Unloading coal at a lake port.

The Use and the Waste of Our Coal Supply

At the Present Rate Coal may be Exhausted while the Nation is Yet Young

By Dr. Joseph A. Holmes, Director of the Bureau of Mines

THE habit of waste is one of the unfortunate inheritances of the 20th century American citizen. It is our most serious hinderance to the development of both individual and national efficiency. More than anything else, it stands in the way of the wise use or conservation of the resources, ample, present and future, supplies of which are essential to our individual and national welfare.

This fact is important enough to command attention when applied to products of the soil, of which we have new supplies each year; or to our forests of which each century may bring returns; or to the soils themselves to which the underlying rocks slowly yield new additions as by careless culture we permit the fertile surface to be eroded and carried off to the sea. It is still more important when applied to our mineral resources, of which we have but the one supply—which supply has required millions of years for its accumulation, and which supply at the present increasing rate of consumption may be exhausted while the nation is yet young; and especially when applied to our fuel resources, of which the portions used each day are completely destroyed.

And, yet, the very abundance, and supposed abundance, of our mineral resources has developed and encouraged the habit of waste. A legislator of many years' experience in national affairs, was recently quoted as saying in a public address: "Why, worry ourselves about a future coal supply when there is undiscovered coal enough in the Rocky Mountain regions to warm this nation for an indefinite future." Another of our "older statesmen" has in recent public utterance voiced the same view: "We have enough coal and to spare," he said, "for a thousand decades of our national history; therefore, we need not concern ourselves about the use, nor the waste of American fuel." And the average citizen has so long heard so much about the "exhaustless resources" of this country, that he is half way inclined to believe such statements.

It is only within the past few years that the real facts of the situation have impressed themselves upon us. The end of the coal supply in certain important centers is found to be already nearly in sight. The cold-blooded statistician studying the future in the light of the past, tells us that, if the increasing rate

of consumption of the past century be continued in the future, our national coal supply may be exhausted within less than two hundred years. The States that first feel the effect of this fuel exhaustion, in spite of their larger supplies, will be those like Pennsylvania, West Virginia, Ohio, Illinois, and Iowa, located near great manufacturing and transportation centers, and upon whose supplies the largest drains are being made—both in the use and the waste of essential resources.

Be this all as it may, as to one fact and principle all thoughtful citizens must agree, namely, that while no one questions the right of each generation to use efficiently of this coal supply all it really needs, this right carries with it a sacred obligation—that no man and no generation of men shall waste that which is not needed for its actual use, and which, therefore, belongs to the nation.

Waste in Mining Coal.

The fact that the loss of coal in mining operations now approximates 250,000,000 tons per annum; or that we leave underground in such condition as to make its future recovery impracticable, half a ton for every

Removing coal from hold of lake steamer to a storage platform.

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ton of coal now brought to the surface, is a fact that commands serious consideration. And what makes a bad matter worse, is the fact that this coal left underground is often a menace to property by originating or harboring mine fires, and often a menace to life by developing supplies of explosive mine gases that may by falls or settling of roof be driven unexpectedly into the working parts of the mine, where open lights or other agencies may ignite it and cause a mine disaster.

In some mines from eighty to ninety per cent of the coal is brought to the surface. In many mines the recovery ranges from sixty to seventy-five per cent of the whole, while in some mines the recovery is from forty to sixty per cent. In some cases this loss consists mainly of the pillar coal left in place to support the roof while the other coal is being removed, and which pillar coal may be later not removed or only partially removed.

In addition to this pillar coal in many mines there is a "roof coal," or "rooster coal," or "top coal," and also a "bottom coal," which is also left underground because lower in quality or more expensive to mine.

Additional losses of coal coming from the pulverizing action of the drills and coal cutting machines (see photo), from the grinding of coal under the wheels of the mine cars (see photo); and from the sorting or screening and washing and general handling about the shaft and tippie. Much of the fine coal in the mines is not removed and remains as a menace to life if involved in dust explosions. Much of the fine coal removed from the mines accumulates in the great black piles of *culm*, where it may or may not burn from spontaneous fires; or it may be shipped away and marketed as slack; or in a few cases this fine coal is being briquetted and sold at prices as high as those obtained for the best lump coal.

All the above sources of waste relate to the losses in mining a single bed of coal. Still other losses come where several beds of coal occur one above the other with thin intervening beds of rock, from the prior mining of the lower bed. This often results in an irregular breaking and settling of the overlying bed or beds of coal in such a manner as to seriously interfere with the subsequent mining and recovery of this overlying or upper coal.

