Power Economy in the Southern Indiana Quarry Industry.

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The limestone quarry industry of southern Indiana offers a fertile field for research along the lines of conservation. The early operators adopted wasteful methods of production, feeling that the abundance of the deposits would give an unlimited supply of first-grade stone. The tendency has been to continue with the old methods and machinery to the present time. Within the last few years, however, competition has become so keen that many of the operators of the district have begun to realize the wastefulness of the present methods and to look for more efficient ones.

The principal losses accompanying the production of building stone in Monroe County can be grouped under four heads:

(1) Losses of second-grade stone.
(2) Losses of human labor.
(3) Losses of lime, cement and fertilizing materials.
(4) Losses accompanying power production.

The losses due to inefficient methods of power production are probably the greatest and the most in need of remedial action. The method of power production throughout the district is wasteful in the extreme. Power is generated in a large number of separate units distributed over the quarry and there is a great loss of human labor in supplying the coal where it is to be used as well as a great loss of coal due to careless handling. Several quarrymen have made careful tests upon channeling machines, at my suggestion, to determine the amount of coal consumed by the different types of machines during a given run, and it has been found that while the Sullivan or Ingersoll channelers cut faster they consume practically twice the amount of coal in a given period of time as the Wardwell type of channeler, which is widely used throughout the district.

In many of the mills the boilers and engines have been in operation over twenty years and the amount of coal used per horse-power hour is at

The Interior of a Modern Mill. This Mill is Entirely Equipped With Electrical Machinery. The Power is Purchased of a Local Power Company.

least six times as much as would be necessary with up-to-date machinery and methods in large central plants.

During the last nine months I have visited all the mills and quarries of Monroe County which are at present in operation, and have taken data on the coal consumption and power produced throughout the district with an idea of showing how great these losses are and at least suggesting a remedy for some of them.

From the data taken I have chosen three plants which are representative of the older type and have averaged them so as to avoid giving out the data of any single plant. The data are as follows:

Amount of coal used per month (tons)	135
Cost of coal at the mine at $1.15 per ton	$155.25
Freight on coal at $.55 per ton	74.25
Total cost of fuel	229.50
Horse-power developed, engine rating	75
Hours of running time during the month	240
Coal consumed per horse-power hour (lbs.)	15

I have also taken the data for three of the more modern type of plants and averaged them to show the great improvement already made toward greater economy. The data are as follows:

Amount of coal used per month (tons)	192
Cost of coal at the mine at $1.15 per ton	$220.80
Freight on coal at $ .55 per ton	105 60
Total cost of fuel per month	326.40
Horse-power developed, engine rating	200
Hours of running time during the month	240
Coal used per horse-power hour (lbs.)	8

Although these figures show that a great improvement has already been made in power production, they also show that there are still great possibilities for further reduction in power costs.

The saving of human labor engaged in the production of the power in central plants over the present methods would amount to two-thirds of the number of men now engaged.

In my final paper on the subject I hope to carry out the above figures

This is a Type of the Outdoor Yard. Winter Work is Out of the Question. These Plants are Slowly Disappearing in Favor of the Inclosed Plant.

fully enough to show the actual cost of power by the present methods in use in the district. At present my data on the value of the machinery and plants and the rates of taxation, insurance, etc., on the same is not complete enough to give any but a very approximate figure.

Engaged in the stone industry of the county there are twenty-nine operating companies controlling twenty-six mills and sixteen quarries. They use approximately 5,000 H. P. and 4,000 tons of coal per month in its production.

For convenience in studying the problem of power production of the county I have divided it into three districts as follows:

District No. 1 includes all the plants in and around Elletsville and Stinesville. This district is controlled by six companies running six mills and two quarries. They use approximately 1,000 H. P. and 750 tons of coal to generate the power.

District No. 2 includes the quarries and mills of Bloomington and Hunter Valley. This district is controlled by eleven companies running eleven mills and five quarries. They use 2,000 H. P. and 1,700 tons of coal per month in its production. Two of the plants of this district buy electrical power from the Central Indiana Lighting Co. of Bloomington, and in figuring the coal consumption for the district I have added the amount of coal they would use in the production of their power if they worked under the same conditions as the other operators of the district.

