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COLORADO SCHOOL OF MINES MAGAZINE

SPECIAL OIL SHALE NUMBER

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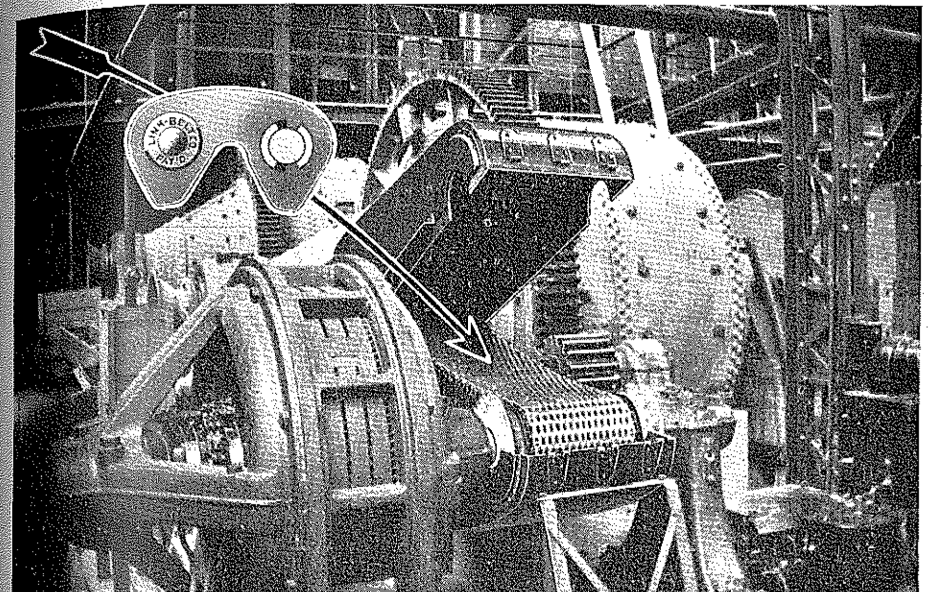

COLORADO SCHOOL OF MINES MAGAZINE

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CONTENTS

The Present Status of the Oil Shale Industry*

By Victor C. Alderson†

THE COMMERCIAL ASPECT.

The Price of Well Petroleum.—The oil shale industry, to be a commercial success, must compete in the open market with crude oil from wells. In recent years, the supply from wells had not been sufficient to meet the demand for oil and yet more oil. If any one has a lingering doubt about this fact, the very recent advances in the price paid by the pipe lines for crude oil in the wells should be an unanswerable argument. Recent trade quotations give:

Pennsylvania crude, $5.00 a barrel (in 1913, $2.05 a barrel).

Wyoming fields, $2.00 to $2.60 a barrel (Grass Creek, $2.60; Elk Basin, $2.40; Lance Creek, $2.55; light oils in other fields $2.25).

Eastern fields, $2.75 to $3.35 a barrel.

Mid-Continental field, $3.00 a barrel (in 1913 quoted at 83 cents; $3.00 is the highest price ever paid for crude oil west of Chicago; this is the third increase in six weeks).

North Louisiana, $2.40 to $2.65 a barrel.

The Cost of Crude Shale Oil.—Conservative estimates give the cost of producing crude shale oil as follows: Assume a well-equipped, efficient plant of 400 tons daily capacity, treating 400 tons of shale yielding one barrel of oil to the ton of shale:

Mining, ton or barrel	$1.25
Breaking	.10
Retorting	.35
Loading and shipping	.05
Amortization, interest, overhead expense, etc.	.10
Cost of barrel of crude shale oil	$1.85

Shale Versus Well Oil.—Crude shale oil, when produced, will naturally first come into competition with the Wyoming and Mid-Continental oils. Since the estimate of $1.85 is conservatively high, the lowest competitive price ($2.00 in the Wyoming field) and the highest price, $3.00 (in the Mid-Continental field) are both well above the danger line. If, then, oil shale retorting plants were now in effective operation on a commercial scale there is little doubt that their product would find a ready market at a remunerative price. There is, too, every reason to believe that the price of oil has only begun its upward course and much higher prices will soon be reached.

Nor will the price of crude oil alone remain high. On account of the present large foreign demand, in addition to the strong domestic demand, the prices of lubricating oils and kerosene will very likely first be affected by the advance in crude oil. The shortage in the supply of gasoline is an additional factor which will help to advance its price also. Other refinery products are also due for an advance. All of which will aid materially in placing the oil shale industry on a profitable basis.

The recent coal strike has brought home to the large consumers of coal the danger of depending solely upon coal for fuel. Already many of the large New York and New England manufacturing plants are changing to oil. Many ocean steamships, as well as those on the Great Lakes, are also changing. In Chicago all the public school buildings, in units of ten at a time, are being changed to use oil for fuel.

On railroads fuel oil is fast coming into favor on account of the low labor cost, the convenience, and the high efficiency.

The following railroads now use fuel oil over all or a considerable part of their lines: Atchison, Topeka & Santa Fe, Southern Pacific, Kansas City Southern, Western Pacific, Northwestern and Pacific, Florida East Coast, Chicago, Milwaukee & St. Paul, Great Northern, Oregon Short Line, Texas & Pacific, Chicago, Burlington & Quincy, Chicago & Northwestern, El Paso Southwestern, Delaware & Hudson (Adirondack Division), New York Central (Adirondack Division), Oregon-Washington Navigation Co., Texas Railways, Missouri, Kansas & Texas.

THE TECHNICAL ASPECT

The Retort.—The price of crude well petroleum and the general demand for oil are factors over which the individual has but little control. The construction of a retort to produce oil from shale is, however, a problem for the individual. Many unthinking persons reasoned that, since shale has been retorted in Scotland for the past sixty years, a retort of the Scotch type could be erected here, oil produced, and success would immediately follow. Unfortunately such reasoning does not hold good. The Scotch shale is

*Published jointly with The Railroad Red Book.

†President of the Colorado School of Mines.

low in oil value, but high in nitrogen; the American shale is high in oil but low in nitrogen. The most valuable Scotch product is ammonium sulphate; ours will be oil. The Scotch retort is built as a double chamber; in one, oil and gas are produced at about 800 degrees;* in the others, the nitrogen at a temperature of 1,700-1,800 degrees.* The successful American retort will necessarily be one-chambered and quite distinct in plan and operation from the Scotch; hence the necessity for preliminary experimental

3. The oil, gas, and shale residue should be continuously removed.

4. Heat should be applied uniformly.

5. The shale should not cake or gum.

6. Each retort should handle a large amount of shale a day.

7. Accessory machinery should be automatic.

8. Hand labor should be reduced to a minimum.

9. A retort should be simple in construction and as near "fool proof" as possible.

Plant of the Catlin Shale Products Co., at Elko, Nevada. Constructed during 1919. Photograph taken in December. (Cut by courtesy of The Red Book)

work to evolve a distinct type or types for American shale. Some of the necessary characteristics of a successful retort are easy to state, but difficult to realize in practice, viz.:

1. The feed should be continuous.

2. The oil should be produced at the lowest possible temperature and removed at once.

* Degrees Fahrenheit.

Most of these specifications are based upon the principle that the production of shale oil must be on a large tonnage basis, like the porphyry coppers in metal mining.

Practical Development.—For the past three years R. M. Catlin of Franklin, N. J., has been experimenting at Elko, Nevada, on a commercial scale. The shale runs about fifty gallons to the ton. The

retort has a daily capacity of 100 tons. The plant consists of retorts, condensers, oil stills, agitator, wax plant, gas producer, storage, tanks and packing rooms. The products for the market are distillate, kerosene, lubricating oil, paraffin wax, and gasoline. About 15,000 gallons of shale oil have thus far been produced, but Mr. Catlin does not yet regard his plant, though of commercial size, as beyond the experimental stage.

The Southern Pacific Company has financed the erection of a full sized Pumpherston (Scotch) unit at Elko, Nev., which is in charge of Dr. David T. Day. The retort is completed and in operation, but reports of the results are not yet available.

