Form-wound, interchangeable armature coils are held in open slots by means of fibre wedges. The coils are vacuum dried and impregnated before the outside insulation is applied. This outside insulation consists of wrappings of paper and mica on the straight portions of the coils which lie in the slots, and servings of treated cloth over the V-shaped coil ends. After the outside insulation is applied the coils are treated with an insulating varnish which renders them moisture and oil-proof. An insulating coil is provided in each armature slot to prevent abrasion of the coil and a fibre wedge holds coil and cell firmly in position.

In case of failure of a waterwheel governor to act, the rotating part of both waterwheel and generator are subjected to unusual stresses, due to the overspeeding of these parts. The rotors here illustrated are designed for the maximum obtainable speeds which result in such instances. These overspeeds vary from 50 to 100 per cent. Due to the wide range of speeds encountered, no one type of rotor construction will give ideal results.

There are several designs of rotors, each one particularly well adapted for the requirements for which it is used. Comparatively low peripheral speeds may permit the use of a cast-iron spider with either bolted-on or dovetailed poles. A higher speed generator may demand an entirely different construction. For such work cast steel or rolled steel plates are often employed. In case of very large machines, it may be difficult to obtain perfect castings, and here the well-proven laminated rim may be employed.

Field coils are ordinarily wound with heavy copper strap on edge and insulated between turns with asbestos. This construction is particularly well adapted to give perfect radiating qualities, and because of the heavy strap used is practically indestructible. The coils are securely fastened between the rotating spider and projecting tips of the field poles by heavy coil supports.

Waterwheel generators of almost any practical capacity or speed for installation in the smallest isolated plant or the largest hydro-electric generating station have been furnished by the Westinghouse Electric and Manufacturing Company.

It is noticeable that the value and conservation of cheap fuel and power in the United States are being more fully appreciated each year. When it is borne in mind that coal in the States of Illinois, Ohio, Pennsylvania, Virginia and Alabama during the year 1910 averaged in price $1.08 per short ton at the mines, it will be better understood why these States occupy such prominent positions in the industrial world. The cost of transport in these States is not a serious item, for the cost of bituminous coal, according to quality purchased, ranges from $1.50 to $3.00 per ton, f.o.b. New York harbor. Coal in large quantities can be had in Pittsburg for $1.00 a ton, but even in remote parts of the above-named States the cost averages under $3 per ton. The supply of natural gas was at one time abundant and cheap, but extravagant waste has led to serious depletion and increase in price. Water power has been developed in some of these States, with the result that the cheap electrical power which is available, has contributed considerably to the development of the country around. As already stated, the movement in the United States towards the utilization of poor fuel is becoming stronger each year, and the result is the establishment of power plants where formerly it was not thought possible, and this is opening out new industrial centres to the advantage of all concerned.

NEW METHOD OF COOLING GAS ENGINES.

ORDINARILY about 30 per cent. of the heat value of the fuel passes from the hot gases to the cylinder walls and pistons, states Prof. Bertram Hopkinson, in a paper read before the Institute of Mechanical Engineers, at Cambridge, describing a new method of cooling the cylinder and piston of gas engines. In order to prevent the overheating of these parts under test conditions, it is necessary to provide a water jacket around the cylinder, and, in the case of large engines, to circulate water through the pistons and around the exhaust valves. Most of the disadvantages under which the gas engines labor are due directly or indirectly to this fact. The complicated and thick-walled castings required for the cylinders are apt to crack under the influence of the wide variations of temperature, and overheating of deposits on the internal walls of the combustion chamber causes pre-ignition, so that it is not always practicable to work a gas engine continuously at its maximum output.

The idea of introducing water into an internal-combustion engine is not new. It is a common practice in oil engines to introduce water along with the oil in order to permit the compression to be raised, and water has been injected into gas engines for the purpose of preventing pre-ignition. Proposals have also been made to introduce water for the purpose of cooling parts of the metal. None of the latter, however, have been practical, if indeed they have ever been more than just proposals on paper, apparently because their originators did not appreciate the conditions which must be satisfied with the injected water to act as an effective cooling agent. If the water be turned into steam before reaching the metal it will not exert any cooling effect, except indirectly by lowering the temperature of the flame, and such lowered temperature is accompanied by a considerable loss of efficiency. On the other hand, water which reaches the walls in liquid form and is there evaporated, absorbs out of the heat given to the walls by the gas the whole of its own heat of evaporation, and there is no loss of thermodynamic efficiency, because the heat used is waste heat, which, in a jacketed engine, would go to warm the cooling water.

The author claims that it is of no use to inject the water in a fine spray, or to introduce it into the gas or air pipe, so that it is carried in suspension in the incoming charge, or, as is often done in oil engines, to spray it in along with the oil. Although some of these devices have proved useful for the prevention of pre-ignition and for the softening of the explosion, none are effective for the purpose of cooling.

The author found, however, that by injecting water in comparatively coarse jets against the internal surface of the cylinder, and the head of the piston, the metal can be kept cool without materially cooling the gases, with the result that there is no loss of efficiency. The temperature of the parts can be perfectly controlled, and simple single-walled castings can be used for the cylinders.

Experiments of Dugald Clerk, the author, and others have shown that the rate of heat-flow from the gas into the metal is far more rapid at and soon after the instant of ignition than at any other time. It seems likely from these experiments that for practical purposes the heat flow into the barrel of the cylinder during the last three-fourths of the expansion stroke might be so small compared with that in the first period that direct cooling of this portion of the cylinder could be dispensed with altogether. This anticipation has been found correct, and