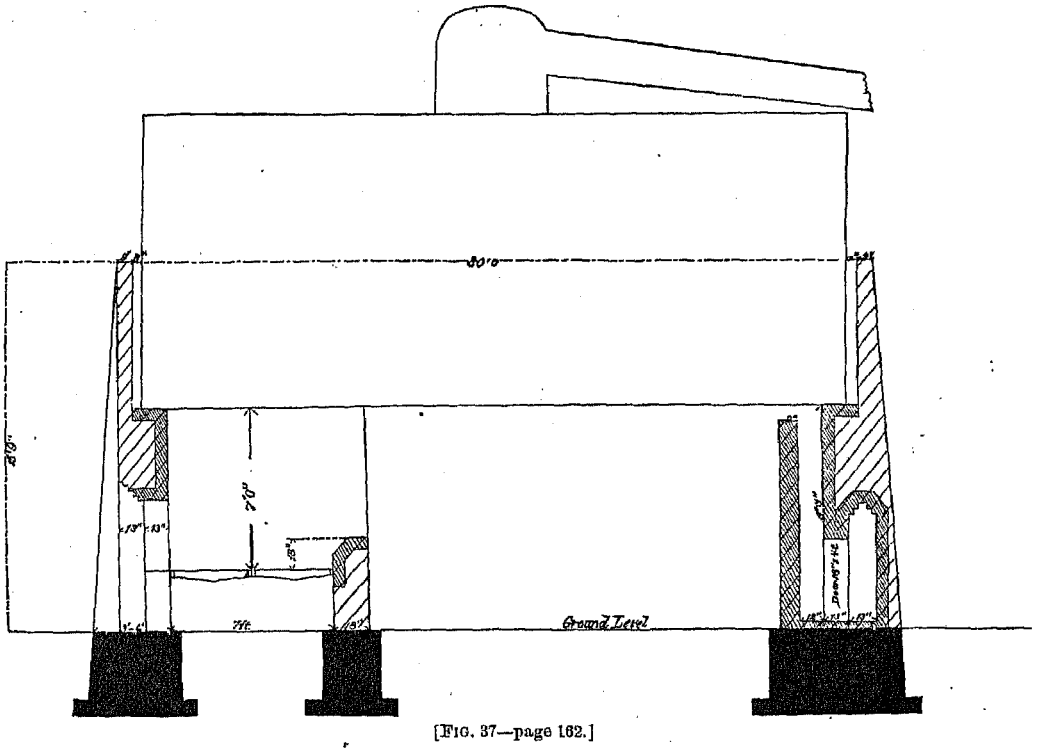
[Fig. 35—page 87.]

Cross-section of flowing well, 1880.