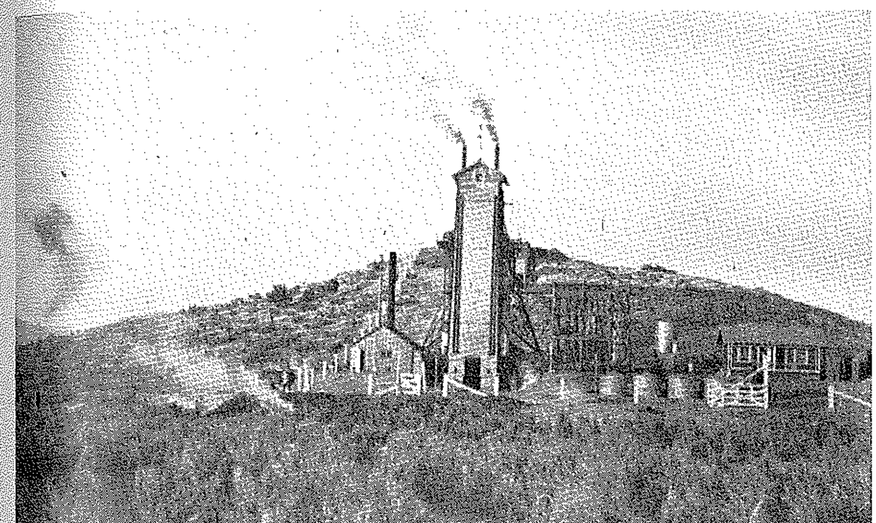
The Wyoming Shale Oil & Refining Company owns 640 acres of shale land in the Bitter Creek district, in Sweet Water County, Wyoming. The shale is unusually rich and averages from fifty-eight to sixty-four gallons to the ton. The company plans to erect an eduction plant this spring.

The American Shale & Petroleum Company owns 1,240 acres of shale land in Sweet Water County, Wyoming. It intends to begin the erection of a Jenson retort April 1, 1920.

The Mt. Blaine Oil Shale Company owns 2,100 acres on Roan Creek, thirteen miles from De Beque, Colorado. The directors of the company intend to erect a Galloupe retort this spring.

At Grand Valley, Colorado, the Consumers Oil & Shale Company of Chicago and the Grand Valley Oil & Shale Company, have spent $25,000 in building roads to their property, preparing building sites, erecting buildings, all preparatory to erecting a 150-ton retort of the Stalmann type in the spring. The total cost is expected to be $100,000. The installation is being done by the Petroleum Engineering Company of Kansas City, Mo., under the personal supervision of Joseph Bellis, Otto Stalmann and J. B. Jones.

The Mt. Logan Oil Shale Mining & Refining Company at De Beque, Colorado, has in process of erection a Simplex retort, manufactured by the Stearns-Roger Manufacturing Company, Pueblo, Colo. Operations on a commercial scale are expected early this spring.



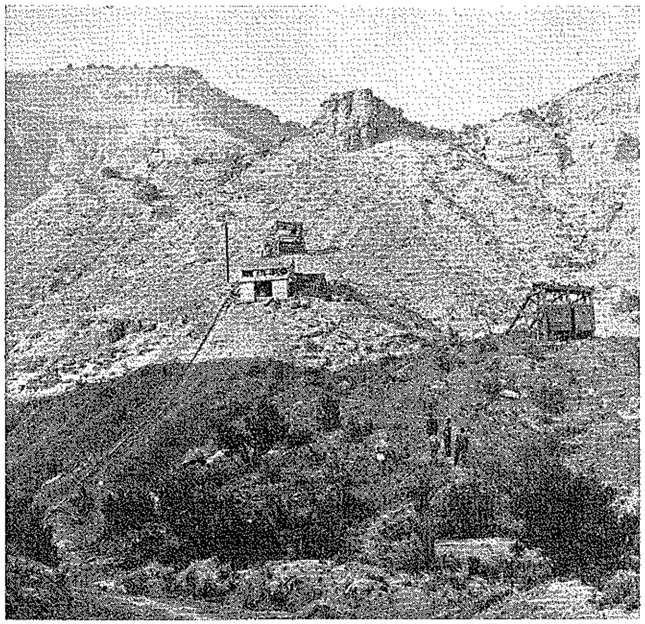
Pumpherston (Scotch) Process Plant, Elko, Nevada. Constructed 1919 by the Southern Pacific Co., under Direction of the U. S. Bureau of Mines. Photograph taken in December. (Cut by courtesy of The Red Book)

The Continental Oil Shale Mining & Refining Company has completed a 50-ton plant, known as the Colorado Continuous Shale Process, designed by Hartley & Dormann, engineers, Denver, in Rio Blanco County, Colorado, and has made a successful run. Bad weather and deep snow have, however, prevented further work until spring, when the company expects to renew operations and to run continuously on a commercial scale.

The Ute Oil Company has nearly completed a plant of the Wallace type with a daily capacity of 400 tons, at Watson, Utah. There are eighteen retorts, of one-ton capacity each. The time of treatment is estimated at fifty-eight minutes; the time for discharge and re-charge ten minutes. The structure is of steel and concrete, with mechanical devices in all the details of handling. The cost is estimated at $350,000. Installation is nearly complete and operations will begin early in the spring.

The Western Shale Oil Company has a sixteen-ton retort of the Galloupe type nearly completed at Dragon, Utah.

The Gas Machinery Company, of Cleveland, Ohio, are now preparing plans for the first 200-ton unit of a 2,000-ton plant of the Wallace type, to be erected by the Shale Oil & Refining Corporation in the



Plant of the Mount Logan Oil Shale Mining & Refining Co., now in Course of Construction, near De Beque, Colo. (Cut by courtesy of The Red Book)

De Beque, Colorado, district. Early summer will probably see this unit in operation.

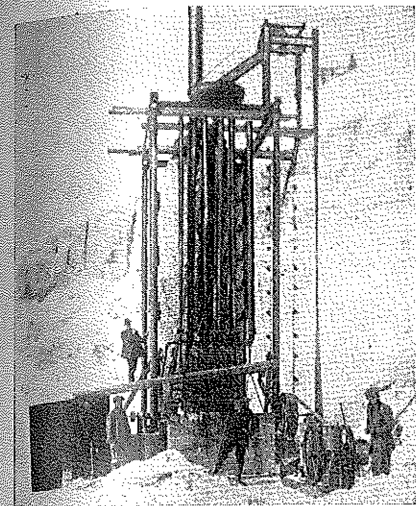
At the Colorado School of Mines two retorts, each of commercial size, are under construction, viz:

A Stalmann retort by the General Petroleum Company, of Kansas City, and a Wallace retort by Geo. W. Wallace, of East St. Louis, Illinois.

On the completion of these retorts, the Colorado School of Mines will be prepared to make complete retorting tests on oil shale in commercial quantities.

Water Supply in Colorado.—A plent supply of water is one of the essential quirements for a successful educti plant. The absence of water makes richest oil shale deposit virtually wor less. R. E. Meserve, a western slope en neer, is authority for the following e mate of the water supply in western C orado:

"A reservoir covering four acres fift feet deep holds sixty acre feet. One cu foot of water per second flowing thi days will fill it, as will also three a one-half statute inches flowing for a ye There are a thousand places on R Creek and its branches, suitable for shale plants, where reservoirs of this pacity can be built and filled from t spring run-off, summer floods and win flow, without lessening irrigation. St engineers' reports for 1905 and 1906 sh an appropriation for irrigation of 1 second feet for a total cultivated area 3,000 acres. At five acre-feet per ac this would take 1,000 acre-feet. Preci tation may be put at fourteen inches, the 270 thousand acres of this field, a using one-third for available run-off, have 85,000 acre feet left above all irri tion. This is enough for a million to of oil shale per day, 300 days a year."



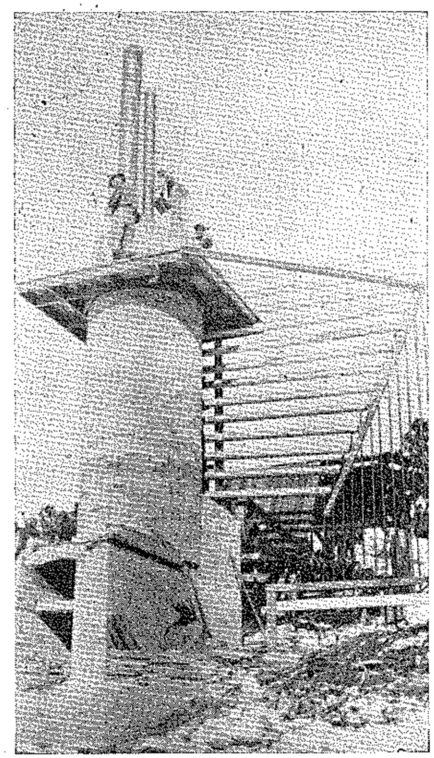
Plant of the Continental Oil Shale Mining & Refining Co., Rio Blanco, Rio Blanco County, Colo. A 50-ton Unit. Constructed during 1919. Photograph taken in December. (Cut by courtesy of The Red Book)

