Columban A. Johnson

Coal, Oil, Gas and Electricity
Our Natural Resources

BY

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PREFACE

As a servant of humanity, and for its best good, without thought of selfish gain, only reimbursement for labor and expense incurred, I have prepared and published this book. It covers subjects vital to our best interests. I have given this book my best thought, and am sure that a careful study of its pages will help my readers to a better understanding of Nature's laws and the wonderful possibilities open to mankind in the developing of untouched resources in the realms of nature.

After making a careful examination and study of the coal, oil, and gas fields of Pennsylvania, Ohio and West Virginia, the writer has been convinced without a doubt that there are many new fields that have never been developed; and if the proper locations are made in the folds of the hills, the present production of these vital necessities will be increased three-fold.

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Coal, Oil, Gas and Electricity Our Natural Resources

CHAPTER I

CREATION

MINERAL, VEGETABLE AND ANIMAL LIFE

The All-wise Creator of the Universe, during the periods of creation, which may have been thousands of years, placed within the openings in the bowels and strata of the earth many mysteries. As we delve into these mysterious chambers we discover forms of life which include coal, gas, oil, sulphur, salt, iron, copper, and various other minerals. They are produced by chemical action on the various strata of earth. In the compounding of the chemicals producing these different products, the mineral product into which predominating elements in the various component parts are formed, will take the nature of the stronger element. Therefore, coal is produced where coal elements predominate and gas where gas elements predominate. These lower species of life are dependent one upon the other for existence, just as the higher forms of life are dependent one upon the other for development and growth. As we approach the surface of the earth we find, in the higher forms of life, one mineral feeding upon the other and producing a more valuable mineral.

When we reach the surface of the earth we find a higher form of life which we term the vegetable kingdom; and we find that this form of life which manifests itself in growth of buds, flowers, and fruitage is dependent absolutely upon the elements: carbon, gas, and other

chemicals contained in the soil, covering from 18 inches to several feet of the surface. In the ground immediately underlying the productive soil we find the lowest form of animal life, worms and various kinds of insects, which come to the surface in the springtime after early rains and the melting of snow followed by the warm sun.

In this surface soil are produced all kinds of vegetable life. The grass, which is per-ennial, is Nature's first production; then come the wild flowers, and the shrubbery, fastening their roots in the soft loam; and the larger trees, often sending their roots down through the sub-soil to a depth of many feet in order to find a substantial foundation for their trunks towering toward the sky. Surface soil is fertilized by natural processes. The decaying of vegetation makes the soil very fertile and thus produces all kinds of vegetable life; and under the skilled hand of the expert agriculturist its productiveness may be maintained indefinitely and increased many fold. Fruitage of vegetables, grains, and edible fruits of every kind supplies all animal life with the required variety of foods needed to sustain life and develop growth.

The animals and fowls feeding upon the grass, grains, and fruits produced by nature and increased by the supplementing of man's genius and skill are fattened and prepared for man's use, as Nature responds to her own sacrificial laws; "Go forth and subdue the earth." Unselfishly laboring with heart and hand brings to their highest fruition the plans of the Master Mind of creation, the development of mineral, vegetable, and animal life, blessings to mankind, progress and prosperity, and the commendation of the Creator upon his labors.

REFORESTRY—THE NEED OF THE HOUR

The extravagant and even wasteful manner of cutting and using the most valuable trees has almost de-

nuded our forests of such superior woods as the Walnut, Oak, Hickory, and Locust. Of these the walnut is the most valuable, having been used largely in the manufacturing of fine furniture during the past fifty years. At this time there is hardly a walnut tree of usable size to be found in the forests of Pennsylvania, Ohio, or West Virginia. The hickory, the white oak, and the locust are still to be found in limited numbers; but it is imperative that immediate steps be taken to rehabilitate these valuable species of trees for the comfort and welfare of future generations. Reforestry is the crying need of the hour, especially the reproducing of these very valuable species.

A serious menace to the less valuable and yet useful trees, which may be called more domestic in their environment, growing in our yards, and on city lots, in our large cities and suburbs, is the smoke nuisance. The great factories, coke ovens, and furnaces belching forth immense volumes of smoke, graphite and other verdure-destroying elements are tending to destroy forests and domestic trees, valuable largely for the beautifying and shading of our streets and yards. We rejoice to know that some effort is being made to eliminate and neutralize excess smoke and everyone should unite heartily in any movement toward the preservation of forests and domestic trees and shrubbery for the protection of human life and health.

CHAPTER II

THE FORMATION OF COAL, OIL, GAS AND OTHER MINERALS

In the area covering Western Pennsylvania, the Allegheny formation bounds the Conemaugh on the north and extends far down the valleys in the overlying formation. It is also found in irregular extension to the West Virginia line, where it is brought to light by the acute folds of that region. Most geologists go to West Virginia for bearings and courses of the Allegheny formation. The formation of the contours, and closely folded anticlinals and wide extensions lead through the state of Pennsylvania. The synclines and their long extensions, as the rivers change their courses, record the gigantic convulsions of Nature which took place during the periods of the formation of coal, oil, and gas as well as the different minerals.

The coal is formed by the trees, plants, and shrubbery during each period and age. Each specie of tree has different elements and a different chemical composition, which in fact accounts for the derivation of over 18,000 coal by-products; as the lower measures are closer to the earth in its smoldering state. The center of the earth is also the center of a great heat at that time permeating its entire mass. The successive beds of coal were formed in a similar manner, but at different periods of time, the ascending measures being closer to the center of the earth. The vegetable life of the earth was covered by the great upheavals of the earth itself. These layers of vegetable life were then subject to the internal heat, which produced a charring action, turning the vegetable life into a form of carbon. The tremendous pressure of the overlying masses tended to compress this carboniferous mass, which resulted

in the formation of coal, and the gradual changing of the climate during each period until the coal beds were formed.

SELECT ROCK LAYER IN THE ALLEGHENY FORMATION

If it were possible to remove all the rock lying above any selected rock such as the Lower Freeport, it would be found that the top layer formed a surface like that of a gentle rolling country consisting of long extended valleys, low rounded ridges or swells. These conditions appear on the Fayette anticlinal, known as the Indiana anticlinal, and elsewhere.

The long extended valleys and their foldings indicate that the Gulf of Mexico and the Great Lakes were at one period of time joined, Lake Erie running far into Pennsylvania between gentle rounded valleys. The ridges and valleys would be found in Western Pennsylvania to have a general extension of north-east and south-west. Some of the valleys would be found to be very long, extending sometimes half way across the states; but in all cases the ridges would nose out so as to be nearly parallel. Further examination of the ridges running together would show that these lines were the axes of a major valley or basin. Geologists recognize that in these long extended valleys and ridges are folds formed by pressure from the southeast and from the Gulf of Mexico; the pressure of the Atlantic Ocean forming the Blue Ridge.

To the upfolds the name anticlines was given, and to the downfolds synclines. The direction of the slope at any point is the dip descending from the top of the Pittsburgh Coal to the Upper Freeport Coal, a distance of 620 feet, showing the greatest disturbance of any of the measures of the coal beds, the changing of the rivers in their courses, and data which points to a well.

CHAPTER III

ALASKA WAS A TROPICAL CLIMATE DURING THE PERIODS

There is a well-founded belief that Alaska was a tropical climate during a period of time; the theory arises from the formation of the coal beds and the oil and gas.

The forests of our country are found on the Allegheny, Blue Ridge and Adirondack mountains and throughout the great major basins and valleys adjacent thereto with their massive trees and abundant foliage, even to the glistening peaks of the Rocky Mountains of the far west with their wild canyons and rapid-flowing river, plowed deep by the glaciers and fed about the base of these giant peaks and deep valleys over wide areas in the mountain and lowlands of our continent. Beginning with a scientific description and topographical study of the growth and environment of the forests with their petrified formations of trees and fossils representing in nature, mineral, vegetable and even animal life throughout the past ages, scientific men in recent times have set themselves to the task of solving these so-called nature problems which are vital to the priceless fuel and mineral deposits, which man has found enrolded in the body of the earth. Included is a brief study of the modulations of the earth's crust, the growth of our forests and the various chemical deposits undergone in the different species from the first periods of the coal ages of the earth's crust down to the present day formations, including the changing conditions of the various formations of the coal beds during the periods of nature's convulsions, changing the carboniferous masses and elementary substances

of the charred elements and the species of vegetable life, converting and carbonizing the organic substances into carbon and coal through combustion, by the action of fire and chemical action of salt water from the unsettled oceans, together yielding many by-products which may be discovered through a process of distillation of the coal.

The synclinal and anticlinal waves throughout these great major basins and valleys have made possible the collection and forming of the oil in enormous pools and confinement of natural gas in the immeasureable natural strata and folds of the earth.

In parts of Alaska and many of the north and southwestern states, such as South Dakota, among the heavy timbers in the Black Hills and petrified forests and fossils east of the Hills, about fifty miles, are the so-called "Bad Lands." Unique in all the formations of the earth's surface, they are termed bad because they possess no agricultural merit; they are unsightly and are difficult to explore, but in no area of the world's surface, it is said, have been found so much of fossil remains—hippopotamus, rhinoceros and such animals which have not for ages inhabited the lands or the waters of North America. Many of these fossils are shown in our best eastern museums. Remains of fish show that some of these spots must have been lake beds.

Yellowstone Lake, an expansion of the Yellowstone River, and the petrified forests of Wyoming contain many petrified trees and fossils, found in the northern part of the state. These petrified remains have been found in the many western states, 600 feet of rock formation overlying the petrified forests. The petrified trees being found sometimes standing perpendicular showing the former growths and environmen of the forest during the ages.

Most of the forests located in national parks and timber land reserves, growing hardwoods: burr oak,

linden, Norway maple, green ash, wild cherry, larch, American elm, black walnut, hackberry and honey locust, and such evergreens as Scotch pine, white pine, Norway spruce, Colorado blue spruce, white spruce, red cedar, arbor vitae. Yellowstone Park was set aside to belong to the people forever, and in this playground of nature many beautiful birds find sanctuary and chant their sweet melodies in these primeval forests. Five thousand, five hundred and seventy-five square miles is under the jurisdiction of the government and Congress has established rules and regulations for the preservation of the park, animals and birds.

This park is one of the four regions in the world where there are large groups of geysers. About 100 active hot springs and geysers are found within Yellowstone, and they vary greatly; some cover acres whilst others have very small surfaces. There are three distinct geyser basins: the upper geyser basin is the most active and contains the noted spouters; the middle geyser basin contains no cones but has a steaming abyss of limestone formation about 30 feet deep which is known as "Hell's Half Acre." Four or five times each day the Grand gives astonishing exhibits, and it is the park's most powerful geyser.

Mammoth hot springs are in the northern part of the Yellowstone Park and the terraces are marvels of gorgeous coloring where the hot water ripples over the unique, scalloped formations. Yellowstone Lake, an expansion of Yellowstone River, is a magnificent body of water said to have a shore line of 300 miles; but it has never been entirely explored. Many other lakes are in this lovely region, which is our very finest National Park. Its geysers exceed those of Iceland, and here are found caverns which contain beautiful stalagmites and stalactites. Many mineral springs of cold, sparkling water are also found here. The park extends beyond Wyoming's state lines about three miles on the north and eleven miles on the west. Six miles from

the Grand Canyon of the Yellowstone, which is ten miles in length, is sulphur mountain, an immense mountain of pure sulphur crystal. Steaming springs play at its base.

There are about twenty high peaks in Yellowstone Park. The headwaters of several large rivers are in this wonderful reserve, and the Continental Divide marks the separation of these waters. Among the mysteries of the rippling waves of the earth's crust within the state of Wyoming are immense natural resources. Her coal reserves are so enormous that they are important factors in the wealth of the state. Oil, natural gas, gold, silver and most of the precious metals are found here in great quantities. Mineral deposits and giant massive trees and fossils of the petrified tropical forests of the formative periods and ages appear in Wyoming, Oregon, Arizona and many of the states in the area included in the region of the Rockies.

By a study of the earth's crust the mineral deposits and temperatures all over this country, scientists have found quite a number of hot spots where volcanic heat is manifestly accountable for records obtained in deep mines and by lowering thermometers into artesian wells. This is not at all surprising when it is considered that not so very long ago much of our far western country was fairly aflame with eruptive fires, a fact evidenced by numerous "cinder cones" and volcanoes rather recently extinguished and by sheets of lava thousands of feet thick, which are spread over thousands of square miles. These evidences of dead volcanoes are frequent. Owing, as is supposed, to a volcanic cause, in the Snake River valley of Idaho, the existence of numerous hot springs is referred to water that comes up boiling from the depths through fissures in the rocky strata. Many wells in Owyhee County yield warm water, plainly owing to lava flow, the region being one of comparatively recent volcanic activities. For instance, Stromboli, which is now throwing off

various kinds of minerals, as well as large quantities of water.

One should expect from the seepage through the fissures and strata of the earth's crust into the active volcano, and burning mountains produced by permitting eruptings throwing off quantities of water by the cooling and condensation of the heat, that the gases rising through the vents and strata in conjunction with the volcanic dust thrown high in the air during an eruption being so finely divided, that much of it would float in the upper levels of the atmosphere. Its particles seem mostly to be minute bubbles, hollow inside. Together with water, volcanoes emit vast quantities of lava mud which hardens into rock. This forms what is called sedimentary lava, a material which in part of our own west covers great areas to a depth of thousands of feet. Volcanic sedimentary product is pumice, which is so porous and so light in weight that it will float on water. Another is obsidian or volcanic glass, a substance of the same chemical composition as pumice, but extremely hard, being of high density. The sediment of the eruptive rocks, represents material thrown up from great depths. In conjunction with the mineral deposits of the earth such rocks are practically impervious to water, whereas the sedimentary substance shale and rock are sufficiently porous to allow water to percolate through them. It is these rock formations that contain the so-called pools of petroleum, usually with water underlying the oil.

In Utah the "Dead Sea of America," a great salt lake, covers 2,00 square miles. Three rivers flow into the lake, but none flows out. The water escapes only by evaporation and seepage through the strata, making it so heavy that one cannot sink in this brine. It contains one pound of salt in every five pounds of water. A dearth of moisture and consequent scarcity of timber and verdure have been the most serious drawbacks from the beginning. There are many natural wonders

here in the way of canons, bridges and stone formations and a saturated mountain of sedimentary oil shale of the formative period, from the earth's crust. The same can be said of the many states east of the Rocky Mountains relative to the formative periods of the earth leveling the major basins and valleys during the convulsions of nature, taking place during each formative period of the coal ages from the earth's crust to the present formation. The minerals treasured in the mountains permits Utah to take her place among the mining commonwealths of the Union.

Many of our eastern and southern states, including Pennsylvania, Ohio and West Virginia, with their great coal beds, mineral deposits and petrified remains of trees, leaves and fossils overlying the Pittsburgh coal measures, covering a depth of many feet. The species of the trees such as the chestnut, oak and various other kinds during the periods reduced the vegetable life to a charring action by the chemical process of the heat units, leaving them undergoing a petrified state and showing many species of the trees and leaves of the forest as perfect in form and appearance as they were almost in their original completed growth. The petrified vegetable life when becoming petrified, the substance being absorbed into the earth, left the remaining substance in a solid rock formation, only to produce a mineral of a different nature in conjunction with the mineral deposits of the earth. The distillation of the vegetable life during their growth and environment and abundant foliage and tropical fruit undergo through life a process of the heat units, throwing off the liquid fuel substance and form the oil pools, and the compounding of the chemical elements and substance uniting together with the various growths, in conjunction with the mineral deposits and chemical elements of the earth forming the coal measures and various minerals the veins of limestone, granite, onyx, asbestos, copper, lead, etc., and the precious metals,

gold, silver, radium, platinum and the diamond, the most valuable mineral treasured in the mountains and fed about the feet of the giant peaks in the strata and folds of the earth. This phenomena in nature has puzzled geologists and scientists of the past centuries and this mystery has never been fully explained and perhaps will remain a mystery to the end of time.

Pittsburgh's industrial center, in the Allegheny formation, is the world's workshop, leads in tonnage and holds the record for finished aluminum, radium and vanadium. It has the world's biggest plants devoted to structural steel, glass, airbrakes, electrical supplies, and is the national plumbing supply center. However, old King Coal is the chief industrial wealth of the state, and the by-products and the mineral deposits treasured in the stratas and folds of the earth during the convulsions of nature, forming the various beds and measures of limestone, marble, granite and iron ore, etc.

The limestone is formed by the ash of the charred organic and elementary substance of vegetable life, subject to a process of the heat units. The marble is formed by the ash of the softer species of the organic substance of the tropical growths by the same process of distillation. Our great granite beds and measures of the New England States, Quincy and Barie granite, the softer formation of the various measures of the South and the solid, flinty formation of the great west are formed by the giant weeds and substance of plant life in conjunction with the mineral deposits of the earth. Our great iron beds are formed by the organic substance and tropical pines.

Crossing the Bay from San Francisco in the direction of Sausalito one sees in a distance the most enormous species of sculpture in the world, the figure of beauty of nature, wonderfully realistic, of the eruptive rocks, representing material thrown up from the great depths throughout the area of the Rocky Mountains and valleys, with their massive mineral deposits of the

formative periods—the designment of art and placing in creation of beauty enfolded in the stratas and realms of nature treasured in the earth.

COAL, 18,000 BY-PRODUCTS

CHAPTER IV

CAVERNS

The earth underwent great convulsions and brought about conditions changing many of the high altitudes of the Allegheny, Blue Ridge, Adirondacks and Rocky Mountains. The emigrating of the mineral deposits carried down and fed upon the basins and valleys, forming many anticlinals, low rounded ridges and swells and famous American caves of our great continent.

