TWENTIETH CENTURY ENERGY.

BY ALTON D. ADAMS.

Beyond doubt coal exerts the widest and most important influence on humanity. Coal constructs and drives the steamship, locomotive and electric car, lights the gas flame and the electric lamp, turns the wheels of industry, and makes habitable the factory, the office and the home. It brings to us a great store of energy from the sunshine of former ages. Unfortunately, our methods of using this product of Nature's laboratory are so wasteful that the greater part of the stored energy escapes without performing any useful work. The supply of coal is limited, how limited we do not know; but a just regard for people yet to be, bids us use with reasonable care this substance, for which science has thus far discovered no substitute.

The losses that occur in the application of the energy of coal to our purposes, result partly from a direct escape of heat during the process of combustion, but often to a greater degree when the heat is changed to motion, electricity, or light. In house stoves, furnaces, hot water and steam heaters it is variously estimated that from one-half to three-fourths of the energy of the coal burned escapes with the flue gases. The steam boilers of large power plants are more efficient than domestic heating devices; and the chimneys of such plants usually receive from one-fifth to one-third of the energy of the coal put into their furnaces. In the very general use of steam for the production of mechanical motion, much energy is lost. The steam contains from one-half to three-fourths of the heat developed by the combustion of the coal used; but the steam engine is able to deliver as mechanical power only from five to fifteen hundredths of the coal's energy. The generation of electricity on a commercial scale is at present entirely dependent on mechanical power, and the dynamo is a very efficient machine, delivering usually in the form of electric current as much as nine-tenths of the energy supplied to it. Unfortunately, however, the steam engine has been the only prime mover available for the general operation of dynamos, and the electricity delivered has been seldom more than one-tenth of the energy of the coal burned.

The production of gas from coal is a process of rather low efficiency. What is known as coal-gas contains about one-fourth of the heating power of the coal from which it is generated; but along with the gas, coke is produced to the amount of five or six-tenths of the coal's total heating capacity. Where the coke can be used or sold to advantage, therefore, the gas and coke together are a fairly efficient product. Nowadays water-gas is largely displacing coal-gas, because its production is cheaper. This water-gas has from five to six-tenths of the energy in the coal consumed for its output; but there is no coke remaining to raise the total efficiency. Coal-gas is suitable for either light, heat or power production, without additions of other substances, but water-gas is available for heat and power only when treated with heavy mineral oils.

The gas engine, whose development has now reached a stage that renders it of great importance as a prime mover, shows a marked improvement over the steam-engine in the matter of efficiency. For example, the best steam-engines deliver in mechanical work only about fourteen-hundredths of the heat energy in the steam entering them, while fair gas-engines convert into motion two-tenths of the heat energy of the gas they consume. This higher efficiency of the gas-engine is more than offset, for plants of fairly large size, not only by the difference in contained energy between coal and the coal gas or water gas it produces, but especially by the prices at which these gases are commonly sold. At one dollar per thousand feet, coal or water gas costs as much for power production as would coal at fourteen dollars per ton in a good steam plant. In small steam-power plants the consumption of coal is relatively very large, and this, together with the small amount of labor necessary for the care of a gas-engine, gives the latter a place where only a little power is wanted, in spite of the high price of fuel in the gaseous form.

For general heating purposes, coal and water gas make a poorer showing than coal. At one dollar per thousand feet, the cost for a given quantity of contained heat is about equal to that of good coal at forty dollars per ton. As more than one-half of the heat energy of coal usually escapes up the chimney, in house heating, and as there is a smaller loss of heat in this way when gas is the fuel, the probable cost of general gas heat is that of coal at from thirty to twenty dollars per ton, when gas costs one dollar per thousand feet. For many special purposes, where a small amount of heat is wanted during a short time, gas is, no doubt, the cheaper fuel, because it can maintain a very small fire, which can be started or extinguished immediately.