THE FINANCIAL ASPECT

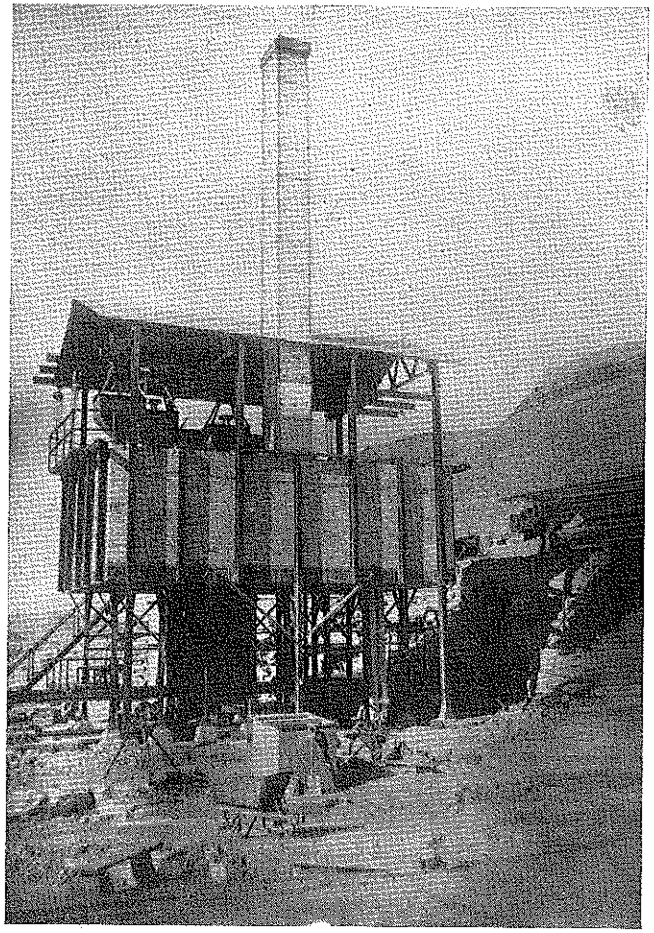
Capital.—It should be borne in mind that the oil shale industry is not a "poor man's game" in the sense that a small amount of capital invested will bring fabulous returns. On the contrary, it is distinctly a "rich man's game", in the sense that a large amount of capital must be invested before there is any return whatever. The smallest unit— and that only as a starter—should be of 100 tons daily capacity to cost approximately $100,000. This unit should be added to, till at least 500 tons a day are reached and 1,000 would be much preferable. Another phase that should be emphasized is that the oil shale industry is a low-grade industry, of large tonnage, of continuous operation, with automatic machinery, and large output. Workmen need only to be "broad in the back". The brains must be supplied in the office. The greatest need of the industry at the present moment is capital to open the deposits, erect retorts, establish refineries, organize distributing agencies, and in brief, to establish the industry on a commercial scale and a paying basis.

The Future.—Rapid as has been the increase in the demand for crude oil and its products, yet the future holds out even greater expectations. There are now approximately 7,500,000 internal combustion engines in the United States. In ten years this number will very likely be doubled to 15,000,000. In spite of the phenomenal growth of the automobile industry, there is no indication of a slackening. Good authorities assert that the next five years will show even a greater increase, or fully 10,000,000 motor cars in operation. The Ford plant alone will manufacture 500,000 tractors in 1920. The United States Shipping Board has ordered that all vessels greater than 5,000-ton dead weight, shall be oil burners and has contracted for 31,000,000 barrels of fuel oil for 1920. France will require 8,400,000 barrels and Italy 336,000,000 barrels of oil in 1920. The potential demand for oil in the United States by 1927 is estimated at 800,000,000 barrels, and yet it is predicted that all well reserves will be exhausted by 1928. But in Colorado alone there is enough easily accessible oil shale to keep 100 plants, each treating 2,000 tons a day, in continuous operation for 800 years.

George Otis Smith, Director of the U. S. G. S., in a recent paper before the American Institute of Mining and Metallurgical Engineers, expressed himself as follows:



Plant of the Western Shale Oil Co., near Dragon, Utah. Galloupe Process, 16-ton Unit. Constructed during 1919. Photograph taken in December. (Cut by courtesy of The Red Book)



Plant of the Ute Oil Co., now nearing completion at Watson, Utah. Wallace Process, 400-ton Daily Capacity. Photograph taken November, 1919.
(Cut by courtesy of The Red Book)

"The position of the United States, in regard to oil, can best be characterized as precarious. Using more than one-third of a billion barrels a year, we are drawing not only from the underground pools but also from storage, and both of these supplies are limited. In 1918 the contribution direct from our wells was 356,000,000 barrels, or more than one-twentieth of the amount estimated by the survey geologists as the contents of our underground reserve; we also drew from storage 24,000,000 barrels, or nearly one-fifth of what remains above ground. In a single decade, then, the consumption of fuel oil by railroads has more than doubled; the consumption of gasoline has increased seven-fold. With the rapidly mounting cost of coal, the competitive field of fu[el] oil for steam use is expanding. We m[ay] lessen the increase in coal or oil co[n]sumption for generating power by h[ar]nessing the water powers of the countr[y] but prime movers, whether driven [by] steam or water, require lubrication.

"A most serious aspect of our oil pro[b]lem presents itself when we consider t[he] entry of the United States as a real fa[c]tor in the shipping of the world. Any n[a]tion that aspires to a large part in th[e] world's commerce imposes upon itself a[n] oil problem, for the future freedom [of] both the sea and the air will be defin[ed] in terms of oil supply."

Oil Shale Comes into its Own.—Wh[at] have all these estimates to do with th[e]

oil shale industry? Simply this. Oil is the fuel of the future. Greater and greater demands are being made upon well oil. Great as are some oil pools, yet the average production falls short of the demand. The only recourse is to the vast stores of oil shale in which lie the potential elements of the future supply of oil. Oil shales are found virtually all round the world. The demand for oil is now strong enough and the price of crude high enough to warrant the commercial production of oil from shale. A number of plants are now nearing completion so that there is every likelihood that the industry will be on a commercial basis in the summer of 1920.

The Requirements of a Furnace or Apparatus for the Maximum Production of Oil from Oil Shale

By Albert H. Low.*

Definitions of Saturated and Unsaturated Hydrocarbons.

Before beginning this discussion it may perhaps be well to give definitions of one or two of the terms to be used. These definitions are not claimed to be complete, but they will suffice for all present purposes.

By "hydrocarbon" is meant a compound formed by a union of the element carbon with the element hydrogen. These compounds are very numerous and some of them are very complex, large numbers of carbon and hydrogen atoms being able to combine together to form all sorts of products. Some of the hydrocarbons are gases, some are liquids, and some are solids. The simplest hydrocarbon is the gas methane. It consists of one atom of carbon combined with four atoms of hydrogen. Here a single atom of carbon has gone its limit and united with all the hydrogen it can. This brings us to the consideration of another term, the term "saturated". In the case at hand the compound, or hydrocarbon, is called "saturated" because the carbon atom has taken on or combined with all the hydrogen possible. Now while a single atom of carbon can take on only four atoms of hydrogen, two atoms of carbon can unite with each other, forming a nucleus that can unite with six atoms of hydrogen. This is the limit of this nucleus as regards hydrogen, and the result is again a "saturated" compound. But it can also form a stable compound without going the limit, by simply uniting with only four atoms of hydrogen, and this compound still possesses the power of uniting with two or more atoms of hydrogen on occasion. Such a compound, having a reserve of combining power, is called "unsaturated".

Both petroleum and shale oil consist mainly of liquid hydrocarbons. Hydrocarbons, such as ordinary paraffine, that, if removed and purified, would be solid, are dissolved in the oil, so that the whole is liquid. Most of the hydrocarbons in both petroleum and shale oil are of the saturated variety, but some unsaturated hydrocarbons are always present and they are undesirable constituents to be removed by refining. They have not the stability of the saturated compounds and easily undergo decomposition with the production of color and odor. The larger the percentage of unsaturated hydrocarbons present, the less the final yield of refined oil.

Nature of Oil Shale.

Bearing the above facts in mind, I will proceed to consider the nature of oil shale and the oil produced from it.

Oil shale contains no oil as such, that is, no oil can be obtained from it by solvents or by pressure. It is a hard clay rock, having disseminated throughout its mass a hydrocarbon material called "Kerogen". When the shale is subjected to sufficient heat the kerogen is decomposed, or undergoes what is called "destructive distillation". If the vapors produced are collected and cooled there is obtained mainly an oily liquid, together with a small amount of gas that fails to condense to a liquid and is therefore called "permanent gas".

According as the same shale is heated or distilled under varying conditions, the resulting products vary greatly, both in their nature and amounts. The reason for this is that the substances evolved from decomposing shale are themselves liable to still further decomposition into other substances, if, after leaving the shale, they happen to encounter, during their escape, a still higher temperature than that which produced them.

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*Professor of Chemistry, Colorado School of Mines, Golden, Colo.