Among the ones of worthy mention are the famous Mammoth Cave in Edmondson County, near Green River, about seventy-five miles from Louisville, Kentucky. It was discovered in 1809. Its entrance is reached by passing down a wild, rocky ravine, through a dense forest. The cave extends some nine miles, already explored and traversed, and requires 150 to 200 miles of travel. The cave contains a succession of wonderful avenues, chambers, domes, abysses, grottoes, lakes, rivers, cataracts, and other marvels, which are too well known to need any more reference than when, behold! the eruptive rocks designed in nature formed these famous caves. One chamber—the Star—is about 500 feet long, 70 feet wide, 70 feet high, the ceiling of which is composed of black gypsum and is studded with innumerable white points that by a dim light resemble stars; hence the name of the chamber.

There are avenues one and a half and even two miles in length, some of which are encrusted with beautiful formations and present the appearance of enchanted palace halls. There is a natural tunnel about three-quarters of a mile long and 100 feet wide, covered with a ceiling of smooth rock 45 feet high. There is a chamber having an area of from four to five acres, and there are domes 200 and 300 feet high.

Echo River is some three-fourths of a mile in length, 200 feet in width at points, and from 10 to 30 feet in depth, and runs beneath an arched ceiling of smooth rock about 15 feet high; while the Styx, another river, is 450 feet long, from 15 to 40 feet wide, and from 30 to 40 feet deep, and is spanned by a natural bridge. Lake Lethe has about the same length and width as the river Styx, varies in depth from 3 to 40 feet, lies beneath a ceiling some 90 feet above its surface, and sometimes rises to a height of 60 feet. There is also a Death Sea, quite a somber body of water.

There are several interesting caves in the neighborhood, one three miles long, and three each, about a mile in length. Many caves, rivers and cavities are found within the area of the Blue Ridge Mountains. The transmutation of the masses and pressure thrust upon the overlying formation of the formative period, being of a more gentle folding while these conditions were taking place in the lower elevations, and the closing up of the greater area in the overlying formation, and the gradual cooling of the structure at a greater altitude, leaving the underlying stratas of a softer nature going through a longer process of cooling and petrification, formed these famous caves, rivers and cavities within our great continent.

Wyandotte Cave is in Jennings Township, Crawford County, Indiana, near the Ohio River. It is a rival of the great Mammoth Cave in grandeur and extent. Explorations have been made for many miles. It excels the Mammoth Cave in the number and variety of its stalagmites and stalactites, and in the size of several of its chambers. One of these chambers is 350 feet in length, 245 feet in height and contains a hill 175 feet high, on which are three fine stalagmites. Epsom salt, niter, and alum have been obtained from the earth of the cave. The Epsom, niter and alum is obtained from the caves, cavities and stratas of the

earth. These mineral deposits are the residue of the salt water from the unsettled oceans by simmering and settling into the lower elevations and undergoing a process of petrification, thus forming a solid mass in the rock formation.

Howe's Cave is situated thirty-nine miles from Albany, N. Y., and perhaps was the dwelling place of Rip Van Winkle, who slept within the area in the quietude of slumber of silent night for twenty years in the famous mountains.

Luray Cave, Virginia, and the Mammoth Cave, Kentucky, are probably the most remarkable caverns known. Discovered in the year 1842, it is related, penetrated to a distance of eleven or twelve miles. The cave is lighted by gas as far as a body of water called the Stygian Lake. The entrance is about fifty feet above the valley and the rock chambers known as the Reception Room, Washington Hall, the Bridal Chamber and the Chapel, are successively reached. Then the Harlequin Tunnel is traversed, and the visitors pass through Cataract Hall and various rooms. The Stygian Lake is 10 feet deep, and is 30 by 20 in extent. Fine stalagmites appear both above and below the lake. The visitor crosses the lake in a small boat, landing on Plymouth Rock. The path follows a small brook and traverses the chambers and passages known as Devil's Gateway, Geological Room, Giants' Study, and Pirates' Hall.

One of the great wonders of our continent and even of the world are the towering mountains of America, which have been formed during the early periods by the earth's convulsions and volcanic eruptions.

These eruptive rocks, representing many kinds of minerals, have during these periods been fed down upon the basins and into the valleys from the higher altitudes, while the mountains have been in eruption and the whole area surrounding the mountains in convulsions.

Within the area of the Rocky Mountains in the western section of our country we find the most wonderful transformations due to nature's immutable laws. Likewise, we find many of the highest and most rugged peaks on the continent. These representative mountains of the west and many peaks in our Atlantic Coast ranges demonstrate to geologists and to nature lovers the sublime grandeur of nature's laws, and they fully appreciate the benefits resulting from these early disturbances, which in the first periods transmuted and transformed these necessary materials and minerals, distributing them equitaly and lavishly into the basins and valleys even to the earth's crust.

Wealth of minerals and richness of adjacent soil invites the courageous pioneer to exploitation, development and assured success.

The height of some of the most noted peaks in the various ranges east and west are herewith indicated for the reader's information.

Mt. St. Elias of Alaska	17,900	feet
Mt. Shasta	14,450	"
Mt. Whitney	15,000	"
Long Peak, Cal.	13,400	"
Pike's Peak, Col.	14,320	"
Fremont Peak, Wyoming	13,570	"
Mt. St. Helen, Oregon	10,158	"
Mt. Hood, Oregon	11,570	"
Mt. Rainer, Washington	13,000	"
Mt. Washington, New Hampshire	6,234	"
Mt. Marcy, New York	5 467	"
Mt. Mansfield, Vermont	4,280	"
Mt. Otter, Virginia	4,260	"

It is a scientific fact that the earth underwent natural convulsions, accompanied by great fires and floods. This gives rise to an explanation of the finding of petrified bones of the pre-historic animals. It is assumed that during the periods of convulsion the animals then inhabiting the earth, terrified and seek-

DISTILLATION
BY-PRODUCTS FOUND IN COAL

GAS
- CARBON DISULPHIDE
- BENZOL
- TOLVOL
- XYLOL
- SULPHUR
- CYANOGEN
- ILLUMINATING GAS
- FUEL GAS

METALLURGICAL COKE
DOMESTIC COKE
COKE BRIQUETTES

COKE
- ELECTRODES
- LAMP BLACK
- OVEN COKE

GRAPHITE
- LUBRICANT
- CRUCIBLE
- ELECTRODE

AMMONIA LIQUOR
- ANHYBROUS AMMONIA
- AQUA AMMONIA
- AMMONIUM SULPHATE
- AMMONIUM NITRATE
- AMMONIUM BICARBONATE
- AMMONIUM CARBONATE
- AMMONIUM CHLORIDE

TAR

CRUDE CARBOLIC ACID
- DISINFECTANTS
- PHENOL

- CREOSOTE OIL
- ANTHRACENE OIL
- LAMP BLACK

LIGHT OIL
- PURO BENZOL
- DYESTUFFS
- PIERIC ACID
- ANILINE
- NITROBENZOL

HEAVY OIL

REFINED TAR
- PAINTS
- TARRED FELT
- PIPE COATING
- SUB FLOORING
- SIDEWALK COMPOSITION
- PAVING MATERIALS

- WOOD PRESERVATIVE
- ANTHRACENE LUBRICATING GREESE
- CRUDE ANTHRACENE
- ANTHRACENE
- ANTHRSQUINONE
- ALIZARIN
- DYESTUFFS

CRUDE CARBOLIC ACID
- NEUTRAL OIL
- FLOTATION OIL

MIDDLE OIL
- PURE TOLOUL
- EXPLOSIVES
- T.N.T.
- NITRO TOLOUL
- PERFUMES
- BENZOIC ACID
- ANTISEPTIC
- CRESOLS
- SALICYIIC ACID
- ASPIRIN
- FLAVORINGS
- PHOTO DEVELOPER
- DYESTUFFS
- PHENACETIN

PITCH
- SOFT PITCH
- MEDIUM PITCH
- HARD PITCH

- BUTTER COMPOUND
- CORE COMPOUND
- TARGETS

LAMP BLACK
CRUDE NAPTHALENE
- PAINT THINNERS
- SHINGLE STAINS
- REFINED NAPTHALENE
- MOTH BALLS
- DYESTUFFS
- INDIGO

18,000 BY-PRODUCTS

- SULPHUR MINERAL
- PENNSYLVANIA
- DIAMONDS

ing refuge from the fires and floods, sheltered themselves in caves and hollows, and were there overcome, being either consumed by the fire or drowned by the floods. Animals whose bodies were consumed of course left no trace to history, but those drowned by the floods of salt water from the unsettled oceans underwent a process of petrifaction; and the convulsions of nature taking place covered over their skeletons, preserving them in a protecting casing of earth. Many of these have been uncovered in recent years.

We know for certain that the earth was still in process of formation or settling to its present shape and composition from the fact that often remains of animals and plants are found embedded in solid masses of granite, slate, and other flinty formation of rock, impossible of penetration in their present day formation except by use of tools and explosives.

OTHER ALLEGHENY MOUNTAIN CAVERNS

Penn's Cave, near Bellefonte, Pa., is famous as a sight-seeing cavern in the limestone hills. Many tourists are attracted to this interesting place, and of late years it has become popular on account of its being easily reached by automobile travel. At Mapleton, Pa., the Mapleton Cave in the rugged hills of Jack's Mountains, a branch of the Alleghenies, is entered through the yards of the Swope-Gayton Quarry Co. The cavern is about a mile long and contains many rooms large enough to enclose a good-sized building. It also includes a stream of water that falls to unknown depths within the cave. This cavern is famous for the great number and size of its stalactites and stalagmites, and for columns joining the floor and arched roof. These have been formed through the ages by the depositing and hardening of the sediment of the limestone water.

PEAKS

Many explanations of geologists and scientists of

the grandeur and mineral deposits of the great chain of mountains do not have the ability to cope with and fully describe the infinitude of creation in the realms of nature and its laws, failing to portray in words and fully express the beauty they behold. The trees, plants, and abundant foliage in their environment and designment in nature, the eruptive rocks and acute folds, stretching far away in the distance in all directions, and the famous mountain scenery breath a spirit of admiration and freedom into the bosom and heart of all mankind. Only the admirers and lovers of natural philosophy can fully appreciate the beauty designed and enfolded in nature. The delightful surroundings in the lofty mountains with their flashing brooks and sparkling lakes, the balsam-laden breath of the great forests, the pure delight of life in the open, and the charming little birds chanting their sweet melodies, are some of the wondrous beauties of the mountains and the attractions of the open land. When we behold the grandeur of creation and of nature throughout the area of these great mountains, the impressions are beyond our ability to fully express and portray.

The giant and glistening peaks, with their concrete pillars of the various sizes and folds of their robes, and the beautifully luxurious gorgeous-colored terraces, cataracts, falls, marvelous volcanoes and glaciers that are set beside each other; and remarkable formations of the wild canyons, scenes of Alpine grandeur; and the great palisades of hanging snow, and rivers that have dug, brawling, glacier-fed, about the feet of the giant peaks and eruptive rocks, form the greater altitudes of the major axis of these great chains of mountains representing their acute folds. The axis, representing the structure of the anticlinals, contours and greater altitudes and acute folds is that line which at every point occupies the highest part of the anticlinal. The major axis is the upward-bending through an anticlinal and the lowest

part of the syncline from which the strata dip in the anticlinal, in which they advance and level. When the syncline is crimped into a number of parallel and wrinkled folds it forms the low rounded ridges and swells; and the continuity of the outlines and formations of the contours and structure profiles form these famous mountains and ridges.

CHAPTER V

GLACIER PERIODS

When one beholds the tremendous movement of a glacier in its passage across the continent it is hard to believe that it owes its power to the soft fluffy and exquisite perfection of form designed by nature to be the symbols of beauty and purity, rather than to the sharpest of her edged tools, planing down lofty mountains and cutting through almost unpenetrable barriers of rock and earth. The rate of movement of a glacier is about two feet per day. The glaciers of the Alps are about twenty thousand feet in height and none is over ten miles in length. Almost every mountain valley of Switzerland has its glaciers, winding like ribbons of light between walls of worn and scored rock and through the forest-covered debris of ancient mountains.

Glaciers once covered the northern part of North America; in fact, the ice king at different times has summoned all his mighty hosts of snow and ice and made an attack upon the grassy plains and wooded hills of the temperate zones. He has sent great tongues of ice from the Hudson Bay; buried Canada under mountains of snow and ice; ploughed up with monster glaciers all of the northern part of the United States; and crept with icy fingers far into the southland; and here remain the enormous piles of gravel and the smoothly planed Rockies which are silent witnesses of the great ice age of North America. Mountains were leveled, mighty rivers were turned back in their courses, the valleys filled with millions of tons of gravel. Were there no such a thing as a glacier today on which we might walk, make measurements, and calculations as to its rate of advance, then possibly, the work done by

ancient glaciers would be mysterious and unintelligible.

When a glacier begins to advance nothing in its immediate pathway is an obstacle to it. Before a glacier our enormous skyscrapers of steel and cement would be mowed down, would crumble like shale and would topple over like surgar cane; our steel plants would simply be erased, the wheels of prosperity would stop. Energy, knowledge, wealth, the appliances of the scientific engineer or the power of the modern capitalist would avail not against the advancing wall of ice. Glaciers pick up masses of rock weighing scores, or even hundreds of tons and carry them far from their original site, across rivers and mountains.

At the present time the earth is 3,000,000 miles nearer to the sun in winter than it is in summer. In other words, the earth's orbit is an ellipse, and the sun is at one of two central points known as faci. Our orbit is now almost a circle but in times past it was an elongated ellipse. The long diameter is known as the major axis and this axis, owing to a number of causes, varies greatly in length. The extreme maximum of eccentricity was passed at about 850,000 miles instead of 3,000,000 as at present.

Shall we have another glacial epoch? Is there any danger of our country's being covered with a sheet of ice possibly a mile in thickness? It is in the lap of periods that any one of many possibilities will bring the age of ice. A slight uplifting of northern lands or a change in the eccentricity of the earth's orbit, would again make it possible. Yes, they are bound to come, but not possible in our day or generation. The past is a prophecy of the future.

CHAPTER VI

TEXT OF GEOLOGICAL REPORT

The geological report of Western Pennsylvania, on the Allegheny formation of coal, was known to the early geologists of the state as the lower productive measures. It can be distinguished from the overlying formation of limestone and the presence of several workable coals, the best known and definable being in ascending order namely: Mercer, Brookville, Clarion, Lower Kittanning, Middle Kittanning, Upper Kittanning, Lower Freeport, Upper Freeport, Pittsburgh, Redstone, Sewickley, Waynesburg. This formation is of value economically from the fact that it embraces the Pittsburgh Coal Beds which are generally of a uniform workable thickness and purity wherever found in Pennsylvania.

The distance of the coal measures, in the overlying formation of Western Pennsylvania and in the Allegheny formation from the top of the Waynesburg Coal to the top of the Mercer Coal; this being the first period and ages of coal. The Redstone, Sewickley and Waynesburg Coal overlies the Pittsburgh Coal and appears in certain districts. The Pittsburgh Coal is more uniform in thickness and workable where measurements and logging can be secured.

The distance in feet from the top of the Pittsburgh Coal to the top of the Mercer Coal is as follows:

Pittsburgh Coal	0
Upper Freeport	620
Lower Freeport	690
Upper Kittanning	850
Middle Kittanning	910
Lower Kittanning	960
Clarion	1650
Brookville	1800
Mercer	2200

MAJOR BASIN AND TROPICAL TREES DURING THE FIRST PERIODS AND AGES

In the Major Basin during the first periods of the coal age there was 2,200 feet to the top of the Pittsburgh Coal, the first ascending measure being closer, permeating the center of the earth. The earth being a tropical climate during the first periods, the trees consisted of the pines, spruces and plants, and were of a softer substance than the trees formed at a higher elevation. The tropical trees being low down through the great basin, were nourished by the mists from the lakes and rivers. The same can be said of the basins throughout the different states and elsewhere. The tropical trees in the great basins were closer than at the present day formation, and permeated the center of the earth. The soft species being of a soft, oily formation, superinduced by heat, the pitchy sap passed off, collecting and forming the oil pools. The remaining substance was found petrified within the sands and rocks. This, in fact, accounts for the finding of oil and gas where the measures of the coal beds do not appear.

MAJOR BASIN AND VALLEY

The Pittsburgh Coal (river seam) in its purity can be found in Western Pennsylvania, in the Pittsburgh District, Irwin, Latrobe, and Connellsville basin. This is indicated by the overlying formation of limestone, which also indicates the presence of oil and gas at these points. In the first periods of the coal ages through this major valley or basin, the long extended anticlinals, the low rounded ridges and swells and their gentle foldings, the leveling and forming of the structure and forming of the coal at a higher elevation during the periods, left the valleys and ridges in their present day formation. Some of those long extended anticlinals parallel to the Blue Ridge Mountains through West Virginia, far in through Pennsylvania where they meet the rivers at McKeesport and Pittsburgh

and are known as the Warfield, Indiana, Brownsville, Belle Vernon, Amity, and Washington anticlinals. On the Amity anticlinal in the Pittsburgh district the Pittsburgh Coal (river seam) rises to an approximate elevation of 1,200 feet above sea level, declines southeast continuing in the same general direction, and again rises. It reaches an elevation of 1,200 feet before crossing what is known as the Murraysville anticlinal in the McKeesport district, declining gently through this major valley or basin. In the overlying formation it reaches far into West Virginia where it is brought to light approximately 50 feet above sea level, by the acute folds of this region. This is the lowest point of the major valley or basin, and the Pittsburgh Coal (river seam) and lower productive measures of coal and sands. From this point the rising of the coal and sands goes north to the Great Lakes.