In other countries regulations require in such cases the prior mining of the overlying or upper beds of coal, in order to avoid this unnecessary settling and breakage of successive higher beds. But in the United States each company has followed the law of "present profits" and least resistance; and the "future welfare of the nation" has remained an iridescent dream.

Losses in the Transportation of Coal.

From the shaft and the tippie the coal falls into the forty or fifty-ton coal cars for transportation by rail (see photo), or into the barges for transportation by river (see photo). In these transport barges, as seen on the Ohio and Mississippi rivers, a single small stern-wheel steamer attached at the rear of the group of the barges, may carry to New Orleans from 40,000 to 60,000 tons of coal (photo).

If intended for ocean or lake transportation by steamer, the coal may be allowed to run from the opening in the bottom of the car (or an elevated track) directly into the hold of the steamer; or each car may be elevated separately and inverted, the coal rushing down the chute into the steamer's hold. At the other terminal port the coal whether transported by barge or steamer is lifted by great

steel grab buckets and placed on storage platforms (see photo), or again placed on cars for further transport (see photo). At every handling of the coal there is an increase of fine coal or slack (photo), and a small per cent of loss. But often the total actual waste in the haulage, including the several transfers,

will aggregate less than 10 to 15 per cent of the original tonnage; and while the fine or slack coal sells at prices from 20 to 50 per cent lower than the good lump coal, with modern automatic stokers and briquetting plants, there is really little loss in actual heating value.

Losses in the Use of Coal.

Great as are the losses of coal in mining, they are proportionately less than in its burning in the furnace of the country. The experienced manufacturer who, as a large consumer of coal, habitually watches the double entries on the pages of his ledger for profits and losses, does not hesitate to express his surprise and disapproval when he hears the story of mining losses, approximately 250,000,000 tons of coal in a single year; but in doing this he often loses sight of the no less serious fact—that of the coal used in his own furnaces, *less than 10 per cent of its heat units are converted into mechanical work* in his factories; or the larger fact, that of the 300,000,000 tons of coal probably used in the power plants of the country (including locomotives), 270,000,000,* or 90 per cent of the whole, was lost in the several transformations of energy; and not more than 10 per cent of the heat units, or the equivalent of only 30,000,000 tons of this coal, was transformed into the mechanical work of the nation.

The situation seems clearer if these losses are subdivided or classified. This cannot be done accurately in a general statement, because of the variations in the different furnaces, boilers and engines. But taking a common type of smaller power plant, the disposition or consumption of British thermal units in the burning of the ordinary bituminous coal (containing 13,500 B. T. U.) has been given as follows:

	B. T. U.	Per cent.
Loss in ashes	135	1.00
Carried off in gases....	2,970	22.00
Loss in radiation from boilers	675	5.00
Carried off in auxiliary exhaust	190	1.41
Loss in radiation and leakage, main pipes..	210	1.56
Loss in radiation from small pipes	30	0.22
Loss in radiation from engine	280	2.07
Rejected to condenser..	7,737	57.31
Converted to power or mechanical work....	1,275	9.43
	13,500	100.00

The government of the United States is probably the world's largest owner of coal lands; it also operates a large number and variety of heating and power plants located in widely separated parts of the country, besides the Panama railroad, lines of transport steamers, and its naval vessels. Furthermore, the fuel problem enters so largely into the manufacturing, transportation and interstate commerce of the whole country that they may be reasonably classed as national problems.

In recognition of these facts, Congress several years ago authorized an investigation of fuel problems, first under the Geological Survey, and subsequently under the Bureau of Mines. Under the latter bureau this work is now being reorganized, and co-operating with other existing agencies, the engineers and chemists of the Bureau of Mines, working at its Pittsburgh laboratories, are endeavoring to locate and reduce or eliminate as far as may be possible the sources of loss or waste not only in the mining, but also in the use of our fuel resources.

(Continued on page 150.)

* This does not include a loss which in extreme cases may reach 25 per cent of the coal, where finely divided non-caking coal passes through the grate bars in an unburned condition, along with the ashes.

This ship consumes 1050 tons of coal each day.

Steamer "Sprague" towing 56 coal boats, containing 1,400,000 bushels of coal.

Good haulage minimizing production of coal dust.

Undercutting coal with compressed air drill.
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(Continued from page 139.)

These problems are intricate, and their satisfactory solution doubtless remote, but they are of such importance as to be worthy of the best efforts of the Government and of its private institutions and individual citizens.

In engineering and architecture we hide our ignorance as to the strength and other properties of structural materials behind the well-sounding phrase, "factors of safety." In these important and intricate fuel problems we hide our ignorance and rest our laurels concerning these losses under the equally comforting expression, "transformation of energy." What American industry needs is technical information, accurate fundamental data, such as comes from varied, extended, continuous, well directed, and scientific research.