Imagine an upright iron pipe, say ten feet high and one foot in diameter, closed at the bottom and filled with lumps of broken shale. Suppose, now, the lower five feet of this pipe to be immersed in a furnace that will raise the entire immersed portion to a dull red heat. It is obvious that the shale nearest the outside of the pipe will reach a decomposing temperature and begin to distill before sufficient heat to effect decomposition has reached the shale in the central portion of the pipe. Thus the outside layer of shale may become entirely exhausted of volatile products while shale in the interior is still undergoing decomposition. The spent shale nearest the outside will continue to get hotter until its temperature is far above what was originally required to decompose it, while the interior shale is still giving off an abundance of volatile products. These interior products naturally take the easiest line of escape to the top of the pipe. The hot, exhausted outer layer of shale has by this time shrunken away from the walls of the pipe somewhat, so as to leave a more or less open channel toward the top of the pipe as far as sufficient heat has reached. The gases coming from the interior will therefore seek this channel of escape in preference to the much more obstructed course up through the center of the pipe. During their exit up along the sides they thus pass through highly heated material and are exposed to temperatures much higher than the temperature of their production. This causes them to decompose into secondary products that are able to exist at these higher temperatures. Now it so happens that the original products of the distilling shale that has reached a proper decomposing temperature, give, after condensation by cooling, less permanent gas and a larger quantity of oil, which is of better quality than if these original products, during their escape, are exposed to higher temperatures and thus suffer secondary decomposition. This secondary decomposition results in the formation of a much larger percentage of the undesirable unsaturated hydrocarbons and more permanent gas, thus after cooling and condensation, giving less total oil, which is of a poorer quality, so that when refined and the unsaturated hydrocarbons are removed, there is obtained less refined oil per gallon of the original crude oil.

Fundamental Principles of Retorting.

One of the most important considerations, then, in the distillation of shale, and it cannot be too strongly emphasized, is to remove the original escaping vapors, as fast as they are formed, in such a way as to prevent them from becoming further heated much above the temperature of their formation. Requirement No. 1, then, is to avoid overheating the original escaping vapors during their exit from the retort or furnace.

It will be observed from the above that the production of the maximum quantity of oil results also in producing oil of the best quality, that is, oil containing the minimum amount of unsaturated hydrocarbons.

In addition to the above it is found that when shale oil itself is again vaporized or distilled by the direct application of dry heat, it is liable to still further decomposition with the formation of more unsaturated hydrocarbons. Therefore, if the original vapors, in escaping from the still, encounter a cool place, so as to become more or less condensed into liquids that are again vaporized as the place gets hotter, the result is again the formation of more unsaturated compounds. The situation is worse if the condensed oil drips back into a very hot place in the retort. Requirement No. 2, therefore, is to avoid any condensation of the vapors before leaving the retort. It will be remembered that the iron pipe previously referred to was filled with shale to the top, while only the lower half of the pipe was heated. Condensation, therefore, would be sure to take place in the cool, upper portion, and some of the condensed oil would be sure to drip back into the hot places below. Also, if the heating were made continuous, by the removal of spent shale from the bottom and the addition of raw shale at the top, the shale holding condensed oil would gradually settle and get hotter until the condensed oil was again vaporized. The entire arrangement of retort and heat is therefore poor.

A third point to be considered relates to the application of heat to the shale. Shale is a very poor conductor of heat, so that if a body of shale is heated from the outside it takes a long time for sufficient heat to effect decomposition to reach the center of the mass, even though the outside has become spent and much overheated. Obviously, then, there is an economical limit to the depth or thickness of a body of shale to be heated in this way, as less time, and therefore less heat, will be required if the shale is treated in consecutive thin sections instead of one thick mass. Experiments have shown that when the heat used is just sufficient to completely carbonize or exhaust a four-inch thickness of shale, it will take twice as much heat to carbonize a thickness of six inches. In other words, by increasing the thickness of the shale 50 per cent, the heat required has been increased 100 per cent. As a practical illustration of how this works out on a large scale, I will quote from the only statements I have available.

In the so-called Scotch process of distilling oil shale the ordinary retort used has a capacity of one hundred and fifty cubic feet and the through-put is four and one-half tons each twenty-four hours. I am unable to state the thickness of the shale in the retort, but it presumably is more than a few inches. In one of the new American processes the retort has a capacity of only fifty cubic feet and takes two tons of shale at a charge, the thickness of the shale as arranged in the retort being only four inches, or a little less. Such a charge can be completely carbonized in about an hour, resulting in a through-put of from forty to forty-eight tons of shale each twenty-four hours.

In the American process referred to, a thickness of about four inches of shale, broken to a maximum size of about one and one-half inches, has been adopted as the most economical arrangement for that process, to obtain the best results. Requirement No. 3, then, is to study the proper thickness of the body of shale to be distilled to attain the most economical working conditions, that is, the least expenditure of time and heat.

In the above statements relative to the application of heat to the shale, the shale is supposed to be at rest, that is, not agitated or revolved while undergoing distillation. It is quite possible that, bearing the above principles in mind, different types of rotating or agitating arrangements could be designed so as to overcome the heating difficulties in some other way with equal or even greater efficiency.

I will lay no special emphasis on the size to which the shale should be crushed or broken, as this depends in a large measure on the process used, or the particular retort or other heating apparatus employed. It is evident that if a large lump of shale is strongly heated on all sides at once, its exterior may become exhausted and overheated while the interior is still undergoing decomposition, evolving products that must thus suffer overheating and secondary decomposition in their exit from the lump.

"Cracking."

I have several times spoken of this secondary decomposition as resulting in the formation of undesirable unsaturated hydrocarbons, with the consequent reduction in the quantity and quality of the oil obtained. The technical term applied to this decomposition is "cracking," as the original oil breaks up or "cracks" into other substances. All of these substances are not of the unsaturated kind. Some are both saturated and desirable, and cracking is one of the methods resorted to in the process of refining to obtain an increased production of such light oils as gasoline, but this intentional cracking is carried on under carefully controlled conditions, which are quite different from the undesired cracking that may occur during the distillation of the shale. And this brings us to the question: "How may this original cracking be prevented or minimized?" I have already stated that it may be largely avoided by removing the gaseous products just as they are evolved from the shale, without allowing them to become either overheated or condensed before leaving the retort. How this can be done is a matter of invention, but it apparently has been accomplished by at least one or more American processes. A second method is to control the temperature in the retort by the introduction of superheated steam. This is done in the Scotch process, with the two-fold object of equalizing the temperature and increasing the production of ammonia. I will refer to the question of ammonia water. While the use of steam does much in the way of preventing cracking it has two great disadvantages, besides the consumption of much more heat in the distillation. It is customary to use as much as half a ton of steam for each ton of shale retorted. All this steam has to be condensed, and, as it may equal in amount several times the total volatile products produced from the shale, the condensing apparatus must be correspondingly increased, with a like increase in cost. This is a serious objection to the use of steam. A second great disadvantage is that the steam and oily vapors are condensed together, forming an emulsion of oil and water that may require weeks to separate. This makes the oil hard to handle, besides necessitating increased storage facilities.

On account of the disadvantages noted, it therefore appears inadvisable to use steam if it is possible to avoid it. This point may be regarded as Requirement No. 4.

Another method of avoiding overheating and cracking during the distillation, and which, according to the inventor, gives satisfactory results, is to pass the crushed shale in stages through ovens heated to different temperatures, beginning with a low temperature, where the heat is just sufficient to start the decomposition of the shale and produce the more volatile products, and continuing through a second and third oven, with the latter sufficiently hot to completely finish the distillation. Heat is saved and the different temperatures attained under this plan by simply having one source of heat for all the ovens and passing the heat leaving the hottest oven to that of the next lower temperature, and so to the next. By drawing off the vapors separately from each oven and condensing them separately, a partial refining may be accomplished. Thus it is seen, as stated before, that methods for preventing or minimizing cracking are purely matters of invention.

Conditions Effecting the Recovery of Ammonia.

I will now pass to the question of the recovery of ammonia. Ammonia is a compound of nitrogen and hydrogen in certain definite proportions. If a complex organic compound or mixture happens to contain both nitrogen and hydrogen, even if no ammonia or ammonia compound is originally present, and this compound or mixture is heated until it decomposes, ammonia is liable to be formed from the evolved gases. This is precisely what occurs in the case of oil shale. Besides hydrocarbons, which of course contain hydrogen, the kerogen in the shale also contains some nitrogen compounds. When heated, the hydrocarbons in the shale will begin to decompose at a temperature of less than 700° F., and the nitrogen compounds will decompose at about 735° F. Ammonia will form in the mixed vapors and its quantity will depend upon the amount of nitrogen in the shale. If this ammonia is removed or drawn off from the retort without suffering overheating it will not be decomposed, but will remain as ammonia or an ammonia compound, to be subsequently easily recovered from the condensed products. It is a valuable by-product. If, however, the ammonia once formed again encounters a high temperature before leaving the retort, it is liable to be again more or less decomposed into its constituents—nitrogen and hydrogen. Ammonia will begin to decompose at a temperature a little above 900° F., and will be completely decomposed at a temperature somewhat about 1,400° F. In some processes, where provision is not otherwise made for preventing overheating, steam is used for equalizing the temperature, thus, at the same time, saving the ammonia from decomposition and minimizing the cracking of the oil vapors. It has been shown that this is not a desirable procedure if it can be avoided. Under the above conditions steam does not apparently assist at all in the formation of ammonia by any chemical interaction, but simply by equalizing the temperature, prevents its decomposition when once formed. Shale is said to contain certain nitrogen compounds that still hold nitrogen after all the oil has been expelled. This residue of nitrogen will now have present no hydrogen to combine with to form ammonia, although there will be some carbon in the form of coke. If this carbonized shale, while still very hot, be now treated with steam which contains hydrogen and oxygen, both the steam and the nitrogen compound may decompose; the oxygen of the steam uniting with the carbon present to form carbon dioxide, and the hydrogen of the steam uniting with the nitrogen present to form ammonia. Under these conditions, therefore, steam is useful in obtaining an increased production of ammonia, but, of course, the disadvantages following the use of steam still remain and the additional ammonia recovered may not be worth the increased trouble and expense.