THE FORMING OF THE RIVERS—ALLEGHENY FORMATION

The Monongahela River is winding and plowing its way through the major basin from Braxton County, West Virginia; the Youghiogheny down the Blue Ridge Mountains through the valleys and ridges; and the Allegheny from the northeast, joined by the Kiskiminetas and Conemaugh and Loyalhanna from the east. All unite to form the Ohio at Pittsburgh.

CHAPTER VII

COAL WAS DISCOVERED IN AMERICA IN 1673

There are strong reasons to believe that the discovery of coal in America was made in Illinois by the early French and the remarkable discovery of the first coal in America of which there is any account was printed in a book of discovery. The coal was found far in the interior of Illinois about 250 years ago, by Father Hennepin, within the strata and folds of the hills on the embankment of the Illinois River. The priest made maps and blue-prints, which accompanied the editions of his great works and journal published in 1698. Location of a coal mine was made near Ottawa, where an inferior quality of bituminous coal was found outcropping to the surface. In reference to the records and maps left by Father Hennepin, many geologists and authorities say, "This is the earliest notice on record of the existence of coal in America."

FORMATION OF COAL AND BY-PRODUCTS

Nestling between the Blue Ridge Mountains and the Fayette anticlinal and known as the Indiana anticlinal in the Latrobe and Connellsville region beneath these gentle rounded ridges, lies the Pittsburgh Coal Measure. The Pittsburgh coal is 800 feet above sea level, this being the lowest point. It rises gently and ascends northeast and southwest where it is brought to light by the acute folds of this region and, as it is a superior quality of coal containing the proper elements and chemical compositions required for the producing of coke, is recognized as the finest coking coal in the world.

SUPERIOR QUALITY OF COKING COAL

This superior quality of coking coal has no doubt

been produced by the different species of hard and soft woods. The oaks, hickory, walnut, etc., and the softer species of trees, the maple, sycamore, beech and chestnut; these woods contain the necessary chemical composition required to produce the superior quality of coal. The chestnut has the greatest chemical composition of the soft woods, but the combining of all in the process of combustion was no doubt essential to perfect and properly balance the chemical elements which have made the products possible.

AN OLD SETTLER'S HOME

PRODUCTION OF COKE

When coal is heated out of contact with the air or oxygen the residue, after the volatile products are expelled is coke. The amount of material driven off, and consequently the amount of coke products depends, for any coal, on the temperature to which the coal was heated and the length of time the heat was allowed to act. A high temperature produces a true coke containing very little residual volatile matter, while a relatively low temperature produces a coke containing a larger amount of volatile matter. This latter coke is frequently called carbonized coal, or preferably "semi-coke." From another point of view coke may be regarded as the coal analogue of wood charcoal. In this discussion the term coke will be considered as referring to true or high temperature coke unless otherwise noted.

Coke is used primarily as a fuel. It finds its greatest application in metallurgical work, particularly in the iron and steel industries. It forms part of the charge in practically all blast furnaces and foundry cupolas. In some places, particularly in Scotland, some blast furnaces use raw coal, generally anthracite, but the number of these installations is too small to be significant. As a blast furnace and cupola fuel, coke must be low in ash, sulphur, and phosphorus, as these are decidely injurious to the product of the furnace. Coke is used to some extent as a domestic fuel. Its chief merit in this case is that its combustion is smokeless. It will burn very much like anthracite coal, and may be used in heating equipment designed for hard coal. In this connection it may be well to mention that low temperature coke or semi-coke would be even a better domestic fuel for it also is smokeless. It ignites more readily than true coke, and holds the fire better. Coke is used in gas producers and in water gas manufacture. In this instance the coke is burned with an

amount of air insufficient for complete combustion. The products of combustion are carbon monoxide and nitrogen. The oxygen of the air first turns to carbon dioxide and this in turn is reduced by the hot carbon of the coke to carbon monoxide.

This operation consumes about thirty per cent of the total heat energy of the carbon in the coke. When the carbon monoxide burns to carbon dioxide the remaining seventy per cent of the heat energy is evolved. In some operations a little of the heat may be saved by using the hot gas as it comes from the producer and also by the use of a regenerative or recuperative system to heat the air necessary for the combustion of the gas. The gas is used as a fuel in heating and melting furnaces, and in internal combustion engines. When water gas is made from coke, air is blown through the producer until the coke bed is at a very high temperature, then steam is sent through the bed until the fire has cooled off somewhat, at which time air is again blown through to again raise the temperature. Steam is decomposed into hydrogen and oxygen, and the oxygen leaves the producer combined with carbon as carbon monoxide and carbon dioxide. In careful operations the CO is high and the CO_2 low. The hydrogen passed through unchanged, or it may pick up a little carbon from methane (CH), but this is never present in any considerable amount. The water gas consists primarily of dioxide, carbon monoxide, hydrogen, methane and nitrogen, the latter constituting on the average about forty per cent of the total gas. When the gas is to be used for illuminating purposes it is enriched, generally with petroleum or tar oils, to increase its candle power. Coke figured as an article of commerce in China over 2,000 years ago.

It was used during the Middle Ages in Europe for domestic purposes and in the arts, but it was not until 1620 that Sir William St. John obtained a patent for a beehive oven. Previous to this time the coal had

probably been coked in piles or mounds in a manner corresponding to charcoal burning. In 1700 J. Becher, a German chemist, obtained a patent for recovering tar from coking coal. In 1781 the Earl of Dundonald secured a patent on a process for coking coal in beehive ovens, which also covered the production of tar, oils, etc. In 1792 Wm. Murdock was successful in producing gas from coal, and by 1812 was able to light the streets of London with coal gas. Murdock is regarded as the founder of the coal gas industry. The first retort ovens were built in Germany in 1830 and in 1835 they were built in Pennsylvania. Since that time the number of ovens has increased rapidly, with the beehive oven being gradually superseded by the by-product oven.

In gas manufacture the coke is a by-product while in coke manufacture the gas is a by-product. The tar and ammonia obtained are to be considered as by-products of both operations.

A gas coal is one which gives a large yield of very good gas on distillation while the coke may not be of so high a quality. Such coals lie between the true coking coals which do not yield so rich a gas, and those which give large yields of gas but which give coke poorly or not at all. Coals of different characteristics are frequently mixed in order to obtain either a good gas from a lean coal or, more often, to obtain a sound coke from a poor coke-making coal. Illinois and eastern coals are mixed in the ratio of eighty and twenty per cent; i. e., eighty per cent Illinois coal to twenty per cent eastern, such as Pocahontas or Connellsville, or other strongly coking coals. In some plants it has been found sufficient to crush the coal finely before charging to secure sound coke. In other plants the crushed coal is charged very wet, the packing due to the water having a tendency toward improving the coking of the coal. In all coking processes the impurities in the coal remain in the coke. About

one-half of the sulphur in the coal is eliminated during the coking process but since the coke yield is somewhat more than 2-3 of the amount of coal charged into the ovens the net amount of sulphur in the coke is very nearly the same as that in coal. The elimination of sulphur is brought about principally by the breaking down of iron pyrite with the loss of half its sulphur.

All the ash in the coal remains in the coke, so that the ash contents of the coke is always higher than that of the coal from which it was made. The same is true of the phosphorus. When coke is sold on specifications calling for low impurities the coal must be carefully prepared for the ovens. This preparation includes crushing, screening or washing, and sometimes all three, unless the coal is very pure to begin with.

At one time coke was made in mounds or piles as mentioned above. A space was prepared by leveling a piece of ground and spreading coal dust on it. Coal was then piled to a depth of about 18 inches over this dust and flues were arranged over this base. The flues were made of refuse coke and lump coal, and were filled with billets of wood. The rest of the coal was then added to the pile. When the mound was ready, fire was applied to the base of the flues. The kindling was ignited and the entire pile was soon ablaze. The pile required constant attention in regulating the admission of air, so that it would burn but would not waste the coke.

When the volatile matter had all burned off the pile was smothered with dust and then a small amount of water was introduced into the vertical flues. The water was converted into steam, which permeated the whole mass, thus finishing the operation and if properly done, leaving very little moisture in the coke.

The time for coking a pile of coal by this method varies from five to eight days. The coke made in this manner was never uniform in quality. The reported yield was 59.1 per cent coke, but this did not state if

this included only good coke, or coke breeze and ashes. This large yield was very probably due to extra precautions taken in this one burning. A yield of fifty per cent would be a good average by this method.

The next advance over mound coking was the use of the so-called beehive oven. The essential features of the beehive oven are a circular, vaulted firebrick chamber, constructed on a suitable foundation with a flat tile floor, an opening at the top through which the coal is charged and the products of combustion escape, and an arched door at the bottom, about three feet high, through which the air for combustion is admitted and the coke watered and drawn. The dimensions vary in different parts of the country but the essential features are the same. However, the ovens are generally thirteen to fifteen feet in diameter and seven and one-half to nine feet high. The oven is charged through the circular opening in the top of the dome. An amount of coal determined according to whether the oven is to run forty-eight or seventy-two hours, is charged into the hot oven from a car running on a track above the oven. The coal is leveled either by hand or with mechanical devices, and the door is bricked up to within two or three inches of the top. The heat from the previous charge, retained by the walls, causes the volatile matter to distill off and finally ignite. The coking proceeds from the top of the coke downward and the necessary high temperature in the oven is maintained by closing up the door. When the evolution of the volatile matter has all been expelled the process is complete, the door is pulled down and the coke is quenched with water and drawn from the oven.

Longitudinal ovens were introduced in 1906 in an attempt to offset the scarcity of skilled labor. The oven is a long narrow rectangular chamber with a sloping roof, constructed of the same materials as the beehive oven, having a door at each end for the admis-

sion of air. It is charged from the top, and the coke when finished is pushed out by means of a special pusher. These ovens vary in size, according to the builders, but have about the same capacity as the beehive ovens; converting a charge of four and one-half to five tons of coal in a forty-eight hour run and a ton or so more in a seventy-two hour run. The yield is variable and cannot be accurately controlled, but runs from fifty per cent to sixty per cent of the coal charged. No by-products, of course, are recovered. In order to increase the yield from beehive ovens and to control the coking operation somewhat better, ovens were designed whereby the gases coming from the coal were burned to heat adjoining ovens. These ovens, known as coppee ovens, after being built, were long narrow chambers provided with vertical flues in which the gases burned. They were thirty feet long and five feet high, with an average width of twenty-four inches, and were four inches wider at the pusher side. Arranged in batteries of twenty to thirty and operated in pairs, the gas from one oven heated the one next to it. The coking time, after a few improvements over the first design, was thirty-three to thirty-six hours. The yield averaged from sixty-five per cent to seventy-five per cent, depending on the coal charged. No by-products were recovered from the coppee oven.

It is stated above that London was first lighted by gas about the year 1812. Coal gas retorts are made horizontal, inclined, or vertical according to the choice of the builder. Coke, tar, and NH are collected as by-products from all three. Each type has its particular advantages. The horizontal retort gives probably the best quality of gas, but since the charge is only about 400 pounds, it is worked off in about four to four and one-half hours. This necessitates frequent charging. The yield of tar is not very great, but the tar is heavy and is very valuable. The coke is light and spongy due to the shallow layer of coal in the retort.

The inclined and vertical retorts take larger charges, do not require recharging so often and give coke and tar of a higher quality. In the case of vertical retorts, steam is often drawn through chambers filled with fire bricks to absorb the heat from the hot gases. When the bricks are hot, the current is directed to a second chamber and the air for combustion is pre-heated by drawing it through the first chamber. When the first chamber has cooled down, the air is diverted and the gases turned in again. These reversals occur about every thirty minutes without either recuperative or regenerative systems to pre-heat the air for combustion and thus effect a very considerable conservation of heat. No high temperature operations could be economically carried on. By-product ovens are of two general types. Those with horizontal flues are modeled after the original Simon Carves ovens, of which the Semet-Solvey and Rothberg are notable examples; those with vertical flues are modeled after the original Coppee oven. The Koppers, Otto Hoffman, New Coppee, Muller, Von Bauer and many others are examples of this type. Considering all the ovens together, the oven chamber proper is about the same size in all, namely, thirty to forty-five feet long, seventeen to twenty inches wide, and about six feet high. The charge is normally about six tons of coal and the coking time is seventeen to twenty hours, depending on the practice at the different plants. All these ovens may be equipped with either recuperators or regenerators to pre-heat the gas. Regenerators are almost always used. They heat the air to about 1,800 degrees Fahrenheit.

The principal difference between any two of the ovens is in the heating arrangements. The Semet-Solvey is heated from the ends through the horizontal flues, the gas and pre-heated air being blown in at one of the flues. In about thirty minutes, the gas and air are reversed and blown in from the other end.

With vertical flue ovens there is still greater variation in the heating arrangements. In the Koppers type the burning gas passes up through all the flues and then down. In the Otto Hoffman oven the reversal takes place in two alternate sections of flues, each equal to one-fourth of the length of the ovens. In the Coppee style the reversal occurs in alternating sections each equal to one-tenth of the length of the oven. In the Muller oven the flues are operated in pairs, the burning gas going up one flue and down the next. The heat lost in the upward passage is replaced by an auxiliary in the upper part of the flue. In the Collin oven there are twenty-eight main flues and twenty-seven auxiliary flues. During the first half hour the gas and air meet in the bottom of the main flues and pass up and down and over through the secondary flues. During the next half hour the gas and air meet in the top of the main flues and pass down and then up and out through the secondary flues. In the Von Bauer oven no reversal takes place. The gas is led through mains to different parts of the flues and air comes from the bottom. In the Koppers oven the reversal takes place in over one-half of the oven at a time. The front half is heated, the hot gases passing off through the rear half. Upon reversal the rear half is heated, while the spent gases pass off through the front half. In any of these ovens the temperature ranges up to about 2,200 degrees Fahrenheit in the oven proper and 500 degrees to 2,200 degrees Fahrenheit in the flues.

With all by-product ovens certain accessory apparatus is used. This consists of levelers to level off the coal in the oven and pushers to discharge the coke and quenchers. When hot coke is quenched in the air, which is the general practice in by-product plants, it turns dark in color. In a beehive oven the coke is quenched inside the oven, and as the steam formed quickly displaces the air, the coke remains a silvery color. For a long time this was the chief argument

against the use of by-product coke and, for that matter, is still heard. Foundry and blast furnace operators, who had been accustomed to the use of beehive coke, thought the darker by-product coke could not be as good. When they were finally persuaded to try it, they were quickly convinced of its merits, and now it is considered by practically every user to be equal to the best product of the beehive ovens. To eliminate this argument, quenchers, such as the Moore quencher, were designed. The Moore quencher has a chamber of somewhat the same shape as a by-product oven, but is slightly larger. The coke is pushed from the oven into the quencher and the water then is added.

In this way the coke is cooled out of contact with the air and has the silver color desired by some users. In considering the structure of coke, it must be remembered that in the beehive oven the coking proceeds from the top downward through the mass of coal. This was the result of giving the beehive coke a pillar-like structure. In a by-product oven the coking proceeds from the walls inward, making the coke blocky and resulting in a line of clearage down the middle of the mass in the oven.

In referring to the comparative yields, only very general figures can be given. No two plants are exactly alike; they do not run the ovens the same length of time or at the same temperature. They do not have the same amount of heated surfaces over which the tar and gases must pass; and the scrubbing and extraction apparatus varies. Using the same coal in two plants may secure the same average yield of coke, but the yields and quality of gas, tar, and ammonia can rarely be duplicated. General average yields are in proportion to the coal charged.

(In an article published by a prominent geologist, it was said, "If coal was not petroleum and was of a liquid form as peat and turf, but was wood; could coke not be derived from wood? And, if not, why do not

some of the geologists say so?")

Peat and turf, being dried, decaying vegetable matter, are composed chiefly of leaves found in bogs and lowlands, and do not contain the proper elements to make coke.

Take thirty species of trees as follows: Chestnut, oak, walnut, sycamore, hickory, maple, etc., reduced to a charring action and mixed together under pressure; turn the vegetable life into a form of carbon and subject to the heat units. This combination will produce coke. Our tropical fruits by the same process of distillation contain many of the by-products found in coal.

CHAPTER VIII

PITTSBURGH, IRWIN, LATROBE AND CONNELLSVILLE BASIN

The Pittsburgh Coal in the Irwin district is at a higher elevation than the coal in the Latrobe-Connellsville basin and is composed of the hardest species of wood of the trees of a higher elevation and not composed of many soft woods, such as the sycamore, chestnut, etc., found at a lower elevation. In the Irwin and Pittsburgh districts the coal is of a more solid formation and the substance contains more gas and heating units for a steaming coal. It is recognized as the finest quality of Pittsburgh Coal for steaming purposes found in Western Pennsylvania. The same can be said of the coal in the Pittsburgh and McKeesport districts where the coal is at an elevation of approximately 1,200 feet above the sea level. In these districts at the highest elevation the coal is superior in quality to that of a lower elevation.

LOWER PRODUCTIVE MEASURES

In relation to the lower productive measures of coal lying along the Blue Ridge Mountains in the Latrobe and Connellsville basin where the Upper and Lower Freeport appear, several workable mines are being operated, as to both measures. Descending through this basin under the Pittsburgh coal, we find the Upper Freeport at a depth of 620 feet and at a depth of 680 feet we find the Lower Freeport. The Kittanning and lower productive measures are at a greater depth. The Upper Freeport is found here at its lowest point, being 180 feet above sea level. The Lower Freeport here is 120 feet above sea level, and rises to a high elevation before crossing the Fayette anticlinal known as the Indiana. There they again

appear and are brought to light by the acute folds of this region, radiating from the major axis of the anticlinal. Several workable mines are being operated as to both measures.

