electric traction on trunk roads, just as it was the pioneer in the development of the trolley car; and should this happen, we shall easily lead the world in the rapidity of our express service.

WATER-CURTAIN FIRE PROTECTION.

Water-curtain protection against fire has been applied to a building in the city of London. During a practical demonstration of the new system made before representatives of the fire insurance companies, its value was so clearly established that a material reduction was secured in the premium. The system is simple in construction and operation. Every outside wall of the building carries, near the roof line, a horizontal water pipe, which is perforated on its under side. These pipes are supplied by a vertical standpipe, and each line is controlled by a valve, which enables any particular wall to be protected by a flow of water, or not, as the exigencies of the fire may demand. In the case of the London building, the horizontal pipes are supplied from a main standpipe, which is under a pressure of 80 pounds to the square inch. Another system of spray pipes is so arranged that a sheet of water may be thrown laterally over the roof, thus rendering it possible to envelop the whole building in a practically continuous curtain of flowing water. The perforations are spaced so closely, and the pressure under which the water is discharged is so great, that the water curtain has proved to be amply sufficient to prevent the flames from passing through it, to attack the building which it shelters. In the particular building referred to in London, the system is supplied by a separate pump installed for the purpose in the building.

At the present time, when the city engineers are at work on the designs for a salt-water main system of fire protection in New York city, it would be opportune for the owners of costly buildings that are particularly exposed to the dangers of conflagration in surrounding buildings, to consider whether the installation of water-curtain pipes would not at once form an excellent protection against fire, and an effective means of reducing the fire insurance premium existing on those buildings. The salt-water main system involves the erection of central pumping stations, from which water at very high pressures will be available. Therefore, the expense to the individual property owner would be merely that of erecting one or more standpipes, and running around the building the necessary horizontal perforated pipes of the water curtain. It would not be necessary, as in the London building, to erect a separate pumping plant, for the reason that the central pumping plant would furnish the necessary pressure.

LOADS ON FACTORY MOTORS.

Average loads in factories are often thought to be greater than they really are. This is due to the assumption in many cases that steam engines work near their full capacities most of the time, though this is seldom true.

Uncertainty on these points often makes factory owners hesitate to contract for electric power to operate their machinery, even at rates that represent large savings over the cost of operating steam plants. It is easily seen, of course, that a rate for electric power that brings its daily cost above that of operating a steam plant, on the assumption that the average is nearly up to the maximum load, may bring the actual cost of operation much below that of steam, if the average load is only one-half or less than one-half of the maximum. A definite conclusion as to the probable average load in any case is all the harder to reach because the ratio of average and maximum loads varies much in different lines of manufacturing work. To illustrate these facts, the following examples of power and energy consumption in three distinct lines of manufacture are given, with the circumstances of each.

In a large factory devoted to the printing of fine cotton fabrics seven induction motors that ranged from 1 to 75 horse-power each and had a combined capacity of 346 horse-power were employed almost exclusively for this work. In order to operate the printing machines a speed with wide variations was necessary, and this was obtained by driving direct current dynamos with the induction motors, and then using current from these dynamos to supply motors that were direct connected to the printing machines. During 260 hours of regular working time at this factory, the consumption of energy by the seven induction motors of 346 horse-power aggregate capacity amounted to 26,461 electric horse-power hours. If these motors had been in continuous operation at full load during the 260 hours, they would have done $346 \times 260 = 89{,}960$ horse-power hours of work. As the actual consumption of energy by these motors during this time was only 26,461 electric horse-power hours, it appears that the average rate at which the motors absorbed electrical energy from the supply line was only $26{,}461 \div 89{,}960 = 0.294$, or 29.4 per cent of their rated capacity. It is to be noted here that the consumption of 26,461 horse-power hours included all losses in the motors as well as the mechanical work done by them.