Permanent Gas.

The valuable products sought in the distillation of oil shale are oil and ammonia. A certain amount of permanent gas is unavoidably produced, but as this gas is largely formed at the expense of decomposing oil, which is worth more than the gas, it necessarily follows that the production of the maximum amount of oil means the formation of the least gas. Whatever gas may be produced should, of course, be utilized in heating the retort, and it may, with the maximum production of oil, be sufficient to furnish about half the heat required. The additional heat necessary may be supplied by producer gas or otherwise, according to the conditions.

I have made no mention of the shape, size, or material of construction of a retort or heating apparatus, as these are variables depending upon the process, proposed output, location, and perhaps other considerations. I have also not taken up any questions relating to recovery of the products, and their refining, as being foreign to the subject at hand.

Resumé.

In view of the foregoing, the requirements of a furnace or apparatus for the maximum production of oil from oil shale, may be summarized as follows:

Requirement No. 1. Avoid overheating the original vapors produced, during their escape from the retort or furnace, and thus, as much as possible, prevent cracking and the consequent loss, both in the quantity and quality of the oil recovered.

Requirement No. 2. Avoid any condensation of the vapors before leaving the retort, thus forming liquid oil which will require to be again vaporized before expulsion. This second evaporation or distillation results in cracking and loss.

Requirement No. 3. Study the proper thickness of the body of shale to be distilled, so as to attain the most economical working conditions, that is, the least expenditure of time and heat.

Requirement No. 4. Avoid the use of steam unless considerations of the process used absolutely demand it, as steam occasions much extra trouble and expense.

In the above discussion I have made no attempt to go into the subject exhaustively, but have aimed rather to present the more salient requirements in as simple a form as possible, that those interested, but perhaps unfamiliar with the subject, might have a better understanding of the situation.

Diamond Drilling, the Ideal Method of Sampling Oil Shale Deposits

By C. Erb Wuensch, '14.

Impossibility of Sampling Shale Deposits from Outcrops.

We hear conflicting statements made as to the "oil content"* and thickness of the oil-shale strata of Colorado and Utah. The truth is, no one as yet knows! Engineers in government and private employ who have taken numerous samples are in accord, in that, it is absolutely safe to assume that there are thirty feet of oil shale strata, in beds more than three feet thick, that will yield one barrel (42 gallons) of oil to the ton. These figures are given to be well within the limits of conservatism. Others who are not so conservative have gone so far as to say that there are at least two hundred feet that can be mined in one body and which will yield an average of better than one barrel per ton.

The reason for these discrepancies is easily explained when one considers the magnitude and inaccessibility of the main oil shale strata in the middle member of the Green River formation. Where the whole formation is exposed in escarpments it is invariably two to five hundred feet high, vertically above the accessible slopes. Hence it is a physical impossibility to sample more than a few feet at the base. If the formation happens to be exposed along an accessible slope, the shale is most frequently of the "paper" variety which is not representative of the solid unaltered material that will be found at some distance from the outcrop. In any event, it is a fact that no one vertical section of the whole formation can be accurately obtained from the surface and outcrops of the cliffs.

Applicability of the Diamond Drill.

From this, it must not be inferred that it is beyond the range of human possibility to accurately sample the shale deposits. The shale beds lie practically flat and the tops of the shale cliffs are composed of gently rolling hills and relatively level expanses, called mesas. Practically every one of these mesas has at least one accessible trail to the summit over which it would be possible to use pack animals. Because of these topographical features, the logical method of sampling the oil shale deposits is by the use of the diamond drill. The diamond drill can be set up on tops of the cliffs and vertical holes bored through the whole formation below.

Brief Description of Diamond Drilling for the Uninitiated.

The diamond drill is nothing more than a series of hollow rods that are screwed together in five or ten foot sections, and at the bottom of which is attached a bit, or cutting tool which is set with diamonds (borts). The rods are rotated by a suitable engine, which for work of this sort is usually driven by steam. As the rods are rotated the diamond bit cuts a circular groove in the rocks and leaves a solid section of rock, or "core," within the center of the rods. At intervals the rods are withdrawn and the core removed. A "core-barrel" is placed in the section of rods adjoining the bit. This

* Technically speaking, "kerogen content," because oil shale contains no oil as such. It is only by the proper application of heat in the destructive distillation of oil shale that oil is formed by the condensation of the educted gases.

holds the core within the hollow of the rods while the latter are being withdrawn from the hole.

The diamond drills for this sort of work are made sectionalized, in order that the individual parts are light enough to be easily packed on animals for use in inaccessible places. In addition to the drill, a small sectionalized boiler is used to generate power for the drill and a pump. The latter is used to force water down the hollow rods. The water removes the cuttings which enables the bit to efficiently operate against the solid rock. The water also serves to keep the bit and diamonds cool.

Technical Data on Diamond Drilling Oil Shale Deposits.

Although there is no actual data on the results of diamond drilling oil shale deposits, there is considerable data available relative to diamond drilling coal deposits. Since the rocks encountered in coal and oil shale fields are practically identical, what applies to one holds equally true for the other, with perhaps one exception. In prospecting for coal it is not necessary to attempt to make a large recovery of core except of the coal itself. In drilling oil shales it will be necessary to make as much core of the whole formation as is possible.

In order to secure a large enough sample to make tests of the various strata, it will be advisable to use a drill which will make a two-inch core. By drilling at the proper speed it will be possible to recover approximately 95 per cent of the formation drilled. About 10 to 15 feet advance should be made per eight-hour shift using two men. The holes will range from 200 to 1,000 feet in depth, averaging about 500 feet. Because of the time that will be consumed between set-ups it will probably cost about $3.50 per foot drilled. It will require a 15 to 20-h. p. boiler to operate a two-inch core drill under the conditions prevalent in the shale fields.

Conclusion.

Diamond drilling is the ideal method of sampling oil shale deposits. It makes it possible to take a complete and accurate sample of the whole oil shale formation at any one point. Every bed and seam can be sampled, and their richness and thickness absolutely determined. The operator will be able to figure whether it will be most profitable to mine the individual seams of richer shale, at a higher cost of mining and a lesser recovery of the total amount of oil available, than to mine the whole formation, stripping the barren material and mining lower-grade shale, with a lower mining cost per ton handled and a higher recovery. He will know beyond a doubt the amount and grade of oil shale that he has available; data so vital to intelligently plan future operations. In addition to this, he will have obtained this information in the quickest possible time, with a maximum of accuracy and the minimum of expense. Now is the time to do this work.

The logical way of doing this work is for a number of companies to co-operate. By so doing, larger contracts could be entered into, and hence a cheaper rate per foot obtained. By thus "pooling" their interests a great deal of the general expense could be distributed over a number of operators. In addition to this, by exchanging the logs of the various holes drilled, fewer holes would have to be drilled by any one individual than if this work were attempted separately by each company.

ELECTRIC FLASHES.

Electrical and compressed air coal-cutting machines are shortly to be introduced into some of the coal mines of England, according to recent reports.

Electricity is being widely used in clearing the North Sea of mines. Many of the mines are sunk very deep, and have antennae which, when touched, cause the mine to explode. Special electric cables several hundred yards long are being used to explode these mines at a safe distance from the boat.

Electric plows are being tried out in Italy, and the trials have proved so satisfactory that it is probable electric plowing will become widely used. The cost has been shown to be less than one-third of the cost of the ordinary tractor work, and the fact that most of the fields are small and comparatively flat, and that the necessary power is available in practically every section of the country, makes Italy especially suitable for the experiment.

The Norwegian Fishery Administration is considering using electrically propelled boats in its fishing fleet. A considerable sum has been allotted for conducting research along these lines.

Electric heat is becoming more and more widely adopted in industrial processes—such as japan baking of automobile bodies, and brass melting furnaces, because of its numerous advantages over other kinds of heat. Some most evident advantages are the greater working temperatures obtainable, the absolute control of the heat, and the evenness of heat distribution.

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TECHNICAL REVIEW

GENERAL.

The Mineral Industries of France. By Maurice Altmayer. (E. & M. J., January 3, 1920.)