For a given illumination, the amounts of energy consumed at the lamp differ greatly between gas and electric service. The ordinary gas flame consumes about sixteen times as much energy to produce the same amount of light as does an incandescent electric lamp, and about sixty times as much as produces an equal illumination in the electric arc. In spite of the low efficiency of the gas-engine, when coupled to a dynamo, the gas used to drive it for the production of electricity yields three times as much light in incandescent lamps and about eleven times as much in arc lamps as would the same amount of gas give off if burned directly at gas jets. The electric heater is one of the very few devices for the transformation of energy that have a perfect efficiency, in that it sends out as heat the equivalent of all the electricity consumed by it. Notwithstanding this perfect efficiency, it can never play an important part in general heating, so long as the production of electricity depends upon heat-driven prime movers of low efficiency. But little more than one-tenth the energy of coal can be delivered to the electric heater, while coal-gas brings one-quarter and water-gas about one-half to the gas stove. While the gas-heater is not as efficient, considering the losses by imperfect combustion and escape of heat through the chimney, as the electric type, it still renders useful a much larger part of the heat-energy of coal. All of the conditions and operations that require heat, mechanical energy, electricity and light thus rest on coal for their production. Heat-energy from coal is more economically applied to power production, and in many cases to heating purposes, through the medium of gas, but coal and water gas contain so small a part of the energy in coal, and are sold at such prices that their advantages over steam at the engine, or over coal at the heater, are largely vitiated. Electricity shows great economy over gas for illumination; it is much cheaper for a given amount of light to use gas in the gas-engine to drive a dynamo and thus supply electric lamps.

A gas produced at a moderate cost, and charged with nearly all the heat-energy from its coal, would materially reduce the coal consumption and cost of heating, power production, and electric lighting. Investigations looking to the cheap production of such a gas have for some years been in progress, and at recent dates the desired results have been obtained in both Europe and America. This comparatively new product, known as "producer" or fuel-gas, contains fully eight-tenths of the heat energy of the coal from which it is made, and, moreover, this coal may be of the cheapest grade. This producer gas can be economically made in even small amounts, such as might be required for a private power or heating plant. It is also adapted for distribution on an extensive scale. The expense of the plant for the production of fuel-gas is moderate, being about the same for a small equipment as that of a first-class steam-boiler plant of equivalent power capacity. As the gas-producer shows an efficiency that is rarely reached in actual practice by the steam-boiler, and as the gas-engine requires only about two-thirds of the heat-energy in gas that the steam-engine does of steam for a given amount of mechanical work, a power plant or factory can save at least one-third of the coal necessary in a steam-plant by the use of a producer and gas-engine. Moreover, the gas-plant is at a decided advantage as to its ability to begin power production at the maximum rate or stop entirely, on a minute's notice, which cannot be done with the steam boiler and engine. In plants for the supply of electric energy to the public, for which the fuel consumed is a very important item, the properties of the gas producer and engine make them of especial value, and their use in electric stations should reduce the price for electric current. In large, private heating-plants, the gas-producer effects a saving over the ordinary steam or hot water equipment, though the gain is not so marked as where power is required. When used in a large plant for general heating, the producer-gas will be burned in a suitable steam or hot-water heater, and the saving will result largely from the cheap grade of coal used. The low heating power of coal and water gases, compared with the energy of their coals, the expensive plants necessary for the production of these gases, and their preparation for purposes of illumination, have all tended to make their general use for heating purposes impracticable. Producer or fuel gas, containing four-fifths of the energy from the cheapest grades of coal, instead of only one-quarter to one-half of the heating power from the more expensive grades, as do the illuminating gases, is available for the general supply of heat in towns and cities, at a rate comparing favorably with coal.

One ton of anthracite buckwheat coal in the gas producer yields on the average from 160,000 to 170,000 cubic feet of gas, which contains fully eight-tenths of the heating power of the coal. The total cost of manufacture for this gas on a large scale is certainly not more than three cents per thousand feet; doubling this amount to cover distribution, charges and profit would give the fuel-gas a selling price of six cents per thousand feet. Fuel-gas has about one-fifth of the heating energy per cubic foot that is contained by the coal and water gases, and at six cents per thousand cubic feet would be equivalant in cost of heating capacity to either of these gases at thirty cents per thousand feet or to coal at about twelve dollars per ton. Gas in house-heaters will give from two to three times as much of its contained heat-energy in useful effect as coal commonly gives and would really equal coal at from four to six dollars per ton at the rate mentioned. The great economy of fuel to be effected by the reduction of coal to gas before its general use for heat and power, and the substitution of glow lamps for the open flame, seem certain to make gas and electricity the forms of energy which will prevail in the twentieth century.

