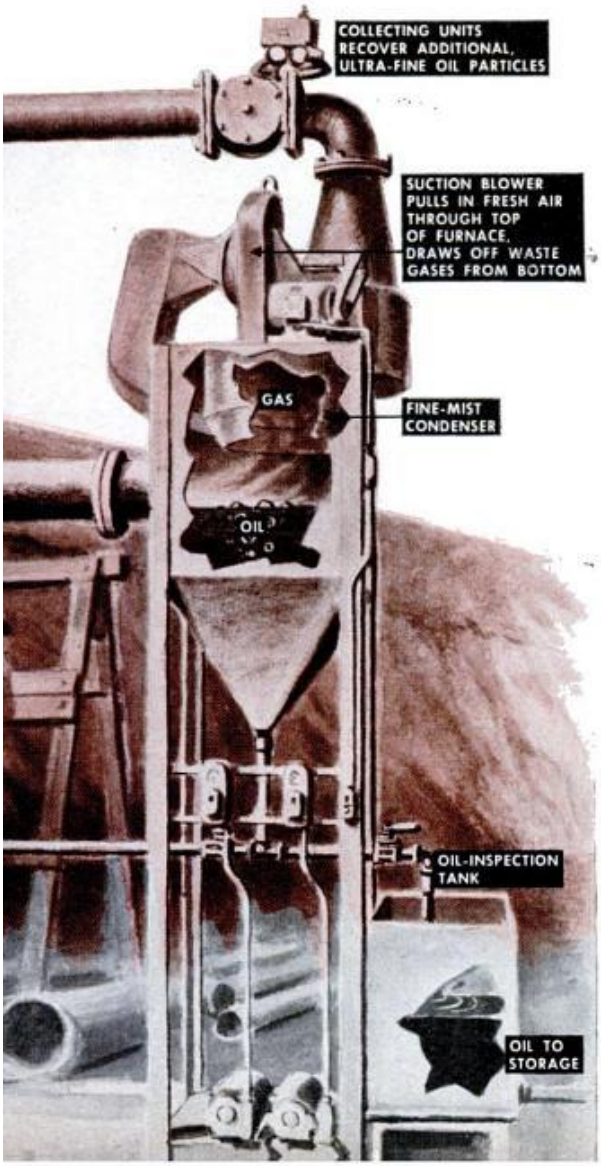
This Oven Makes Oil Out of Rocks

Engineers are testing ways of using plant fossils from mountains to keep you well supplied with liquid fuels.



By Andrew R. Boone

YOU can't get blood out of a stone. But scientists are now taking oil out of a rock. The rock is oil shale, a kind found in nearly every part of the world. It looks like dull-grey slate, but contains kerogen, the solid remains of tiny plants that lived millions of years ago in the bottoms of prehistoric lakes. Kerogen can be processed into an oil that can be "cracked," like petroleum, into gasoline, Diesel fuel, lubricating oil, and fuel oil.

Getting oil from shale is not a new idea. Many foreign countries lacking petroleum have been doing it for years—France started in 1838, more than a century ago. The United States, however, has until recently lagged in this field, despite our extensive deposits of high-grade oil shale. We had huge petroleum supplies—and petroleum is still the best source of gasoline.

Today, however, American petroleum no longer seems inexhaustible. To be sure, we think huge reserves exist untapped, but the proved reserves—those we are sure of—contain only enough to last 11 more years at the present rate of consumption. So even though there's plenty of oil overseas, the oil industry and government agencies are searching for ways to make economical gasoline from coal, natural gas, tar sands, and oil shale. Standard Oil researchers estimate that gasoline made from shale could be sold for only four or five cents more than the present price of petroleum gasoline, although other experts put the cost higher.

Cutting this price differential is the problem now being tackled by several oil companies and the U. S. Bureau of Mines. Engineers of the Union Oil Co., of California, have developed a new kind of furnace (see drawing on previous pages) to boil the oil out of shale kerogen. It is the first such device to operate without water—and water is expensive, or even non-existent, in the rich shale fields in the Rocky Mountain area. An experimental retort of this new type is already operating at Wilmington, Calif. It can handle in one day 50 tons of shale in chunks up to three inches long, turning out 1,500 gallons of oil.

