UPPER CANADA RAILWAY SOCIETY 1941

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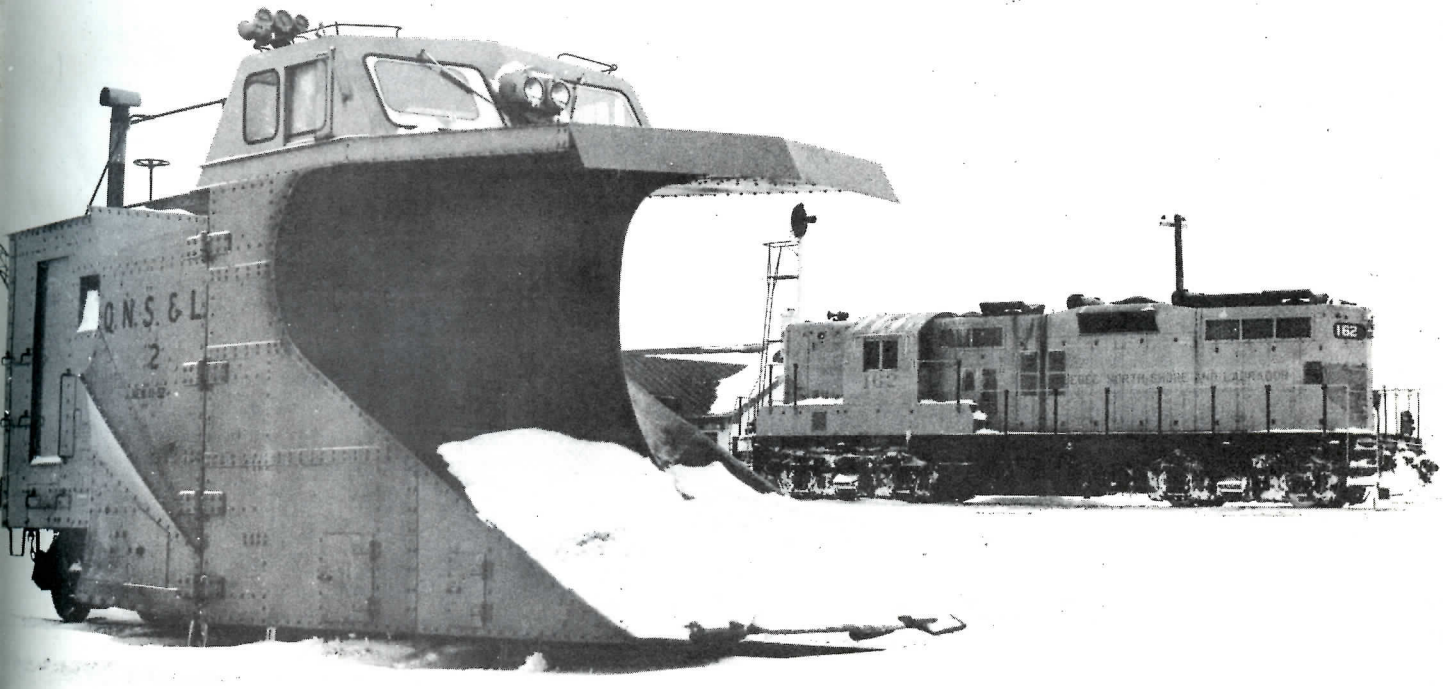
Automation on the Q. N. S. & L.



The Q.N.S.. & L., the railroad that hibernates in the winter. No. 162, seemingly about to be swallowed up by the modern steel wedge plow in the foreground, is stored on one of the hump tracks at Sept Isles. It is engines of this type that have been converted for automatic operation.