The author reviews in an authoritative manner the post war mineral situation and reconstruction period in France. He emphasizes the fact that despite the restitutions of the peace treaty with Germany, France faces a serious shortage of coal. A detailed and lengthy description is given of the post war position of the major metals. The exchange problem is discussed briefly. The article is simply an attempt to describe to the American reader a few of the means at the disposal of France to resume her position and rank in the world's activity towards progress and better times. W. S. L.

Wolfram Mining in China. By C. Y. Wang. (E. & M. J., January 3, 1920.)

A brief comment on the production of the metal that developed under the stimulus of the war demand. Government and military machinations render the future of the industry dependent on the sweeping reform of existing political conditions. W. S. L.

Mine Bookkeeping By C. B. Holmes. (E. & M. J., January 3, 1920.)

This article offers many suggestions as to the ways and means of effecting material economies in mining operations. the merits of a proper cost-finding system and of the detection of leaks by compiling daily reports of tonnages and labor costs, are praised highly by Mr. Holmes. W. S. L.

The China Clay Industry of the West of England. By Henry F. Collins. (Mining Magazine, November, 1919.)

China clay is, after coal, the most important of the limited list of raw materials that the United Kingdom can export.

The geographical distribution of the principal deposits of china clay in the West England is shown on a map which accompanies the article. Most of the output of the clay comes from the Hensbarrow district north of St. Austell. Nothing as yet has been found in the Wendron area.

The following topics are discussed in detail in this article:

1. Nature and composition of china clay.
2. Mode of occurrence.
3. Method of winning clay.
4. Separate and disposal of sands.

The article is accompanied by tables, photos and maps. It is to be continued in the next issue. F. A. L.

The Minerals of Anatolia. By Norman M. Penzer, B.A., F.G.S. (Mining Magazine, November, 1919.)

This article is continued from the October issue, page 221, and gives particulars of the mineral deposits of Asiatic Turkey, about which little is known in this country, though the Germans compiled records some years ago. The minerals and metals treated in this issue are: nickel, tin, arsenic, sulphur, borates, salt, lithographic stone and marble, kaolin and Fuller's earth, opals and bitumen. The article is to be continued in the next issue. F. A. L.

Mining Conditions in Russia. (E. & M. J., January 10, 1920.)

In this article a general review of mining conditions in Russia during 1919 are presented and some of the methods used for stimulation of mining are stated. High cost and scarcity of available labor have forced the mining industry in Russia to look to mechanical devices for the continuance of operations. W. S. L.

The Bunker Hill Enterprise—II. By T. A. Rickard. (Mining & Scientific Press, January 10, 1920.)

A continuance of the historical article dealing with early mining operations in Idaho. The first successful prospecting in the Coeur d'Alene district is dwelt upon. W. S. L.

MINING.

The Tin District of West Africa. By D. J. MacDonald, M. Inst. M. M. (Mining Magazine, November, 1919.)

In the mining magazine for May a brief summary on the Winnebah tin deposits, West Africa, made by the firm of Innes, MacDonald & Sealy. This article was written by Mr. MacDonald from the notes of Mr. A. C. E. Seale, who had been in charge of the prospecting work during the last six months.

The existence of a deposit of high-grade coarse alluvial cassiterite was found by a syndicate four years ago in the bed of a stream flowing into a salt-water lagoon on the seacoast about five miles west of the port of Winnebah.

The outbreak of the war put a stop to the operations, until they were renewed in 1918, under circumstances more favorable.

There are at least four or five companies now in operation upon these tin deposits or hold options on them.

F. A. L.

The Kelly Silver Mine, at Randsburg, Calif. By Jay A. Carpenter. (E. & M. J., December 27, 1919.)

A descriptive article dealing mainly with the romantic and accidental discovery of the valuable property by two prospectors returning from a futile two-years' search. Exceptional returns from preliminary shipments bring wealth to the owners and inspire adjacent leasers to active development. W. S. L.

Standardized Cross-Cut Rounds. By Howard Drullard. (E. & M. J., January 3, 1920.)

An illuminating account of improved methods of drilling and blasting at the property of the North Butte Mining Co. The following topics are ably discussed:

1. Adjusting the machine so as to obtain maximum results.
2. Descrimination in the selection of powder for breaking different kinds of ground.
3. Attention to ventilation an important factor in producing results.

Illustrations of the instruction and requisition cards issued to miners working on development headings. Results indicate that a high standard of efficiency has been reached by this company in its drilling operations. W. S. L.

Divide Silver-Gold District of Nevada. By Geo. J. Young. (E. & M. J., January 10, 1920.)

Four general groups of prospects comprise the Divide area which bears a certain geological similarity to the Tonopah district. Description of the general exploration and development methods followed are given, together with mining, supply costs and other data. W. S. L.

METALLURGY.

Differential Flotation of Zinc-Lead Sulphides by Metallizing the Blende. (E. & M. J., December 27, 1919.)

The results of the experimental work of C. C. Freeman, of Broken Hill, on the differential flotation of lead-zinc sulphides are embodied in U. S. Patent 1,301,551, April 22, 1919. Dilute carbonate of soda solution used as a frothing agent was found to give indifferent results, but a great improvement was noted when the zinc sulphide particles had been superficially coated with certain other metals as copper. The metallizing of the zinc sulphides is the result of electrolytic or other action when copper or one of its salts or a metal electro-negative to copper is in contact with the flotation pulp. Oil, the inventor says, is unnecessary in the first treatment, as it helps to float the blende along with the galena thus fouling the lead concentrate. The process is claimed to be of particular commercial value when the zinc predominates in the ore or mixed concentrate and when removal of pyrite is necessary.

W. S. L.

Electric-Resistance Furnace of Large Capacity for Zinc Ores—II. Operation of Furnace and Characteristics of Process. By Charles H. Fulton.

In this article we have details of the experimental work with electric resistance furnace of commercial size, based on the author's well-known plan of making briquets with the zinc ore to be treated, and using these briquets as resister for an electric furnace.

The article is well illustrated. Several tables and diagrams are included.

The furnace and process presents the following characteristics expressed in a brief way:

1. It maintains the physical and metallurgical conditions of the present-day retort practice.
2. The energy of the distillation is generaled within the charge itself.
3. It is a large unit furnace. The handling of material will be done by cranes.
4. Probable costs have been calculated which show a marked reduction over present costs.
5. The process can be applied to zinc ores, even to the so-called complex ores.

F. A. L.

Production of Copper from Secondary Material. By Lawrence Addicks. (Chem. and Met. Eng., January 21, 1920).

In addition to the circulating products incident to normal copper refining the plant is often called upon to treat a wide range of metallurgical by-products from outside sources as well as miscellaneous copper-bearing scrap material. The article discusses the methods of sampling miscellaneous products entering the refinery, their treatment in regular or special furnaces, with a discussion of the commercial possibility of recovering some of the impurities as metallic by-products.

F. A. L.

A Contribution to the Study of Flotation. By H. Livingstone Sulman. (The Mining Journal, November 22, 29, and December 6, 7, 1919).

This article, although published in other magazines, is more completely printed from an abstract of a paper read before the Institute of Mining and Metallurgy. It is written in technical form and is very clearly described by sketches and diagrams.

All the questions connected with flotation that the Mineral Separation, Ltd., have made such a success, are clearly brought out by Mr. Sulman. The article is continued in four numbers of the Mining Journal. F. A. L.

A Contribution to the Study of Flotation —III. By H. Livingstone Sulman. (Mining & Scientific Press, January 24, 1920.)

The discussion of the physics of the process continued. The author discusses the dynamical aspect of surfaces, modification of surface characteristics during ore dressing processes and interfacial tension. W. S. L.

Elements of Smelting Plant Design—I. By Oliver E. Jager. (Mining & Scientific Press, January 31, 1920.)

An interesting article, the purpose of which is to explain the method of selecting some of the appliances usually found on a modern smelter, as well as to discuss certain generalities. Only the metallurgical side of the subject, however, is treated. Some of the topics discussed are size of plant required, economics of the problem, effect of local conditions, selection of the process, and the chemical nature of the ore to be smelted.

W. S. L.

A Contribution to the Study of Flotation II. By H. Livingstone Sulman. (Mining & Scientific Press, January 10, 1920.)

A further elaborate discussion of the physics of flotation. The author discusses the molecular constitution of solids and liquids, gravitation and molecular forces, surface energy and surface tension, pressure in bubbles and the dynamical aspect of surfaces. W. S. L.

Experimental Flotation of Low-Grade Quicksilver Ore. By E. G. Stowell and Will H. Coghill. (Mining & Scientific Press, January 24, 1920.)