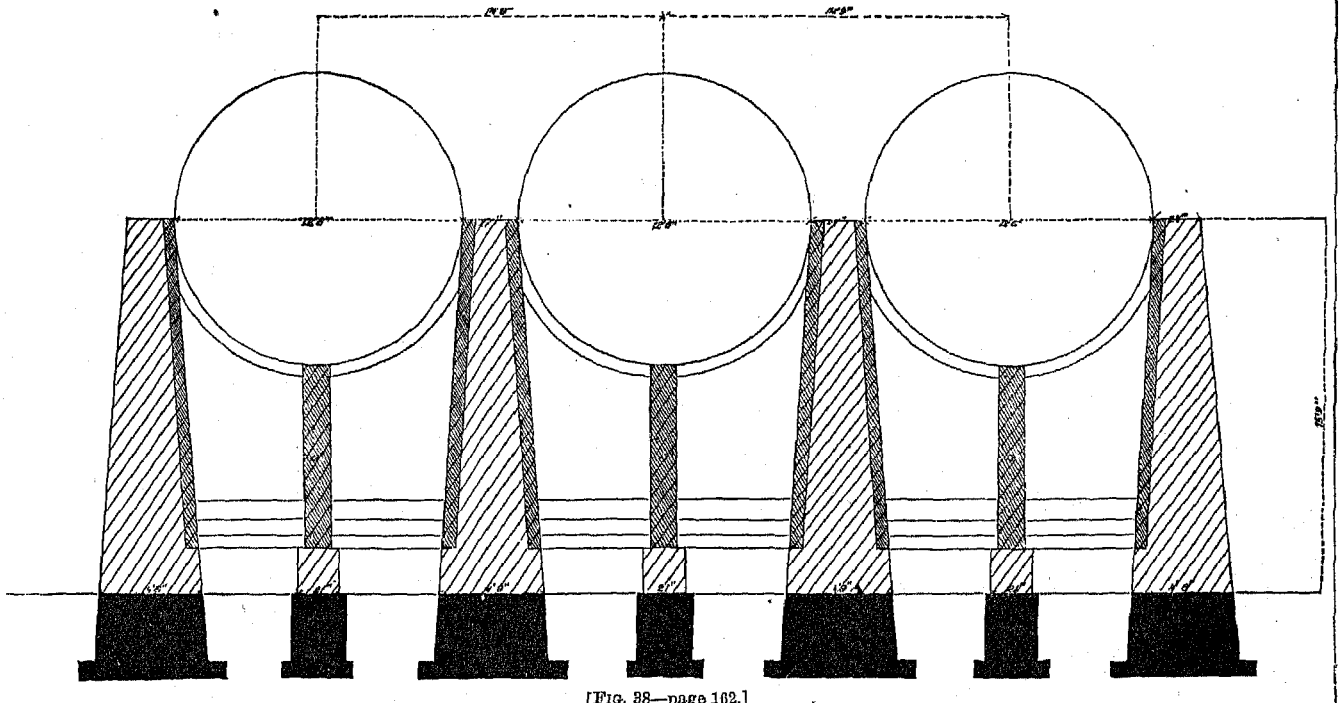


(FIG. 36—page 88.)

