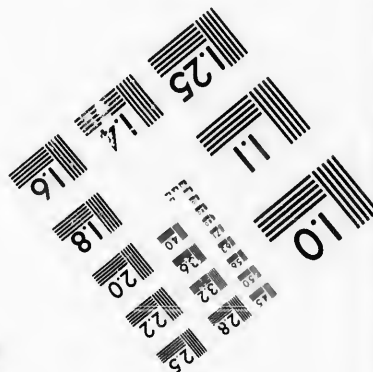
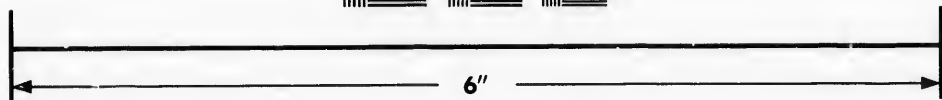
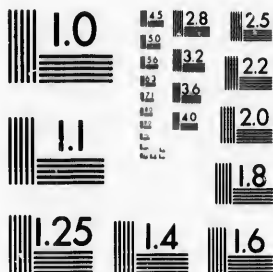


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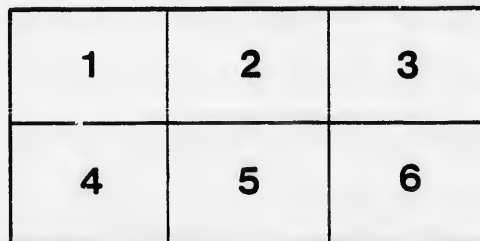
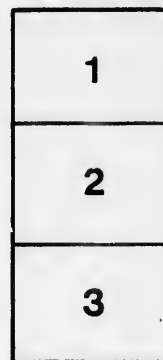
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173 Physique, n^o 8

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CANADA

SPECIAL APPENDIX "A"

TO

REPORT OF MINISTER OF PUBLIC WORKS

FOR

FISCAL YEAR 1897-98

REPORT BY THE CHIEF ENGINEER

ON THE

"DENISON HYDROGRAPH"

PUT UP ON

QUEEN'S WHARF, WESTERN ENTRANCE, TORONTO HARBOUR

MAY, 1898

OTTAWA
GOVERNMENT PRINTING BUREAU
1898





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REPORT ON THE "DENISON HYDROGRAPH" PUT UP ON QUEEN'S
WHARF, TORONTO HARBOUR IN MAY, 1898.

DEPARTMENT OF PUBLIC WORKS OF CANADA.

CHIEF ENGINEER'S OFFICE, OTTAWA, 2nd August, 1898.

E. F. E. ROY, Esq.,

Secretary, Department of Public Works.

Sir,—I have the honour to transmit herewith a communication from Mr. Napier Denison, of the Meteorological Service of Canada, dated 30th July, 1898, relative to the new hydrograph devised by him, which has been put up at the western entrance to Toronto harbour, for the use of this Department.

Mr. Denison's ingenious, self-registering lake gauge, or hydrograph, is calculated to be of much service both for navigation and meteorological purposes.

A similar instrument has just been completed to be installed at the Kingston Graving Dock, and it is very desirable that a few more such automatic gauges be put up at other important points on the Great Lakes as soon as practicable.

I would recommend that Mr. Denison's interesting communication, inclusive of illustrations, be printed in extenso as an appendix to the official report of the Department for the fiscal year ended 30th June, 1898.

I am, sir,

Your obedient servant,

R. STECKEL,
for Chief Engineer.



Toronto, 30th July, 1893.

The Chief Engineer,
Public Works Department, Ottawa.

Sir,—I have the honour to present a drawing (lit. 1) and description of a new hydrograph recently devised by me, and acting under your direction set up at the western entrance channel of Toronto harbour.