During the periods of the formation of the Pittsburgh coal and overlying measures, forming the Redstone, Sewickley, and Waynesburg coal, the Pittsburgh and Redstone joined together during the same period of convulsions and possibly formed the Pittsburgh and overlying measures during the same period. The most plausible theory to account for the coal being formed joined together in the overlying formation is that these conditions may be made possible by the emigrating of the charred substance of vegetable life of the higher altitude carried down and fed upon the basins and valleys in the overlying formations. The most possible theory of this phenomenon in nature, as to the transmutation and emigrating of the coal from the greater altitude and the forming of the various veins and measures in Pennsylvania, Ohio and West Virginia, and the coal being found joined together is that the coal may have been formed during two periods, and the possible age of our great continent during the periods of creation may be of shorter duration than many thousands of year. In conjunction with the mineral deposits the transmutation of the sand and rock were carried down and fed upon the major basins and valleys during the transmutation of the coal. Relative to each period, in the McKeesport district on the high altitudes of this region of the Youghiogheny River, the Pittsburgh coal and Redstone are formed together. These conditions appear in Washington County and in many sections throughout Pennsylvania and West Virginia, usually where the structure and formation has been raised at a greater altitude of the formative periods. In the overlying formation, again rising and being brought to light throughout the basins and valleys by the acute folds of these regions, these same conditions

appear, and the same can be said of the formative periods of the Freeport measures of coal in the overlying formations, the descending and the pitch of the coal being formed at a greater depth throughout the major basins, where it is again brought to light by the acute folds of the regions.

These conditions appear in the Conemaugh formations and northeastern sections of Pennsylvania, forming the anthracite coal and measures carrying a greater thickness. The uniting and compounding of the various charred substances of vegetable life at a great altitude and less area forms the coal beds in more irregular veins than throughout the basins and valleys with their gentle foldings.

In the overlying formations of the Allegheny and Blue Ridge Mountains, the structure contours and strata of the rock are silent witnesses of the great convulsions of the earth which took place during the periods of the coal ages. The structure has been changed at the same time in many places from a horizontal to a vertical elevation, changing many of the high altitudes of the structure and elevations forming the Allegheny and Blue Ridge Mountains.

In the Latrobe-Connellsville basin lying along the Blue Ridge Mountains where the upper and lower Freeport measures appear and are formed together, the separating and descending through the basin of the coal northwest reaches the Allegheny River at a point near Harwick, where they again appear and are brought to light by the acute folds of this region. The same conditions appear in West Virginia, near Bilington, Barber County, and in many other sections throughout the state, where the Freeports and other overlying measures have formed the Pocohontas coal. Similar formations are found in the region bordering on the Elk River where the coal seams are apparently joined together.

Relative to the lower productive measures in Ohio,

including Freeports and Kittanning measures, we find the structure in the overlying formation more uniform throughout the basins and valleys of the state, the coal beds being formed in the overlying formation, very close to the surface in many sections throughout the state; so that much of the mining can be done by stripping or removing a small portion of the surface, where the various thicknesses of the coal measures are disclosed. These measures of coal are found to be produced by the vegetable life. Trees, largely maple, beach, birch, and various species of the oak, undergoing a process of the charring action of the heat units during the convulsions taking place forming these measures, and the water lying throughout the basins and valleys overlying these measures, the coal underwent a process of petrification by the action of the salt water combined with the chemical element of the earth, leaving the coal in a solid formation. Usually a superior quality of coal is formed in the measures underlying an abundant growth of timber where the forests are dense and the undergrowth luxuriant. In many districts in the basins and valleys throughout the states the quality of the product is the highest and where the surface growth is small, immature and scrubby, the coal underneath is invariably of an inferior quality and does not contain as many by-products.

LOWER PRODUCTIVE MEASURES IN WESTERN PENNSYLVANIA, OHIO, AND WEST VIRGINIA

As to the lower productive measures of coal in Western Pennsylvania I can say that the Freeports have been quite extensively operated. The Kittanning measures are being operated in certain districts where the measures of the Pittsburgh coal do not appear. These measures underline the Pittsburgh coal which is at a greater depth in Barbor County, West Virginia. The Kittanning measures are being operated in Braxton and Kanawha Counties. The Upper and Lower Freeports have been operated quite extensively in this

section of the state and the same can be said for the state of Ohio. In regard to the Upper and Lower Freeports and Kittanning coal in Columbiana County, I might say that several workable mines are being operated in these measures at Lisbon. The coal lying in the basin underwent a process of petrifaction caused by the chemical action of the salt water from the unsettled oceans during the convulsions of nature through the periods. This coal is closer to the surface, and is harder than the coal formed at a higher elevation throughout the country.

The Central Mining Company located at Lisbon, Ohio, is now operating in this field and is producing a fine grade of coal, having recently acquired a large acreage of these productive measures.

PREVENTION OF CATASTROPHE

The mining of the lower productive measures of coal, lying in the great basins has always been a source of imminent danger to the workmen, and the terrible catastrophes of recent years should be sufficient warning to prompt immediate action looking to the safeguarding of human life among the intrepid men, who have the courage to perform this very essential work many miles underneath the earth's surface. The ventilating of the miles of area required for ingress and egress to these mines should be carefully studied by expert engineers in conference with the best trained mining experts, and a plan devised whereby this danger might be reduced to a minimum. We would suggest that in every field where it is necessary to drive entries into a solid coal bed, in addition to the regular air shafts and manholes, a series of holes reaching to the depths of the mines be bored, of a sufficient diameter to permit the egress of the men in case of emergency.

These holes should be drilled at the most strategic points. Four twenty-inch bore holes should be drilled to the mile, covering and parallel to the entire courses

of the entries. They should be cased with twenty-inch concrete tiling with iron hand holds, bolted through the pipes along the workings as a means of escape for the men in case of combustions and explosions. Such a safeguard would make it practically impossible for the black damp and other dangerous substances to accumulate in such quantities as to endanger life by explosion or suffocation. When a safety plan of this character is worked out and perfected, the danger will largely be eliminated. Confidence will be established in the minds of the workmen and larger production will be sure to follow. The larger expenses of providing for widows and orphans will be saved and more happiness in miners' homes and operators' mansions will certainly be enjoyed. When the Government of the United States takes the proper steps to ventilate the coal mines, by holes being drilled the proper distance apart to eliminate these poisonous gases and safeguard the lives of the miners, they will have not only saved the lives of men, but thousands of dollars which is spent through the Bureau of Mines.

The formation, strata, and logging of the Allegheny formation and depth of the measurements from the top of the Pittsburgh Coal and Sands, to the first periods and ages.

LOGGING

Of special interest to coal, oil and gas prospectors is this scientific table of logging showing the depth and formation of the Allegheny formations and strata, from the Pittsburgh coal to the Niagara sands. It includes very essential information and a standard table of the measurements in Pennsylvania, Ohio, and West Virginia, of the actual formations of the strata, and priceless fuel deposits that man has found enfolded in the bosom of the earth. From this valuable table the driller derives knowledge of all the geological formations down to the first formative periods of the earth's crust, to a depth of 5,000 feet.

RED STONE, SEWICKLEY AND WAYNESBURG COAL
CORAL SAND

Datum.	Pittsburgh Surface	Sands	Coal
100	Pittsburgh Coal Top		
200	Homewood Lime		
300	Ames Limestone	300	
400			
500			
600	Upper Freeport		620
	Lower Freeport		690
700	Upper Kittanning		850
800			
900	Middle Kittanning		910
	Lower Kittanning		950
	Salt Sand	970	
1000			
1100			
1200	Big Lime	1200	
	Big Injun	1250	
1300			
1400			
1500	Squaw Sand	1550	
1600	Clarion Coal		1650
1700			
1800	Brookville Coal		1800
	Murraysville Sand	1830	
1900	Hundred-foot Sand	1960	
2000			
2100	Thirty-foot Sand	2110	
2200	Mercer Coal	1st Periods and Ages	2200
	Gordon Stray Sand	2220	
	Gordon Sand	2260	
2300	Fourth Sand	2310	
	Fifth Sand	2360	
2400	Byard Sand	2440	
2500	Elizabeth	2550	
2600			
2700	First Warren	2790	
2800			
2900	Second Warren	2910	
3000			
3100			
3200	Speechley Stray Sand	3225 Lower Productive Meas.	
	Speechley Sand	3270 Sand	
3300			
3400	Tiona or Balltown Sand	3400	
3500	Sheffield Sand		
3600			
3700			
3800			
3900	Bradford Stray Sand	3910	
	Bradford Sand	3950	
4000	Kane Sand	4020	
4100	Brennan Sand	4160	
4200			
4300	Burghan	4305	
4400			
4500	Second Burghan	4500	
4600			
4700			
4800	Erie Sand	4800	
4900	First Ages	4900	
5000	Niagara	5000	

CHAPTER IX

FORMATION OF OIL AND GAS

In conjunction with the formation of coal, oil and gas were formed under similar circumstances. The trees that grew during the periods to form oil were of a different specie of wood, having a pitchy, resinous composition and of a soft, oily formation, such as pines, spruce and plants. Superinduced by heat and pressure the pitchy sap distilled into oil and passed off from a heavy sap to a liquid; thus forming the oil pools. At the time of the extinguishing and drowning out of the fires of the forests, gases collected from the burning and smoldering substance of the forests, uniting with gases generating and rising off the oil and salt water. These were under the generative influence of the heat pressure and passed into the different sands found in the anticlinals.

Expansion took place and where there were long extended fissures or pockets, expansion was easily accomplished; but not where great bodies of this newly formed oil and gas were confined in compartively small pools and pockets. In comparison to the amount of the oil and gas this expansion was difficult and was accomplished through compression. When a well is drilled into a pocket, the sands of which are close grained and not porous, only a small proportion of gas is found in comparison with the size of the pocket, and a small producing well is the result. When, on the other hand, a pocket containing a highly compressed body of gas or oil is tapped, and the sand porous and open grained, the so-called "gusher" is the result.

Where gas and oil are contained in the same pocket, and both are equally compressed, it is possible to produce great volumes of gas without a trace of oil.

The gas, being more volatile, passes off first. If a sufficient pressure remains after the passing of gas, the oil may flow afterwards, although the emptying out of the gas may entirely deplete the pressure. It is the writer's firm belief that if a search were made through abandoned gas wells, great quantities of oil might be found lacking the necessary force needed to raise itself to the surface. For proof of this theory, a similar parallel exists, well known in coal mining, where volumes of air, compressed by the pressure of millions of tons of water are forced into small pockets. If the pockets containing this air were tapped it would rush out under great pressure. If, on the other hand, the water were pumped out, the pressure would return to normal.

LARGE PRODUCER OF CRUDE OIL ON THE RANGER FIELD, TEXAS.

Well flowing 12,000 to 15,000 barrels per day is here shown. Note the "gusher" throwing sand and dust into the air.

PRODUCTS OF PETROLEUM

Kerosene is only one of the products of petroleum. This last word means rock oil, and was once thought to be a mineral in its origin. Now we know that it is closely connected with coal and is usually found in its neighborhood.

Petroleum has been known for hundreds of years, but it is only recently that kerosene came into use.

Your grandfather can no doubt remember when it first was offered for sale. The early explorers of what is now the United States knew of petroleum oozing out of the ground or floating on the surface of the water in several parts of the United States.

They found that the Indians rubbed their bodies with it, and said that it made them active and quick. it out of them. Sometimes they skimmed it off the So when this country became settled the whites also began to use the oil. Sometimes they laid blankets on the ground where the oil appeared and then wrung small. It was then sold by peddlers at a high price, surface of the water. The quantities they gained were as Seneca Oil, Indian Oil, or some such name. It was rubbed on the body as a cure for rheumatism, or taken as medicine. Few families would use more than a pint in a year. The men boring wells to get salt water in Western Virginia in 1806, found much petroleum along with the brine. This caused a great deal of trouble here and at other places, but no one seems to have thought of using it, except as a liniment or as a medicine, for many years. Finally in 1848 Samuel M. Kier had some of the thick substance distilled and secured an oil which would burn in a lamp, though it had a horrible odor. It was called carbon oil and sold for a dollar and a half a gallon.

People began to sink wells to get the petroleum, but the natural gas which sometimes appeared with the oil caught fire and caused an explosion. The oil was then sometimes used to make machinery run

more smoothly, but still the business did not grow rapidly. In 1846 D. Abraham Gesner obtained an oil from coal which he afterwards called kerosene, and a company was organized to manufacture it.

The company was successful and other oil-works were established. The demand grew and Mr. Silliman, of Yale College, was employed to find out whether there was any likeness between coal-oil and petroleum. He conducted his experiments on Oil Creek, in Pennsylvania, and reported that petroleum furnished excellent oil for burning. Samuel N. Kier had sold some oil for burning in 1848 and two years later James Young got some oil from shale which would burn. People began to want more of this oil, and a company was organized to take oil from a spring in 1854, and in 1856 it was determined to try the experiment of boring a well deep into the earth. The company hired Edwin L. Drake to superintend the work. This man had been a railway conductor, who had resigned because of ill-health. A new company was organized, and finally, in 1858, Colonel Drake, as he was called, arrived in Titusville, Pennsylvania, and tried boring the well. Tools could not be had, and not until May, 1859, did work really commence.

A tube was driven down to the rock and the workmen began to drill, accomplishing about three feet a day. Colonel Drake was determined to go on and borrowed the money necessary to keep the drillers at work. On Saturday, August 28th, 1589, the drill seemed to move easily just before the workmen stopped for the day. One of them visited the well and found that it was full of oil. A pump was attached and was found to yield twenty barrels a day. The whole region went wild. Every foot of land along the creek was bought or leased by men who intended to drill for oil. Wells were sunk in every direction. The town grew in a few months from a populatcn of a few hundred to fifteen thousand. Many men grew rich almost at once. The

news spread and men in other sections where oily springs had been found also sunk wells. The Drake well did not last many years. Gradually the yield grew less and less, and finally gave out altogether. Colonel Drake had thought that it would be permanent and did not try to buy or lease other land. Finally, he left the oil regions with $16,000.00, which he afterwards lost, and for a time was very poor. When the men who had gained millions in the oil business heard of his poverty, they raised some money for him and the Legislature of Pennsylvania voted him a pension of $1,500 a year as long as he or his wife should live. In other sections a different kind of oil was found. This was thick like molasses, and was used only to make machinery run more smoothly, and today the wells in the Franklin district send their oil over the whole world.

A third kind of oil, which could be used both for lamps and machinery, was soon discovered. Some of the wells spouted oil. In all hundreds of wells were sunk in the district, and oil was also found in West Virginia and Kentucky. Soon refineries were established to separate the oil into its different parts. In later years oil was found in many states. New York, Indiana, Illinois, Ohio, Kansas, California, Oklahoma and Texas produced oil in large quantities. In the days when wells were drilled for salt water, it was found that by exploding powder in the bottom of the well, sometimes more water could be secured. The same experiment was tried with the oil wells and was often successful. At first powder was used, but it was soon found that nitro-glycerine was better. This substance is a mixture of nitric and sulphuric acids, with glycerine, and is very powerful. A few drops will wreck a house if it is struck sharply. It does not always explode from fire. A little powder or dynamite and a small iron weight is attached and when dropped the explosion shatters the rocks in the bottom and cleans out the paraffine which has clogged the well. Sometimes wells

which have furnished only a few barrels a day, yield hundreds after an explosion of this kind takes place.

When a well is drilled to the productive sands and a light showing is made and it is necessary to increase the production by shooting with nitro-glycerine, the well should be primed by three to five quarts, especially when the sand is close grained and not porous. This being the case a larger volume of combustion is made, and then thirty to forty quarts when used brings better results. When one hundred twenty-five to one hundred fifty quarts are used it grinds the rock and hinders the expansion of combustion. Many wells have been ruined by too large a shot of nitro-glycerine.

OIL SHALE IN UTAH

DISCOVERY OF PETROLEUM

Petroleum was first discovered in Alsatia in 1735. A few years later a small refining plant was constructed, and the wells have been worked for a period of almost 180 years. They are among the oldest petroleum wells in the world. These oil deposits are the only ones in the world worked by shafts. As early as 1836 the suggestion was made by J. Prietwich, Jr., that geology should be applied to the location of petroleum, and in 1861, L. G. Andrews of Marietta, Ohio, published an article entitled: "Rock Oil, Geological Relations and Distribution." He followed this later by a study which he published under the title, "Petroleum in its Geological Relations." The first oil company prospectus which included a geological report, was published in 1866 by J. S. Newbury, of Cincinnati, and during the year 1867 a number of geologists suggested theories in connection with locating petroleum.

It was not until Dr. White won the victory for Geology in 1889 that the oil men realized the importance of the theory and it began to be adopted by the industry in a practical way. Dr. White wrote the following letter to a friend in which he made reference to the fight he made for the general adoption of the structural theory for the occurrence of oil and gas:

"There are only a few kinds of true surface indications of petroleum and most of them are easily recognized. In regions where oil has not been proved to exist, either oil, gas or some bituminous substance, or the formation of the sand, rock and shale are the only reliable indications of its presence. Oil may seep from a porous bed or ooze from joints in the rocks, or it may issue with matter at some spring or may form a film on pools, swamps, meadows, or in water wells. At most such seepages the oil escapes in but small quantities, yet the rainbow-hued film it spreads on water and its odor are almost certain to attract attention. In some places oil fills the pores or a part of the pores

of a bed of rock that appears at the surface, but it does not flow. It may appear as tarry patches on the face of the rock or it may emit an odor, nor do they show any indications of oil, although when the rock is broken in a fresh surface it may fairly reek with petroleum. Some such rocks give no odor of oil even when freshly broken, but when they are subjected to simple chemical tests they yield traces of oil, bitumen or paraffine."

