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GEOPHYSICS

Forty Mile Holes May Supply World's Power

By JAMES STOKLEY

Some day the world's coal supply will be exhausted.

Then where will the world's supply of energy come from?

There is the possibility of using water power. Power may be obtained from the tides. Or perhaps directly from solar radiation.

But though the earth may yield up all of its available coal, there will still be energy left within it.

In digging some of the first of the great tunnels through the Alps, which, though high above sea-level, were really a mile or more below ground—in this case the top of the mountain—men were prostrated by the heat.

Hades has always been thought of as a hot place, and has been placed down in the center of the earth. What are the possibilities of tapping the fires of hell, or at least what nearest correspond to these ancient ideas?

It is generally believed that the center of the earth is hot, even though scientific modernists may have given up the idea of these regions being presided over by a fireproof, non-inflammable devil.

Not so many years ago speculations on obtaining heat from the earth were regarded as almost as much nebulous vaporizing as the steam itself emitted from the hot springs in various parts of the world.

But a few years ago Sir Charles Parsons, inventor of the steam turbine and one of the most distinguished of British engineers, made a suggestion. He proposed that scientific men should cooperate in sinking a shaft into the earth twelve miles deep. The suggestion was really a very conservative one, because he did not say that the shaft would be sure to bring untold wealth to its backers, or anything of the kind. The

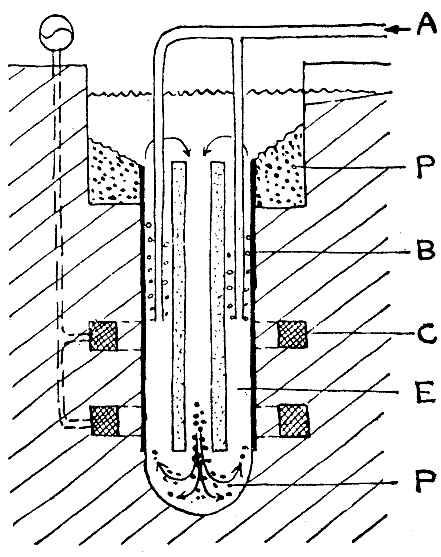

DIAGRAM OF HIGH TEMPERATURE BORE HOLE, for using the earth's heat for power, as proposed by John L. Hodgson, British engineer. This diagram is taken from Mr. Hodgson's book, and shows the method of digging the hole. A indicates pipes for introducing compressed air; B represents the bubbles of heated compressed air; C the alternating current circuits to melt the aluminum alloy, E, of the same density as the rocks through which the hole is bored.

chief reason for doing it, as he said himself, was "We don't know what is down there, and we ought to."

Now another British engineer has carried the problem even further. At the recent meeting of the British Association for the Advancement of Science, in Leeds, the question came up again. Before the section on engineering of the association a paper was read by John L. Hodgson. In this paper he told of his exhaustive studies of the possibilities of digging such a shaft and using it as a source of power.

First of all is the amount of heat in the earth. According to Mr. Hodgson, it is 31 million times as great as the world's coal supply. The latter, he estimates, is 8,000,000,000,000 tons. This would raise the temperature of 6,400,000,000,000,000 tons of water from the freezing to the boiling point.

Why worry about our diminishing coal supply with all that heat beneath the soles of our shoes? But, asks the layman, isn't this supply of heat in the earth also limited, and if it is used up, won't it leave the earth a dead and cold planet, perhaps like the moon?

To this Mr. Hodgson responds with an emphatic "No!" As a matter of fact, the heat in the earth is continually being lost anyway. First it is conducted through the crustal rocks to the surface, and then it is radiated out into space. According to his estimates every square mile of the earth's surface radiates in a minute and a half as much heat as would be obtained by burning a pound of coal. If only 20 per cent. of this could be utilized as it flows out, a single square mile of surface would produce 40 horsepower. A thousand tons of coal burned in a second would produce the same amount of heat that the earth loses in a second. But instead of waiting for the heat to come to the surface, the best way seems to be to go down after it.

Even though all this heat is going out of the earth, it does not mean that our planet is getting cooler. This is what Mr. Hodgson says:

"This heat loss is wholly or partially balanced by new heat which is continually being generated in the earth's interior by rock friction, chemical change and radioactivity.

"The rate of heat production due to rock friction and chemical change has never been estimated.