Photo: J.A. Brown

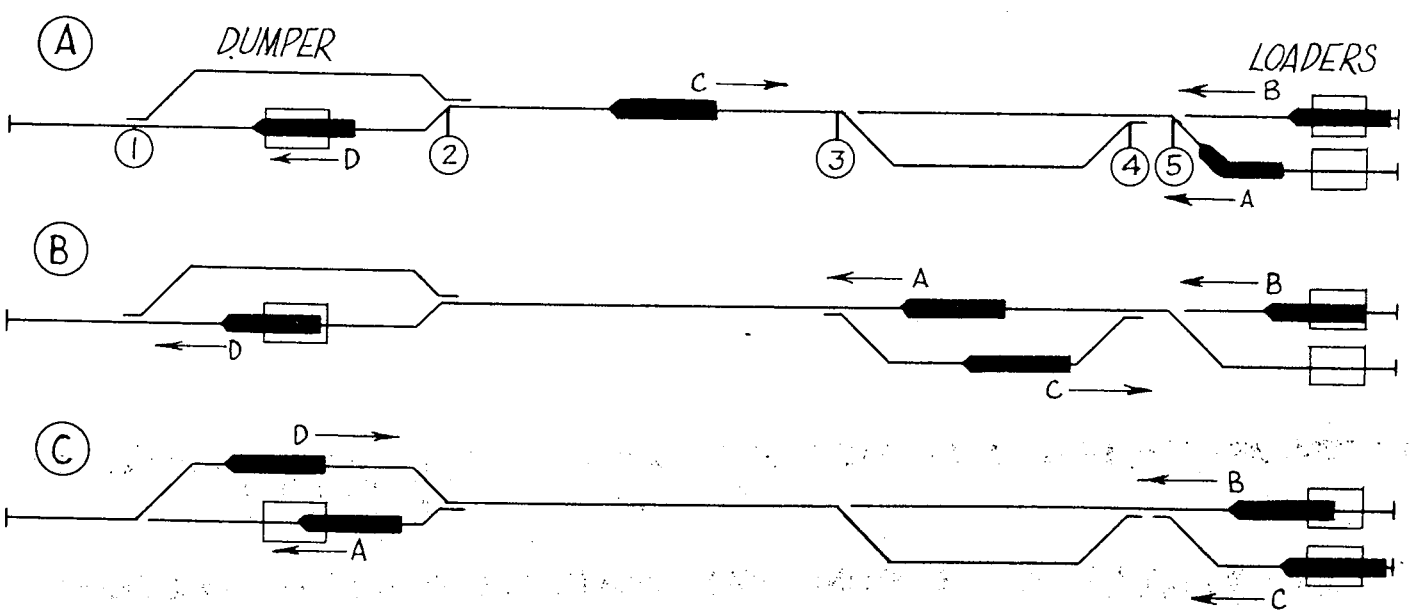
UPPER CANADA RAILWAY SOCIETY
BOX 122 TERMINAL "A" TORONTO, ONTARIO

Crewless Trains on the Q.N.S.&L.

In the barren wilderness of western Labrador, only 800 miles south of the Arctic Circle, fully automatic equipment is controlling the operation of four trains running over a five mile stretch of track near Labrador City. This railway, a link between the Smallwood Mines of the Iron Ore Company of Canada and a crushing plant located at the terminal point of the Carol Lake branch of the Quebec, North Shore and Labrador Railway, can handle 55,000 tons of raw ore each day in 18-car trains hauled by 1750 horsepower general purpose diesel road-switchers. It is perhaps significant that the railway that was first to run its trains with only a four-man crew should be the first to eliminate the crew entirely, and with scarcely a word heard from the railway unions who habitually oppose this sort of technological advance. While this short stretch of railway is operated under conditions not enjoyed by railways everywhere, it will serve as a continuing experiment in automatic train operation for years to come.