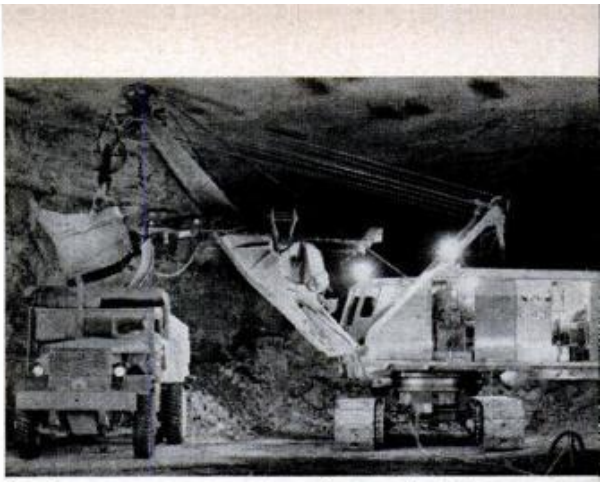
The retort is first filled with shale. A small pile of dry kindling is laid on top and ignited. When the top layer of shale has burned to a cinder, a blower starts sucking air downward through the bed from the top to the bottom. At intervals of 15 seconds, as carbon in the shale burns the upper crust to coke, a hydraulic piston pushes up a new batch of shale from the bottom. This raises the entire load of shale. A rotating plow wipes off the shale residue into a chute.

Heat Releases Oil As Vapor

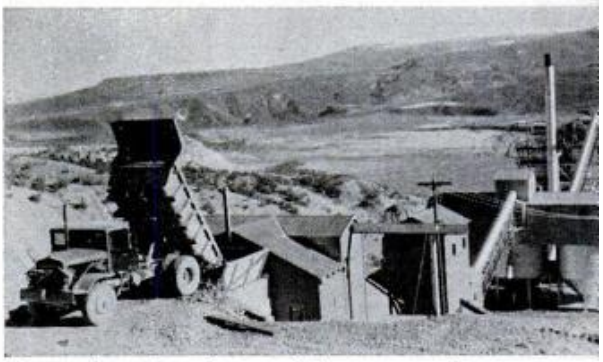
Burning occurs in a zone only a few inches thick immediately below the residue. Downward-moving air helps transfer heat from this belt into the shale. All shale raised to a temperature of 750-1,100 degrees F. releases its oil in the form of vapors. Driven down into cooler shale by the air blast, these oil vapors condense. Thus the burning shale furnishes heat to break down the kerogen of the layers of shale immediately below it, while the incoming shale furnishes cold surfaces to condense the released oil.

The condensed oil, together with non-condensable gases, escapes through slots into the collecting system. Two collecting units, including a "silent-sound" device that turns fine mist into large drops, recover ultra-small oil particles from the waste gas and return them to a storage tank. In a commercial plant, even the waste gas might be used as fuel for steam electric generating plants. Union Oil engineers estimate that waste gas from 35 full-size retorts could produce as much electricity as Boulder Dam.

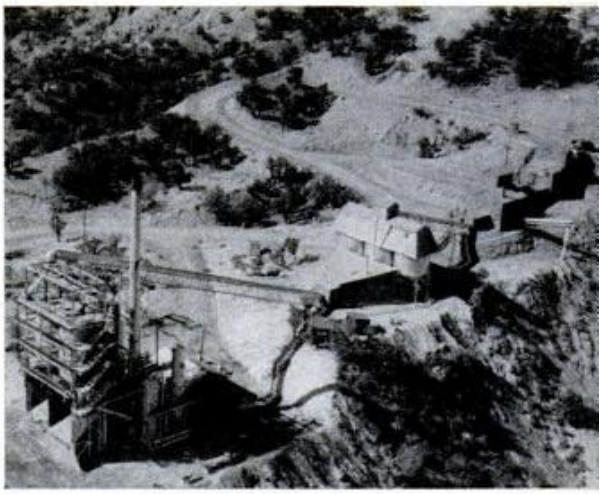
Still another method of getting oil from shale is being tried by the Standard Oil Development Co. at the Esso Laboratories in Baton Rouge, La. There shale will be pulverized to the consistency of fine sand before being heated to extract the oil. The finely