"The rate of heat production in the surface layers due to radioactivity, however, seems to be more than suf-

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ficient to make up for the relatively small amount of heat lost by radiation.

"It is therefore probable that the earth is getting hotter, and that the vast store of heat is increasing rather than diminishing."

Various attempts, in most cases quite successful, have already been made to use the heat of the earth. Even the primitive Maoris in New Zealand make use of hot springs for washing and cooking, while those in Iceland have long been used to aid the growth of vegetables.

Power from the earth, however, is more modern. There are three principal places where it has been accomplished, in California, in Italy and in Japan. The American installation has been in Sonoma County, about 105 miles north of San Francisco. This is a region somewhat resembling Yellowstone Park in that it contains a great number of hot springs and "mud baths," though real geysers are lacking. Five holes have been bored to a depth of about 450 feet in this region. Steam comes to the top with a pressure of 300 pounds per square inch. After allowing for losses in transmission, this gives 4,500 kilowatts of electricity, enough to supply heat and power for a good-sized town.

In Italy, at Larderello, in Tuscany, about 45 miles from Florence, is one of the most famous natural steam power plants. Prince Piere Ginori Conti, an Italian nobleman, has superintended this operation. The deepest of the twelve holes which have been sunk in the region there abounding in natural steam is 700 feet. From them is obtained 7,500 kilowatts of electrical power.

In the city of Beppu, on the island of Kyushu, in Japan, a start has been made to use power from hot springs. Here a small plant has been erected, while plans are under way to enlarge it.

These natural steam power houses are quite different from what Mr. Hodgson proposes, however, even though there are many places in the world where such projects might be carried out. In these places, the hot water or steam is produced by water from below passing through hot surface rocks. These, he says, may hold surprisingly large amounts of energy in the form of heat. One cubic mile of hot rock, he says, when cooled down 1,000 degrees Fahrenheit will yield as much heat as 182,500,000 tons of good coal. This, if used in a plant only 20 per cent. efficient will give 47,400,000 horsepower for a year.

"It is the vast reserves of a heat in the deeper crustal rocks and in the central core of the earth which must prove the great attraction to engineers until the problem is either solved or abandoned," says Mr. Hodgson.

To do this with our existing technical knowledge, he declares, would require the transfer of some material particles, as by a circulating liquid or gas, from the lower regions to the surface. If you hold a silver spoon in your hot coffee, the handle of the spoon soon becomes hot. Here the heat is conducted much as electricity is conducted along a wire. However, Mr. Hodgson does not believe that the heat that could be brought from many miles below the earth's surface to the top by any such means would be enough to pay for the cost involved. Neither does he think it practicable to use thermocouples, pairs of two different metals which give an electric current when heated. The current is too small.

Accordingly he suggests a bore hole, made double in form. Through a center pipe water descends from the surface. At the bottom it comes in contact with the outer wall and the heat of the earth at this depth converts it into steam. The steam then flows to the top to drive engines. If such a hole were a foot in diameter and 30 miles deep, he calculates that it would yield about 4,000 horsepower under ordinary working conditions, for the first 500 years.

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Forty-Mile Hole for Power

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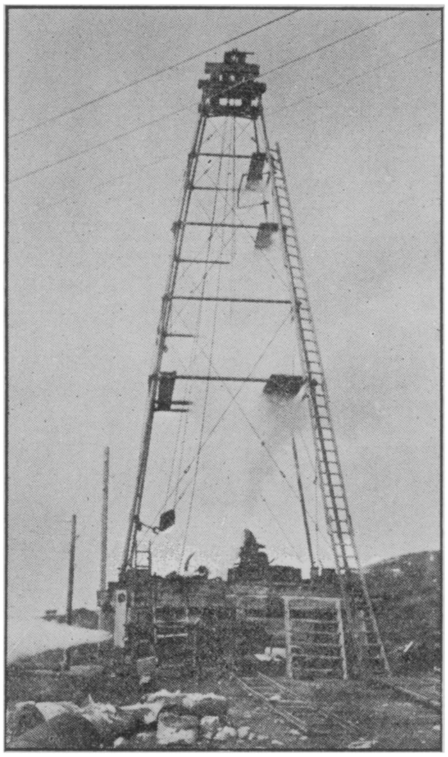
As the rock in the immediate neighborhood of the hole would give up its heat first, the yield would be greater at first. But even after 4,000 years, he estimates, the cooling would not have extended farther than 2,000 feet from the hole. If the hole were made larger, the yield would be somewhat increased, but the greatest advantage would come from making it deeper. Taking a hole 30 miles deep and a foot in diameter, an increase to ten feet in diameter would only increase the heat yield a third. But making it 40 miles deep instead of 30 would increase it about one and a half times.