A is the recording cylinder 2 feet in length by 24 inches in circumference, which by means of the clock *B* completes one revolution every 24 hours; *C* and *C'* are the standards upon which the cylinder revolves. *D* and *D'* not only carry the small pulleys *E* and *E'*, but form the terminals for the horizontal nickel plated guide rod *F* and another similar and parallel rod immediately behind it. These rods form a track for guiding the carriage *G*, on which the self-recording pen *H* is mounted. The penholder is pivoted so that it may be thrown back from the cylinder when changing the recording sheet. The float *I* is placed in a shaft composed of two concentric parts, viz.: an outer square box of 2 inch planking measuring about 12 by 12 inches inside, perforated with a number of auger holes near the bottom which is closed, and an inner cylindrical galvanized iron tube *K*, 10 inches diameter inside, also closed at bottom, which has only a few small holes near its lower extremity.

This composite shaft was sunk by outside the storm signal house where the instrument has been h permits of the inner tube *K* being drawn out and cleaned, should the cross become choked. The lower portion of the outer box is attached to lower timbers of the wharf, as shown at *J*, while the upper portion is to prevent any possible future settling of the upper cribwork from dista

The movement of the float is transmitted to the recording sheet in the following manner:—

A cord of fine twisted brass wire passes from float *I* over pulley *L* to and several times around pulley *M*, and is attached to the outer grooved circumference of this pulley. At the smaller grooved circumference of the same pulley is attached a similar flexible metallic cord which passes over pulley *E* through the centre of the carriage *G*, and then over pulley *E'* to the counter weight *N*.

The ratio of the motion of the pen to that of the float is as 1 to 5. The horizontal lines upon the recording sheet represent heights in feet and tenths of a foot, and the heavy, medium and fine vertical lines indicate hours, half-hours and quarter hours respectively. As the circumference of the cylinder measures 24 inches, an inch upon the sheet corresponds to one hour in time. To correctly set the instrument, it is only necessary to move the carriage *G* along the flexible wire, until the recording pen has reached the required number of feet and tenths of a foot above the previously

determined datum, then firmly attach the carriage *G* to the wire by means of the set screw *O*.

To change the recording sheet, the pen *H* is thrown back, the cylinder including friction gear *P* placed upon a table, the old sheet taken off by raising two special spring clips at either end of the cylinder, and a new sheet substituted and held firmly in place by means of these clips. After the cylinder is again in proper position, it is easily set to the correct clock time by turning until the point of the pen agrees with this time as shown upon the sheet. This can be accomplished without injuring the clock, for, when properly adjusted, the socket *P* so fits over the end of the shaft as to permit of the cylinder being easily moved by hand, but binds sufficiently to prevent slipping during the normal movement generated by the clock. A set or clamp screw has, however, been added, so that a perfect connection between clock and cylinder may be readily ensured at all times.

The traces from this hydrograph not only furnish a continuous record of the hydraulic variations of the Great Lakes, which is of primary importance to your Department, but also will prove of great scientific value by demonstrating the existence of numerous rapid secondary fluctuations in the water level on these lakes, or short undulations of various forms similar to those which have been studied upon the Swiss Lakes, where they have been termed "Seiches." The writer has made a careful study of these undulations, as derived from records afforded by a combined lake level and barometric registering instrument termed a hydro-aerograph, which was set up at the mouth of the Humber River last July for the Canadian Meteorological Service,* from which he has deduced the existence of:—

1. A longitudinal and a transverse "Seiche" of about 4 hours plus 45 minutes and 45 minutes duration, respectively, due to abnormal differences in the atmospheric pressures which obtain at the extremities and on opposite shores of the lake.
2. Shorter undulations after the passage of a wave of considerable amplitude, due to the direct action upon the surface of the water by atmospheric waves, which are known to exist before and during the passage of severe storms, including thunderstorms.
3. A measurable lunar and solar tide.

Although the instrument above described has only been in operation since last May, many interesting types of undulations have been obtained. On illustration II, appended hereto, three varieties of such undulations or oscillations registered during different weather conditions, are shown.

