shaft) = 4 times the diameter of shaft, and for speeds under 1,000 R. p.m. length of bearing = 3 times diameter of shaft. Oil rings are to be preferred to chains if they are seamless, as chains have a tendency to stick. The oil should be changed at the greatest interval of time of one month, and the reservoir cleaned out of all brass dust that may have accumulated. The small amount of trouble involved in so doing will save the replacing of bearings at frequent intervals

Motor and isolated dynamo users have a very wise (?) plan of placing their machines in an out of the way corner where dust gathers in quantity, and neglecting to pay attention to the requirements until some day the motor fails to "mote" and ...e dynamo fails to "pick-up;" then in hot haste they send for the maker, and with the "finger of scorn" upraised, they, by their language and gestures, blame the machine for failing to operate under treatment that they would be ashamed to give a steam or gas engine, or even a water motor.

THE DISCHARGE OF THE ST. LAWRENCE RIVER.*

BY PROF. C. H. M'LEOD, MA. E., M. CAN. SOC. C.E.

The extreme low water of the St. Lawrence in the autumn of the past year called especial attention to the variations in the discharge of the river, and it seemed to the writer to be a matter of no small importance to obtain a measurement of it at the exceptionally low stage existing in the early part of November.

From enquiry made at the time, it was learned that it was not the business of anyone in Canada to gauge the St. Lawrence, and that the only measurement ever made below Montreal was that by W. J. Sproule, M. Can. Soc. C.E., under the direction of the Montreal Flood Commission, in 1886.†

Having in view the interest of a measurement at this special time, and as the work happened to fall into line with one of the courses of surveying lectures then in progress in McGill College, the writer induced some of the students of the University to undertake the work under his direction, assisted by Prof. C. B. Smith, M. Can. Soc. C.E., and J. G. Kerry, A.M. Can. Soc. C.E. The Hon. G. A. Drummond very kindly placed his private yacht at the disposal of the college for the purpose, and Frank Redpath gave up two days of his valuable time to take charge of the yacht during the work.

The position chosen for the gauging is situated about forty miles below Montreal, its upper limit being approximately 6,200 feet below the wharf on the north shore of the river, at Lanoraie. This choice was made not only because it is the position best suited for the work within easy reach of Montreal, but also chiefly for the purpose of comparison with Mr. Sproule's work, the position being that in which his measurements were made.

It was intended that the gauging should be made during the first week in November, but owing to unavoidable circumstances it had to be postponed, and was not made until the 13th and 14th of the month. The lowest water levels occurred on Oct. 28th, Nov. 2nd and 7th. On the first day of the measurement, Nov. 13th, the water level was seven inches above its lowest point, and it rose three inches while the work was in progress.

For a mile or more both above and below the gauging area, the river runs a straight course and has a very uniform cross section. Over this distance also, the levels which were taken under the direction of the Flood Commission in 1886 showed a constant surface slope.

In order that the measurements might be entirely comparable with those of Mr. Sproule, similar methods to those employed by him were adopted. The velocity observations were made on rod floats immersed to the greatest possible depths. In the reduction of the work, the observed velocities were corrected by reference to a vertical velocity curve obtained from measurements with an electrical current meter, by Amsler. The rods were of uniform section, and were loaded with lead weights within tin cylinders, having the same section as the rods. The immersed depths of the rods ranged from 6 feet to 42½ feet. The average velocities were obtained from the times of crossing of the two ranges, and were checked by the velocities between the stations along the lines, the positions of which were fixed by box sextant angles to points on the shore. All data as to soundings were, through the kindness of Mr. John Kennedy, taken from the plans of the Montreal Flood Commission.

The plate No. 8 shows the contour lines of the river bottom and shore lines for the length of 3,000 feet, over which the float observations were made. It shows also the courses of the several floats, with their observed velocities and the immersed depth of each float. The plate No. 9 gives similar information for Mr. Sproule's measurements. The plate No. 10 shows the average cross sections for the entire length of 3,000 feet. The upper section refers to the work in 1886, and the lower one to that in 1895. The mean position and lateral range of each float is also shown on the diagrams. The dotted lines below represent the most probable velocity curves resulting from the observations. In both cases the plotted velocity curve is that which results from the float observations, after applying the small correction due to depth of immersion, as compared with the average depth of the water along its path. This method of reduction gives, of course, slightly smaller values than those arising from the observed velocities, and the discharge as here computed for 1886 is somewhat less than the official figures of the Flood Commission. The area of the cross-section in 1886 was 115,298 square feet, and the discharge 311,101 cubic feet per second. The area of the 1895 cross-section—when the water was one foot nine inches below official low water—was 105,432 square feet, and the discharge amounted to 216,621 cubic feet per second. At the period of lowest low water in 1895, in which the water level was, as nearly as can be ascertained, two feet seven inches below official low water, or corresponded to a depth of seven feet eleven inches on the flats of Lake St. Peter, and 24·9 feet minimum depth in the navigable channel of the river, the cross-section was reduced about two per cent. below that of November 13th and 14th, 1895. Assuming that the discharge of the river varies proportionally to the area of the cross-section, and taking as data the results of the measurements above given, the discharge at the lowest water stage of 1895 amounted to about 196,000 cubic feet per second.

Referring now to the degree of accuracy which should be expected in work of this kind, the positions of the lines I, III, VII, VIII, X, XI, XIV and XV, Plate No. 8, will be found to accord somewhat closely with those upon which the 1886 discharge depends. The addi-

* A paper read before the Canadian Society of Civil Engineers.

† Some measurements as to the discharge of the St. Lawrence were made by the late Mr. Guerin in 1832, at Montreal, and are referred to in the report of H. F. Perley, then chief engineer of public works, for 1892-93.