Mr. Hodgson, as an engineer, has not been content with calculating what such a hole would do if we could dig it, but has actually worked out a scheme for making the hole!

Present mining methods make the limit of a hole by their use about 2 miles. Below that depth the pressures of the rocks become too great. But. Mr. Hodgson proposes a method of getting around this by something similar to hydraulic mining. Instead of using a stream of water to cut away the rocks, he suggests the use of a stream of molten metal—an alloy of aluminum. With this alloy, which has the same average density as the rocks it encounters, their pressure is balanced. Pebbles of quartz or flint carried by the liquid metal aid its work, while it is kept molten by electric circuits. When the desired depth has been reached the metal is removed and replaced by water.

Of course, since it is not even known whether the method would prove practicable, it is hard to estimate the cost of such a hole. However, he makes some rough comparisons of the cost of operation with that of an ordinary steam plant. An investment of about $2,500,000 at five per cent. would be required to yield 4,250 horsepower from coal at $5.00 per ton according to his estimate.

"The cost of a high temperature bore hole to produce the same amount of heat should scarcely be more than ten times this amount when the technique of making such bore holes has been adequately worked out," says Mr. Hodgson, "while the cost of the much shallower high temperature heat bore holes possible in volcanic areas should be able to compare very favorably with the cost of producing heat by any other method."



IF A DEEP BORE HOLE, such as is proposed by John L. Hodgson, British engineer, is ever made to utilize power from the earth, the top of it might look something like this. The installation shown here is at Lardarello, Italy, where Prince Ginori Conti has made use of natural steam as a source of power.

But the "high temperature" hole is not the only possibility. The engineer also proposes what he calls a "low temperature" hole. This consists of two bore holes, about 5 miles deep and connected by horizontal passages about 30 miles long. This 30 miles of horizontal passage, for the first 1,000 years, would produce an average of more than 4,250 horsepower, he believes. Such a system of holes, in his opinion, would not cost any more than ten times the cost of the present steam plant of like power. Then there is also the possibility of sinking it in regions where valuable ores are to be obtained and so reducing its cost indefinitely. Already a world shortage in such metals as zinc, tin and lead is in sight because all the pockets in which they occur within a mile of the surface are becoming exhausted.

With this system, a few workers would be required underground, and Mr. Hodgson suggests that they could be encased in heat proof suits through which air at about 60 degrees Fahrenheit circulated. This air could be obtained from tanks of liquid air either carried on trucks or by the workers themselves.

Apparently, then, our present methods of producing power are cheaper, but Mr. Hodgson's conclusion admirably summarizes the problem. This is what he says:

"We are, with regard to the problem of using the Earth's Internal heat, very much in the position of an eighteenth century 'outcropper' quarrying for coal in the hillsides of Yorkshire. Noting the dip of the strata, he could quite well reason that far below the surface there must be immense reserves of coal, which on the one hand he did not need to exploit because the hillside quarry provided for all his immediate needs, and which on the other he could see no possibility of exploiting at a profit because he knew nothing of such devices as the steam engine, the electric motor and the air compressor.

"Yet because the problem of making use of the deep lying coal seams was not lost sight of, men in Yorkshire today are mining coal thousands of feet below the surface by the methods and applications that were not even dreamed of by the 'outcropper' of two hundred years ago."

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ZOOLOGY

The Hunters

Far in the north
  Wing through the night
Goblin-eyed owls
  Spectrally white.

Far in the south
  Saucer-fed snakes
Weave through the attics
  When the moon wakes.

Triune is death
  For the race of the rat—
Winged owl, scaled snake
  And velvet cat.

—Elizabeth Coatsworth, in the New York Times.

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Aluminum was discovered just 102 years ago by Dr. Hans Christian Oersted, Danish physicist.

New York schools are experimenting with the use of moving picture reels to teach current events.

Travelers in the desert sometimes quench their thirst by drinking water stored by some of the desert plants.

The modern device of dressing sports contestants in different colors was a custom of the Romans.