Each recent year has witnessed some advance in the line of greater fuel efficiency; and while each advance has been small, the aggregate has during the past decade raised the percentage of heat units converted into mechanical work from five or six to nine or ten, and slightly more in a few cases. The gas producer and gas engine, the steam turbine, and the improved reciprocating engine, represent steps in this advance. So does also the

including the saving of such valuable by-products as creosote for the preservation of timber, and sulphate of ammonia, so largely used in the fertilizing of crops. The other is the use in large gas engines of the blast furnace gases that formerly were entirely wasted, and in many places are still largely wasted. The losses in these two fields, added to the shameful waste of natural gases, still aggregate yearly from \$50,000,000 to \$100,000,000; but improvements are under way in all these lines.

How These Mining Losses May Be Reduced.

No one questions the fact that these losses are real; nor are there any serious differences of opinion as to the proposition that these losses should be avoided. Just how this best can be done is another matter, and one about which a difference of opinion may naturally arise. The situation is full of interest; full of problems for the statesman, the engineer and the economist, the consumer and the producer. It involves the very essence, the purpose and the practicability of the movement for the conservation of resources.

The case may be stated as follows:

We have but the one supply of coal, and this supply is essential to both the future and the present welfare of the nation. At the present increasing rate

petition with operators in other States.

The remedy is easily stated, but not easily developed. The cut-throat competition should give place to a reasonable combination under such Federal or uniform State control of prices as would guarantee reasonable returns on mining investments, and require mining practices in which both accident and waste are reduced to an absolute minimum. This regulation and readjustment should be extended so as to include the freight and terminal agents' charges; and if this be properly done, safe and clean mining may be realized without material increase in the cost of coal to the ultimate consumer.

If to the American people the doctrine of conservation is a thing of substance and not a dream; if those of us who today are wastefully luxuriating in the abundance of inherited resources, have seriously at heart the rights and the welfare of those that are to come after us; if we are really in earnest about safeguarding the lines of the more than a million miners who labor underground for our comfort and welfare, we should enact and enforce the Federal and State legislation necessary for the accomplishment of these ends. We should render possible the business-like reorganization of this great basic industry. We should see to it that this underlying economic basis is sound, whether judged from the standpoint of the individual or the nation—from the standpoint of the present or future welfare of the nation.

The Vibrations of Metals

It has been contended that solid metals may reveal by their structure the vibrations to which they have been subjected. In explaining this phenomenon, experiments were made in England to show that a beautiful wave structure can be imparted to the surface of mercury by the vibrations of a tuning-fork, and that even the surface of solid lead which has been subjected to similar vibrations possesses a structure resembling that of a vibrating surface of mercury. Mild steel was defined as a "solid solution" of iron and carbon, free from cinders. Metallurgists have doubled the strength of steel as it was known in early days.

Iodide of nitrogen, a black powder, is one of the most dangerous of all explosives. When dry, the slightest touch will often cause it to explode with great violence.

There appears to be a certain rate of vibration which this compound cannot resist. In experiments to determine the cause of its extreme explosiveness, some damp iodide of nitrogen was rubbed on the strings of a bass viol. It is known that the strings of such an instrument will vibrate when those of a similar instrument, having an equal tension, are played upon.

In the present case, after the explosive had become thoroughly dry upon the strings, another bass viol was brought near and its strings were sounded. At a certain note the iodide of nitrogen on the prepared instrument exploded.

It was found that the explosion occurred only when a rate of vibration of 60 per second was communicated to the prepared strings. Vibration of the G string caused an explosion, while that of the E string had no effect.

The question is often asked, What force least expected does the greatest damage to buildings? One architect's answer to this question may be a surprise to those who do not understand that it is the regularity of vibration that makes it powerful.

"I venture to say," remarked this architect, "that you would never suspect that violin-playing would injure the walls of a building. Yet it certainly does. There have been instances when the walls of stone and brick structures have been seriously damaged by the vibrations of a violin. These cases are, of course, unusual, but the facts are established.

"The vibrations of a violin are really serious in their unseen, unbounded force, and when they come with regularity, they exercise an influence upon structures of brick, iron or stone. It follows, of course, that there must have been continuous playing for years to cause the loosening of masonry or to make iron brittle, but it will do so in time."

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WANTED.

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MISCELLANEOUS.

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Coal car is picked up bodily, turned over, and discharges to chute.

development and introduction of the several types of automatic stokers; these latter contributing to efficiency and at the same time lessening the smoke nuisance from modern power plants.