Another case illustrating an entirely different line of work from that just considered was a large plant devoted to the construction of heavy machinery. During one month of 26 working days, or very nearly 260 hours of operation, this plant drew 77,000 electric horse-power hours from the supply line. At this time there were in use about the plant 21 induction motors that ranged from 10 to 100 horse-power each, and had a combined rating of 590 horse-power. If these motors had all been fully loaded during the 260 hours that the plant was in operation, their output would have amounted to $590 \times 260 = 153{,}400$ horse-power hours. As the energy actually consumed by the motors during this time was 77,000 horse-power hours, the average load which they took from the supply line was $77{,}000 \div 153{,}400 = 0.5$ nearly, or 50 per cent of their total rated capacity. Here again the figures given for the consumption of energy include all motor losses.

Still different conditions and results are presented by a third case, which was that of large mills engaged in weaving cotton cloth. In this case the motor equipment of the mills included 27 machines that ranged from 5 to 300 horse-power capacity each and had a total rating of 3,412 horse-power. This capacity was made up of induction motors for all except 200 horse-power in the synchronous type. During 273 hours of mill operation, this being the regular working time in a certain month, these motors absorbed 833,469 electric horse-power hours from the supply line. If all of the motors had operated continuously at full load during the 273 hours under consideration, they would have done $273 \times 3{,}412 = 931{,}476$ horse-power hours of work. As the actual consumption of energy reached only 833,469 horse-power hours in this time, it follows that the average power drawn from the supply system was only $833{,}469 \div 931{,}476 = 0.89$, or 89 per cent of the total motor rating, all losses included.

These three illustrations are taken from plants that were operating under normal conditions, and evidently cover quite a range of practice. The print works may be taken to represent approximately a large class of plants in which the demand for power is very intermittent, and in such cases it seems that the consumption of energy may drop to about one-third of what it would be if the motors were fully loaded during the hours of operation. In machine shops the rate at which energy is drawn from the supply line may be approximately equal to one-half of the rated power of the motors employed. As might be expected from the constant nature of the work, motors employed in weaving cotton cloth show an average power consumption well up toward their normal rating, in the above case 89 per cent.

If the average powers actually delivered by the motors in the above cases had been considered, their percentages of the motor capacities would have been smaller than those found above because there is a loss of energy in the motors themselves. The percentages as found, however, are what the prospective user of electric power most wants to know, because they approximately represent the ratios of his average consumption of power to the rating of the motors in use. In this connection it is well to have in mind certain facts relative to the rates usually charged for electric supply, and their relation to the net service which the customer actually gets. Lighting rates are usually made for electric energy delivered on the premises of consumers at a voltage suitable for the operation of lamps. Thus if the consumer uses 110-volt, 16-candle-power lamps that take 50 watts each, he can operate twenty of these lamps one hour for each kilowatt-hour of energy that he buys, because $50 \times 20 = 1{,}000$ watts. This takes no account of losses in the wiring of buildings which should not usually be more than 1 or 2 per cent. When it comes to electric heating the current from the supply lines will probably still be delivered at about 110 volts, and if the heaters are designed for a lower voltage the consumer may have to provide his own transformer. As there will probably be a loss of at least 5 per cent in the transformer, the heaters will get 3,438 heat units less about 5 per cent for each kilowatt-hour that is paid for. Electric motors are rated according to the power they deliver, not the power they absorb, so that an electric horse-power-hour of energy from the supply line cannot yield a horse-power hour of mechanical work. At full loads the efficiencies of good motors, both direct-current and induction types, range from approximately 75 per cent in the one horse-power to 92 per cent in the 100 horse-power size.

At partial loads efficiencies drop, but a mixed lot of motors, among which are some operating at one-half load, should have an efficiency of as much as 80 per cent. On this basis one horse-power-hour drawn from the supply line would yield 0.8 of a brake horse-power during one hour, or one kilowatt-hour from the line would yield 1.07 horse-power-hours, since the horse-power is 0.746 of the kilowatt.

A result of this motor loss is to make the cost per brake horse-power greater than the cost per electric horse-power from the line. Thus, if the motor efficiency is 80 per cent and the rate paid is two cents per electric horse-power-hour, or $60 per working year of 3,000 hours, the cost per brake horse-power is 2.5 cents per hour, or $75 yearly.