District No. 3 includes the rest of the county, that is, all the mills and quarries around Clear Creek and Saunders Station. In this district there are twelve operating companies running nine mills and nine quarries. They use approximately 2,000 H. P. and consume 1,650 tons of coal.

In looking for improved methods of power production the following possibilities present themelves:

First, each operator can make an effort to produce as much of his power in a single unit as possible, and distribute the power to the different machinery of his plant electrically. This method is becoming more and more common in the stone mills of the county, but very little effort has been made toward the use of electrical machinery in the quarries.

At least two of the operators of the district are using compressed air to drive their quarry machinery, but a careful study of the costs of power production in this form shows that the fuel cost is materially raised, although the advantages of such a system are: Small waste in handling

An Interior View of the Plant of One of the More Up-to-Date Companies. This Plant is Equipped for Night and Day Running, as Well as Winter Work.

coal, less human labor, and a cleaner quarry. As a method of conserving power it cannot be called successful, although the failure in one case may be laid to the fact that the channeling machines used with compressed air are of the old steam types with the air hose introduced into their boilers, thus keeping the faults of the steam channeler and adding to them the line losses of compressed air. This method would be far more economical with modern compressed air chambers.

Second, a central plant for each district might be constructed with an idea of handling the coal more easily and having an adequate water supply. These plants could be located so that the cost of distribution of the power by electricity would be a small item, as the districts are reasonably compact and easily reached.

Third, we might consider water power with electrical distribution to the plants. In fact, such a plant is already in existence at Williams, but on account of the uncertainty of their water supply the plant is equipped with a steam auxiliary. Their proximity to the quarries and mills of Lawrence County makes it probable that most of their power will be sold there, as the heavier line losses in distributing to this district would tend to center their interests in the southern part of the stone belt. Other projects have been suggested, but the extremely high first cost of the construction of a water-power plant makes it rather a question of the future than of the present power problem.

Lastly, and probably the most economical solution of the problem is the construction of a large central plant in the coal fields with high tension transmission of the power to the quarry districts and the use of electrical machinery throughout the plants. This plant could be equipped with modern automatically stoked boilers with superheaters and condensing engines; or the plant could be equipped with gas producers and gas engines. An interesting calculation on the subject can be made by taking a single district and showing the possibilities for that district if the operators could unite to solve their power problem.

I have taken District No. 1 and attempted to calculate the cost of such plants from the data available, but, in general, calculations of this kind are only approximately true, as the price of materials is constantly changing and the tendency of contractors is to hide the true costs by unbalanced bidding. This makes it difficult to estimate prices.

The following figures are reasonably correct for a 1,000 H. P. plant:

A Yard in One of the Local Mills, Showing One of the Largest Slabs of Dressed Stone Ever Sent Out of the District.

Steam plant:

2 engines totaling 1000 H. P.	$25,000
Necessary auxiliaries at $8.50 per H. P.	8.500
4 fire-tube boilers, 200 H. P.	5,700
2 400 K. W. generators, 550 volts	9,628
2 16 K. W. exciters, direct current	810
Switchboard equipment, $4.25 per K. W.	3,400
Cost of stack at $3.00 per H. P.	3,000
Foundations for engines and boilers	3,000
Piping and installation	2,000
Total cost of plant without buildings	$63,038

If turbines were used with three 250 H. P. water-tube boilers and superheaters instead of the above equipment, the total cost would be $57,150.

