

by boiling. Permanent hardness is always due to sulphates or chlorides of lime or magnesia. Upon boiling such water for some time the slightly soluble sulphate of lime gradually separates out and settles on the boiler. This bears out an earlier statement to the effect that the composition of scale varies according to locality, so that only an analysis can determine the best method of dealing with any particular case. Permanently hard water may be softened by means of washing soda, but is not affected by addition of lime.

But water may be quite injurious to a boiler without containing any lime; a complaint has come to my ears that the water from a certain place beyond Hamilton causes much annoyance because of its corrosive action, causing leakage at joints. It has been suggested that this water may contain iron, or perhaps tannic acid, but the former would not act harmfully; tannic acid, if present in such quantities as may be found in parts of the Georgian bay, attacks iron readily, as would naturally be inferred from the remarks made above on its use as scale remover.*

Turning from the chemical side of the subject, let us consider a few points concerning the boiling of water. It is commonly said that water boils at 100° Centigrade or 212° Fahrenheit. Is this true? Into a glass flask some pure water is poured, and the bulb of a sensitive thermometer lowered into the liquid. When the water boils the thermometer indicates about 101 1/2°C., and remains at this point; if the thermometer be raised into the vapor, 100° is registered. If now some iron filings or a few small cinders be dropped in, the temperature of the boiling liquid falls to 100°. Presence of the rough particles seems to aid in the formation and loosening of the bubbles of vapor at the bottom of the flask. In accordance with this, it is found that water boils at a lower temperature in a vessel of copper than in one of glass. If some salt be added to water the boiling point is raised 2°. After performing these experiments before a junior class in physical science, the writer said to the class: "It is a well-known fact that the water in a locomotive boiler is at considerably above 100°; why is this?" One pupil suggested "presence of impurities," evidently thinking of the experiments previously made; another considered rust to be the cause; finally a pupil ventured the opinion, to as a matter of experience, that the increased pressure in the boiler kept the vapor from rising until the temperature was raised much above 100°. It has, in fact, been determined that at a pressure of 2 atmospheres, or 30 lbs. to the square inch, water boils at 120°; at a pressure of 15 atmospheres, water boils at 200°.

It is easier to show the lowering of the boiling point caused by lessening the pressure: A glass flask is half filled with water, and this is boiled until the upper part of the flask is filled with steam; the mouth of the flask is now tightly corked, and the flask inverted over a basin. If now some cold water is poured over the flask the water within boils vigorously, and may be kept boiling until cool enough to be held in the hand. This paradoxical result is due to the condensation of the steam in the upper part of the flask, causing a partial vacuum; therefore, the water is under very slight pressure, and boils at a low temperature.

Everybody has seen water dropped on a hot stove dancing over the surface in the form of spheres until the edge of the stove is reached; also, we know that if the stove is not very hot the drops behave quite differently, resting on one place and turning into steam. To ex-

amine into the curious behaviour of the water in the first instance, a disk of brass slightly hollowed out on the upper surface may be used. If this is heated nearly to redness, a spoonful of water may be placed upon it without any sign of boiling. This assumes the form of a much flattened sphere or spheroid, rolls about rather uneasily on the brass, and gradually becomes smaller through evaporation. If the brass is allowed to cool, nothing happens until the temperature falls to a certain point, when the water suddenly commences to boil violently, and is in a few seconds turned into a cloud of vapor, leaving the brass perfectly dry. By a proper arrangement it may be actually seen that the large drop does not touch the brass disk, and this fact may be proved in other ways. Why is this? The old explanation was that the spheroid rests upon a cushion of steam, and is thus preserved from contact with the metal and consequent boiling. But why does this steam not escape at the sides of the space, causing production of more steam and a rapid lessening in size of the spheroid of water? A later explanation is that the spheroid is supported by a Crooke's layer of steam, in which the particles of steam are rapidly dancing up and down between metal and spheroid, thus keeping the two apart. This spheroidal state of water has frequently been assigned as a cause of boiler explosions, and many arguments have been advanced pro and con. I shall close with the suggestion that this matter be discussed.

The Proposed Railway Commission.