This paper gives the result of a joint investigation carried on by the U. S. Bureau of Mines, and the Oregon Bureau of Mines. It deals with the experimental flotation and table concentration of a cinnabar ore, containing 0.5 percent mercury. Numerous screen analyses and the conclusions drawn therefrom are given. Table concentration tests proved discouraging. Along with detailed procedure on the flotation tests, methods of grinding and their influence on flotation are discussed. Acidity in pulp was found to be neutralized by grinding in ball mill. The beneficial effects of lime water and fine grinding are enumerated; 90 percent extraction obtained. W. S. L.

OIL.

Petroleum Resources of the World. II. By John D. Northrup. (E. & M. J., January 3, 1920.)

In the second installment of this article the author deals with the commercial control of the petroleum industry by various countries. The names of the companies operating in different parts of the world are given. American, British, and Dutch interests control most of the world's oil. The author states that the United States is supreme in the Western hemisphere, but deplores the lack of an aggressive foreign nationalistic policy similar to other foreign governments.

W. S. L.

Geologic Distillation of Petroleum. By Baily Williss. (A. I. M. E., Jan., 1920.)

In 1882, Peckham put forward a provisional hypothesis to account for the distillation of petroleum. He did not formally state the hypothesis, but discusses facts drawn from many fields. He tried to point out "fractional distillates" produced under high pressure, and consequently at a comparatively high temperature.

The object of this paper is to test Peckham's hypothesis and the contributions to it made by White and Johnson, by considering the geologic activities of Appalachian province in the light of the present-day knowledge. F. A. L.

The Petroleum Resources of the World. I. By John D. Northrup. (E. & M. J., December 27, 1919.)

The basis of this article was issued in mimeographed form for Government use only, and after the armistice, the remaining copies were released to the general public. The article summarizes briefly and concisely information relating to

1. Geological strata in which oil is found.
2. Geographical distribution.
3. Future prospects in various countries.
4. Political control of the present production. W. S. L.

PERSONALS

'95.

C. Terry du Rell is now residing at 4112 Ingomar St. N. W. (Chevy Chase), Washington, D. C.

'98.

Mr. Fred Johnston, formely Supt. of the A. V. Smelter, at Leadville, has removed to Pueblo, where he is connected with the A. S. & R. Co.

'01.

A. K. McDaniel, recently Asst. General Manager of the Western Company, has become associated with the organization of Edwin M. Bosworth & Co., Bonds and Stocks, 610 First National Bank Bldg., Denver, Colo.

'07.

Warren C. Prosser is a member of the firm, Prosser & Haynes, Engineers, 718½ Ohio Street, Wichita Falls, Texas. They specialize in oil field work.

'08.

Russell R. Bryan is with the Sunnyside M. & M. Co., Eureka, Colo.

Burr J. French has been transferred to the South Bend Plant of the Studebaker Corporation. Address 905 E. Donald St., South Bend, Ind.

'09.

E. W. Enriquez is General Supt. for the Compania Minera del Mirasol Cusihuirachic, Chihuahua, Mexico.

'12.

John Davenport, Metallurgical Engineer, of 5 Custom House St., Boston, Mass., has recently been issued a U. S. Patent for the production of pure sulphur dioxide from smelter smoke. Davenport is also consulting engineer for the Wausau Abrasive Company, of Chicago.

E. T. Hager is at present operating a chromite mine and mill in San Luis Obispo County, California, for the L. H. Butcher Co., of San Francisco.

We have received the sad word of the sudden death of Paul Hilsdale's wife, at Salt Lake City, Utah, on February 5th. She leaves a 3-year-old daughter, Katherine. Interment was at Columbus, Ohio.

'13.

J. M. Frankel has changed his residence from Morenci to Clifton, Ariz., P. O. Box 843. He is still with Arizona Copper Co., Ltd.

L. G. Trueheart has resigned his position with the Arizona Copper Co. to become Superintendent of a new copper property in northern California.

'14.

Adolph Bregman was married on December 31, 1919, but we have been unable to obtain further details. His address 155 W. 84th St., New York City, N. Y.

Thomas T. Gow is now head of the physics department at the Peking Academy, Peking, China.

Fred S. McNicholas and Mrs. Emil M. Dickman were married on January 13th at Butte, Mont. Mr. McNicholas left on February 1st for Colombia, South America, to become Superintendent of the Chicago Mine, at Puerto Andeas, via Cartegenia.

'15.

B. C. Essig is Field Engineer for U. S. Bureau of Mines and the State of Colorado. The Bureau and the State are co-operating in making a survey of the mines of Colorado with the view to solving some of the ore-dressing problems.

'16.

Jay J. Burns is with the Butte & Superior Mining Company, Butte, Mont.

'17.

H. E. Munn has been made Manager of The Sunnyside Coal Mining Company operating mines at Strong, Colo. Munn divides his time between the Denver office and the mine.

Fred C. Sealey has returned from Peru, South America, and is now at 1435 Race St., Denver, Colo.

S. A. Mewhirter has been promoted from Asst. Engineer, Longfellow Division to Engineer, Coronado Division, of the Arizona Copper Co. He is now at Metcalf, Ariz.

'19.

Russel J. Parker has arrived safely at Tshikopo, Kasai District, Congo Belge, West Africa, care of Forminiere.

D. B. Doyle, '08, is Managing Engineer at the mine.

OBITUARY.

Anne Fuller Hilsdale, wife of Paul Hilsdale, 1912, died of pneumonia February 5th, at Salt Lake City. She leaves a daughter, Katharine, 3 years old. Interment at Columbus, Ohio.

The Hardinge Conical Mill Company Changes its Name.

The Hardinge Conical Mill Company with main office at 120 Broadway, New York, and branch offices in Denver, Salt Lake City, Spokane and London, announce a change in name to the Hardinge Company.

The velocity with which electricity travels is even greater than the velocity of light. Experiments have demonstrated that electricity travels at the rate of 186,427 miles a second. Thus electricity could travel to the sun and back in less than 20 minutes.

ATHLETICS

By F. A. Lichtenheld, '20.

BASKETBALL.

Mines 30; Colorado U. 20.

For the first time in seven consecutive years, has Mines been able to defeat U. of C. at Basketball either on their own floor or on Boulder's floor. The defeat was a surprise to Boulder, but those around the Miners' camp had a hunch and are always willing to bet on their lucky seventh.

Mines got the jump on the Boulder men and swept them off their feet. During the first ten minutes U. of C. was held scoreless, while Mines advanced with an eight-point lead. Willard then made Boulder's first score, but Mines quickly increased their lead to nine points, which they held throughout the first half. The score at the end of the first half was 15 to 6. Boulder's men showed plenty of fight, but were licked after ten minutes of playing. Mines also had plenty of fight and played the game well.

The second half was a little slower; both teams did not put all they had into the game, because Mines didn't have to and Boulder couldn't. Boulder used plenty of subs this half, but despite the fresh material, could not stop the slaughter the Miners started. E. Bunte was removed from the game because of personal fouls. Galucci replaced him and gave a good account of himself.

For Boulder, Brown, Breckenridge and Willard were the stars. Willard at forward made sixteen of their twenty points. He connected with several long shots that looked pretty from the spectators' viewpoint. He would undoubtedly have had more had it not been for the guarding of E. Bunte. Brown at guard played well at defense.

For the Mines, Bryant, Dunn and Davis were the stars. Davis guarded the goal in a most efficient manner. Bryant at forward gave a fine exhibition of passing and shooting. He made five difficult field goals and six free throws out of a possible eleven. Dunn, at forward, played a steady game. He kept fighting the ball all the time, and with his speed, he was a big factor in connecting with three field goals that did a lot towards putting the game on ice.

A. Bunte, at center, did well. He played a good, steady game, getting through field goals and only one foul recorded against him.

The lineups:

BOULDER.	F.G.	F.T.	P.F.	T.E.
Schrepferman, forward	0	0	1	1
Willard, forward	6	4	1	1
Breckenridge, center	1	0	1	1
Brown, guard	0	0	0	1
Noggle, guard	0	0	1	0
Bibal, guard	0	0	0	0
Bell, center	1	0	1	1
Williams, forward	0	0	0	1
Smith, forward	0	0	0	0
Totals	8	4	5	6

MINES.	F.G.	F.T.	P.F.	T.F.
Dunn, forward	3	0	1	0
Bryant, forward	5	6	1	0
A. Bunte, center	3	0	1	0
E. Bunte, guard	1	0	4	0
Davis, guard	0	0	2	0
Gallucci, guard	0	0	2	0
Totals	12	6	11	0

Referee—Demitt, of Aggies.

Conference Standing.

	Won	Lost	Pct.
Mines	1	0	1.000
Colorado College	1	0	1.000
Aggies	2	0	1.000
U. of C.	1	1	.500
Denver U.	0	2	0.000

WRESTLING AND BOXING.

The Colorado School of Mines defeated the Colorado College crew in the first Rocky Mountain Intercollegiate Wrestling Contest at Colorado Springs. Mines won six out of nine matches. Some very fine mat work was presented; no boxing bouts were scheduled. The summary of the events are as follows:

First match, 115 pounds—Won by Weinsteind, Mines, over Lise, C. C., in 3½ minutes with a nelson and crotch hold.

