hour, or 2.5 per cent. thermal efficiency. Some plants will do better than the above with proper conditions, and some may do worse, but in general it may be said that the performances of steam plants lie between the limits of 2.5 and 10 per cent. thermal efficiency.

Plants consisting of gas producers for transforming coal into gas for use in gas engines have in general a much higher thermal efficiency than steam plants doing the same work. They are, however, not built quite so small as steam plants, the smallest being about 25 horse-power, and in general they have not been built so large, the largest being only a few thousand horse-power. Their efficiency, however, does not vary so much as is the case with steam plants. It may be fair to say that under the same conditions as previously outlined these plants will use 1.25 to 2 pounds of coal of fair or poor quality per brake horse-power-hour, which gives a thermal efficiency ranging from 18 to 10 per cent. These plants can be made to do much better than this, and perhaps may do worse, although the variation is not nearly so great as for steam plants.

Gas engines operating on natural gas or on illuminating gas from city mains will, on fluctuation of load with the regular work, average about 12,000 heat units per brake horse-power-hour, or 20 per cent. thermal efficiency. Explosion engines operating on crude oil will average about 25,000 heat units per brake horse-power-hour, which is equivalent to about 10 per cent. thermal efficiency. Explosion engines using gasoline should operate at a thermal efficiency of about 19 per cent. under similar operating conditions.

The efficiency of an alcohol engine may be assumed at this time to be unknown, but as alcohol can be burned in engines designed for gasoline, it may be assumed that such an engine will have with alcohol fuel the same thermal efficiency as with gasoline, to wit, 19 per cent. for fair working conditions.

From the above brief discussion of the efficiency of different methods of power generation from different fuels it appears that quite a range is possible, though not so great a range as exists in the case of cost of fuel energy. Efficiency is seen to lie somewhere between 2½ and 20 per cent. for all the fuels under working conditions. It is known that actual thermal efficiency under bad conditions may be less than 1 per cent., and under the best conditions as high as 40 per cent. but these are rare and unusual cases.

The range given is sufficient to indicate that a highly efficient method may make the fuel cost per unit of power less with quite expensive fuel than it would be with cheaper fuel used in a less efficient machine. It is also perfectly clear that without proper information on the efficiency of the machine or the efficiency of the plant it is impossible to tell what the cost of fuel per horse-power-hour will be, even though the price of the fuel per ton or per gallon be known. From the figures given on the cost of fuel and a fair average for plant efficiency the cost of fuel per horsepower-hour is computed as given in the preceding tables.

ELECTRIC RAILWAY STATISTICS OF CANADA.

According to the annual report of the Department of Railways and Canals of Canada, there were in operation at the close of the fiscal year ended June 30, 1906, 814 miles of electric railway, 195 miles being double-tracked. The paid-up capital amounted to $63,857,070. The gross earnings aggregated $10,966,872, an increase of $1,609,747, and the working expenses $6,675,038, an increase of $756,844, leaving the net earnings $4,291,834, an increase of $852,903. The number of passengers carried was 237,655,074, an increase of 34,187,757, and the freight carried amounted to 506,024 tons, a decrease of 4,326 tons. The car mileage was 56,618,836 an increase of 4,659,735 miles. The accident returns show a total of 47 persons killed during the year, and 1,653 persons injured. Power was supplied in 15 cases by water, and in 41 cases by steam. Ontario has 441 miles, Quebec, 198, New Brunswick, 16, Nova Scotia, 54, Manitoba, 32, and British Columbia, 72 miles. Returns were received from forty-seven companies.

THE ANCHOR ARMS OF THE QUEBEC BRIDGE.

The bridge in course of construction across the St. Lawrence river, near Quebec, is 2,800 feet long between centers of anchorages, and will have a total width of 82 feet. It is designed to carry two railroad tracks, two highways, and two electric car tracks on a single deck about 160 feet high above extreme low water. The 1,800 feet cantilever span across the channel is flanked by two 500 feet anchor arm spans, each of which weighs about 12,500,000 lbs.

The erection of the south anchor arm on fixed falsework was completed last summer. Some of the details are entirely novel, and all are of interest on account of their dimensions, many of them unprecedented.

Work on them has been in almost constant progress for about four years, and they have been made to conform to a rigid analysis of conditions, to elaborate computations, and to the requirements of the highest grade of shop work. They have also been adapted to the greatest safety, facility, and rapidity of field erection, and have been proportioned to secure the greatest rigidity in the structure consistent with economical weight. Indeterminate stresses have been avoided, and members are proportioned strictly according to the actual service which they will perform under assumed maximum conditions. The great capacity and unprecedented dimensions of the bridge have therefore involved such high stresses in large members that the latter have exceeded all previous limits for shop built pieces; it has been necessary to provide unusual sections, some of them very massive and some of them limited only by the restrictions of transportation and by the maxima of commercial manufacture of steel plates and sections employed.

The main trusses are in vertical planes 67 feet apart, the top and bottom chords are segments of parbolic curves, intended to combine a graceful outline with theoretical requirements for depth. They carry the single-deck floor on a 1 per cent. grade up from the level of the bottom chord at the anchorage to a point 120 feet above the top of the main pier. The depth of the trusses increases from about 97 feet on the centers at the anchorage to 315 feet at the main pier. They are divided into five 100-feet main panels, or ten 50-feet sub-panels, each main panel being subdivided in two 50-feet panels. Alternate sub-panels have horizontal struts and counter diagonal struts stiffening the main web members. An important feature of the design is the use of separate pins at each main panel point top and bottom for the connections of chords and tension diagonals with the vertical posts. This arrangement greatly reduces the bending moments and consequently reduces the sizes of the pins, and facilitates assembling the members during field erection.

The trusses have lateral bracing in the planes of the top and bottom chords and in the floor system. The top lateral system is composed of transverse struts and X-braces in every panel, all riveted between horizontal connection plates at the tops of the vertical posts. The struts have rectangular cross-sections made with four angles latticed on all sides. The X-braces have I-shaped cross-sections, made with two pairs of angles back to back, latticed, one brace being cut to clear the other at the intersection, where both are field-riveted betwen top and bottom flange cover plates. The lower lateral system consists of transverse struts and X-braces in each panel; the former are pairs of built channels with vertical webs, flanges turned in and latticed; the latter have each flange built of two angles and one cover plate, 26 inches wide, the two flanges connected by latticing in two vertical planes, the connections corresponding with those of the top laterals. The floor system consists of floor-beams at panel points, supporting twelve lines of web-connected stringers, all braced together with zigzag angles in the planes of their top and bottom flanges.

Tranverse swaybracing is provided in their planes of all the vertical posts, and is arranged in one or two panels above the roadway, and one or two panels below it. The horizontal struts and X-braces all have rectangular cross-sections built of four angles latticed on all sides; they are field riveted at their intersections and at the ends between wide and heavy jaw plates, which also serve as splice plates for the vertical posts and have their edges curved to give