PARIS EXPOSITION NOTES.

Contracts for the dismantling and razing of the Paris Exposition buildings have been signed, and the job has been given to a Chicago firm which tore down the buildings after the Columbian Exposition, and also those at the Omaha Exposition. The contract for the work was signed the day the Paris Exposition opened. Lumber is very dear in France, and there will be 75,000,000 feet available after the close of the Exposition.

An interesting collection of weapons is to be seen in the building devoted to forestry and chase. A number of cases contain weapons sent by the Czar and those which belonged to Prince Eugene, lent by the Duke of Leuchtenberg. A gun which belonged to the Czar Paul I. is to be seen, and the sword which Napoleon wore at Tilsit, and which he presented to the Emperor Alexander. A number of pistols of different kinds and fowling pieces which belonged to the Princess Elizabeth, also a pistol belonging to Henri III. of France, are shown. The Imperial Treasury of Moscow has loaned a sword which was given by the City of Paris in 1814 to General Osten-Sacken, who was governor at that time. Prince Lwoff has loaned a sword which was worn by the Emperor Napoleon, bearing the date 1806; it is richly ornamented. The arms of the Prince Eugene de Beauhamais are shown, among which is a sword worn while Viceroy of Italy and another worn as Prince of France. The cross-bow which belonged to the Queen Marie de Leczinska has a barrel in steel, damascened and inlaid with gold. Among other objects are a single-barreled gun of the time of Louis XV., and a number of gems and pistols of the eighteenth century, besides a collection of sabers and swords dating from 1791 to the present time.

The number of entries to the Exposition has been steadily increasing ever since the official opening, but at no time has the crowd of visitors been so large as that of Sunday, May 27, when a total of 406,196 persons passed through the entry gates, 52,131 of these being non-paying; at 10 o'clock in the morning the circulation in certain places had become difficult, and in the afternoon the crowd was greatly increased in the Champ de Mars, the Rue des Nations and the Invalides. The spectacle, when viewed from the height of the Trocadéro Palace, is interesting and novel; the weather was fine, and it is evident that the Exposition is beginning to attract a large part of the public. At certain times the crowds at the entrance gates were such that special measures had to be taken to avoid accident; a number of police agents were stationed at each passageway to regulate the traffic. The moving sidewalk was at times completely filled, and the stream of persons passing at a high elevation is one of the interesting sights of the exposition. The electric railway also carried a great number of passengers and is of great convenience in passing from one section of the grounds to another as but short time is employed to make the circuit. The palaces and pavilions have never before received such a number of visitors; the various buildings of the Exposition are practically completed, and many of the national pavilions are already open to the public. In the main buildings of the Champ de Mars, a great number of the exhibits have been completed, and the others are making rapid progress.

The Army and Navy Building, which is situated on the banks of the Seine, contains a number of interesting exhibits. Among the principal exhibits may be mentioned a collection of Hotchkiss rapid-firing guns of different types, with a number of projectiles. The Mangin Company show a number of arc projectors for marine use; and the Clamond Steel Works has a collection of field cannon and ammunition wagons. An interesting exhibit is that of a number of stuffed horses and mules attached to ammunition wagons, showing the system used in the French army. The Dubos Company has a new system of diving suits and appliances. A number of fine models of French boats are to be seen here; these are exhibited by the different dock and naval construction companies. Some of them have been furnished by the Société des Chantiers de la Gironde, who show a model of the "Kleber" and the method of boat-construction; the firm of August Normand, of Havre, have a series of models of cruisers, among which may be mentioned the "Azuma," built for the Japanese government, and the "Massena" and "Guichen," of the French navy. A number of automobiles for military use have been already installed. Among these is a heavy transportation wagon of the Scotte system, having a steam engine mounted in the forward part, the rear being arranged to carry freight; another large freight wagon is that constructed by the De Dion Company, using the gasoline system. A number of light automobiles are to be seen; one of these is for the officer's use, and another for the military postal service.