SCIENCE NOTES.

The Slaby-Arco-Braun system of wireless telegraphy is in use across Lake Baikal.

A new molybdenum compound has been discovered by Prof. Moissan. It is obtained by heating charcoal with melted molybdenum and aluminium in the electric furnace. The resultant metallic mass is treated with a concentrated solution of potash, says the Engineering and Mining Journal, and well-defined needle-shaped crystals of the new compound are obtained. The substitution is very hard, and resists all acids but nitric. It is not decomposed by water or steam at a temperature below 600 deg. C. It resembles tungsten carbide. It is hoped that the new compound may be useful in making molybdenum steels.

For some time past the scientific cultivation of the potato, i. e., the selection of the best and most fecund varieties for seed, has been in progress in Great Britain, and this year the experiment has been attended with highly successful results. One farmer, who has been engaged in several trials with new species, has this year lifted a tuber weighing 4½ pounds, while another has obtained a specimen of another variety weighing 4 pounds, 7 ounces. One farmer who planted 12 pounds of seed of a special variety has gathered in a crop of over 750 pounds. Investigations are now being carried out to obtain a "disease-proof" potato, as the predominance of disease wreaks considerable havoc among the crops, and is responsible for a heavy percentage of waste.

With reference to the suggestion advanced by the Hon. C. A. Parsons at the recent British Association meeting, that deep borings should be made into the earth's crust for the purposes of investigation of the earth's interior, and that a shaft such as this might be sunk to a depth of 12 miles, another scientist has pointed out that the pressure of the rock at such a depth represents some 40 tons per square inch and would render the task impossible, owing to the inward viscous flow of the rock material. In reply the Hon. C. A. Parsons suggests an experiment to solve the problem. He points out that the crushing stress required to make hardened steel flow lies between 120 and 300 tons to the square inch, while for tough brass or cartridge metal the flow is at about 80 tons per square inch pressure. His experiment would be to take a column of granite or quartz rock and carefully fit it into a steel mold. A small hole would then be bored through its center, and a pressure of 100 tons per square inch then applied, to observe what shrinkage would result. Such a pressure as this would correspond to that encountered at a depth of 38 miles.

The climate of Manchuria plays an important rôle in the war between Russia and Japan. Up to the present, we have had but little precise information upon this point. M. J. Ross has lately given some indications as to the climate of that region, and the character of the different seasons. He states that in the months of March and April there are strong southwest winds which bring with them heat and moisture. At the end of March the winter season ends. The under-soil is still frozen at this time, but the ground can be worked for agriculture. April appears to be the only month of spring. At the end of this month the sowing of wheat commences. Summer begins in May, and at the end of June or the beginning of July the wheat is cut. Up to the end of June rain is rare and the sky is generally clear, while cloudy weather is an exception. The heat reaches a maximum at the end of July and first part of August. Afterward come heavy rains or storms. It often rains for several days and nights without stopping. The soil is completely saturated and inundations are frequent. September is the harvest month, while October gives some of the finest weather of the year. At this time the heat is agreeable during the day and the sky is clear, with bracing air, while vegetation is at its height. At the end of the month the first night frosts begin to appear, and in November the cold weather commences and keeps up until March. At Mukden, the temperature sometimes goes down as low as —33 deg. C. During the day, however, the cold is not excessive, and sometimes in the middle of winter the sun's rays become very warm, on account of the southerly position of that locality. The maximum temperature of summer is 98.6 or 100.4 deg. F. About ten months of the year are dry for the most part, and the excessive wet season only occurs during a month or so. At Niutschwang, on the north shore of the Gulf of Liao-tung, the mean winter temperature is 16 deg. F., and the mean for the summer, 74.8 deg. The mean annual temperature is 47.1 deg. F. The Russian maritime provinces have a very low mean annual temperature. Thus at Vladivostock the average for the winter is 10.2 deg. F., and for the summer it is only 39.9 deg. F.