in the second. These two examples should be sufficient to indicate that "oiling up" is an important part of the care of machinery.

The conditions may next be considered, and the first which presents itself is that of varying pressure and varying speeds and, as important to consider, varying temperature; these are the conditions under which a lubricant is required to work, and to meet these it should possess sufficient body to withstand pressure, and to be fluid and free running for speed. The qualities which we may look for in a lubricant are a freedom from injurious elements, abrading or corrosive, and having stability in that it will not solidify in the cold nor evaporate in the heat, this latter tendency producing two results, either the total loss of the lubricant, or what is called gumming, which is part of the lubricant evaporating and leaving the solid portion in the bearings; this latter is a characteristic of vegetable substances, the total evaporation occurring with mineral oils of light grade. The corrosive nature referred to occurs with animal products, these having a greater tendency to rancidity and also requiring more chemical treatment to bring into condition and thereby being in greater danger of being tainted with corrosive impurities.

We need not consider the long list of substances which have been used as lubricants, solid, liquid, dry, wet, thick, thin, clean and dirty, for all these have been features of the various lubricants which have had their place in the markets, but we may be satisfied that in the animal oils and greases, with their great range of body, their freedom from impairment by atmospheric action and other physical changes, that we may obtain a lubricant fitted especially for our requirements, but it lies with the users to examine them in practice for the features enumerated, and, what will be found the main cause of dissatisfaction, misuse of them must be corrected. It is within bounds to say that the use and not the stuff is what is wrong, and in this direction should improvement be sought, with a better attention to bearings to keep them *steadily* supplied; three cents a gallon cut obtained on an oil is nothing to boast of if thirty cents worth of coal be used instead of the oil.

THE ELECTRIC LIGHTING OF TRAINS.

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Electric train-lighting is occupying the attention of the larger railway companies on this continent at present to a large extent, and in a number of cases has been adopted for the better class of train service. In Europe the development has been much more rapid and on many lines it has or is in process of displacing the oil and gas formerly in universal use. The reason for the change is not far to seek. The public demands the utmost luxury when traveling, and having been educated to the advantages of electric lighting at home is quick to appreciate the same advantages on the railways where at the present time it is counted a luxury, but will soon become a necessity. The public recognizes the fact that as the electric lamp is free from flame there is no risk of fire and no vitiated atmosphere to breathe and it has an illuminant and not a mere gloom disperser as with oil and gas. Its ready adaptability to being placed where wanted makes possible the use of reading lights in the seats and in other positions where any other form of illuminant would be impossible.

The railway companies are not slow to appreciate these advantages, but naturally wish to be assured that electrical illumination will not be more costly and less reliable than other methods. As regards the cost, from recent experiences of different companies it appears that it is at least as cheap as gas and more expensive than oil. That this inferiority in point of cost as compared with oil will not hinder its introduction is evident, for oil has superseded candles although more costly, and even if electric lighting were more expensive than gas its acknowledged superiority would render its use advisable. As regards reliability, which is certainly equally important with cost, the apparatus used in all systems of electric lighting is practically identical with that used for the illumination of buildings and should be as reliable in operation.

Storage batteries at the present time are thoroughly commercial, as are the dynamos and generating apparatus. In the case of axle driving some complication in the regulating apparatus may exist and it is particularly at this point that a careful selection of apparatus is essential. The several systems in practical operation may be divided into two general classes, the first where each car on the system is independent and capable of taking care of itself, and the second where each car is dependent upon some method of charging located either upon the train or at certain points along the line. The first class necessitates the use of an axle-driven dynamo under each car with sufficient storage battery capacity to carry the lights over the periods when the train is not in motion or running too slowly to

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enable the dynamo to light the car. Generally speaking the operations of this equipment is as follows: When the train is at rest or running under fifteen to twenty miles per hour the battery operates the lights, when the speed mentioned is reached the dynamo having attained the proper voltage is automatically connected to the lights and battery through the operation of a governor or electro magnetic mechanism, and the battery is charged and the lights operated from the dynamo. To regulate the voltage which would increase in proportion to the increase of speed of the train if not controlled, two general methods are adopted, either by keeping the speed of the dynamo constant or by regulating its field strength. The first is attained where the machine is belt-driven by allowing the belt to slip, the amount of slip being governed by some form of belt-tightening arrangement. This, while apparently unmechanical at first sight, works well in practice, and has the merit of extreme simplicity. Where the dynamo is rigidly geared to the axle the system of the regulation of the field strength to vary in inverse proportion to the speed is adopted, which may be done either by an automatically controlled resistance in the shunt field, by changing the resistance of the magnetic circuit of the field magnet, or by a system of differential field winding. By the above system each car is a separate and self-con-