The record of the 19th of May illustrates the very great and rapid oscillations set up by the passage of a thunderstorm. Upon the extreme left a phenomenal rise of 1.06 feet in less than 5 minutes, is registered, which is followed 20 minutes later by a fall of 1.08 feet in 4 minutes. The notched and complex appearance of the latter portion of the trace appears to be due to interferences of the larger undulations

* Fully described in a paper read before the Toronto meeting of the British Association, entitled "The Great Lakes as a Sensitive Barometer," by the writer.

as they travel from one side of the lake to the other. Similar abnormal undulations have frequently been observed upon Lake Erie, where they have been falsely termed "tidal waves."

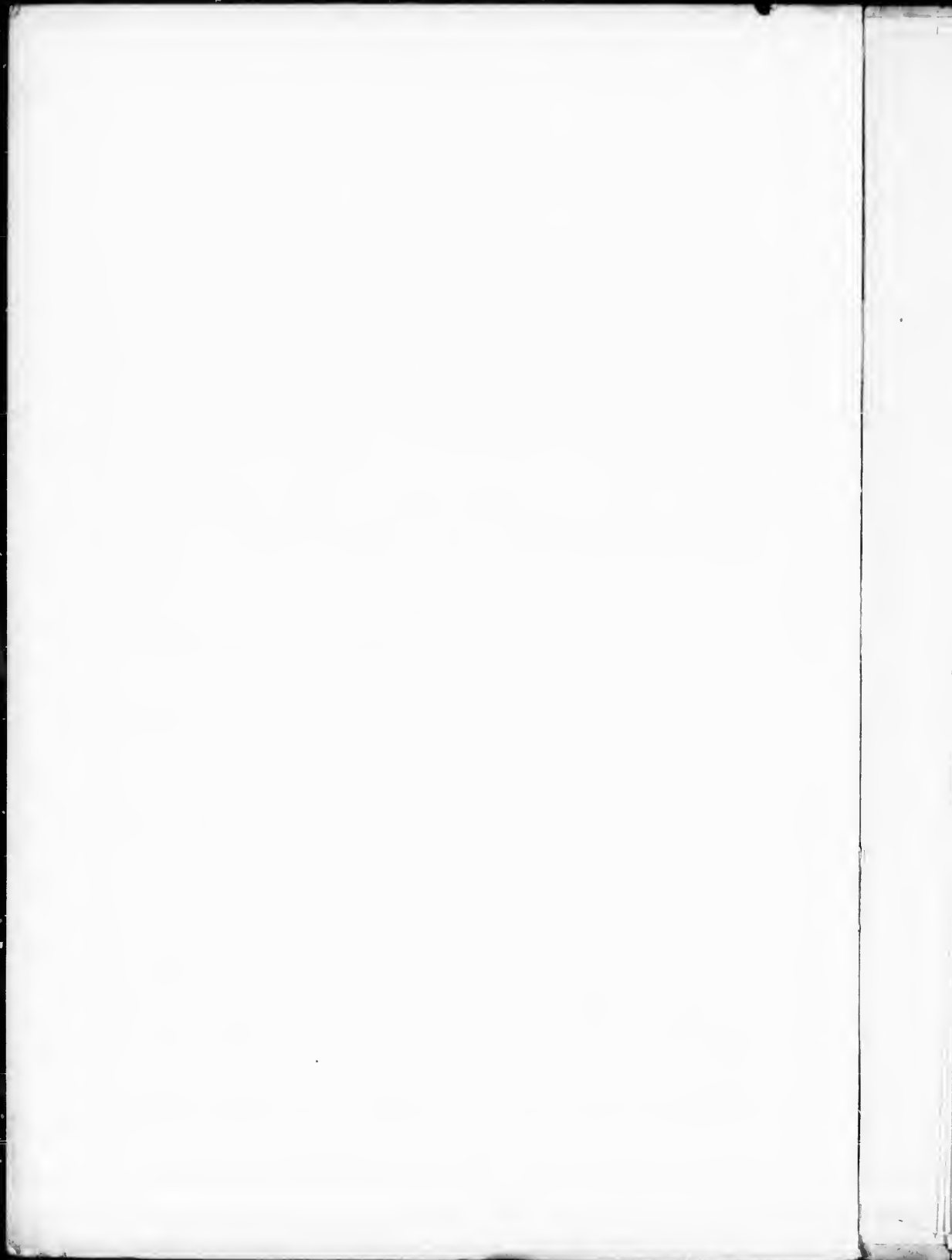
The intermediate diagram taken from the trace obtained on the 31st of May, represents a moderately disturbed record during a falling barometer, in advance of an approaching area of low barometer from the north-west. Near the beginning and an hour and a half from the end will be seen abnormal movements of the pen, due to the passage of steamers. As soon as an approaching vessel comes within the piers, although several hundred yards distant, the pen rises rapidly until the vessel is opposite the instrument and then falls as suddenly, often showing, as in the former case, a range of $\cdot 2$ of a foot. This action is usually followed by a transverse oscillation of the water in the channel, lasting from 5 to 10 minutes.