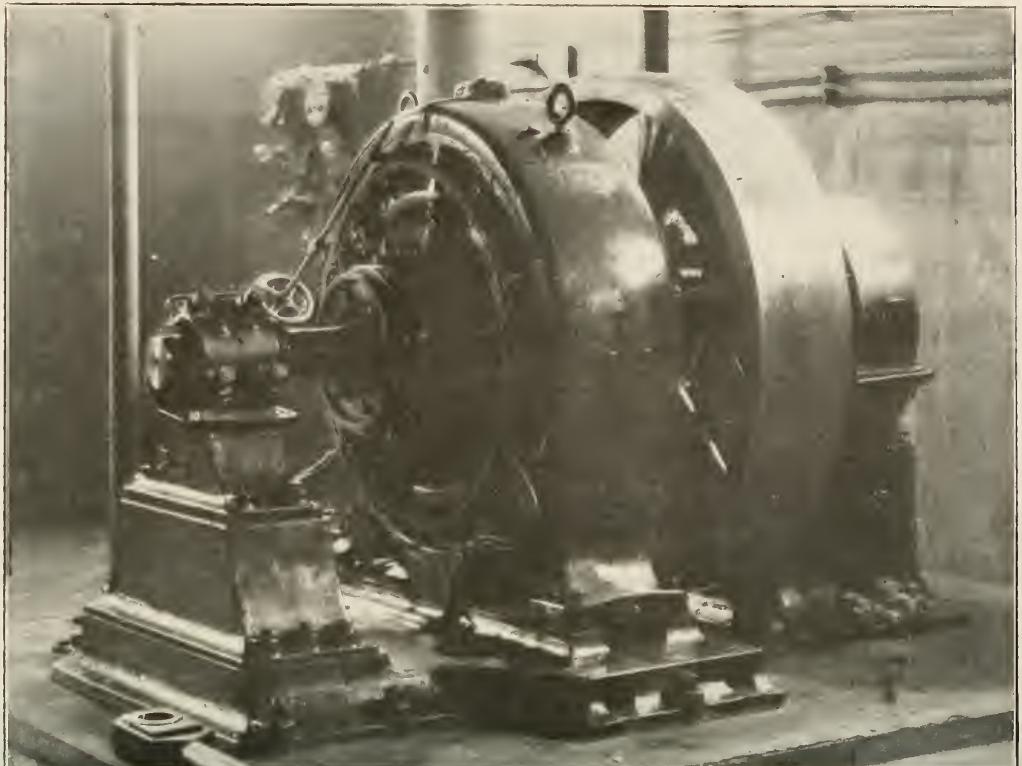
The fixed charges against the steam plant would be as follows:

Interest at 5 per cent. on whole investment	$3,152
Taxes and insurance at 2 per cent	1,251
Depreciation at 10 per cent	6,304
Total fixed charges	$10,717

Operating charges for one year:

Labor	$3,900
Coal at $1 70 per ton, 5,000 tons	8,500
Repairs, 1 per cent. of first cost	630
Oil, waste, etc.	1,650
Total operating cost	$14,680
Total cost of power for the year	25,397

Price per K. W. hour, calculating on a 10-hour run, 308 days, 1.1 cts. The same calculations on a producer-gas plant of the same size offer a comparison which is well worth studying.



A 105 H. P. Fleming Harrisburg Engine Direct Connected to a 75 K. W. Westinghouse Generator. This Engine is Carrying Three Electric Cranes; a Diamond Saw, and the Lights for the Plant. This Outfit is Economical When Carrying a Fairly Constant Load Near Full.

The cost of such a plant would be as follows:

Gas-producers at $23 per H. P.	$23,000
Accessories, including draft equipment, $9 per H. P.	9,000
2 500 H. P. gas engines	38,000
2 400 K. W. generators 550 volts	9,628
2 16 K. W. exciters direct current	810
Switchboard equipment at $4.25 per K. W.	3,400
Foundations for engines and producers	3,000
Total cost of plant without buildings	$84,138

Fixed charges on gas plant:

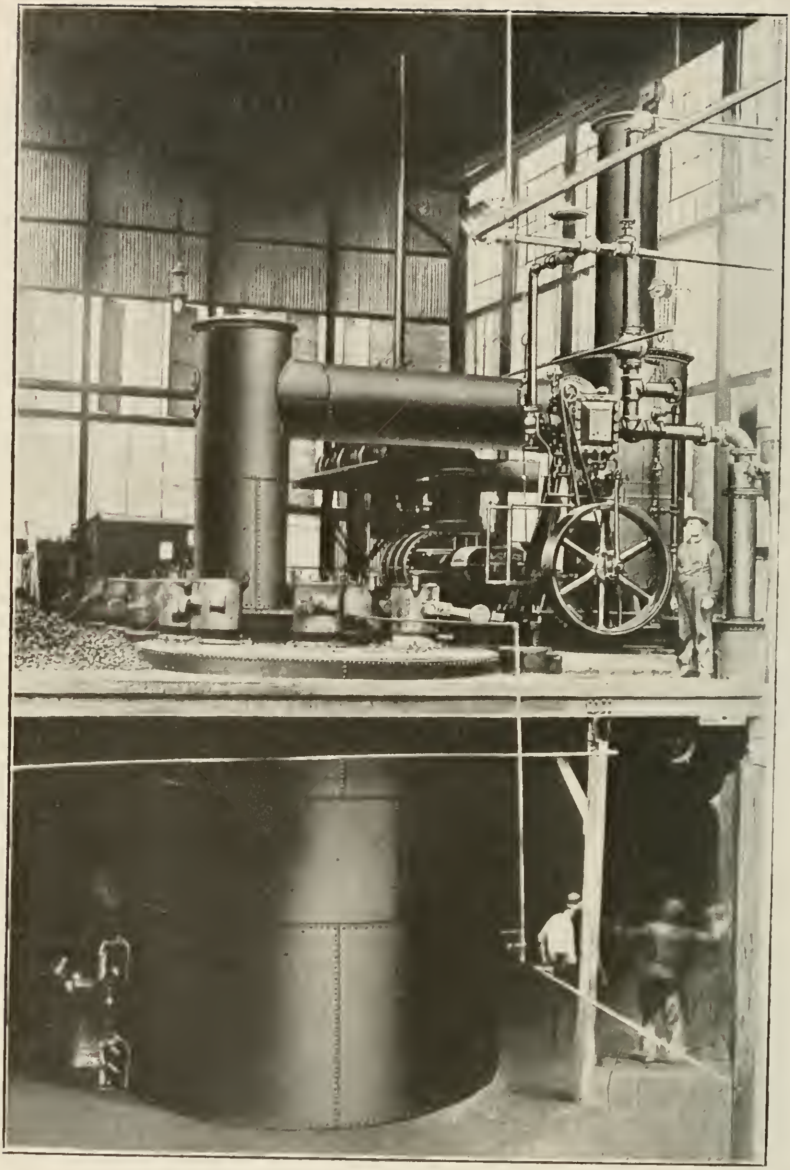
Interest at 5 per cent	$4,207
Insurance and taxes at 2 per cent	1,683
Depreciation at 10 per cent	8,414
Total fixed charges	$14,304

Operating charges on gas plant for one year:

Labor	$3,900
Coal at $1.70 per ton, 1,500 tons	2,550
Oil, waste, etc	1,650
Repairs	630
Total operating cost	8,730
Total cost of power for the year	$23,034

Cost per K. W. hour, 308 days, 10 hrs. per day, .93 cts.

I have placed in the equipment two engines with the idea of showing another economy. The villages of Elletsville and Stinesville do not have an electrical plant for lighting. If such a plant as I have outlined were erected there the over-night run on one of the engines would furnish much-needed power for lights at a very small expense. In fact the power could be developed for an additional .4 of a cent a K. W. hour after the fixed charges have been figured against the day run.