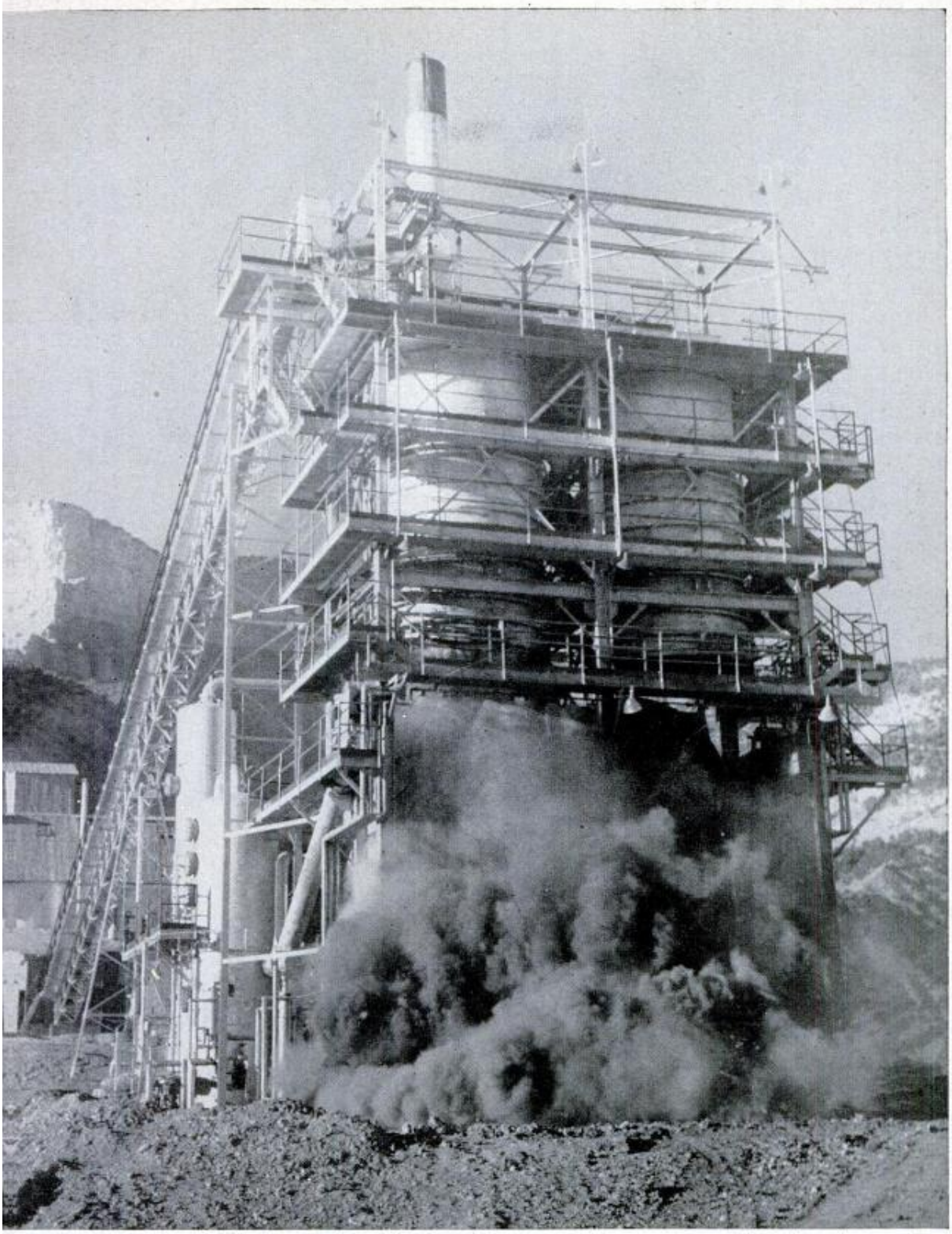
In sharp contrast to most underground mining, huge machines are used in shale quarries. This is because shale is strong, permitting excavation of large, high rooms without supporting pillars.