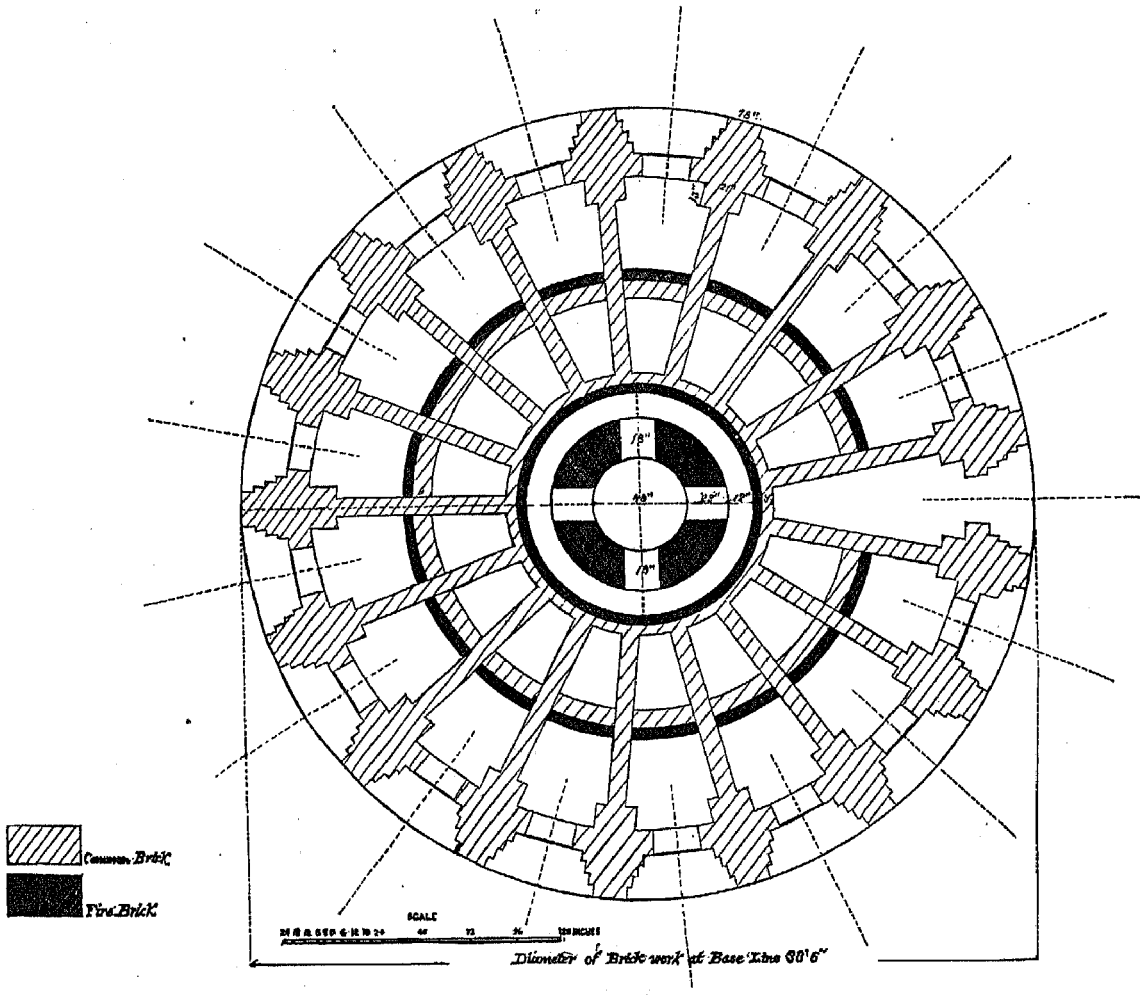
Sucker-rod movement.