In the California oil districts, beds of burned or clinkered shale are almost as significant of the presence of petroleum as oil-saturated beds. At some places the shale was saturated with oil seeping from underneath beds and was then in some way ignited and baked into a brick-red or to a bright cherry-red mass ranging in hardness from that of soft building brick to that of almost glassy slag. The California oil region is the only known place in the United States where such burned shales indicate the probable occurrence of oil, although shales have been similarly baked in other regions by burning coal beds that lie near the surface.

Escaping gas may indicate oil, but the gas is usually almost unnoticeable except where it rises through water in bubbles to the surface. As some kinds of gas are not associated with oil, escaping gas should be sampled and analyzed. If the gas escapes in large quantities it may be tested with a match. Practically all gases that are commonly associated with oil will burn.

THE LOCATING OF OIL AND GAS FIELDS IS A SCIENCE, AND NOT GUESS WORK

The odor of the gas is also an indication of its character. One of the commonest gases that does not indicate the presence of petroleum is hydrogen sulphide, which smells very unpleasant. In some places large quantities of oil have escaped to the surface and formed deposits of asphalt, or other bituminous sub-

stances. Such deposits indicate that oil once existed in the region, and that the region is worthy of careful study, but they are not a certain indication of the presence of petroleum which may have escaped to the surface, or it may have been altered to some bituminous substance. Iron, from which oil can not be extracted, and gypsum, rock salt and sulphur, are associated with oil. On the Gulf Coast of Texas and Louisiana gypsum or rock salt on the surface or in water wells may indicate the presence of oil, as the oil fields of that region are commonly associated with "salt domes" that contain great masses of salt and gypsum. These minerals, however, occur also in abundance, in regions where no oil has been found and where it can not possibly exist. Many things are frequently referred to as indications of oil which have no connection whatever with it.

Probably the most common of these is the rainbow colored film produced on water by iron oxide or manganese oxide, or by decaying animal or vegetable matter. This film can easily be distinguished from the film produced by oil, for it has no smell of petroleum and it is brittle, whereas an oil film is tough. An oil film when stirred will become streaked with colored bands that double and twist about, but do not break apart, and any openings that are made in it have smooth edges which are likely to draw together. Rainbow films that do not indicate oil will break into separate patches when stirred, and the patches are not likely to join corners, and many of them are divided by narrow cracks that show no tendency to close. It is often said that a country looks like oil, that is, the surface gives the speaker the impression that it must be underlaid by oil. This remark means only that the country looks like some other oil-producing region which the speaker has visited. The surface appearance of a region, however, means absolutely nothing as indicating the presence of oil, for oil may occur under a surface of any kind, from the orange groves of Cali-

fornia to the alkali plains of Wyoming; from the ice circled hills of Alaska to the sun-blistered table lands of Utah. And similarly, in many regions where the surface is of exactly the same type as that in certain oil fields there is not a drop of oil. Some men declare that a guide to oil may be found in the vegetation, the trees, bushes, grasses and flowers. But the oil is found as abundantly in the treeless plains of Kansas or the Gulf Coast as in the pine-covered ridges of Pennsylvania and West Virginia or the hickory-covered hills of Oklahoma.

Even in a region that is known to be oil bearing and in areas having the most promising geological conditions a positive statement that oil in paying quantities is sure to be found in certain areas is not justifiable, although in some such areas the chances are ten to one that it will be found. In spite of all these facts some men who call themselves "diviners," "oil finders," "oil witches" and other names suggestive of unusual powers, pretend to be able with or without the assistance of instruments, to detect unfailingly the presence of oil in paying quantities. Nearly all the methods employed by these men are based upon superstition or upon some methods of the old-time alchemists, who claimed the power to change lead, iron, and other metals to gold. Some of these "oil witches" simply use a forked stick, like the peach tree twig or the hazel wand of the "water witches." Others have elaborate instruments, fitted with magnets and coils, supposed to work through "magnetism," or provided with parts made of platinum, gold, silver, copper, lead, iron or some other metal, supposed to work through "affinity of metals."

These men are usually ready to prove the correctness of their guesses with somebody else's money, but there is hardly a record of an "oil witch" raising his own money on his certain knowledge, and of the thousands of devices tested not one has proved to be of the slightest value as a means of finding oil. Now and then, of

course, oil is struck at a place chosen by the use of one of these devices, for in a region where oil may exist occasional success in finding it by any means is inevitable. A great many of the best oil fields in the United States were found by blind, random drilling, with no attempted guidance either scientific or supernatural.

Many popular beliefs about the occurrence of oil deserve particular mention. It is sometimes said that oil occurs below the surface of the ground in some regions, just as water does in others. This would mean that a well in an oil region is as likely to strike petroleum as a well in a water-bearing region is likely to strike water, that the oil is distributed in an almost continuous sheet beneath extensive parts of the country.

This is not true. Another statement frequently heard is that the oil forms an underground stream and that a lucky location for a well must lie over that stream. Expensive and fruitless drilling has repeatedly shown that such streams of oil do not exist. A belief that is strongly held in some parts of the country is that oil pools are connected, that some channel connects the pools in an oil region. This belief is absolutely disproved by the ranks of barren wells that encircle practically every producing oil pool in the world. Another wrong idea is that petroleum occurs in underground ponds or lakes. In fact, prospectuses of some oil companies refer to lakes and rivers of oil, giving the idea of great caverns filled with oil. Not a single such cavern has been found in any oil field in the United States. Oil is really contained in the tiny openings between grains of sand, in the pores and crevices of a crystalline, or as in the largest wells, in the comparatively small openings of a porous rock.

Petroleum always occurs as a liquid. Its most volatile parts may be taken into the air by evaporation, or into dry clays by absorption, but the solid or semi-solid substance that remains is not called petroleum,

but is known as asphalt, albertite, grahamite, or by the more general term bitumen. Although all petroleums are liquid, they differ in their qualities; in fact, two petroleums from different levels in the same well are seldom exactly alike, either in appearance or in value. They may differ notably in color. By reflected light, as seen in a pail or container, oil is commonly green; but it may be black, brown, or yellow. Most of the petroleum from California, from the Gulf Coast of Texas and Louisiana, and from Mexico is black or dark brown. Most of the oils from Wyoming, Kansas and Oklahoma are green. Most of those from the Appalachian field are green or yellow. All the more productive oil districts of the United States, however, yield both dark and light oils.

The color of petroleum as viewed by transmitted light, that is, as seen in looking through a clear glass container full of oil, may differ as much as it does when viewed by reflected light. It is most commonly some shade of brown, but it may be yellow or green or rather exceptionally it may be coal-black. The color of oil is a rough indication of its value. Oils of the lightest color are generally the most desired. The typical Pennsylvania oils, which have a higher market value than all others, are amber, light brown, or light green. Dark oils are rarely seen in the Pennsylvania district, and such as are obtained there, have a comparatively low value.

The viscosity of oil is another characteristic that differs widely in different fields. The viscosity is measured by the rate at which the oil will flow although it might be determined by its stickiness. Some petroleums flow as freely as water, others are so thick that they flow almost like molasses and hang in slimy, icicle-like points, to a stick or other object that may be thrust into them and then withdrawn.

A third differing characteristic of oil is its weight. It is commonly believed that oil will float, which means

that it is lighter than water. This is not absolutely true, for some oils are so heavy that they have little or no tendency to come to the surface of the water and a few rare oils will actually settle sluggishly to the bottom of a water filled vessel. The weight of the oil compared with the weight of an equal volume of clear water, at the same temperature is known as its specific gravity, and like its colors is a fairly reliable indication of its value. The truth is, the lighter the oil, the higher the value. For the light oils contain a larger percentage of gasoline than the heavy oils, and just now, the gasoline content of crude oil has more to do with determining its prices than any other thing.

A fourth characteristic of petroleum is its smell. Most Pennsylvania and West Virginia oils have what may be called "a paraffine smell." California oil has an entirely different smell, for it contains compounds known as aromatic hydro-carbons, which are not found in eastern oils. Gulf Coast oil smells more like the California than the eastern oils, but not exactly like either. Some petroleums have an odor that is almost sickening, others are almost fragrant.

Petroleum is contained in the rocks that underlie certain parts of the country. Most oil is found in beds of sandstone or limestone, but associated with these beds there are invariable shales (improperly called slate, by some oil men) and clay. In practically every oil-producing region of the world, beds of limestone or sandstone lie between thick beds of shale or clay. A region without these rocks has small prospects of containing an accumulation of petroleum of any commercial value. Certain other kinds of rock such as granite, gneiss, schist and quartzite are distinctly unsuited to form oil fields, and drilling in such rock is a waste of time and money. Of course, as there are exceptions to all rules, a few recorded wells have struck oil below rocks such as these indicated, but no paying oil fields have ever been opened in such rocks.

In every oil field a little oil is scattered so generally through the oil-bearing beds that a well reaching below at almost any place, is likely to get a showing, such as a rainbow-colored film on the drilling water, but oil in paying quantities is in comparatively small pools. In these pools practically every opening in the oil-bearing bed is filled with oil or with the gas that generally accompanies it.

FORMATION OF OIL POOLS

The formation of an oil pool appears to depend on several conditions, while other conditions that are not yet clearly recognized or defined, may account for the absence of pools. In areas of sedimentary rock by far the most important and indeed the only condition that can be detected by a study of the surface is the structure of the rocks, by which is meant the way they are folded or tilted. Where the oil-bearing beds are arched or bowed upward, the oil has, in many places, formed pools at the top of the arches. The ideal form for an oil-bearing bed or set of beds is a basin or a set of basins turned upside down, but in many places simple arching is sufficient to afford a gathering ground for oil. Some other types of structural feature are considered moderately favorable for the accumulation of oil, such as the terrace on which the dip or inclination of a bed is interrupted by a flattening like a step; or a terrace, beyond which the bed again slopes downward at its original angle. The proper location to prospect for oil in a region where it is known to exist is in a place where the beds of rock show anticlinal structure, that is, where the beds are thrown upwards into an arch; or as it is called by geologists, an anticline.

An anticline can perhaps be detected by an untrained man, but he is very likely to confuse the structure with the form of the surface of the ground and so be misled. In such cases the practical oil geologist should be consulted. Statistics show that out of 33,366

wells drilled east of the Rockies, 7,388 drilled for oil were dry wells, and 2,267 drilled for gas were dry. Subtracting this from the total completion leaves 23,711 productive oil and gas wells.

Government statistics show that 87 per cent of the wells drilled and located by geologists were found to be productive.

In this case if geologists had been consulted there would have been only 1,255 dry holes instead of 9,655 as above mentioned.

PETROLEUM SUPPLY NEARING EXHAUSTION

Of all the raw-material problems confronting the world today the most outstanding and acute is the problem of its petroleum supply. Petroleum is one of our most vital resources. The industrial life of every nation depends today upon the products of petroleum; for these products lubricate the vehicles of transportation by land, sea, and air, as well as all the machinery engaged in supplying the manufactured articles necessary for modern civilization. The world is now demanding oil. It is indispensable. Without it, many wheels of industry would stop. There are in use in the United States over 6,000,000 registered automobiles and this number is increasing at the rate of over 1,000,000 a year, to say nothing of the farm tractors, trucks, airplanes and motor boats. The automobile industry is still in its infancy. Besides, the increase in the use of oil as a fuel for our navy, merchant marine, railroads and industrial plants amounts to millions of barrels annually. A serious shortage of gasoline exists, for according to estimates our underground reserves are thirty-three and one-third per cent exhausted and we are almost at the peak of production. A decline in the production of petroleum in the United States is only a matter of a short time, while consumption is increasing at an alarming rate. Our oil reserve for the United States as far as the pools are concerned, will be ex-

hausted within a few years. We are facing an oil famine that is liable to paralyze the industrial world. The development of producing fields and exploration of unproven territory is failing to bridge the ever-widening gap between the production and consumption of petroleum.

Our underground pools of petroleum have been drained considerably. The domestic use of oil is advancing at a rate that indicates a yearly consumption of more than 6,000,000 barrels in 1920, with the supply becoming exhausted in not many years. It is true that the Government has spent considerable time and money in the last few years in a study of the oil shale deposits. As a result of the field examination, made from 1913 to 1916, it has been clearly demonstrated that this potential source of petroleum is so substantial that the Government has set aside a special reserve for the American Navy of 5,500 acres of oil shale in Utah.

Until recently the oil shales of the United States have been referred to by the Government geologists as a reserve supply. When the oil pools are nearing exhaustion, and when the demand and price shall warrant, the new industry will be established, this supply of shale will be available for extraction and will be used to supplement the supply of petroleum. The present process of extracting the oil from the shale will take centuries of time as to the distillation of the shale fields. The recently discovered coal, oil, and gas fields in Alaska by our own geologists, while as yet undeveloped, promise well for the future. It is reported that an area covering possibly one million acres has been set aside by the Government for future exploration that is expected to prove rich in the production of coal, oil, and gas. An immense oil field has been opened in Alaska along the McKenzie River. According to the mounted police one well drilled by the Imperial Oil Company is flowing at the rate of 1,000 barrels an hour at 800 feet. Arrangements are being made to pipe the

oil to the nearest navigable stream. The field is 300 miles long and 200 wide. It is known as the Fort Norman field, many prospectors have camped there and hundreds more are on their way. The rigors of climate will not deter our promoters from operating this field and marketing this supply in the states and the future of our Navy and Merchant Marine is therefore assured in the event that our domestic supply should become exhausted.

The new production credited to the completion aggregated 3,388,040 barrels or only 21,097 barrels more than in the previous year, a difference that is very small, when the great increase in the number of completions is taken into consideration.

The new production was more than double that for any previous year. The total is 1,890,635 barrels greater than that for 1916, which held the record until 1919. North Texas leads in the amount of new production with 1,046,427 barrels, a loss of nearly 700,000 barrels when compared with the figures for the previous year. The percentage for this division was 31, whereas in 1919, it contributed more than half of the grand total. Oklahoma occupies second place with twenty-three per cent. The Gulf Coast follows with seventeen per cent and Kansas with six per cent. The Kentucky-Tennessee region made the best record of the fields east of the Mississippi with 41,354 barrels new production, although the division had the least number of wells completed during the year. (Experience has shown that natural gas is commonly associated with anticlinal or roof-shaped folds of the containing rock. The line drawn along the highest part of the folds is called the axis. A study of the strata of the gas fields of Pennsylvania shows that nearly all of them lie close to the axis of some anticline.)

INTENSIVE OIL PRODUCTION

New records were set in the oil fields in 1920, and

this period will go down in history as the most active year to that time. A very great number of completions were the result of intensive operations throughout the various fields, a condition brought about by oil prices being a great deal higher than have been paid in Pennsylvania for crude oil since November, 1869. In the oil fields east of the Rockies there were 33,366 wells completed during the year 1920, an increase of 4,903 over 1913, which held the highest record for six years. The greatest number of completions were reported from Oklahoma where the total was 9,097 or 901 more than for the same division in 1919. Second place as to the number of completions goes to North Texas with 6,479, an increase of 29,150 over the previous year. Kansas was credited with 3,163 wells completed, a decline of 279. The Pennsylvania fields completed 5,718, an increase of 540. Kentucky and Tennessee reported 2,888 new wells, a loss of 828. North Louisiana had 1,246, an increase of 542, and the Gulf Coast reported a gain of 527, with a total of 1,763. Among the completions were 7,383 dry holes and 2,267 gas wells. Subtracting these from the total leaves 23,711 productive oil wells, an increase of 3,325 over the figures for the previous year.

CHAPTER X

NATURAL GAS

The demands for natural gas are now greater than the available supply. Food and trees can be grown. Water supplies are constantly replenished by nature, but there is no regeneration in natural gas; and when the gas is once used it is gone forever. While no one knows exactly how natural gas is formed, yet enough facts are known about it to indicate that nature's process was very slow during such periods, meaning thousands of years. The collecting of the gas from the burning, smoldering substances of the forests, the extinguishing and drowning out of the fires of the forests, the raising and generating of the oil and salt water, at the same time were under the generative influence of the heat pressure passing into the different sands found in the anticlinals. The use of natural gas is not an inalienable right, but a privilege enjoyed by about ten per cent of our population in the United States, used in a most extravagant and wasteful manner, with no regard for the future and not appreciated until it is gone. Every appliance known to man should be used to bring about the most economical consumption of the gas and the most effective method of transmission and distribution. Since a normal characteristic of every gas field is that its natural pressure declines as the gas is removed, it becomes necessary to increase the rapidly declining pressure by mechanical means. Natural gas is a natural resource which men have learned to use for the satisfaction of their wants. The misconception regarding the position of natural gas has arisen from failing to appreciate that man creates no new matter, and can merely get the materials of nature ready for consumption; since every product of industry owes its origin to natural resources.

THE FLOW OF GAS

In Pennsylvania, Ohio, and West Virginia, the flow of gas may be continued for a period of forty to fifty years, if the proper locations are made within the folds of the hills. This is the belief of the author, a coal, oil and gas expert of many years' experience, who has made an extended and very careful study of the rock and the formations in the states above mentioned. The finding of gas in the Speechley, Bradford, and Kane sands, which are of the lower measures and under greater rock pressure leads to the above theory relative to the durability of the flow.