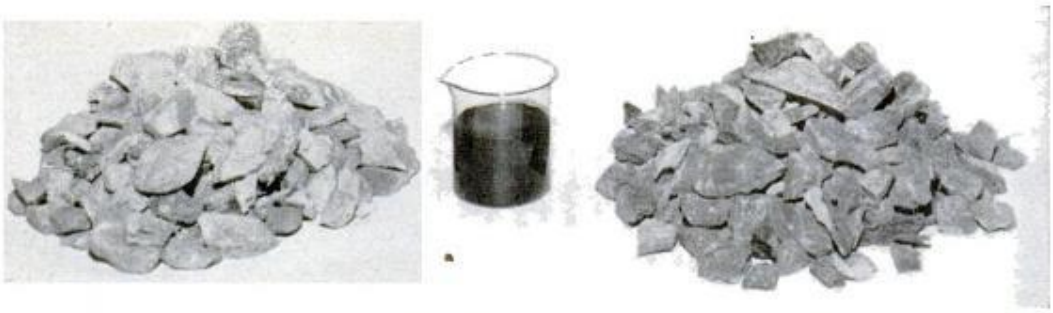
Conversion of rock into oil begins as a dump truck empties shale into a hopper that feeds it to the first of a series of crushers. Photos here show Bureau of Mines' Colorado plant.



Crushed and screened, shale is fed from storage bins on belts over scales that continuously weigh all material. Then it goes into the top of the retort (far left) for processing into oil.



Smoke and fire mark the end of a shale-processing run at the Bureau of Mines' retort. Unlike Union Oil Co.'s continuously fed retort, this furnace burns one charge of shale at a time, starting at top and working down to bottom. At end, retort's bottom opens like trap door, dumping fiery residue onto ground. In principle, however, the furnaces are same.



How much oil can you squeeze out of rock? Beakerful above was obtained by heating small pile of shale (left) to 750° F. Remaining is pile of cinders (right), for which no definite use has been found. Oil shown is crude, must be refined to make gasoline and other products.

ground shale behaves like a liquid when steam or gas is blown up through it and can easily be pumped through pipes from one reaction vessel to another. This "fluidized-solids technique" eliminates many of the problems involved in handling raw shale.

The oil obtained from shale by any of these methods is a crude, thick liquid that must be refined to make gasoline and other things. So far, no economical method of refining shale oil into usable products has been found. The naphtha in shale oil contains tar acids and tar bases not usually present in crude petroleum. Straight-run shale gasoline is a small fraction, having an octane rating below 60, and is high in sulphur, gum-forming, and unstable in color. Aviation gasoline and jet fuels probably can be made, say the experts, but at high cost. "Admittedly," says Boyd Guthrie, chief of the Bureau of Mines project at Rifle, Colo., "the refining of shale oil into usable products presents unusual challenges."

Transportation a Problem, Too

Whether the crude oil will be refined at the shale mines or nearer big cities is a question over which the economists are still arguing. The oil solidifies at room temperature, so it must be kept warm during movement through a pipeline. A 100,000-barrel refinery, plus a pipeline for oil or gasoline from the Colorado deposits to Southern California, would cost an estimated $200,000,000.

The retorts that cook the crude oil out of the shale will probably be near the mines, however, since it seems pointless to transport the heavy rock—of little value after processing—any farther than necessary. The first production center is likely to be in the Colorado-Utah-Wyoming area, which has some of the country's richest oil-shale deposits. Some beds in that mountainous region are 1,300 or more feet deep, and one 70-foot vein, called the Mahogany Ledge, yields about 50 gallons of oil for each ton of shale.

Two experimental shale mines are already being operated by the Bureau of Mines near Rifle, in western Colorado. One, a "selective" mine, digs out different kinds of shale so that the retorts get a thorough test. The other works only one vein—the Mahogany Ledge—as a commercial mine would. Various tools and mining methods are being tried.

Since shale is hard and strong—unlike coal—big underground rooms can safely be cut from it, permitting low-cost, mechanized mining. The selective mine has a test room, unsupported by pillars or timbers, 70 by 100 feet in area. The commercial demonstration quarry is about 50 feet high and 60 feet wide (it has supporting pillars), large enough for the machines used in road construction and strip mining. One drill, operated by two men, makes enough holes for 1,000 tons of rock per shift. A three-cubic-yard electric shovel and an overshot loader of similar capacity put the broken shale into big Diesel trucks.

Simultaneously with the shale-oil program, research into other sources of oil products is going on. More money is being spent on this combined problem than was expended on catalytic oil cracking a decade ago. Two huge plants are now being constructed to convert natural gas into liquid fuels. The Bureau of Mines has three plants now working or under construction. One, at Louisiana, Mo., produces 200 barrels of gasoline daily from coal. At Morgantown, W. Va., methods for making carbon monoxide and hydrogen from coal are being developed. And at Laramie, Wyo., the Bureau is conducting its own research on shale-oil refining. Science is fighting on many fronts to end the threat of an oil famine. END