The abnormally quiet trace, taken from the record of the 25th of May, was secured during fine settled weather when the barometer was high throughout the lake region.

Hoping this instrument and a similar one just completed for Kingston may meet with your approval, and that their introduction may lead to the installation of others upon the Upper Lakes,

I have the honour to be, Sir,
Your obedient servant,

F. NAPIER DENISON,
Meteorological Service of Canada.





PUBLIC WORKS, CANADA.

ILL. I.

HON. J. I. TARTE . . . MINISTER OF PUBLIC WORKS
A. GOBEIL . . . DEPUTY MINISTER
LOUIS COSTE . . . CHIEF ENGINEER

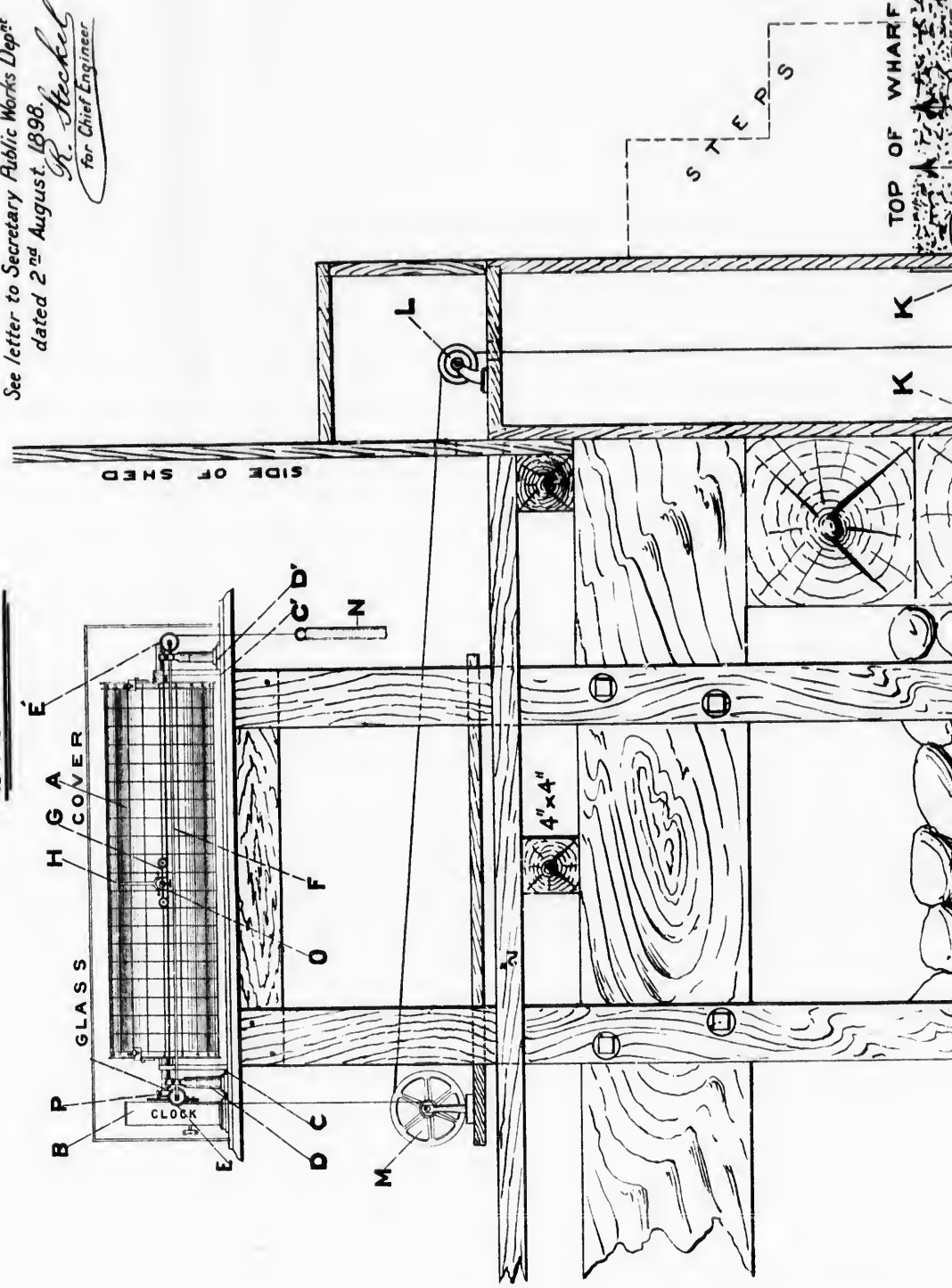
TORONTO HARBOUR

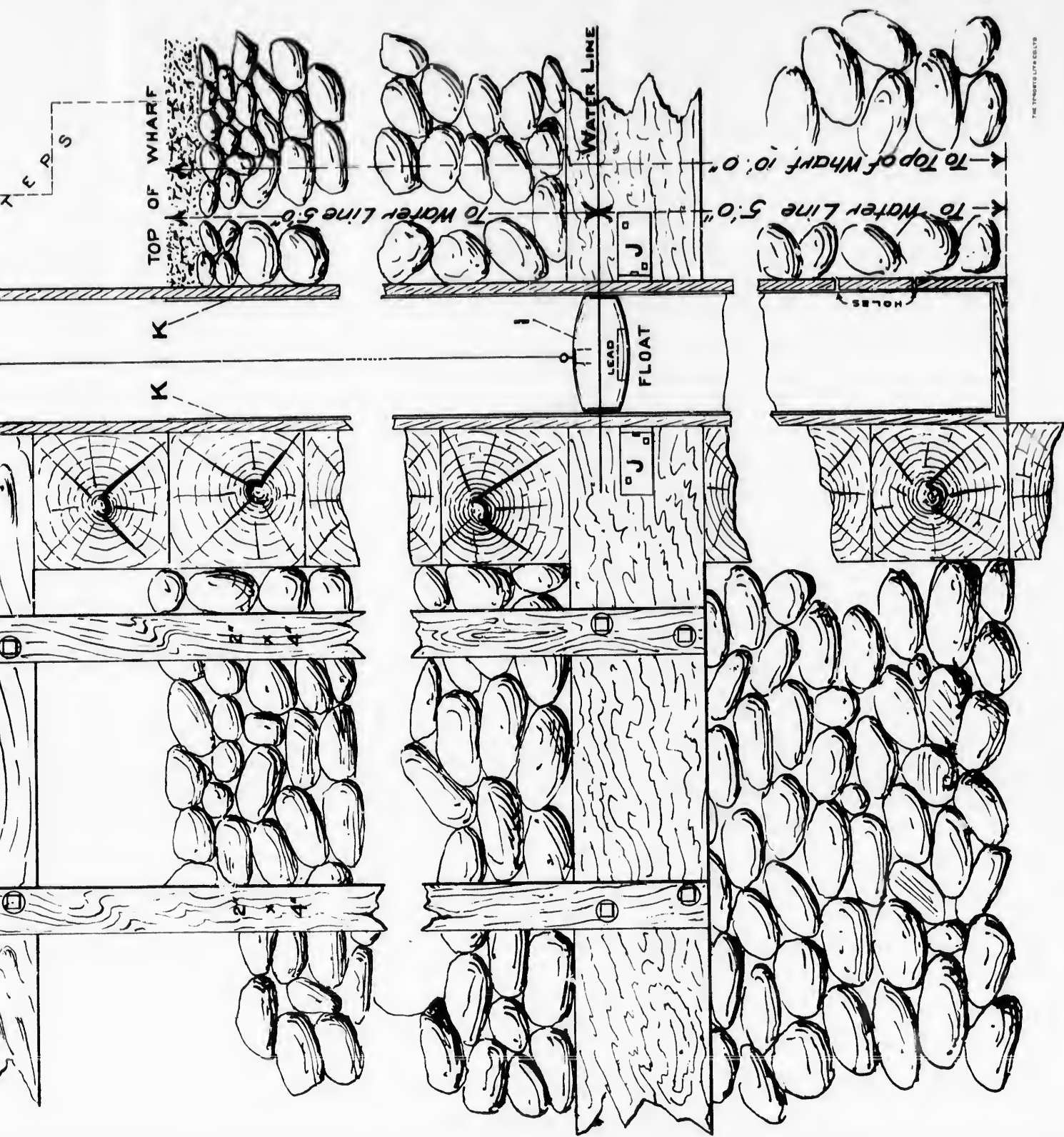
DENISON HYDROGRAPH PUT UP ON QUEEN'S WHARF