WASTE OF NATURAL GAS

The history of the natural gas industry is an appalling record of almost unbelievable waste. The common methods of production, transmission, and use, have resulted in wasting more gas than has ever been utilized. At the present time a survey of the entire natural gas industry indicates clearly that the amount of waste even today is greater than the amount of gas actually consumed. At the present time we are wasting over 800 billion cubic feet of gas per annum. On the basis of what it would now cost to replace this ideal fuel, the money value of this waste amounts to $1,200,000,000.00 a year, or more than $3,000,000.00 per day.

Natural gas is purer and has about twice the heating value of any manufactured gas that can be made. Man, with all his skill, has never been able to manufacture gas that is equal in quality to the natural gas, which is now so generally wasted. To replace the 600 billion cubic feet of gas now annually used would cost about $1,200,000,000.00 annually.

Domestic consumption was at first very low. Since in most fields there is unrestricted competition between various companies, this had the immediate effect to

make it impossible for any one company to conserve the gas for future use without co-operation with its competitors. The public has frowned upon any arrangements for co-operation on the theory that competition was desirable. This has resulted in a wild race between the various companies, each trying to get the gas out of the fields, with the result that the supplies were drained very heavily and are, therefore, not available for future use. In certain fields about 600 billion cubic feet of gas were produced last year. This represents about 75 per cent of all gas sold in the United States.

Natural gas is found in twenty-three states but 98 per cent of the total production is in West Virginia, Pennsylvania, Oklahoma, Ohio, Louisiana, Kansas, California, Texas, and New York. Forty per cent of the total production is from West Virginia.

PROOF OF MEASUREMENTS

It often happens that when a well is drilled to the lower productive measures, such as the Speechley Sand, at a depth of 3,270 feet below the Pittsburgh coal according to location, or the Bradford and Kane sands at a lower depth and no production is found, the well is abandoned. This procedure is often a serious mistake, as the drill at this depth will often be deflected as it penetrates the hard shale and flint-like sands. The drill may shift several feet, and in many cases the productive sand may not have been penetrated at all. In every case where there is any doubt in the mind of the promoter and driller a thorough test should be made by a minute examination of the sand brought to the surface. This would prove to the satisfaction of all concerned that justice had been done and best service rendered for the benefit of the owners. When a well is completed and capped, a line laid, and the production turned into the company's high pressure line, it should be connected with the pressure instead of against the pressure. All small wells with a low rock pressure

could be utilized and the high pressure line would be drawing instead of forcing a large part of the production back into the small producer. All production should be sold to the distributing companies by the use of a Westinghouse, or other reliable meter, through which the gas will flow freely and be registered correctly, thus giving correct measurements for the entire production sold therefrom.

There has been extensive drilling throughout Western Pennsylvania in the various fields since the first well was drilled in the Murraysville gas field in 1878. It has from the first been a great producer of gas. The first well drilled in 1878, the Beaver Valley well, a few miles from Apollo, coming in only a few days ahead of the Haymaker No. 1 at Murraysville, proved to be the largest gas well. It was estimated to have had a flow of from twenty to thirty million cubic feet of gas per day for five years, before being attached to a pipe line in 1883. During that year much drilling was done in the Murraysville field and it became recognized as the oldest gas field in the state. Other fields came to prominence; appreciating the fact that the Sewickley field is not a new field by any means. It has always been a gas and oil producer. There are many wells in this locality, some of which have been producing continuously for thirty years. Particular attention has been called to this field lately, owing to the statements of noted geologists that the Elizabeth and Speechley sands underlie a part of this section.

The McKeesport field where the Youghiogheny joins the Monongahela fifteen to sixteen miles southeast of Pittsburgh, has been the center of attraction since August 23, 1919, when the best paying well in the world struck gas at 2,939 feet, in the Speechley sand. The flow started at four million cubic feet, quickly increasing to sixty-two million cubic feet per day, and as the gas had been contracted for at seventeen cents or more per thousand feet, it did not take long to net

the owners a clear million dollars. Investments of $150.00 a share are said to have brought dividends of over $3,000.00 the first month. The second largest well was drilled in the field April 24, 1920, through the Speechley sand to a depth of 3,070 feet. The well had a flow of 27,672,000 cubic feet of gas a day, drilled by the Reynolds Oil and Gas Company. Several companies drilled through the Speechley sand and opened a flow of between ten and twenty million cubic feet. The drilling of wells in this field was so intensive in Snake Hollow, Versailles, Bryn Mawr, and Long Run, that it almost drained the field in this section. The field was about eight miles in length and five miles in width across the major axis of the Murraysville anticlinal at Snake Hollow. Anyone who thinks that McKeesport is a new field does not know that oil and gas were drilled for in the Long Run district long before 1878.

In that year the Bayard well at Elrod Station was drilled to a depth of 1,030 feet. Enough gas was struck to throw salt water several hundred feet in the air. No attempt was made to make it a gas well. Another well had been drilled on Ninth street, McKeesport, now owned by the Crown Chocloate Company. This oil well to the present day shows a production and tracings of oil. A short time later a well was drilled in the Tenth ward with tracings and seepage of oil. It is in the basement of a dwelling at the present day. In the Long Run district several wells have been drilled into the Speechley and Bradford sands and were found unproductive. Among these wells is the Ripple well, which produced about 250,000 cubic feet per day in the Elizabeth sand. It was drilled to the Speechley sand at a later date, and found productive in that formation. The same conditions prevail at the Dravo well, the Matthews well, and across the road at the Russell well. On the Bayne property a dry well was drilled in the lower measures of the productive sands. There has been quite extensive drilling from time to

time since the Speigle well was brought in with a flow estimated at ninety-two million cubic feet. Up to that time the Allebrand well was the largest in that section for many years. Both of these wells were in the hundred foot sand, and eventually were drowned out.

For forty years or more developments have been going on in this field with varying success, and perhaps these activities will continue for many years more.

On the Murraysville anticlinal the logging of wells shows from 2,940 to 3,270 feet to the Speechley sand. On the Fayette anticlinal, known also as the Indiana anticlinal, wells have been drilled to the Speechley sand varying from a depth of 3,320 to 3,538 feet. The Johnson Gas Company drilled a well through the Speechley sand to a depth of 3,538 feet, the Speechley sand being at a greater depth in this region. This shows a dipping of the sands to the northeast leveling in the Connellsville basin, and raising to the Blue Ridge Mountains.

There has been quite extensive operation in Westmoreland County by the Latrobe Steel Spring Company, and the Peoples Natural Gas Company. The Peoples Natural Gas Company drilled a well worthy of mention in the Blue Ridge Mountains four miles west of Ligonier in Kelly's Hollow along the Lincoln Highway. It was sunk to the lower productive measures of sand, at a depth of 6,200 feet, with a flow of 400,000 cubic feet per day. The gas is odorless and the well is the deepest producing well in Pennsylvania.

In the following counties: Venango, Mercer, Marion, Washington, and Allegheny, wells have been drilled to the lower productive measures with very good results as to both oil and gas. Butler, Venango, Crawford and Allegheny Counties are the producers of oil in Western Pennsylvania. There are 258,600 active wells in the United States winding back and forth in an iron net work concealed beneath the oil territory of the country. A gigantic system of pipe lines, 50,000

miles long, is daily doing work that would require 200,000 oil tank cars and 8,000 locomotives fully one month to handle according to estimates of pipe line statistics.

Virtually every barrel of oil taken from the nation's 258,600 active wells is transported through these pipe lines, and in this way, reaches the oil refineries, and consequently the oil markets, weeks and sometimes months sooner than if shipped by rail.

THE HISTORY OF THE PIPE LINE SYSTEM IN 1861.

Herman Janes, of Erie, Pa., conceived a four-inch pipe line from the Tarry farm to Oil City, Pa., but never carried it out. Then in 1862 a bill to aid pipe line construction was introduced in the Pennsylvania Legislature, but it was beaten by "teamster" opposition.

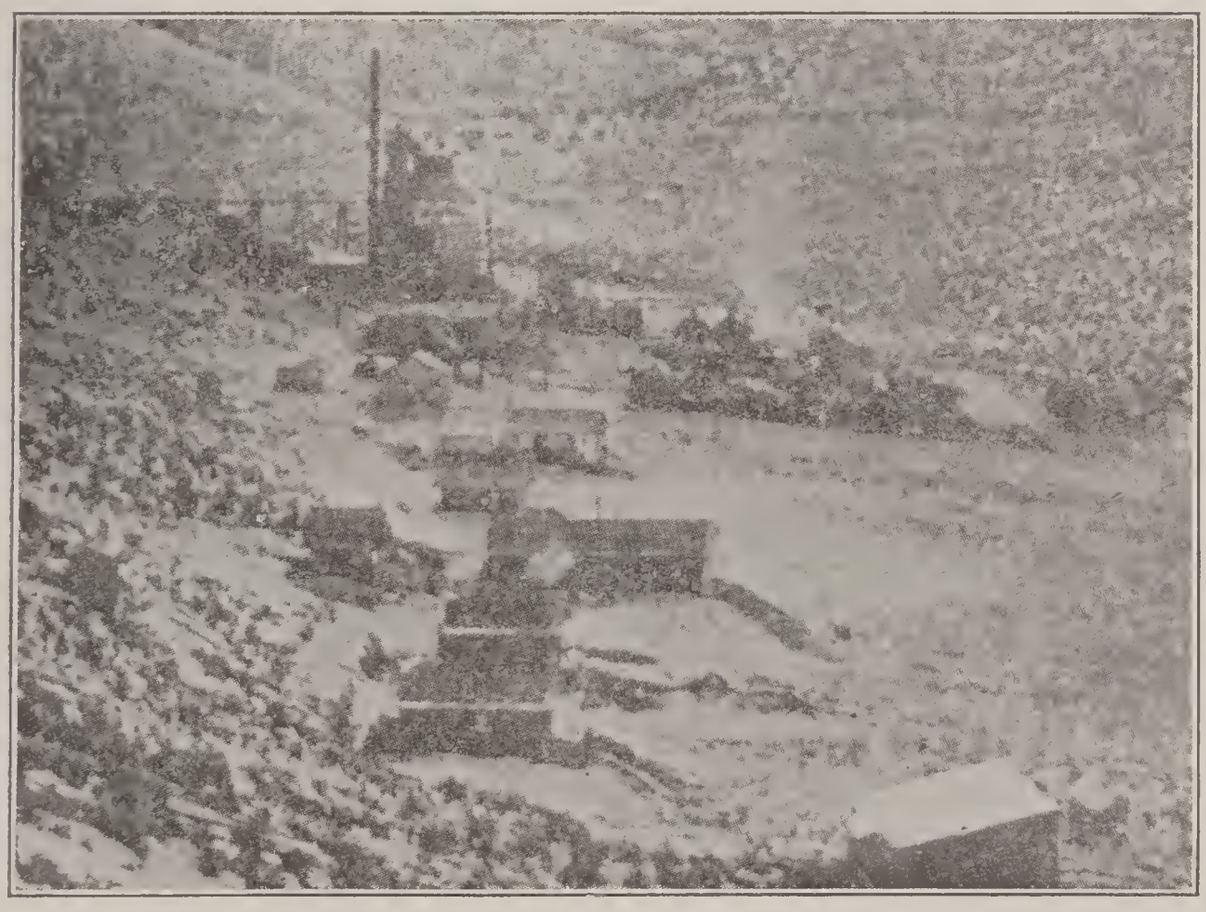
In the same year J. L. Hutchins, a New Jersey operator, constructed a two-inch pipe line from the Tarry farm to Humbolt; but the teamsters destroyed the line, tearing up huge strips of it. He tried again in 1863 but again the line was destroyed. In 1865, with the aid of the police, Henry Harley successfully resisted the teamsters and operated the first successful line of two-inch pipe handling from six to eight barrels a day. Then the net work of lines that operates at the present time in Pennsylvania began to spread. The new southern field in Oklahoma and adjoining states was equipped almost from the beginning with this new oil transportation system. The field is a winding space of lines. Truck systems extended north to Illinois refineries and south to the Gulf Coast stations.

It is estimated that the pipe lines of the United States are worth $500,000,000.00.

GEOLOGISTS AND SCIENTISTS ARE BAFFLED

The rumbling sound beneath the earth's crust in the lower strata and fissures through our continents underlying the great oceans, and the generating of

the gas from the heat possibly thousands of feet below the earth's surface and the gas bursting through these main fissures are causes of earthquakes and volcanic eruptions. The most plausible theory to account for the rumbling sounds is that they are caused by the sands and rock formation settling down upon the earth's crust. Through our New England states it is well known that the earth is in a process of settling to the present day. In Pennsylvania, in the Allegheny formation little is known of our anticlinals and contours shifting, and settling down upon the earth center; since within the past years gas has become more active through these large extended fissures due to pressure upon the crust of the earth by the overlying formation.



PLANT PRODUCING OIL FROM SHALE

Earthquakes are manifest wherever bending of the earth's crust is in evidence, while if this phenomenon occurs on the coast, it is accompanied by volcanic action. Tremors affect the earth's crust, which probably does not exceed thirty miles in thickness, but are usually within thousands of miles of the earth's surface. The greater pull of gravity on the earth's surface at new and full moons renders earthquakes more frequent at these periods. It is suggested that the accumulation of these deep low pressures results in great explosions. Earthquakes appear almost always to be connected with change of barometric pressure. We have three principal types of waves accompanying a shock, which reach the observing station by three separate routes: first, in a direct line through the earth; secondly and thirdly, by traveling over the earth's surface in opposite directions. From the time elapsing between the arrival of these three waves, it is possible to calculate the distance of the earthquake.

Within the world's history about 30,000,000 people have been swallowed up or killed by earthquakes. Twelve thousand persons were killed in the Chinese Province of Kansu by the quake which occurred there in March, 1921. According to advices received here Kansu Province is near the Spensi border of China. Scientists are interested because phenomena of this kind observed in other places constitutes a mystery that has never been satisfactorily explained. The remarkable example of this phenomenon occurred in 1784. For an entire month the Mexican town of Guanajuato was kept in terror by a succession of subterranean roarings and explosions unaccompanied by the trembling of an earthquake in the vicinity of the flat shoal mountains. In North Carolina, the dwellers have been much alarmed at intervals during the past year by unaccountable rumbling and explosive noises; they fear lest the mountains may become an active volcano. During a period covering at least a century a small

town in Connecticut was famous for what were called Moodus Noises.

These noises were like the reports of big guns heard from a distance of many miles. They were not caused by blasting, which in recent years they have heard occasionally, having been much louder. In Italy it is quite common in some localities and the natives and peasants attribute them to supernatural origin. They resemble a distant or muffled discharge of cannon, sometimes single and sometimes in succession. Usually they are heard when the sky is calm and clear. An Italian scientist gave them the name brontidies, meaning thunderlike. They are certainly not thunder, however, and a queer thing about these detonations is that they always seem to be at a distance. Along the shores of Ireland, the little isle so green, mysterious explosions unaccompanied by earthquakes have been long known as water guns. On the coast of Belgium loud detonations of the same character are often heard and are called by the people sea cannons. It may be possible that geologists and scientists, studying the underlying strata beneath the earth's crust, will locate the main fissures containing this great volume and supply. The discovery and utilizing of these available products may be brought to light within the near future.

CONSERVATION AN ECONOMIC NECESSITY

With the available supply of coal, oil, and wood rapidly diminishing, we are facing a situation that in the not far distant future will mean restricted use of these products or a discontinuance of their use entirely. Wasteful extravagance is in a large measure responsible for this condition and unless remedial legislation soon becomes effective in the checking of waste and extravagance we will be face to face with a total exhaustion of these most essential products. Then the wheels of progress would be brought to a standstill

and disintegration and ultimate dissolution would come to our country. The logical solution to the problem is rigid conservation. It is true that some effort has been made to conserve the forests and to replenish by replanting and cultivation, but much remains to be done even in forest conservation and practically nothing has been attempted in the way of restricting the use of oil, gas, or coal.

Our great manufacturing plants, railroads and big buildings, depending largely upon coal for operation, lighting and heating, are consuming coal so rapidly that the country will be drained of these products within the next one hundred years. It is estimated that in the use of coal in factories, blast furnaces, hot mills, and railroad engines, such a tremendous draught straight pressure is required that a waste of 25 to 45 per cent coloric measure is incurred. Cannot these losses be either entirely eliminated or at least largely reduced?

What is the penalty?

DISTILLATION OF LIQUID FUEL

Not coming, but already here, we have just entered the epoch of liquid fuel. The age of liquid fuel has already commenced, and we are only at the beginning of immense technical, industrial, and social developments. All over the world power alcohol can be distilled from well nigh every form of vegetation, in the tropics especially, where the growth is rapid. Untold and ceaseless supplies of power alcohol can be obtained from the annual growths of many vegetable substances. Back of all this we have the possibility of laboratory making of synthetic liquid fuels. All fuels are compounds of hydrogen and carbon. Every act of combustion links carbon with oxygen. In water we have a universal supply of hydrogen linked with oxygen.

The problem then is, to take carbon from the air and hydrogen from water and combine them to make

the whole range of liquid fuel. From petrology to heavy oil, the coal areas of the world cover about 772,700 square miles, the United States and China far exceeding all others. The life of the world's coal at the present rate of output is a question not quite so simple, as it is complicated with other factors, such as the future growth of the demands for coal, and the use of other fuels, etc. Among the nations, the United States leads with a production of over five hundred million tons. Britain and her dependencies produce nearly one-third of the world's output.

WHAT IS THE PENALTY?