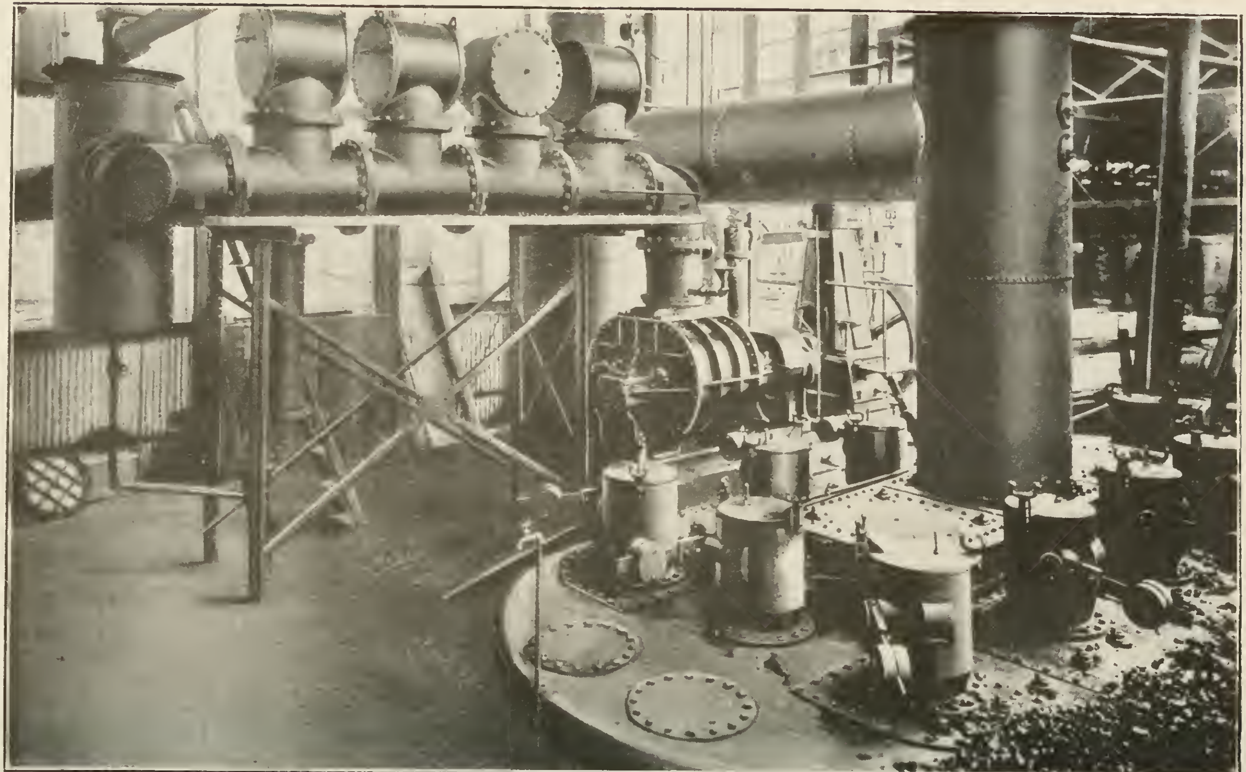
A View of Both Floors of a 1000 H. P. Producer-Gas Plant.

From these figures it will be seen that there is only a slight difference in the cost of power for the two types of machinery, but these figures would diverge in favor of the gas producers as the size of the plant was increased. If the plant were located in the coal fields and the power brought over as high voltage current, the amount of money saved on freight would pay for the transmission line in about eighteen months. In fact, for such a plant the line losses and cost of transformers at both ends of the line would bring the price of power to about the same figure.

Probably the ideal solution for the power question would be to furnish the entire district with power. This plant to be located in the coal fields and be of the by-product recovery type with gas engines and the power transmitted at 33,000 volts. Such a line and voltage would be the cheapest for conditions as they would be in this district.

There are numerous plants in Europe which depend upon the by-products recovered for their profits. A good example is the plant at Dudley Port, South Staffordshire, England, where a Mond by-product plant practically pays for all the fuel used, in the by-products recovered. The two principal by-products are ammonium sulphate and tar. The ammonium sulphate alone returned $2.25 per ton of coal burned, and the tar sells for $0.19 per ton of coal burned.

Ordinary bituminous coal will return 80 to 90 pounds of sulphate of ammonia per ton. Such plants now in operation produce a Kilowatt per hour of power on 1.54 lbs. of coal fired. Since the price of coal is so low in this district the cost of power would be but little over the fixed charges on the investment. This problem of power economy for the quarries begins to be of especial interest over the entire district, and if the issue were met squarely a great saving of money would result, as well as great economy in coal consumption.



The Feeding Floor of a Large Producer-Gas Plant, Showing the Large Floor Space Occupied.