

condition of the roadbed and the size and efficiency of the return. A complete and thorough examination of the points where the city electrician had reported damage to the pipes was also made.

The following summary states concisely the conditions existing in the city.

#### District Affected by Stray Currents.

The report of your city electrician, a copy of which is attached (Exhibit D), giving location of pipes damaged dating from January 1905 to June 4, 1909, shows that electrolytic action has mainly taken place in the following districts:—

1st—Princess Street, from Logan Avenue to Notre Dame Avenue.

2nd—Portage Avenue, from Hargrave Street to Forth Street.

3rd—District enclosed by Main, Broadway, Hargrave and the river.

4th—Notre Dame Avenue, from Main Street to Winnipeg Electric Railway Company's sub-station.

5th—Ellen Street, from Notre Dame Avenue to McDermot Avenue.

6th—Langside Street, from Portage Avenue to Ellice Avenue.

(These districts are shown shaded on Drawing No. 1.)

Pieces of water pipe and lead covered cables taken from these districts by Mr. Cambridge were examined and showed without doubt that holes and breaks in them had been caused by electrolytic action. (Photos of these attached.)

The damage reported in districts Nos. 1, 2, 5, and 6 is caused by the very bad condition of the bonding on Portage, Notre Dame and William Avenue and Sherbrooke Street tracks. On Portage Avenue, from Hargrave Street towards Sherbrooke, where the roadbed is unpaved, the bond wires, which are Nos. O, B, and S, soft copper wire with bonding cap terminal, give readings in equivalent feet of rail of 20 to 60 feet—this shows very bad condition of bonding. (Readings are given in Exhibit A.)

At several places the bonds are uncovered and many broken bonds were noticed. Current is leaving the tracks in Sherbrooke Street, South Portage and Notre Dame west of Sherbrooke (rails are positive to pipes), entering the pipes, flowing down these until close to Main Street is reached (along Main Street from river to C.P.R. subway, pipes are positive to rails), the current leaves the pipes to rails, telephone cables on other pipes causing the damage reported—it accounts also for the trouble reported in the T. Eaton Company's store. (Report of city engineer, March 2, 1909.)

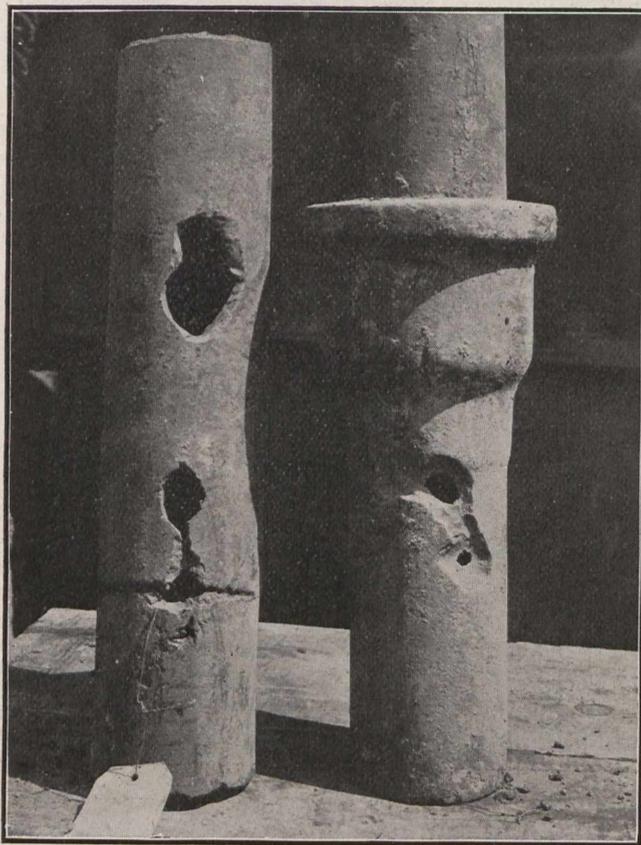
In connection with district No. 3, that is, in the district around the car barns on Main Street close to the river, the rails on Main Street are bonded to the water pipes. The heavy water mains on this street carry a large part of the railway current till it reaches Water Street, Notre Dame Avenue and Portage Avenue East, that is, district No. 4, the stray currents are here given back to the telephone cables which are bonded to the negative bus-bars of the sub-station on Mill Street and also to the intricate network of mains and service pipes lying in this district. This accounts for the trouble reported in the McIntyre Block. In this connection, the writer desires to state that on May 26 in company with the city electrician this building was visited. In the basement a recording amperemeter was connected between the water main and the telephone cable. Charts of current readings were kept. At the time of the visit 50 amperes were recorded and the water pipe was positive to the telephone cables. With the statement reported by your city electrician that such a condition involves danger of fire, the writer does not agree, although the conditions there are remarkable enough that conditions might be assumed under which fire could be possible. The remedial scheme referred to above, that of bonding the tracks with water and gas pipes, although it may afford local protection and was considered good practice some time ago, will greatly increase the amount of stray currents and should not be encouraged.

The bonding of the tracks on Main Street from the river to the C.P.R. subway is good. (Readings are given in exhibit "E.") In addition to the rails which are heavy (70 and 95 lbs. to the yard), a 500,000 c. m. cable runs between the rails and is cross bonded to the track. On account of the bad condition of the track returns in the other parts of the city causing stray currents everywhere, the tracts on Main Street, connected to the bus-bars through heavy copper returns, draw the currents from the piping along this street. This is shown by the electrolysis survey, as readings taken along this street between the high pressure hydrants and domestic water pipes show these positive to the rails. As a matter of fact throughout the whole centre of the city this condition is met (see drawing No. 3).

It can therefore be stated that electrolysis is taking place through the entire centre of the city.

#### Return Feeders.

The tracks are bonded at the corner of Main Street and Portage Avenue to the return feeders of a total sectional area equal to 6,848,000 circular mills. The drop of potential between this point and the negative bus bars, if these carried the whole railway current would reach 12 volts at



times. The distance is approximately 1,200 feet, that is, the drop of potential from these tracks to the station is one volt per 100 feet. This is altogether excessive, a voltage drop of one-half volt per 300 feet is usually considered large enough. The above condition is responsible for the trouble reported in district No. 4.

#### Tracks in Very Bad Shape.

Return feeders, besides the one stated above, are also used (see drawing No. 2), they are bonded to the tracks at different points of the system, but they are of comparatively small section and little current can be carried by them. To sum up it will suffice to say:

1. With the exception of Main Street from the Assiniboine River to the C.P.R. subway, Portage Avenue from Main Street to Hargrave Street, Notre Dame Avenue from Main Street to Charlotte, Corydon Avenue from Pembina Street to Lilac Street, Lilac Street from Corydon Avenue to Woodlaw Avenue and the tracks which are being now bonded with electrically brazed bonds (i.e. Dufferin Avenue and Logan Avenue) the track returns of the Winnipeg Street Railway Company are in very bad shape.