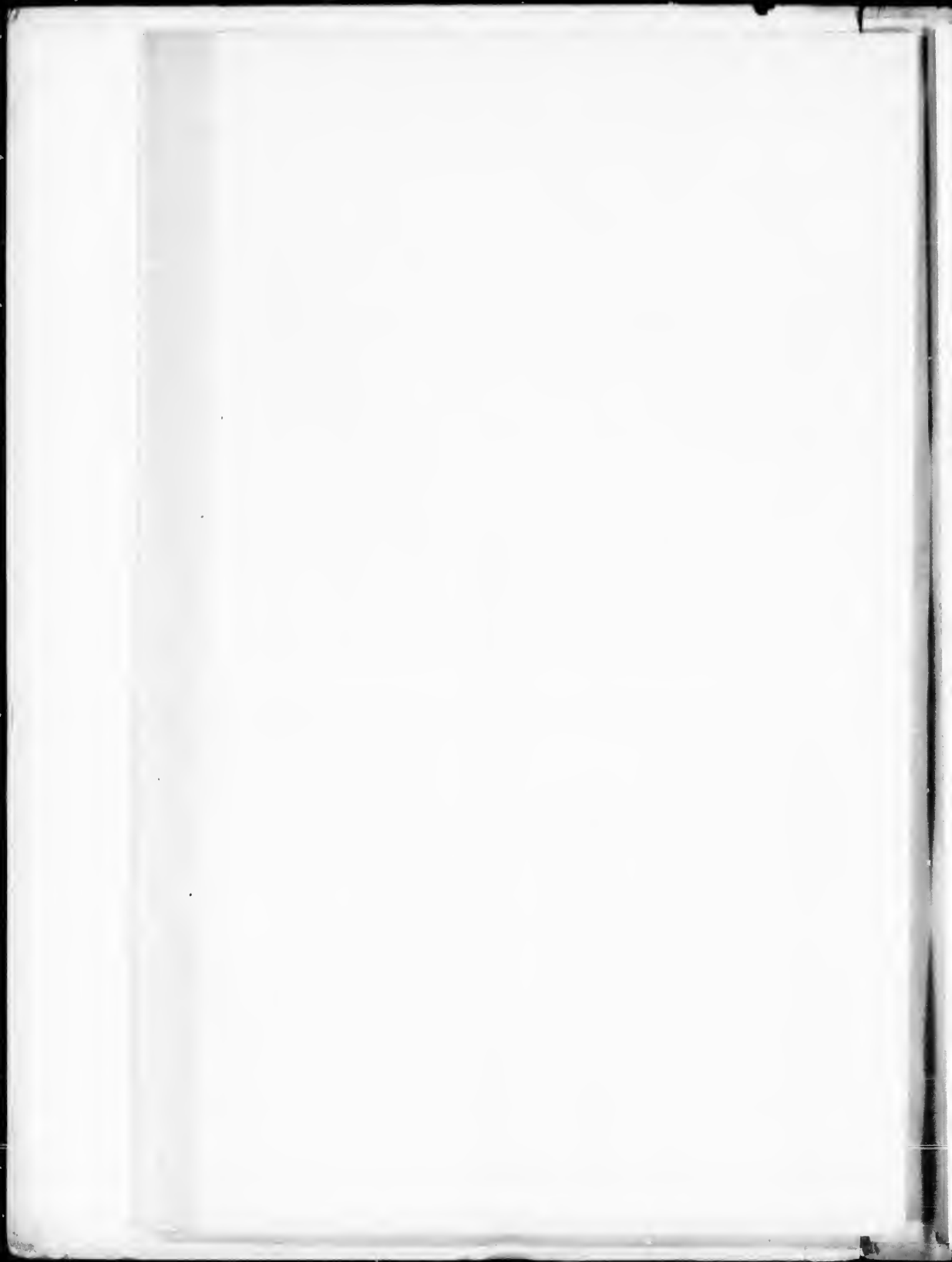
IN THE SPRING OF 1898

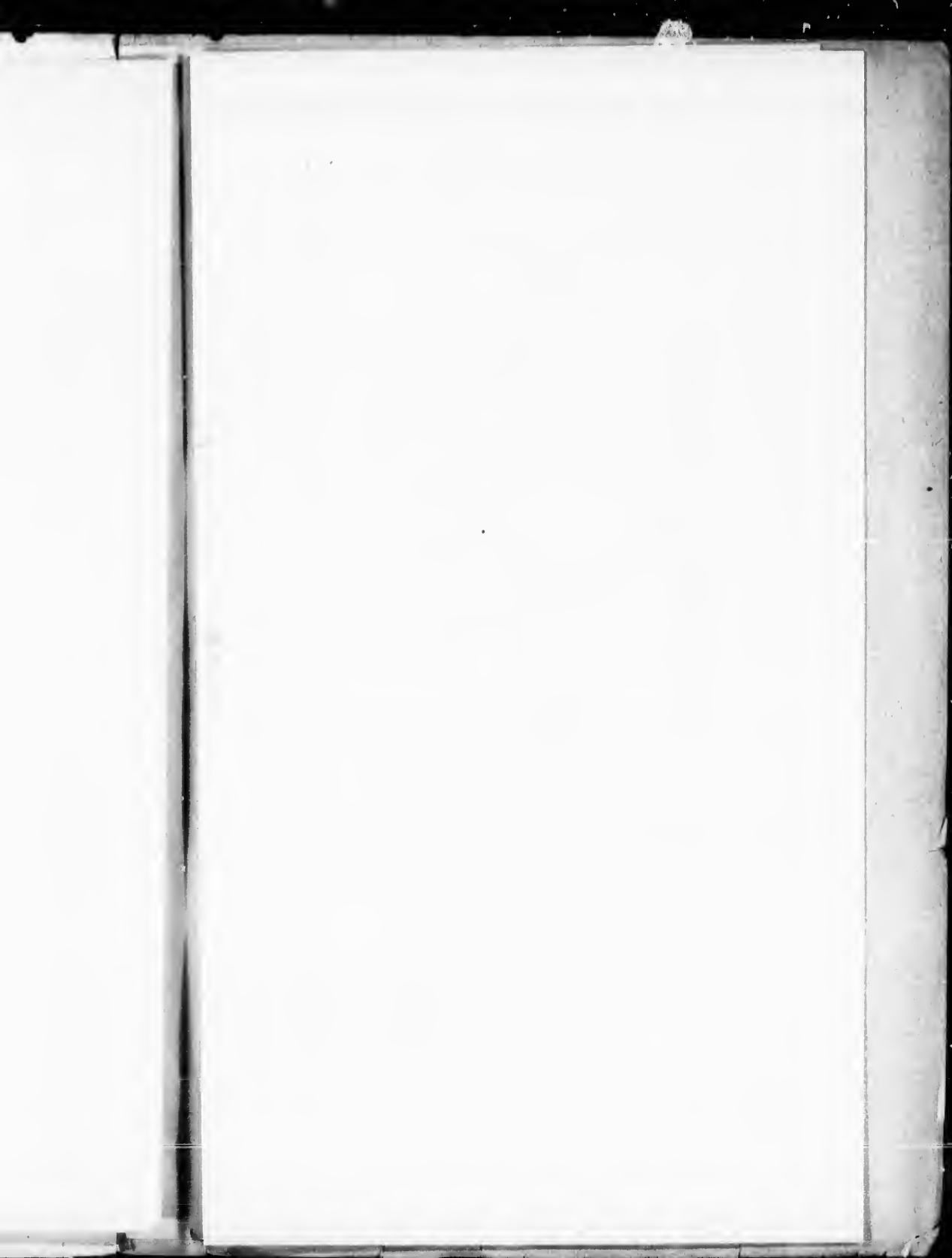
$\frac{1}{16}$ FULL SIZE

See letter to Secretary Public Works Dept.
dated 2nd August, 1898.
R. Hecker
for Chief Engineer