These automatic stokers and special grates have further contributed to the conservation of resources by making possible the more efficient burning of fine or slack coal, which formerly was relegated to culm piles as waste, and as such to be burned in the open air. Briquetting is making another contribution along the same line. Another step in the direction of practical conservation, cleanliness, and hygiene—and one that should be pushed more rapidly—is the location of the great power plants at the mines, and the burning there, either in gas producers or specially constructed furnaces, of the low grades of coal now thrown away because they will not bear transportation; and the electric transmission of the power so developed to adjacent cities, towns and isolated plants.

I look forward to a time—and it cannot, I believe, be far distant—when ample supplies of electricity so generated and brought into our factories and our homes will not only give us light and power, but will also cook our food and warm our houses.

Two other marked advances in the economic utilization of coal deserve mention because of both their extent and their far-reaching importance; one is the large beginning in the manufacture of by-product coke for the latest steel plants of the United States Steel Corporation,

Much coal is lost as dust during handling.

of use and waste of this supply, it will be used and destroyed while the nation is yet in its youth. By mining and using this coal more efficiently, the life of the supply may be extended indefinitely, and both the present and future welfare of the nation thus properly safeguarded. The coal operator does not practise wasteful methods by preference. He is, however, operating under a system that encourages and even renders inevitable these wasteful practices; and for which system the public itself is largely responsible.

A Federal statute makes it impossible for the coal producers to co-operate or combine with a view to fixing a common or non-competitive price for coal at the mine. The demand for coal during the winter season of each year being much in excess of that during the warmer months, and the entire lack of storage facilities at the mines requires for this cold weather demand a mining capacity much in excess of that necessary for the summer needs. Under such a system there is constantly in progress a fierce struggle for business, and a reduction to prices so low that they often fail to cover the actual cost of production—so low that safe and clean mining is discouraged and even rendered impossible. Meanwhile, no two States have similar mining laws for the protection of life and property, nor will any State enact, or enforce, if it enacts, drastic legislative requirements, for if it does it thereby places its own mine operators at a serious business disadvantage in the sharp com-

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Furthermore this car has bigness, strength, proved durability, beauty, fine finish, comfort. Still further, it is a Chalmers car. On the radiator is the famous blue and white monogram.

And the price, including all these unusual features of value, is \$1800.

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Many motorists, hearing of the Chalmers "Thirty-six" for the first time, then learning the price, have felt much the same way.

But they are wrong. There really is such a car as the Chalmers "Thirty-six," with the features named above—for \$1800.

You can see this car now at our dealer's store near you. And it will look better to you there than it does in this advertisement. See it. Ride in it. Place your order as early as you can because there is sure to be an over-demand.

Ideal Car for the Farmer

This is an ideal car realized. A car perfectly adapted to the needs of the up-to-date farmer. The long stroke motor gives all the power and speed you

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The "Thirty-six" is heavy where weight means maximum strength, but there is no useless weight. We claim that this car is lighter than any other car of the same power, roominess and strength, and that it is stronger than any other car of the same weight.

This car overcomes the inconveniences of all preceding cars. The Chalmers Self-starter, air pressure type, does away with the trouble of cranking. Big tires and Continental Demountable rims rob punctures of their terrors.

Given Severe Tests

While the "Thirty-six" has every up-to-the-minute improvement, still there is not a single untried principle or part in its makeup. In November, 1910, we started three of these cars on the road to test them—one in the mountains of Pennsylvania, one in the sands and heat of Florida, and one in the varied conditions of the Middle West. They were run an average of 10,000 miles each before we O. K.'d the model for manufacture.

Here is a big car—big radiator—big hood—big wheels and tires—big body with big roomy seats—big, strong frame—big axles—big all over, and yet it isn't a cumbersome, costly upkeep car.

Not only has this car all of these unusual features of construction and convenience, but with them it has beauty. It is a *fine* car.

Compare With Many Cars

There are bigger cars than the "Thirty-six" and smaller ones. Cars of more power and of less. Heavier cars, lighter cars. There are higher priced cars and lower priced cars. And yet we ask you to consider this car on the basis that it is the most nearly ideal car for the farmer of all that are made.

Take the size, the power, the conveniences, the construction, the comfort, the beauty and the price

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Public announcement of this car was first made on July 6th. Prior to that date, dealers had signed contracts for all we can make. They were anxious to sign up for twice the number, but we had to allot just so many to each territory. Since our announcement appeared, the Sales Department has received requests from more than two hundred other dealers, asking for the privilege of handling the Chalmers line in their section.

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