Second match, 125 pounds—Won by Kay, Mines, over Carter, C. C., in 6 minutes with a scissors and half nelson.

Third match, 135 pounds—Won by Bemis, C. C., who was given decision over Kaufman, Mines, after 10 minutes with no falls. Bemis had Kaufman in a scissors and head hold and nearly down when the whistle blew. Ten seconds more would probably have scored for Bemis.

Fourth match, 158 pounds—Won by Terry, Mines, over Hinton, C. C., in 8 minutes with a scissors and head hold. This bout was very fast and both men displayed much science.

Fifth match, 145 pounds—Won by Serefinni, Mines, over Daywalt, C. C., who got a decision in 10 minutes with no fall. Serefinni confined himself mostly to the scissors and head holds. The men were very fast.

Sixth match, heavyweight—Won by R. C. Crawford, Mines, who threw Brumfield, C. C., in 9 minutes. Brumfield played in rather hard luck. He attempted to head spin out of a head hold, but got too close to Crawford, his shoulders striking his opponent's body. Crawford fell on Brumfield, and was given the verdict.

Seventh match, 158 pounds—Won by Elliott, C. C., who threw J. W. Crawford, Mines, in 7 minutes with a head and scissors hold. The going was decidedly fast and quite rough. Crawford was severely punished, and it took ten minutes to put him on his feet.

Eighth match, 145 pounds—Senning, C. C., was given the decision over Thompson, Mines, in 10 minutes with no fall. Senning was the aggressor all the way through, and was given the verdict because he was the top man for 45 seconds.

Ninth match, 108 pounds—Won by Denisteind, Mines, who threw McCool in 9½ minutes with a head hold. Denisteind was caught in several tight places, but managed to either bridge or head spin to safety.

The Mines scored another boxing and wrestling victory for itself. In its meet with the University of Colorado they won six out of ten matches. Two were a draw and two matches were won by Boulder.

The surprise of the evening was when Ferguson, of Colorado, won the decision over R. F. Crawford, of Mines in the heavyweight wrestling. Crawford won the heavyweight championship of the D. A. C. Tournament last week in Denver.

Salisbury, of Colorado, lost to Watkins, of Mines, on a decision in the welterweight boxing, while Trinnier, of Colorado, and Clothier, of Mines, boxed to a draw in the middleweight boxing class. Levings, of Mines, defeated Fineberg, of Colorado, in the bantamweight boxing, on a decision. Adamson, of Mines, defeated Pringle, of Colorado, in two rounds in the featherweight boxing, and Weiss, of Colorado, and Strock, of Mines, boxed to a four-round draw in the lightweight division.

Serefinni, of Mines, defeated Weber, of Colorado, by a fall in five minutes in the 145-pound wrestling. Weber was substituted for Coleman just before the match. G. W. Crawford won over Fulgum, of Colorado, in the middleweight wrestling by a fall in 11 minutes. Kay, of Mines, defeated Chapin, of Colorado, in the featherweight wrestling by a decision. Lovelace, of Colorado, defeated Thompson, of Mines, by a decision in the 135-pound wrestling.

All of the wrestling events were scheduled ten minutes, and the boxing contests were scheduled for three rounds.

A wrestling contest has been arranged with D. U. sometime early in the Spring. This will give Mines its third appearance at this branch of sport. The game has proved very popular this Winter. It is more than likely that boxing and wrestling has come to stay.

School News

ENROLLMENT AT THE SCHOOL.

The second semester commenced on January 12th, with atotal of 335 students enrolled. Seventy-six scholarships were cancelled and only 135 freshmen are left out of 199 that completed the first semester.

The Colorado School of Mines is giving the following popular lectures on Petroleum Technology:

Wednesday, February 4—I. The Fundamental Principles of Oil Geology (Part I). By F. M. Van Tuyl.

Wednesday, February 11—II. The Fundamental Principles of Oil Geology (Part II). By F. M. Van Tuyl.

Wednesday, February 18—III. The Composition and Properties of Oil and Gas. By F. M. Van Tuyl.

Wednesday, February 25—IV. The Origin and Occurrence of Oil and Gas. By F. M. Van Tuyl.

Wednesday, March 3—V. The Methods of Prospecting for Oil and Gas and the Development of Oil Fields. By F. M. Van Tuyl.

Wednesday, March 10—VI. The Oil and Gas Fields of North America and Wild cat Territory of Promise. By F. M. Van Tuyl.

Wednesday, March 17—VII. The Origin, Occurrence, and Distribution of Oil Shale. By F. M. Van Tuyl.

Wednesday, March 24—VIII. The Future of the Oil Industry in North America. By F. M. Van Tuyl.

Wednesday, March 31—IX. The Refining of Crude Petroleum. By A. H. Low.

Wednesday, April 7—X. The Production and Refining of Shale Oil. By A. H. Low.

The lectures will be given in Simon Guggenheim Hall at eight o'clock on the evenings of the dates announced.

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WALTMAN, W. D.
1215 First National Bank Bldg.,
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Phone Champa 5236.

WOLF, HARRY J.
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Rocky Mountain Club,
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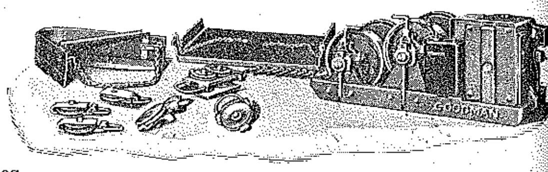

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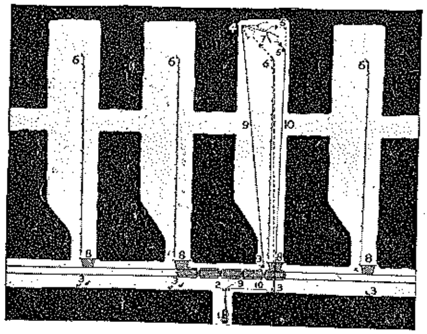

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4. Tail rope face sheaves.
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10. Lead rope.

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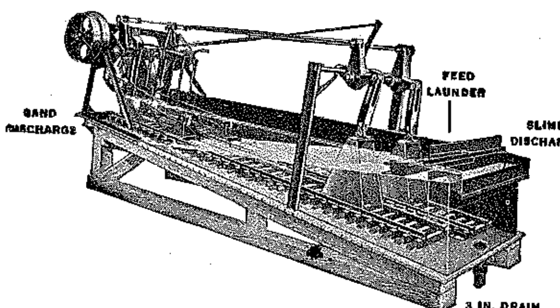

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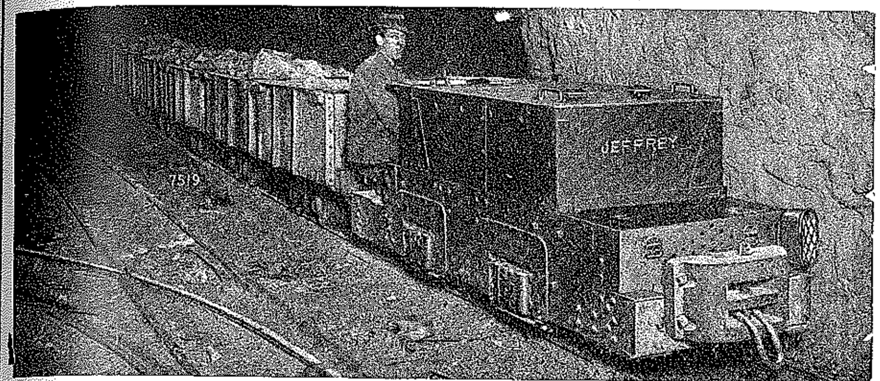

Upper Illustration:
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Lower Illustration:
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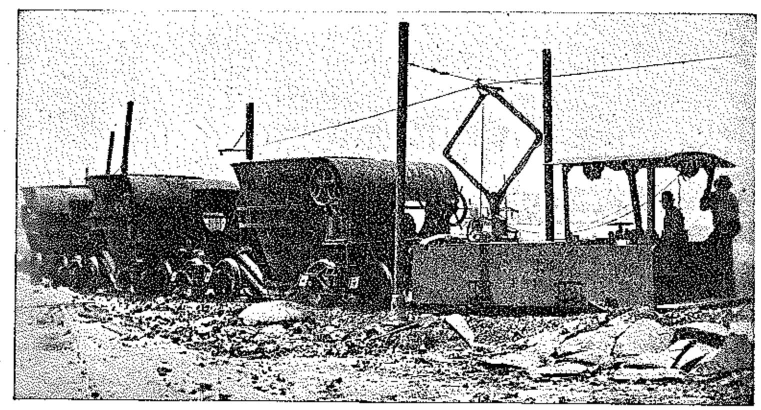

VOL. X APRIL, 1920 No. 4

COLORADO SCHOOL OF MINES MAGAZINE

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