[Fig. 37—page 162.]
Lateral vertical section of cylindrical still.

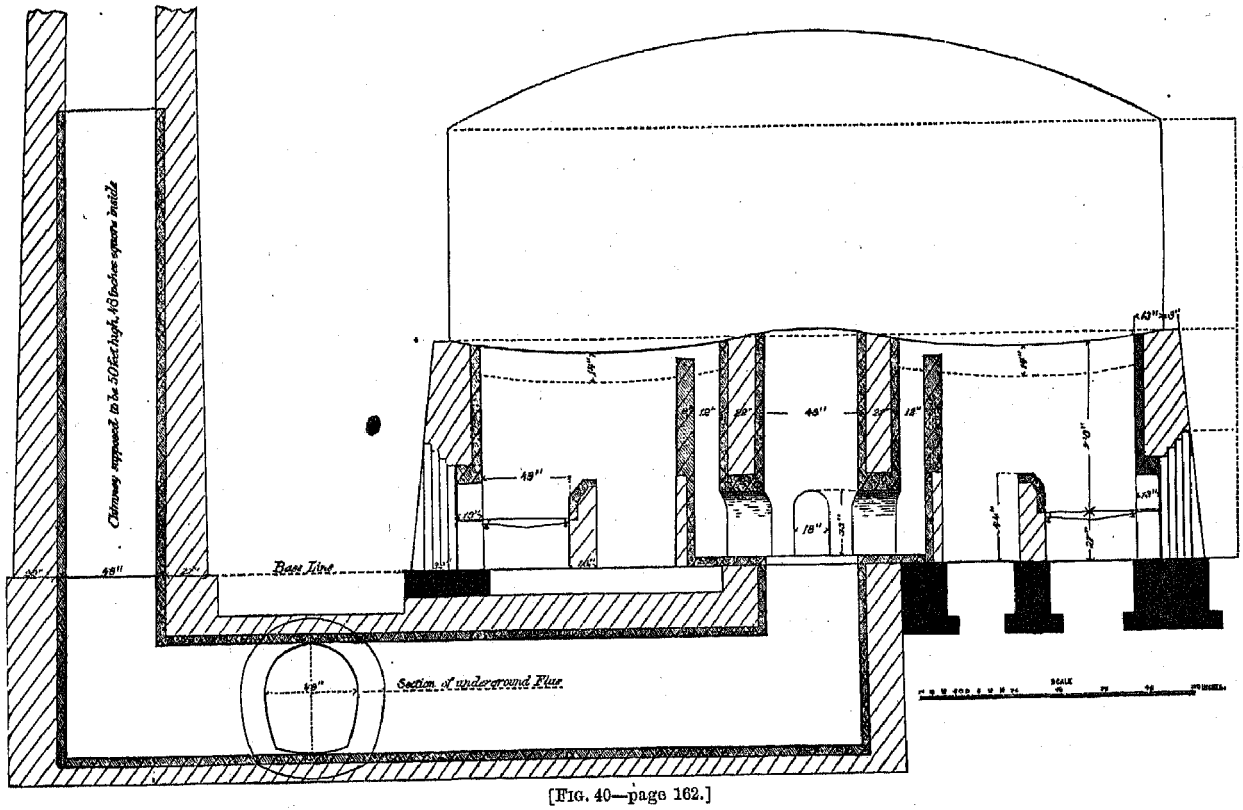


[Fig. 38—page 162.]
Transverse vertical section of cylindrical still.



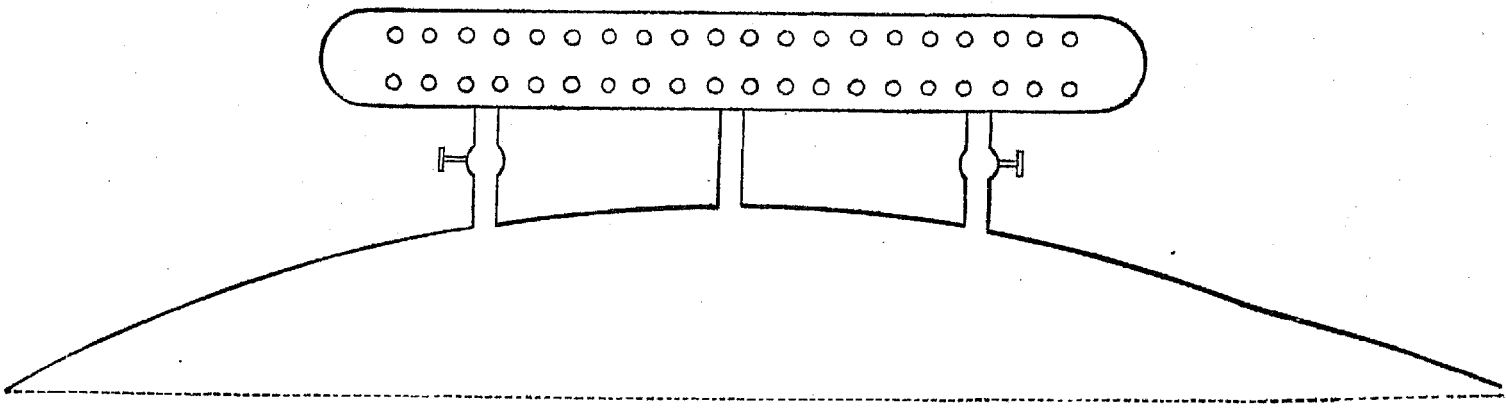
[FIG. 39—page 162.]

Horizontal section of cheese-box-still setting.



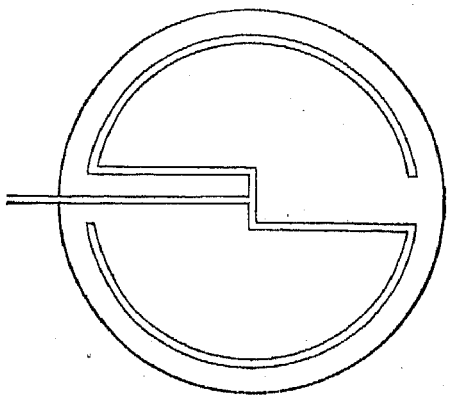
[FIG. 40—page 162.]

Vertical section of cheese-box-still setting.