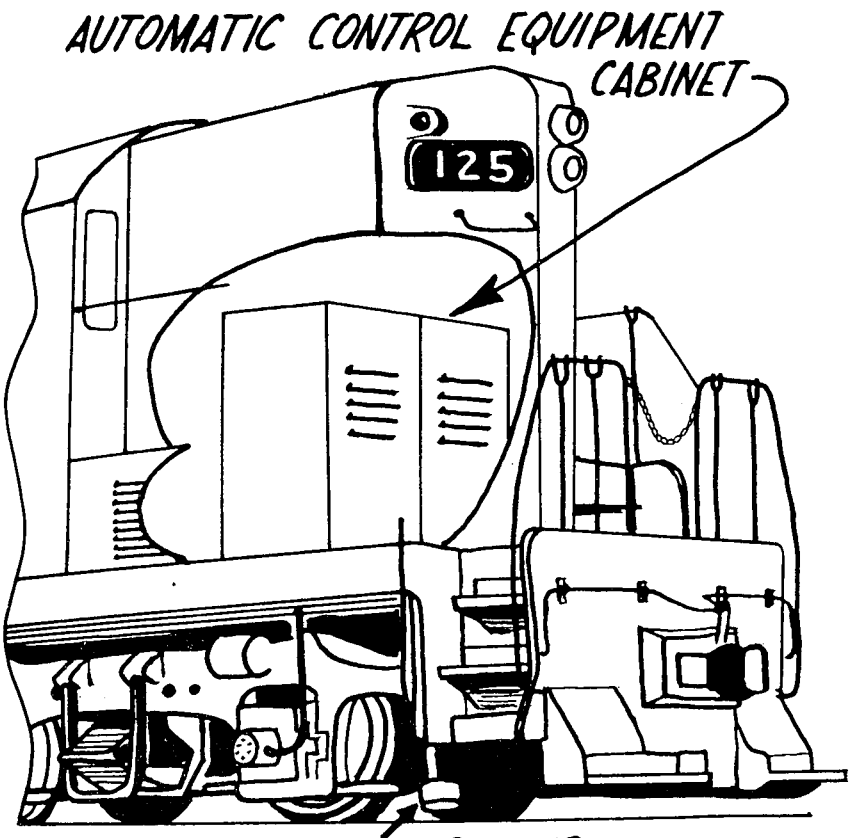
The trains are unique in other ways as well. The ore cars are about 40 feet long and have air-operated drop sides to permit their load of ore to be pushed sideways out of the car. Each car has a capacity of 95 tons and rides on two four-wheeled trucks that are fitted with air-operated, electrically-controlled disc brakes. The couplers are of a modern tight-lock design. Because of the punishment that the cars must withstand while being loaded (the ore may drop several hundred feet into the car), the car bottom is of abrasion-resistant steel over an inch thick, and overlapping aprons close the gap between cars to prevent stray ore from finding its way to the track during loading. The trains are arranged so that the loads are pulled by the locomotive from the loader to the dumper and pushed in the opposite direction. No cabooses are used on the trains but the last car has equipment to pick up control signals from the rails when it is leading the train.

The operating cycle for each train starts when it is pushed empty into a tunnel in whose roof the ore loading hoppers and chutes have been cut, then being drawn slowly out while the ore cascades into the cars from above. (See step "A" in the diagram below.) When the train is loaded, an operator releases the train to the main line control equipment which then handles the train at speeds of up to 30 m.p.h. between the dumper and crusher. The four trains are moved over the line in the sequence shown below.



At the dumper end of the run, the train is brought to a stop within 7½ inches of a predetermined spot and the dumping begins. The automatic equipment controls the advancing of the train so that each car stops at exactly the same spot for unloading without further manual intervention. Once the last car has been unloaded, the train heads into the tail track beyond the dumper, switch no. 1 moves to the reverse position, and the train starts northward toward the loaders. If the single track between switches 2 and 3 is not occupied, then the train of empties continues toward the passing siding and over switch no. 3 which has been lined for the siding. Under normal conditions, another train passes the empty train here with non-stop meets being the rule. As soon as there is an empty track in the loaders, the train moves into it and the cycle repeats.

While the apparatus used in this system is quite complex, the principles of its operation are not. and a brief description of them is given here. All decision making apparatus is mounted at trackside and the equipment on board the engines only serves to make the train obey the command instructions sent to it. Thus, the system functions much like a model train set-up, under control from a remote location, with the control information transmitted over the two running rails. Unlike a model railroad, the train wheels need not be insulated from each other as the coded electrical control signals are picked off the rails inductively, ahead of the leading set of wheels on either the locomotive or leading car. The code signals consist of 60 c.p.s. current, switched on and off at various rates to represent different control commands. For example, current pulses at a frequency of 37.5 pulses per minute are decoded by the equipment on the locomotive and cause a service application of the brakes to be made. Other codes are 75 p.p.m. for a train speed of 7.5 m.p.h., 120 p.p.m. for 15 m.p.h., 180 p.p.m. for 30 m.p.h., and 270 p.p.m. to reverse direction of the train. A complete lack of code pulses, or a steady current causes emergency application of the train brakes. The latter condition could be caused by broken rails, improperly-lined switches, the presence of another train or malfunction of the control gear. Thus, the system is seen to be "fail safe" in that most equipment failures will cause the train to stop.