PUBLIC WORKS, CANADA. ILL. II

HON. J. I. TARTE..... MINISTER OF PUBLIC WORKS
A. GOBEIL..... DEPUTY MINISTER
LOUIS COSTE..... CHIEF ENGINEER

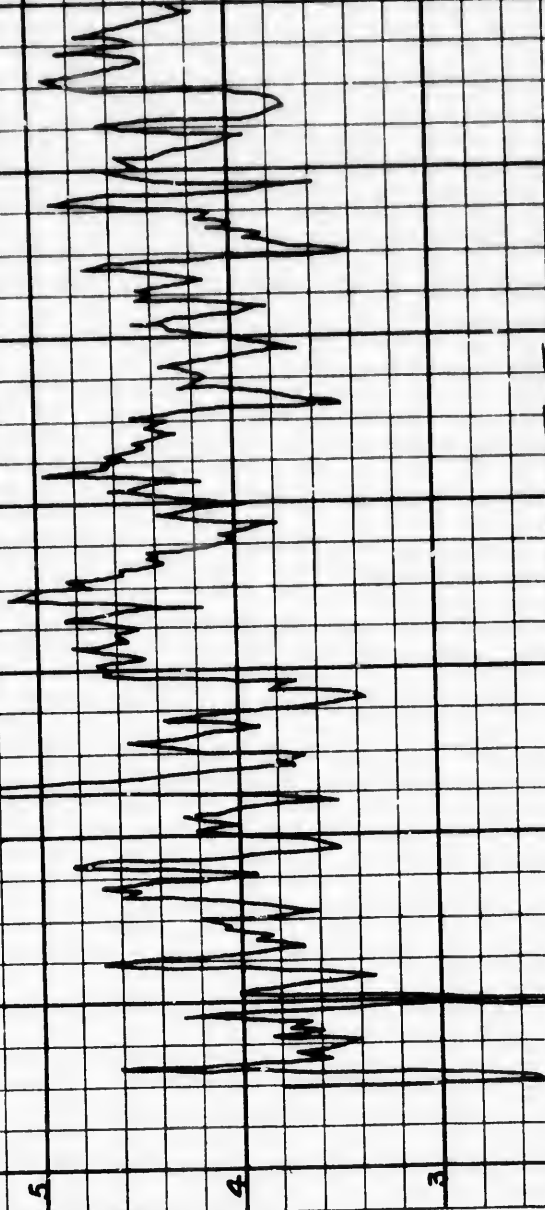
TORONTO HARBOUR

INTERESTING UNDULATIONS ON
LAKE ONTARIO
REGISTERED BY THE DENISON HYDROGRAPH
AT THE QUEEN'S WHARF

See letter to Secretary Public Works
Dept. dated 2nd August, 1898
R. H. Tucker
for Chief Engineer.



19th May 1898



31st May



25th May



7 Hours