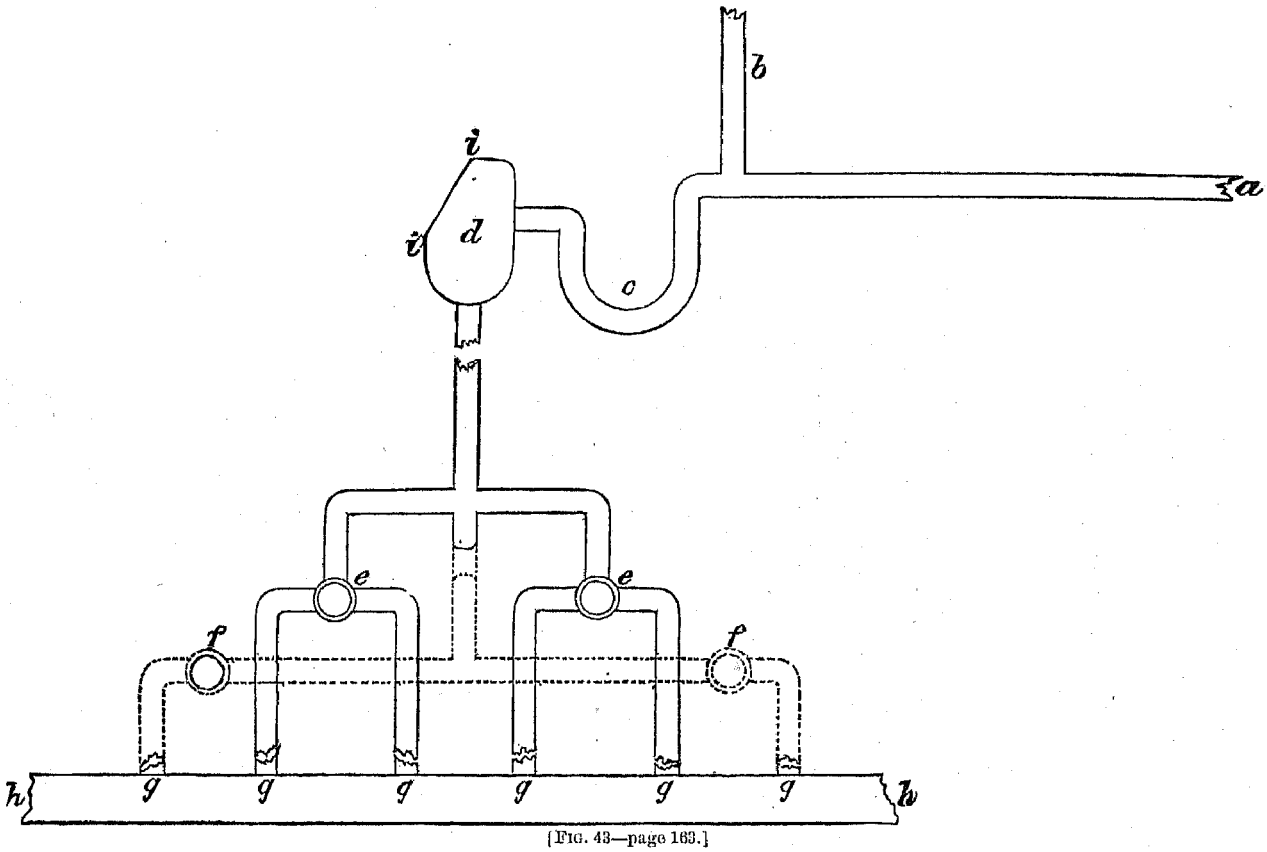
[FIG. 41—page 162.]

Section of condensing drum.