No problem is so difficult that a solution is impossible, and the logical conclusion is to substitute some other power for the operation of the large fuel wasting factories, mills, and engines of various kinds. The operating of great power houses where electricity is generated for trolley car systems makes a heavy drain upon our reserve supply. We believe that it is possible to furnish power at a minimum cost, and for this water power is available. The chain of great lakes skirting our northern border is admirably situated, ready to be harnessed for service in the greatest enterprise of modern civilization. It is true that the first cost of this enterprise would be enormous, but the conserving of our fuel supply would amply repay for its promotion. Sufficient power may be thus secured to operate all the great electric plants of the middle west and eastern states. In addition to providing this power, which seems to be so essential, at a minimum cost out of this development, inland canals could be constructed which would relieve, in some measure, our overburdened transportation systems, which has been a serious problem for the past several years, causing largely increased costs to the ultimate consumer of the most staple products.

Another fact which might mean much to hu-

manity, as an outgrowth of these great developments, would be the easy construction of sluices and other waterways for the irrigating and fertilizing of much of our arid, unproductive soil in the great farming sections of the middle western and southern states. So many assured beneficial results can be obtained from using the power contained in the basins of the great lakes that we feel like urging our legislatures and the Congress to enact favorable laws, and immediately provide means for the securing of these great benefits to mankind, and thus safeguarding for future generations ample protection and adequate supplies of the necessities of life.

CHAPTER XI

ELECTRICITY

The analysis of the compounding liquid fuel substances shows that they may be ultimately compounded and used in place of gasoline and furnish heat units for motor power transportation; also the collection of the transmutation acid waves of the volatile liquid fuel substance of the atmosphere forms electricity when properly balanced and placed in contact and in conjunction with the proper fuel substances and mineral deposits of the earth. Collecting electricity from the air will also furnish power, light and heat to the machinery of the world, generating and transmitting electricity to supply motor power to automobiles, enterprises and homes. Electricity will be taken from the atmosphere; all these phenomena will no doubt take place in the near future.

The electrifying of our great railroad systems began over eight years ago, and is the universal question of the age. More than eighty years ago Thomas Davenport, a Brandon, Vermont, blacksmith, completed a working model of an electric railway. A few years later a car was ready for a trial trip, the power being provided by an electro-magnetic engine. This device was driven over a circular track in Springfield. Mr. Davenport, apparently satisfied that public conveyances could be propelled by electricity, rested on the honors he had achieved. News of the devices spread and stirred into action a score of able men, among whom were Professors Moses G. Farmer, C. G. Page and Thomas Hall. They labored for years to perfect an electric railway, but their efforts were futile. Professor Page came the nearest to success. In the spring of 1887 his car ran between Washington, D. C., and Bladenburg, Md., a

distance of five and a quarter miles. The maximum speed was eighteen miles an hour and it proved too much for the professor's batteries, which were ruined.

It was generally conceded that progress had been made and thereafter, for a period of thirty years, many inventors tinkered away at batteries and made many trials, but there was always something the matter, which convinced the majority that the use of electricity for transportation purposes was merely an interesting thought, like perpetual motion.

Then entered the field the experimenter Thomas A. Edison and Stephen Field, who advanced so far that in 1879 Mr. Field filed an application for a patent on a third-rail system. Mr. Edison built a small road, and after many trials it became known that the use of electricity as power for transportation was practicable. In 1883 Field and Edison produced an electric locomotive that moved around a small circular track at the Chicago and Louisville Expositions.

During the long period of tests and failures Frank J. Sprague, a student at the United States Naval Academy, had followed with deep interest the various attemps to make a success of the idea, and in 1883 he resigned from the Navy and for five years made an intensive study of electricity and how it might be controlled for use in transportation. Some of his tests were made in Pittsburgh before distinguished gatherings. Everything was going nicely and financiers were becoming interested in the matter, when one day a fuse blew out during a trial. There was a startling flash, and the car was out of business. Then Mr. Sprague interested Oscar T. Crosby, afterwards Secretary of the Treasury, and S. Dane Green, in his invention. They all went to Richmond, Va., where on a very dark night early in 1888 the first electric car was tested. It ran well under electric propulsion until it came to a hill, when it bucked, and four mules were commandeered to drag the car back to the barn.

Efforts to perfect the mechanism were continued until finally a car was placed in service. Passengers were willing enough to ride in it, but they soon grew doubtful of ever being able to reach their destinations with an "electric horse." There was more or less trouble at all times, and winter storms added to the general uncertainty of electric travel. These first electric cars in Richmond were run over a mud road-bed on rails one-third the weight of those used today. The road was ballasted, the wooden stringers being laid in dirt. But despite these disadvantages the first round trip of a little more than three miles was made in about an hour. More cars were added, and finally they became an everyday sight, and experts employed by other local railroad companies were sent to Richmond to study the new contrivance. The news traveled abroad, and Mr. Sprague went to Italy to install an electric road there.

According to electric experts, the precise date when the electric car was proved practicable was May 4th, 1888, and the thirty-third anniversary was celebrated with ceremonies in many of the smaller cities. During these thirty-three years the electric railway industry has made enormous strides. A statement issued by the American Electric Railway Association says that today there are 80,000 electrically propelled passenger cars in the United States, and that they carry annually 14,000,000,000 passengers, or ten times as many as ride on steam railways. The receipts of the various companies this year will, it is estimated, amount to several hundred million dollars. There is invested in the lines approximately $5,000,000,000, the trackage is 44,400 miles and 300,000 men are employed in the service.

WHAT IS ELECTRICITY?

It has been the universal question of the ages past. It is the most powerful element in nature and is rapidly becoming the most useful agency of civilization

through the scientific efforts of human genius. The progress made in the generating, concentrating, and controlling electricity, making it a servant of mankind is the marvel of the age in which we are now living.

THE ANSWER IS: MINERAL, ANIMAL, AND VEGETABLE LIFE

Decompositions of wood, vegetable, and animal life going through a process of deterioration each day and year; and in their disintegration sending forth life-giving elements, chemical compounds, and substances furnishing materials necessary to new growth; undergoing a perpetual process of transmutation until life ceases to flourish and completely decomposes. The decomposed matter contains billions of elements and chemicals of various species. These different substances send forth many gas by-products and distribute electricity through the atmosphere. These newly formed growths in their environments absorb many carbon gases and chemical composition of decomposed matter on their return to life. By the mist, rain, and dampness all these forms of life send forth by the decomposed matter a perpetual and new supply of electricity, gas, and by-products each day. These lower forms of life we term minerals, copper, zinc, radium, gas, etc., one depending upon the other for existence. When we reach the surface, we find a high form of life which manifests itself in growth. The various species of trees and plants during maturity and growth absorb hydrogen, oxygen, and dioxide.

Many species of the plant life during maturity and growth, such as poison ivy, laurel, and others, absorb carbon monoxide and oxalic gas, a very poisonous substance. The growths of grain contain many chemical elements, wheat 16, oats 14, etc., and absorb hydrogen and oxygen. Vegetable, mineral and animal life contain millions of elements and chemical compositions. All forms of life contain electricity, one greater than

the other. These forms of life take many years going through a process of decay, each day becoming more nearly extinct; from time to time the new growths taking the place of the former growths.

WHAT ARE WAVES OF ELECTRICITY?

The substance of mineral, vegetable and animal life; the essence of each specie of life contains gas. Each specie of life links gas with combustion. The growth of grain and grass, which is nature's first production, absorbs hydrogen, a colorless gas, which is a more volatile and inflammable substance, and the lightest element yet known, being fourteen and one-half times lighter than air. When combined with oxygen it produces water. Many trees and plants absorb more carbon gases than others, as they are of a heavier and liquid form and not as volatile. Various vegetable growths breathe hydrogen, oxygen, and nitrogen, from the rain, mist, and dampness, absorbing nourishment, breathing and sustaining life and growth. At midnight, when the mist and dew are falling fast, the various species of life, trees, plants, and grain absorb nourishment more freely. The atmosphere containing these acid gases is more volatile and purer. These chemical elements and waves properly balanced and purified in conjunction with hydrogen and oxygen, in combination with nitrogen and argon, the changing of the gases and elements of the clouds, mist, dew, and vapor, settling and uniting more freely at midnight, no doubt are essential as to the essence and waves of electricity, perfectly and properly balancing the chemical elements which have made this product possible.

The atmosphere is saturated with gases forming waves of electricity, like the ocean waves, of volumes of steam winding its way into space. The rising of the sun each twenty-four hours, with illuminating power and magnetic power of attraction, permeating to the center of the earth, sends forth light and heat, thereby per-

forming the functions and duties of nature, a most important one being to purify these gaseous acid waves when carried through the atmosphere to a higher altitude by this magnetic power of attraction. The gases and acids of the various species of life unite more freely in conjunction with nitrogen and argon, more volatile substances, and rise to a higher altitude by distillation of the acids and volatile waves of the heavy acid gases, and acids of mineral, vegetable, and animal life, in combination with hydrogen, oxygen and ozone, a pure substance of the electromassage and transmutation of the volatile acid substance. The consummation and concentration of the waves of electricity in space and attracting of the acid waves make possible radio telegraphy. The rising sun each twenty-four hours has its functions and duties to perform such as permeating the center of the earth. The magnetic attractibility and reflection of light and power of gravity of the sun upon the center of the earth properly balances these elements and substances and sends forth waves and elements and chemical compositions, nourishing and sustaining life and growth each twenty-four hours.

The balancing, refining, and uniting of the waves of gases and volatile substances combine with hydrogen, oxygen and ozone. Nitrogen is a gas which with argon constitutes 4-5 of the volume of the atmosphere; it is the basis of nitric acid and rises to a higher altitude by distillation of the substance of each specie of life, mineral, vegetable, and animal.

The distillation of the volatile acids forms a greater and more powerful acid and consumer of electricity. This powerful volatile acid in conjunction with ozone, transmitted into space, forms the waves of electricity. The magnetic power of attractability and extension of sound is more easily carried by the placing and accomplishing of the greater and more powerful elements and chemical compounds which have a more magnetic power of attracting the waves of electricity in this new

field of industry by concentration of radio telegraphy.

The atmosphere becomes saturated, collecting, accumulating, and spreading the waves of gases and electricity by the reflection and magnetic attraction of the sun on the surface of the earth, thereby properly balancing these chemical products into winding circles and spaces, in the current of the air; and when the rain and electric storms approach and take place, the lightning burns up this surplus supply of electricity, gas, and impurities found in the currents of the air, thereby purifying the atmosphere. This heavy atmosphere saturated with hydrogen, oxygen, and nitrogen from the waters of the oceans and seas sends forth volumes and clouds of hydrogen, oxygen, and nitrogen. Fog and mist across the land nourish and sustain the various species of life in their environment and transmutation of life and growth.

This atmosphere purified, becomes calm and clear, and is known as ozone. The transformation by the attractability and extending of sound, is more volatile and clearer. This atmosphere purified and volatile, attracts and carries the sound over the land across our great lakes, into mid ocean and across the great seas. The mysteries of nature attract the sound, and waves of electricity are picked up by radio telegraphy. The linking and uniting together of our great lakes, oceans, and seas, with the land and the magnetic attraction of the sun draws the water over the land, into space.

Hydrogen is a colorless, gaseous, inflammable substance, which liquifies under great pressure, and is the lightest element known. When combined with oxygen, a colorless, odorless gas, it forms water; and in conjunction with nitrogen and argon, constitutes one-fifth by volume of the atmosphere surrounding the earth.

The magnetic attraction of the sun properly balances these elements and gaseous acids. The essence and acid waves form electricity. They send forth gases and unite the greater minerals and chemical elements of

the various species of life. Our great oceans and seas, are the sounding boards, linking and connecting up the sound midway between land and the greater and more powerful chemical elements of mineral, animal and vegetable life. The atmosphere is more calm and clearer and susceptible as to carrying and attracting sound, than the land, as the structure is at a higher altitude and the obstructions on the land affect the carrying of the sound. These elements and acids may ultimately be compounded and combined so as to produce a solution or liquid containing the original units of power and multiplied by concentration; this product would be very useful. Many trees and plants have greater chemical elements in their composition than others, as the chestnut, locust, oaks, etc.; the chestnut has the greatest quantity of chemical elements as well as the most magnetism. The writer has seen where lightning was attracted by the magnetism of the greater chemicals striking this particular species of tree. It is known that stakes made for fence purposes were struck by lightning twenty years after they had been placed in the ground, due to the chemicals in the wood attracting, through magnetic power, the electricity of the air, and forming a current to the ground. These growths of life in their environment having reached maturity or felled in growth, when life ceases to flourish, die and return to nature's earth, the loam containing eighteen inches to several feet of soil, and retaining many of the producing elements.

Scientists and electrical engineers, after studying the many inventions, apparatuses and devices for generating, transmitting, and distributing this valuable product, claim, if poles were placed around the earth extending one from another a complete circuit would be formed. The earth rotates 24,000 miles a day; then these wires would cut the lines of force and would create an electrical current, which would supply half the world at a minimum cost. If this is true that the

earth rotates, or whether the sun has its path to travel, as the magnetic power of attraction of the sun gathers and properly balances the chemical waves of electricity into winding circles and space, making the essential product possible, the placing of poles properly wired would collect the great chemical attraction of the waves in zones and districtc. No doubt, when properly established, this power will be sufficient to supply one-half to three-quarters of the world at a minimum cost.

The harnessing up of this most valuable product for the future is most essential and means the keeping of the wheels of industry in operation, as it will be only a short time until the supply of coal, oil, gas, and wood will become exhausted; and we will have to use electricity, the most wonderful of all nature's products. The electrifying and extending of our great railroad systems, the branching out of our street railways and electric machine shops and mills, and lighting and illuminating of our large buildings and homes; the many new inventions and devices; and all our future progress will depend largely upon the collecting and distributing of the waves of this most essential product. The exhaustion of our precious coal fields being most alarming to industry, turning the wheels of prosperity; the acquiring of a new scurce of energy is the greatest asset the Government can develop. In the consumption and willfully extravagant waste of coal, a mineral that contains over 18,000 by-products to the ton, billions of dollars have been lost by the failure to appreciate and reclaim these many by-products. The oil fields are becoming weakened by lubricating our wheels of industry; our gas supply is ceasing to flourish; wood is diminishing and the crying need of reforestry is heard. All industries must depend largely on electricity as the future power.

Hydrogen is a colorless, gaseous, inflammable substance, which liquifies under great pressure and is the

lightest element yet known, being fourteen and one-half times lighter than air. When combined with oxygen it produces water. Hydrogen is the standard unit for the estimation of atomic weights and volumes. Oxygen, a colorless inodorous gas, which, with nitrogen and argon, constitutes one-fifth by volume of the atmosphere, and in combination with hydrogen forms water. Nitrogen is a gas which with argon constitutes four-fifths by volume of the atmosphere and constitutes the basis of nitric acid. Carbon is an elementary substance present in all organic compounds and occurring in nature in two distinct forms as the diamond and graphite. The action of heat on vegetable and animal tissues produces carbon in the form of charcoal, lampblack, coke, etc.

Ash, the residue of plants or animal substances, remains after subjection to red heat—the waste of burnt coal or the remains of a human body when cremated. Sulphur is a non-metallic element, brittle and of yellow color, insoluble in water, but fusible by heat. Hydrogen peroxide is defined as hydrogen dioxide. It is an unstable compound, H. O., containing relatively twice as much oxygen as does water. It occurs in minute quantities in the air, and also in rain and snow. An aqueous solution of it is obtained by the action of dilute acids on barium dioxide. In medicine it is used as an antiseptic. Hydrogen oxide, chemically, is water, H_2O.

Nitroglycerine is a highly explosive, oily liquid, prepared by the action of nitric and sulphuric acids upon glycerine, as is also nitroleum. Sulphite, chemically, is a binary compound of sulphur.

Excepting the sulphides of the alkali and alkaline earth metals the metallic sulphides are insoluble in water, or nearly so, and many occur as minerals. Binary compounds of sulphur with the more negative elements, bromine, chlorine, fluorine, iodine, and oxygen are not usually called sulphides. Hydro-carbon is a compound

containing only hydrogen and carbon. Carbon monoxide is a colorless, odorless gas, C O, almost the only definitely known compound in which carbon seems to be bivalent. It is a product of incomplete combustion of carbon. Carbon disulphide is a clear liquid, CS_2, of high refractive power and unless perfectly pure, of very disagreeable odor. It dissolves caoutchouc and several other substances not soluble in water. Carbon dioxide is a heavy, colorless gas, CO_2; it extinguishes flames and is popularly called carbonic acid gas.

Nitric acid is a monobasic acid, HNO_3, composed of hydrogen, nitrogen, and oxygen, and is formed by the action of sulphuric acid on nitrates. Oxide is a binary compound of oxygen with an element or radical, as iron oxide, methyl oxide, nitrogen oxide, etc. Disulphide—(a) This compound contains two atoms of sulphur combined with an element or radical—called also bisulphide. (b) A compound of one atom of sulphur with two of another element. Oxalic designates or pertains to a dibasic acid, C_2HO_4, or $COOH_2$, existing in oxal. It is an acid potassium oxalate. Oxalic acid is obtained as a white crystalline substance. It is produced and prepared on a large scale by the action of fused caustic soda or potash on sawdust. Monoxide is a colorless, odorless gas, a product of incomplete combustion of carbon. Ammonia is a transparent, pungent volatile gas used in medicine and the arts, spirits of hartshorn and a middle oil. Methane is an inflammable liquid obtained from the distillation of wood and coal, also methene, methlene, etc.

ATMOSPHERE

The aeriform fluid surrounding the earth is composed of 79 parts by volume of nitrogen with 21 parts of oxygen and carbonic acid and argon, with a varying proportion of aqueous vapor, ammonia, ozone and organic matter. This gaseous envelope of the acid fluid waves is believed to be the same as that surrounding the heavenly bodies.