Under the heading "The Dominion of Canada Seeking Trouble," the *Railway World*, Philadelphia, Pa., says:—

It is a remarkable circumstance that just as the Governor-General of Cuba has promulgated a statute for the regulation of the railways of the island, which contains convincing evidence of having been adapted, in many respects, from the railway act of Canada, and has thus given a rather notable testimonial to the success of our northern neighbor in dealing with its railways, Prof. S. J. McLean has submitted to the Canadian government a report in which he advocates the enactment of a new statute and the creation of a railroad commission with extensive powers. Prof. McLean was appointed nearly a year ago as a special commissioner by the Dominion government and charged with the duty of investigating Canadian railway conditions with a view to recommending legislation. He has prosecuted inquiries in many different regions, has received a large number of complaints, and has evidently become an adherent of the idea that Canadian conditions require the further intervention of legislative authority in the relations between the shippers and the railways. At present such supervision as the Canadian railways receive at the hands of the government is by means of the Railway Committee of the Privy Council, which is composed of certain cabinet ministers who are associated for that purpose with the Minister of Railways and Canals. This committee fixes maximum rates which are promulgated after receiving the approval of the Governor-in-Council. The *Toronto Globe* is authority for the statement that these maxima as a rule exceed the highest rates which the traffic could bear, and are therefore higher than the railways could charge with results satisfactory to themselves. Consequently the rates actually charged are usually considerably lower than those prescribed as maxima and, within the limits fixed by the latter, the railways are at liberty to, and actually do, reduce and advance them at will. The maximum rates, therefore, serve no purpose except to provide the railways with an argument in favor of the reasonableness of their

charges, of which they are not slow to avail themselves. They can readily answer to each complaint that the rates charged are lower than those established by the government, which they might charge if they chose, and which are presumably wholly reasonable and just. Prof. McLean suggests that legislation be adopted which would apparently go quite to the other extreme, not only requiring the railways, as in the U.S., to file schedules showing the rates actually charged, but supplementing this provision by one that no change shall be made without the previous approval of the government. While the present conditions would appear to permit undesirably rapid fluctuations in rates, though perhaps not more rapid than have at times occurred in the U.S. under a law requiring the publication of those charged and fixing three days as the minimum notice of a change, it is certain that the provision suggested would abolish that elasticity in charges which is so essential to efficient service. Indeed, as between the lack of stability in the present system and the lack of elasticity in that proposed, there can be no doubt that the latter would be less desirable. Without attempting to review the evidence, most of which would have to be interpreted in the light of an intimate knowledge of the local conditions, which Prof. McLean has collected, it is perfectly safe to suggest the advisability of proceeding very slowly in the adoption of such radical changes as he proposes. Canada has been notably free from industrial depressions and her escape from the influence of the serious financial crises which have successively swept over the U.S. and given pause to its industries is nothing less than remarkable. It is not contended that the financial and industrial depressions which have recurred with such regularity in this country were caused by unwise railway legislation, but no student of the conditions which brought them about and characterized the periods of their duration is likely to deny that such legislation was one of the cumulative causes which prolonged them and added to their intensity. At the time when granger and populist legislatures in the U.S. were doing all in their power to render the railway business unprofitable, Canada was engaged in the promotion of railway enterprises by governmental aid. Its interest in its great railway systems is still direct and very heavy, and it is more than unlikely that it can be induced to adopt measures which would seriously impair their value. If the Canadian government seriously wishes to ascertain just what forms of legislation should be avoided, it can do so by consulting the statute books of many American states.

Better Maps Wanted.—In a discussion at the Toronto Military Institute recently, Major Sankey, City Surveyor of Toronto, said that Ontario has the worst system of maps that any intelligent country could possess. No trigonometrical or topographical survey of the province exists. Actually, the level of Lake Ontario from tidewater on the St. Lawrence is not accurately known. From the commercial and industrial standpoints alone such work was urgently needed. For instance, in certain fisheries litigation which took place not long ago, the only means of ascertaining whether a certain spot was in Canadian or U.S. waters was a calculation as to the time taken by a tug to reach it from one or the other shores of Lake Erie. Again, there is not a river whose basin is accurately and definitely known, a point of much importance in such projects as the Georgian bay canal.

A plan for providing pensions for employees of the I.C.R. who have been 40 years in the service has been elaborated at Moncton, and will be laid before Parliament during the session.

*The writer has since been furnished with a sample of this water, and finds large quantities of organic matter (vegetable) present; such matter, when heated, has a highly corrosive effect on iron. The peat bog from which this supply is drawn is well known to the writer, and is an entirely unsuitable source of supply.