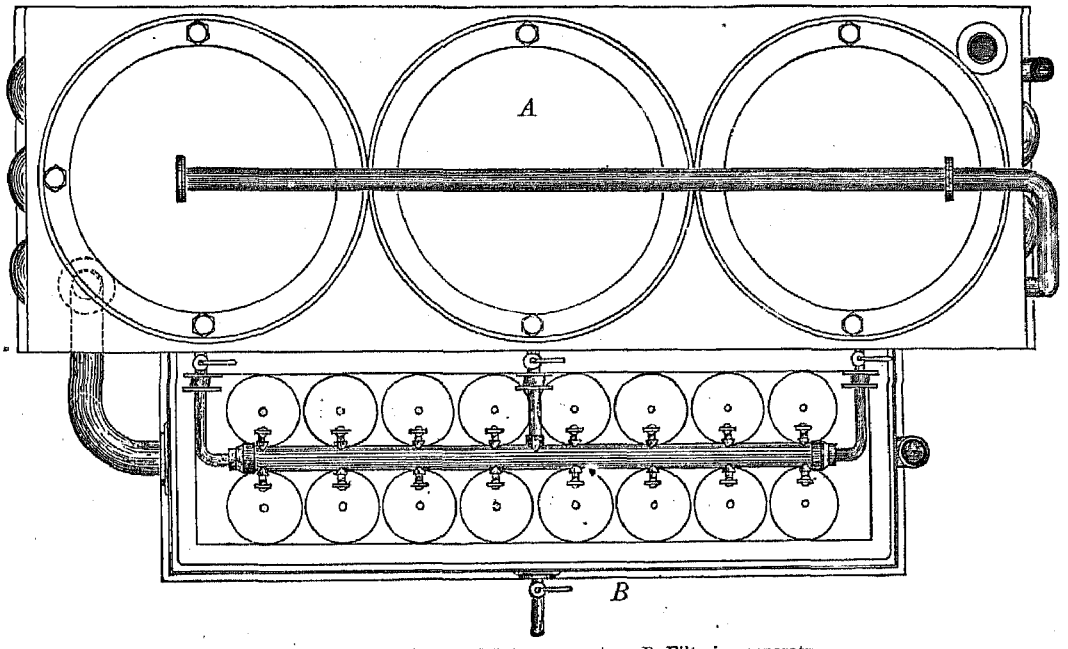
[FIG. 42—page 162.]

Section of steam-pipe for still head.



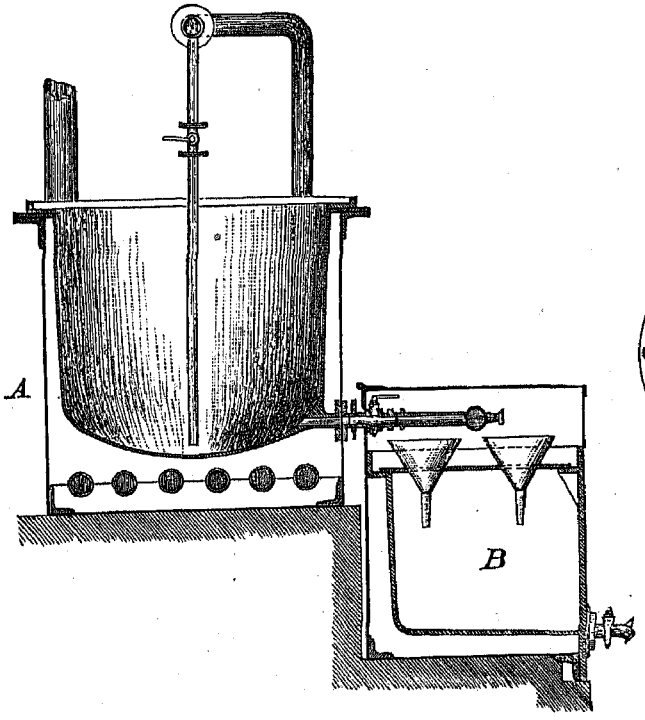
[FIG. 43—page 163.]

Diagram showing arrangement for distributing distillates.



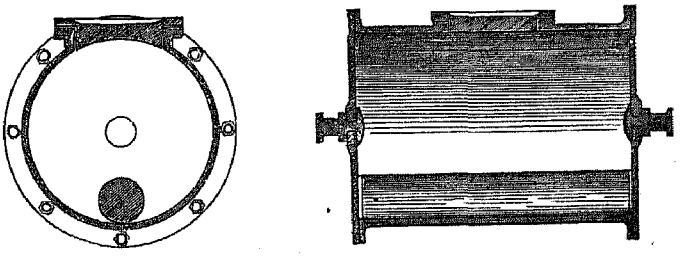
Horizontal section; A, Mixing apparatus; B, Filtering apparatus.
[FIG. 44—page 174.]

Ramdohr's paraffine filtering apparatus.



