A similar installation, also equipped with a standby petrol motor, has been used in Denmark for the public supply of electricity, the charge being equivalent to 11½ cents per kw. hour for lighting and 3½ cents for power.

The capital cost was $4,300, and the balance of revenue over expenditure for the year's working was $538, which shows 12½% on the investment to meet interest, sinking fund and depreciation.

This is an expenditure and result which would make the supply of electric light possible in many small villages where the cost of continuous attendance on steam or gasoline engines is almost prohibitive.

An example of a small plant is that manufactured by J. C. Child's & Co., of Willesden Green, England.

This consists of a wind-turbine mounted on a steel tower 50 feet high and complete with dynamo and battery. The dynamo is of 2 kw. capacity at 130 volts, and comes into operation automatically between the speeds of 800 and 1,600 r.p.m. The voltage is kept constant by varying the field excitation by a system of 6 graded relays. The batteries are automatically cut in or out, as necessary, and the plant requires but little attention.

The cost of this plant in England would be equivalent to about $1,215, and under London conditions, where the mean velocity of the wind is stated to be 8 miles per hour, it would supply about 1,500 kw. hours per annum. Allowing 10% interest, etc., on the investment, this represents an annual cost of $122, or just over 8 cents per kw. hour.

To give an idea of what this 1,500 kw. hours would do, let us assume a ranch with ten 25 c.p. tungsten lamps and one 2 h.p. motor. Then assuming the average use of the lamps over the whole year in a ranch house to be 3½ hours each per day, these 10 lamps would consume 400 kw. hours per year, and the remaining 1,100 kw. hours would operate the 2 h.p. motor at times when light was not required for over 2 hours every week day in the year.

This, however, is by no means the limit of what could be got out of such a plant. London is far from being a windy place, and in a very large proportion of places the wind is both more frequent and of higher velocity, increasing the output of the plant more than proportionately.

Another plant by the same makers consists of a wind-turbine on a 75-foot steel tower connected to a 4 kw. dynamo and battery. This plant is entirely automatic in operation and bearings and gears are so designed that it is claimed they could be left for 12 months without attention. With an average wind of 9 miles per hour the plant would supply about 5,000 kw. hours per year.

In addition to supplying 100 lamps it operates a motor which drives as required either a chaff cutter, circular saw, or root pulping machine.

In a German plant two batteries are used, each capable of supplying one evening's load. In the daytime the batteries are charged in parallel. At night one battery is used in parallel with the dynamo to maintain constant voltage at the lamps, any surplus power being used to charge the other battery, and the following night the functions of the batteries are reversed. When there is no wind both batteries are put in parallel on the load.

An interesting application of the wind driven electric generating set was that installed on the S.S. Discovery for the expedition to the Antarctic regions, with a view to economizing fuel. This was designed by Mr. Arthur Bergtheil, of Bergtheil & Young, London, England. In this case constant voltage is maintained, irrespective of the wind, by using two generators opposed to one another, mounted on the same shaft, and varying in speed from 500 to 2,000 r.p.m.

The tower is 20 feet high and the windmill 12 feet in diameter, developing about 3 h.p. in a 15-mile wind.

GRAVEL AS BALLAST.

The following excerpts are taken from an article by C. Brauning, appearing in Zeitschrift für Bauwesen, and translated for the American Railway Engineering Association. The full article appears in Bulletin No. 136 of that association.

Owing to its high cost, hard stone, crushed, can only be afforded for ballast in roadbeds which are heavily taxed with traffic, while stretches taxed to a less extent must resort, at least for some time to come, to material near at hand, mostly river or mountain gravel. The greater carrying capacity of crushed stone is principally due to the many sharp edges of the individual pieces. This gives it the high resistance when used as ballast, which is not greatly reduced under shock. On the other hand, the gravel pieces give way easily under pressure and lose still further in resistance when subjected to shock. The object of this article is to determine to what extent gravel makes possible a uniform and permanent roadbed.

The observations direct themselves first to the conditions to be met. It was desirable to follow out the changes in different individual roadbed stretches and note their greater or lesser durability in comparison with the peculiar characteristics of the ballast of each stretch. The ballast of the observed stretches consisted of a mixture of coarse and fine gravel with a sand content of 25 to 33 per cent., consisting of grains under 1 mm. greatest diameter. The cross-ties were spaced 750 to 840 mm. The traffic over the roadbed yearly amounted to about 1.2 million tons. Among the daily trains which covered these stretches were several which had a velocity of 75 kilometers per hour and more. The observations were continued two years, the elevation of the rails was taken every two months, and during affecting weather conditions more often. It was determined that the most important observations come just previous to the occurrence of, during the time of the heaviest, and just after the complete disappearance of frost.

It was to be noted from the observations that close relations exist between the different elevations of the rails and the nature of the soil upon which the roadbed rests. Every clay and clay-bearing soil drove the track upward, and as other observations indicated, also towards the sides. The more uniform such soil is, and the more uniformly it is distributed, the more uniform the tendency to lift the track seems to be, and to lower it again after the disappearance of frost. Irregular mixtures of sand and clay, as occur in earthen embankments such as are formed by dumping led to very unfavorable action in spots, owing to the fact that the earth, due to the action of the frost, was unevenly forced upward and outward and did not regain its original position after frost had disappeared. Clean and evenly fine grained sand proved to be quite constant under the action of frost, and a similar absence of the expansive force of frost was noted in the gravel ballast itself, though it was not entirely free from earthy constituents.

During the seasons of no frost such apparent influences of the soil underneath the ballast were not noted. The effect of the deposits, which came principally into consideration here, changed itself according to the water-absorbing capacity of the clay-bearing sub-soil, but the contour of the sub-grade varied within such narrow limits that it was impossible to observe individual changes. In the summer time the sinking of the rails was generally very small and hardly measureable. Several times notice was taken of the rising of the rails up to 2 mm.—however, only at the hottest time of the year.

A comparison of wooden cross-tie construction was also made with longitudinal stringer construction made up of