Chemical Elements — Symbols

Argon—An element associated with nitrogen and one of the constituents of the air.

Ozone—An allotropic form of oxygen present in the atmosphere especially after electric disturbance.

Hydrogen ---------- H
Oxygen ---------- O
Nitrogen ---------- N
Carbon ---------- C
Sulphur ---------- S
Ash ---------- A
Hydrogen Peroxide ---------- H_2
Hydrogen Oxide ---------- H_2O
Sulphide—A chemical binary compound of ---- Sulphur
Hydro-Carbon—A compound of hydrogen and carbon ---------- H.C.
Carbon Monoxide ---------- CO
Carbon Dioxide ---------- CO_2
Carbon Trioxide ---------- CO_3
Carbon Disulphide ---------- CS_2
Nitric Acid—A monobasic acid ---------- HNO_3
Oxide—A binary compound of oxygen with an element.
Disulphide ---------- S_2
Oxalic Acid ---------- $COOH_2$
Monoxide ---------- NO_2
Ammonia ---------- NH_3
Sulphate ---------- CH_4
Methane ---------- C_2H_6

Nitrogen Monoxide is nitrous oxide.

Coke Analysis Dry Basis ---------- Moisture
Fixed Carbon
Sulphur
Ash

British Thermal Measurement (Units) --- B. T. U.

NATURAL EXAMPLES OF THE ATMOSPHERE OVERCHARGED WITH CARBONIC ACID GAS

The most remarkable natural example of the atmosphere contaminated with carbonic acid gas in certain sections is found in the Valley of Death on the island of Java. Due to the barrenness of the valley and elements of the organic substances and settling of the

sediments of the greater acid gases of the atmosphere falling to the lowlands and valleys, these conditions are brought about. No vegetable life exists, and the acids and more volatile gases absorb the elements necessary to the maintenance of vegetable and animal life. Where the valleys are of a more gentle folding and the substances are more equally balanced by the nourishing of vegetable life by the aeriform fluid of the atmosphere, elements upon which living organisms feed are more evenly distributed.

Death Valley has never been fully explored, because of the danger of remaining more than a few moments in its poisonous atmosphere. Approached through an opening between the hills, it is seen to be an oval-shaped valley, about half a mile across. It is about thirty-five feet deep; the bottom is hard and sandy, without vegetation, and strewn with large stones. The surface is covered with the bones of animals, birds and human beings. This is because the carbonic acid gas, being heavier than the atmosphere, settles to the bottom of the valley. Dogs and fowls, thrown into it, fall senseless instantly and die in a few minutes. No craters or fissures are visible on the level of this valley, and it is thought that the openings are near the base of the rock surrounding the immediate hills.

Another valley similar in atmospheric conditions is the "Death Valley" of California.

HEALTH CONSERVATION

The accumulation of the decomposed wood of the forests and decayed vegetable and animal matter, as well as the gas, smoke, graphite and other verdure destroying elements and deadly germs carried up by the currents of the air, pollute and contaminate the atmosphere and carry these elements over the land to all parts of the country during the day; and when night approaches, the settling of the mists and fogs brings them down where man breathes the atmosphere more

freely and becomes sick. From this same cause animals become infected by the contagious diseases such as distemper, diphtheria, etc., they being even more susceptible than the human race. Among the animals that spread diseases are our domestic animals, the horse, the dog, and the cat. The air is only purified by the electric storms that burn up the gas germs and poisonous substances contained in the currents of atmosphere. In the lowlands and in the congested centers, we find the greatest menaces to health. In boggy, marshy valleys, where stagnant streams and pools of polluted water accumulate, absorbing a drainage of filth from the surrounding hills, there are bred all forms of the most dangerous and malignant diseases.

The draining of these pools, and the use of proper chemicals in the stagnant water will in a large measure dispel the dangers emanating from these sources. One of the most serious sources of danger in our large cities is the congregating of our foreign population in the poorer districts; and constant care should be exercised in the supervision of these sections where open cesspools and accumulation of all sorts of filth are found in cellars, in yards, and in alleys. Decaying vegetation is another source of serious danger and the burial or incineration of such matter in a properly constructed garbage furnace is the practical solution to this problem. In parts of Europe decayed vegetables are collected and distilled and many liquid fuels derived, such as alcohol, ammonia gas and many other valuable products. "Clean up" should be the watchword of every city, town, village, and hamlet.

Hygiene, the most important subject that confronts the mind of man, has been largely a neglected science. Even though much has been accomplished in the past few decades, to eliminate contagious diseases of the most serious types, practically nothing has been attempted by medical science or health organizations for the improvement of health conditions, and purify-

ing of the atmosphere by chemical compositions. We are all convinced that health destroying and even death germs pollute the air we are breathing. A strong physical body may be able to withstand these germs for many years without showing the evil effects sure to result from such contamination; but ultimately, as age creeps on and the organic system becomes impaired and less able to throw off these germs, the victim weakens and prematurely dies. It is true that the average length of human life has been materially increased during the past twenty years by a scientific study of germ infection and improved sanitation and the use of medical compounds; but only a start has been made in this direction. During the world war a great epidemic broke out known as cholera or black fever, which cost many a life, due to the decomposed animal matter carried in the currents of the air to all parts of the world. The settling of the heavy atmosphere brought the poisonous germs to the lowlands, where people breathed them and took sick. Much remains to be done in the way of co-operation with nature in clearing and purifying the atmosphere.

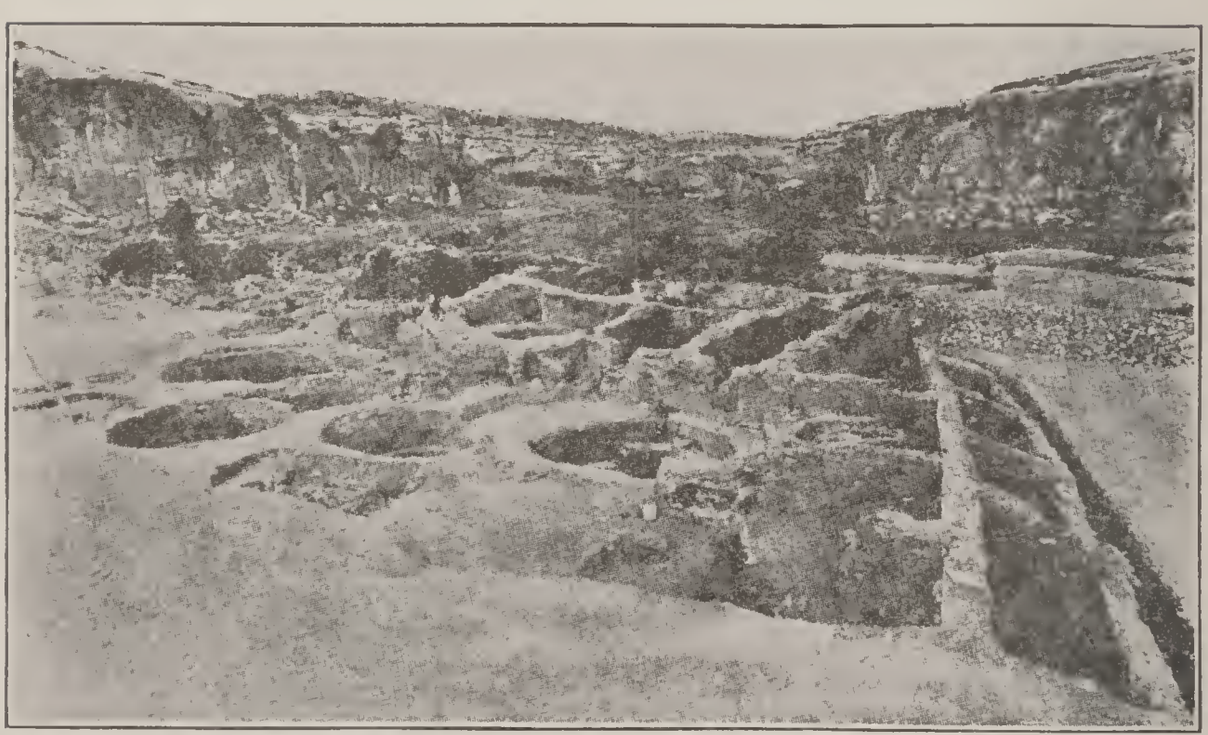
IN CHETTRO KETTLE WAS FOUND AN APARTMENT OF A THOUSAND ROOMS

Modern apartment houses, comprising perhaps thirty suites and a total of two hundred rooms, are looked upon as achievements in the building art. But what would some of our present-day architects and builders think of an apartment house containing a thousand rooms, and so substantially constructed that, although built ten centuries or more ago, the walls are still in an excellent state of preservation?

Complete and indisputable evidence of such an apartment has recently been unearthed in what is known today as Chaco Canyon, New Mexico. Archaeologists working under directions at Santa Fe have brought to light the remains of a huge structure which,

in their belief, was occupied a thousand years or more ago by a race which has suffered complete oblivion.

In recent years the desert sands have been swept aside in Chaco Canyon, revealing one wonder after another. But the greatest wonder of all has been found in the section known as Chettro Kettle. Here was found an apartment of a thousand rooms which, entirely buried for centuries, would occupy two large blocks if set down in a modern American city. Its great curved front extends for seven hundred feet, and in its walls are fifty million pieces of quarried stone, not to mention thousands of logs, poles and slabs which were evidently cut in distant forests, transported by man power, and set in their respective places with the aid of stone implements. According to the archaeologists in charge of the work of excavating, all signs point to the fact that this building was not erected by slaves, as in the case of the pyramids, but by a virile people who found pleasure in the work.



APARTMENT HOUSE OF A THOUSAND ROOMS

It is estimated that five years will be required to complete the work of excavating Chettro Kettle, although enough has already been done to demonstrate the marvelous constructive ability of the ancient but unknown race that was responsible for the building. In enduring, residential architectural qualities this race attained to levels not surpassed by the architects of the ancient world. Here is a building which, abandoned, unroofed and in many places exposed to the elements, stands as very few specimen walls in any land have withstood the ages. Archaeologists say that in wall construction the Chaco builders were unsurpassed and that it is doubtful if our modern masonry will be as enduring.

From observations at Chettro Kettle, American Research is convinced that the people who lived in Chettro Kettle were of a race that matured in its culture without serious interruption, and that mysteriously went into oblivion at the summit of its civilization. There is here no evidence of a decaying civilization, such as may be seen even today in sections of the Rio Grande Valley. But, while all signs point to the fact that abandonment came at the full tide of life, there are also no signs of sudden destruction, a fact which makes the disappearance of this race more mysterious than ever. It is hoped that somewhere within the ruins of Chettro Kettle something may be found which will tell the name and something of the blood, language and cultural potentialities of these remarkable people. All that is known now is that the community consisted of approximately ten thousand people and that some three thousand acres of cultivated land kept them in food.

Looking down into the excavated portions of the ruins, one gets an excellent idea of the knowledge of construction possessed by these people who lived more than a thousand years ago. Reinforcement of partition walls was frequently gained by embedding timbers

in the masonry, just as the concrete walls of today are reinforced by iron rods. Floors and ceilings were constructed by first laying heavy supporting timbers across from wall to wall. Upon these were laid smaller logs, placed closely side by side, over these came thin cedar slabs, next a layer of cedar bark, and finally a solidly packed layer of earth. Some of the rooms show a remarkable state of preservation of both masonry and timber.

CHAPTER XII

TREES—PLANTS—FOLIAGE—FLOWERS

We behold the perfect symmetry and perfect grandeur in Creation, in the realm of nature and her laws, of the great growths of the forests of the earth in their environment, and the mineral deposits of vegetable life treasured in the strata and folds of the earth by Almighty God, the just Creator, who presides over the destiny of all creation. The forests of our great continent—the giant forests of California and Mexico —with their great growths of Sequois and cypress trees, some of them tiny babes of a year, springing shapely from the warm, moist soil; some of them are youngsters of a thousand years, just peering over the top of the sugar pines; some of them youths of two thousand years, with fine rounded crowns and huge bent arms hugging their plumed trunks; some of them majestic seniors three hundred feet in height who began life while the dreams of silent night hovered over their brows.

Perhaps the "General Sherman" was a healthy young fellow, four thousand years old, bending his head in adoration of General Sherman during his memorable march from Atlanta to the sea. This is the largest tree in the world, measuring two hundred and eighty feet in height and thirty-six and one-half feet in diameter. It derived its name in 1879 in honor of the famous soldier. Many scientists and authorities estimate the age at thirty-six hundred years. Many woodmen of the west, particularly in California, declare that the General Sherman is six thousand years old. Man cannot cope with his aboriginal rivals with a fine prospect of adding another thousand years or more before he bows his head in submission to the scythe of time.

The General Grant is in the National Park, with ten thousand sequois associates, and is the second largest tree—so gigantic that it would reach from fence to fence if set down on a country road and with a height about nine times the width of the road.

Looking down upon us humans, he shakes his shaggy head as he beholds our puppet vanity, and contemplates the disparity of his near maturity, the age of trees and the counting of the wood rings of a living tree. These cannot be counted until the veteran of the countless summers and winters tumbles to the ground. Man takes a pencil, some paper and a magnifying glass, and calculates the age on the basis of one ring for each year. Counting the rings of one of the giant trees thirty-five feet eight inches in diameter, exclusive of the bark, upwards of four thousand annual wood rings were found in which there was no trace of decay, after all these centuries of mountain weather. In the giant forests of the Sequoia National Park are a number of these trees, the General Sherman, the Abraham Lincoln and the William McKinley, which is approximately three hundred feet high. The General Grant is in a park of the same name, and the George Washington, and ten thousand sequois keep it company.

At least four of the big trees are alive and healthy. These aristocrats are found only in a narrow strip two hundred and fifty miles long on the western slope of the Sierra Nevada mountain range in Central California. It has an elevation of five thousand to eight thousand feet. This genius consists of many species and flourishing trees in the Arctic region among the fossil remains, the great species of trees, plants, flowers and foliage of the forests, and the great petrified forests of the formative periods, within the area of the region of the Rocky Mountains and many states throughout our continent with their giant petrified trees and fossil remains. One of the inspiring points of the

Rocky Mountains is Lookout Mountain, giving a majestic view of the surrounding country; only from a situation like this can one realize the richness of the mountain scenery and grandeur of the immense ranges stretching far away into the distance.

Scientitsts and botanists are studying the compounding and balancing of the liquid fuel substance and chemical elements of the various species of the trees, plants, flowers and foliage of vegetable life. The solving and compounding together of the chemical elements of the liquid substance all being studied for medical purposes, as well as distillation and analysis of the billions of the species of vegetable life, trees, flowers and plants, beautiful in creation in the realms of nature and its laws during life and growth from the formative periods of the earth's crust, absorbing the necessary nourishment and chemical elements and substance of the earth, during life and environment.

In conjunction with the required nourishment and transmutation of the elements of the atmosphere forming the liquid fuel substance, sending forth their abundant foliage the tropical fruits and flowers, and each succeeding year performed their functions in life, nourishing and sustaining mineral, vegetable and animal life from the earth's crust, and in the formative periods forming the many mineral deposits treasured in the strata and folds of the earth. And vegetable life, trees and their abundantly plumed foliage and delicious fruits and plants, with their fragrant odor and beautifying, dazzling flowers and lilies of the valleys, sipped the dewdrops of the early morn and budded into life and flourished in the sweet and charming roses and fragrant flowers throughout our great continent. The forests within the area of the region of the Rockies and the giant trees in their environment with their abundant foliage and plumed togas bend their huge heads in adoration in memory of the perennial growths of the beautiful flowers and foliage in Creation, rendering

their lives to the requirements of nature and its laws, to the distillation of the charring action of the heat units, yielding and forming many of the mineral deposits of the earth, and at the same time absorbing into the earth, together with the remaining organic substances of the liquid fuel and chemical elements of the earth, and the transmutation in life and growth each succeeding year. In conjunction with the mineral chemical elements and substance of the earth, and transmutation of life and growths treasured in the realms of nature and its laws on our great continent were deposited during the ages.

Everyone knows how the old and grizzled nations of the old world look with curiosity upon our government, which in 1776 set up its own form of government and named itself "The United States of America." Europe called it "The American Experiment." The four million Americans of that day are one hundred and six millions today; the thirteen states are forty-eight today, and many of them are larger and more powerful than the majority of European kingdoms. The stripling, now grown to be a giant, has saved the world. It made an army four million strong, bridged the Atlantic that it might pass, plowed the roaring sea in the days when the world was upset by the world war, safeguarded the perilous task, marked the ocean lanes to make safe the way of the mariner, and piled up resources with might and main, representing more might and majesty than all the old world kingdoms combined. Heroes of great athletic fame, champions of individual liberty and deeds whose hard facts loom large, swelled the world's records of accomplishment in the cause of liberty that makes every American breast swell with pride. Americans gave up their lives for freedom.

Shall heroes die in vain? They battled for world honor and the right of all men to be free, making the outcome for liberty inevitable; they fought with the

spirit of 1776 for liberty, and with a purpose that won the admiration of all mankind. This government, the product of one hundred and forty-five years, marks the most marvelous years of development ever passed through by any nation, and within the winding of the web has harnessed up the resources of our great continent, promoting the development of the mineral, vegetable and animal life, and perpetually flourishing and advancing in obedience to nature and her laws.

All living objects are created and fully develop to maturity by nature. America enjoys the richest heritage ever handed down to any people. It is your heritage and mine, and by united efforts in the spirit of humanity and sacrifice we may make our country a still greater servant of humanity in obedience to Almighty God and in pursuance to His laws, in the years which are before us.