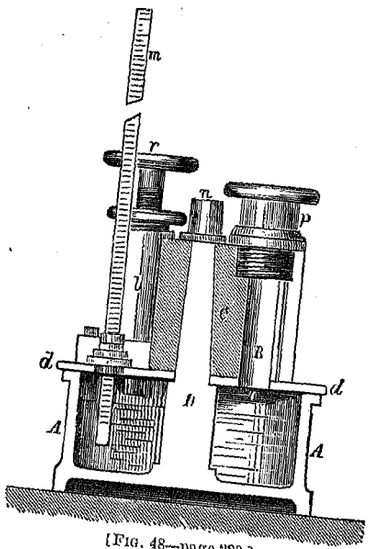
Vertical section; A, Mixing apparatus; B, Filtering apparatus.
[FIG. 45—page 174.]

Ramdohr's paraffine filtering apparatus.

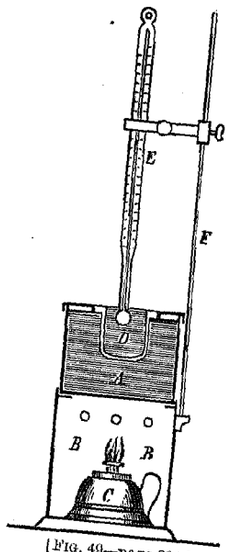


[FIGS. 46 and 47—page 175.]

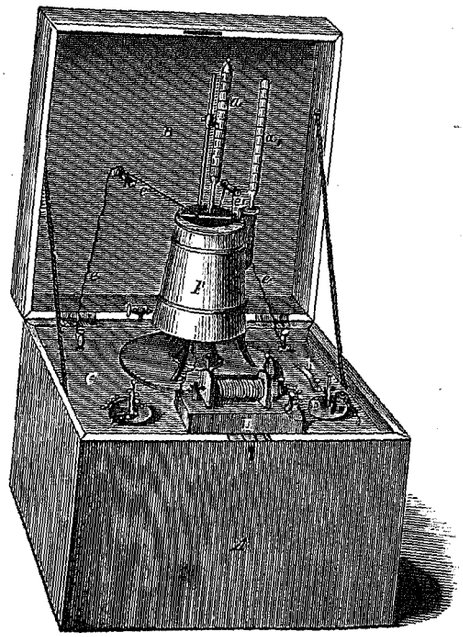
Ramdohr's charcoal pulverizing drum or cylinder.



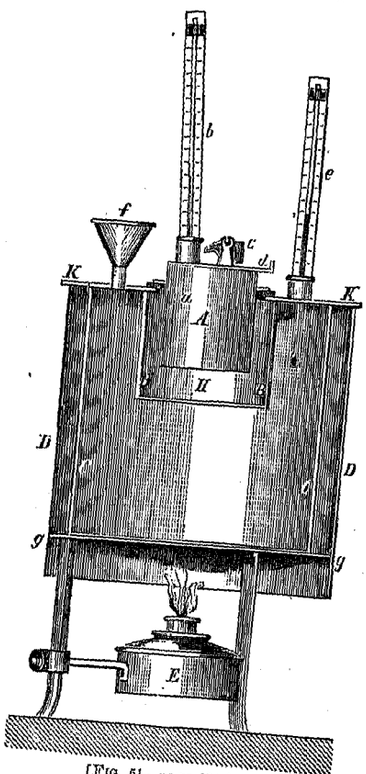
[FIG. 48—page 223.]
Salleron-Urbain tester.



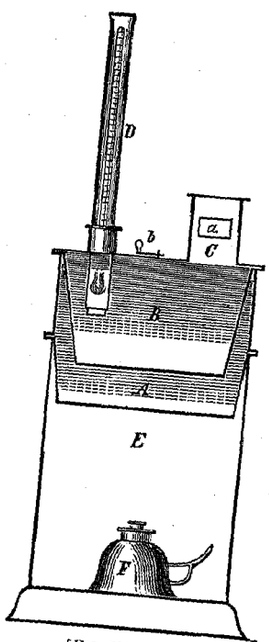
[FIG. 49—page 224.]
Tagliabue's open tester.



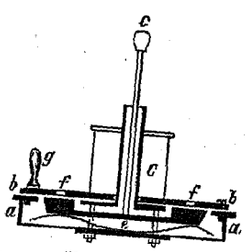
[FIG. 50—page 224.]
Saybolt's tester.



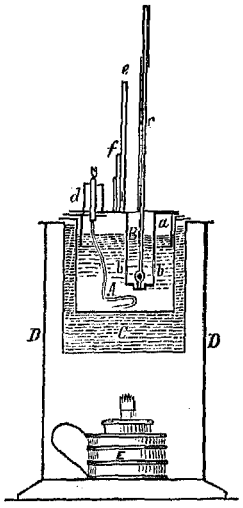
[FIG. 51—page 224.]
Abel's tester.



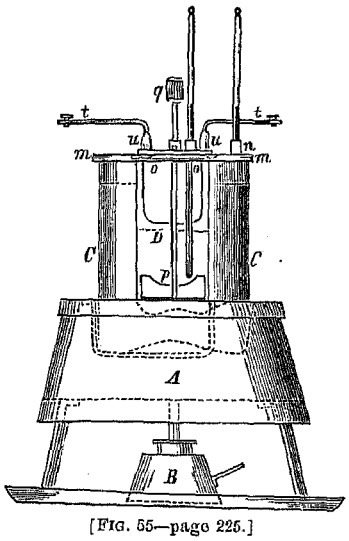
[FIG. 52—page 224.]
Tagliabue's closed tester.



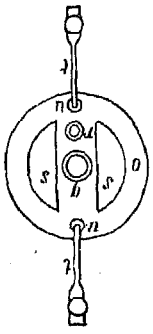
[FIG. 53—page 224.]
Tagliabue's closed tester.



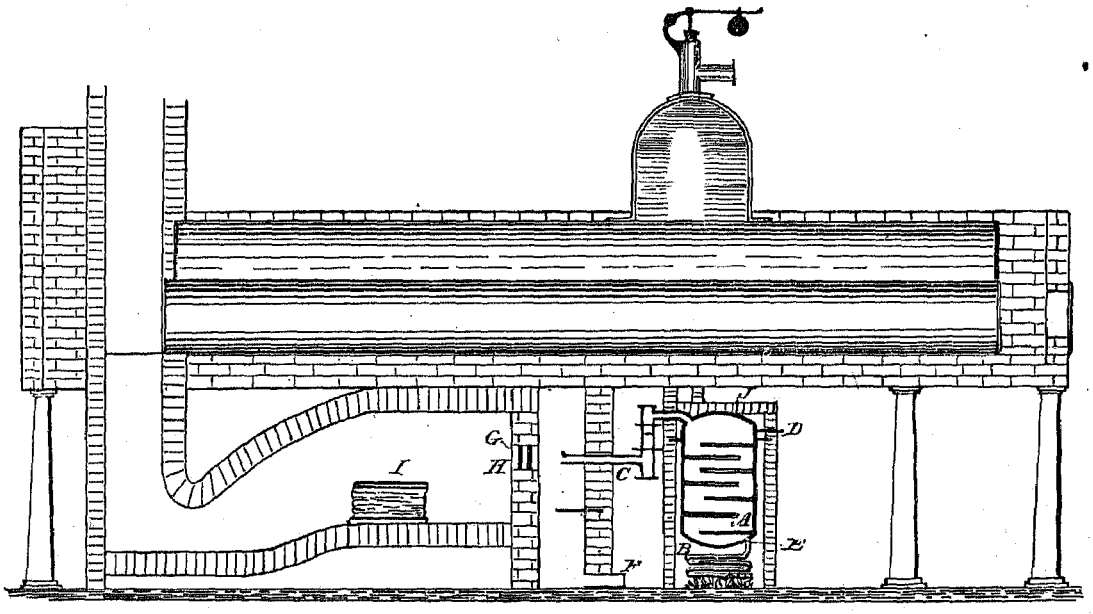
[Fig. 54—page 224.]
Parrish's naphtometer.



[Fig. 55—page 225.]
Engler's tester.



[Fig. 56—page 225.]
Engler's tester.



[Fig. 57—page 250.]
Vertical section of Eames' petroleum furnace.

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