On the locomotive, the control signals actuate the engine throttle and the train brakes exactly as would a human operator. Mounted on one of the driving axles is a speedometer generator which supplies an electrical signal to the control gear to tell it if the train is moving and at what speed. The train speed is maintained at the level called for by the control signal by comparing it and the signal from the speedometer. If the actual speed is more than ½ m.p.h. low, as might happen should the train encounter an upgrade, the throttle is opened wider. Once the control-set speed is exceeded by ½ m.p.h., the throttle is closed and the train coasts on its momentum. If the speed should increase to 2 m.p.h. over the control-set speed, a service brake application is made and held until the speed drops to the correct level. This latter condition is, naturally, the result of the train encountering a downgrade in the direction of its travel. By the technique explained above, simple "on-off" devices can be used to handle the complex function of train control.

At the loader and dumper terminals, it was desired to have remote control of the train while it moved at very low speeds. At these locations, the control signals are of a different type, being continuously variable modulation of a carrier frequency tone that is transmitted to the locomotive inductively through wire loops laid between the rails. The train speed in these areas is continuously variable from 1/8 to 3/8 m.p.h. within a tolerance of one-hundredth m.p.h. An operator at each terminal controls the starting of the loading and dumping cycles only; all other train movement commands are originated by the automatic control gear.

This installation of an automatic railway, rather than a conveyor belt, pipeline or truck and road scheme illustrates graphically the utility and economy of the flanged wheel rolling along a steel rail, a principle that has been in constant use for over a hundred years. Significant too, is the elimination of manual control on the system. While it is doubtful that automatic control such as this will see widespread use on the majority of Canadian railway lines, it is possible, indeed hoped, that more use of these systems will be made on specialized railway operations such as rapid transit lines and heavily trafficked, completely grade-separated main lines, in order that the maximum economic benefit may be derived from them.

C.P.R. News

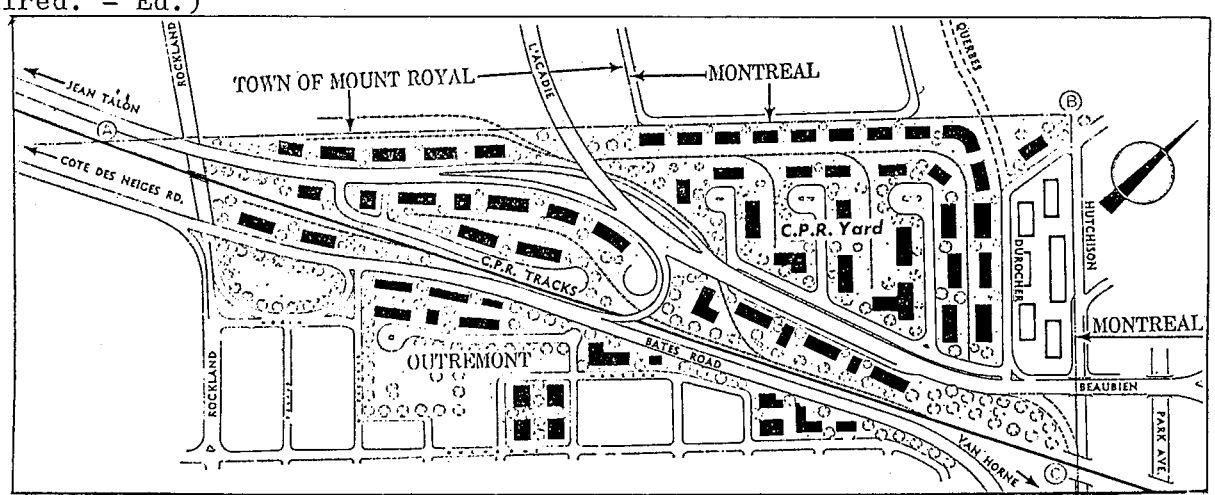
* A high-level flood control and conservation dam at Woodstock, Ontario which will channelise the Thames River and Cedar Creek, will force relocation of the C.P.R.'s trackage to the north side of the Thames sometime during 1963.

* The Board of Transport Commissioners has refused to approve a new fare tariff for the Montreal - Lakeshore commuter service as filed by the Canadian Pacific Railway on December 14th. The railway had planned to increase the fares on the services by amounts of from 10% upwards on January 1st, 1963. Single fares would not have been affected. The Board plans to set a date and place for a public hearing on the proposed increases.

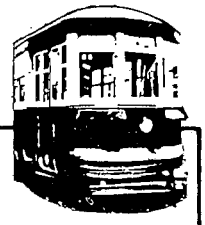
* Permission has been given the Canadian Pacific Railway to withdraw passenger service between McKerrow Junction and Little Current, Ontario, effective February 28th, 1963. The 39-mile branch line was served by a mixed train originating in Sudbury.

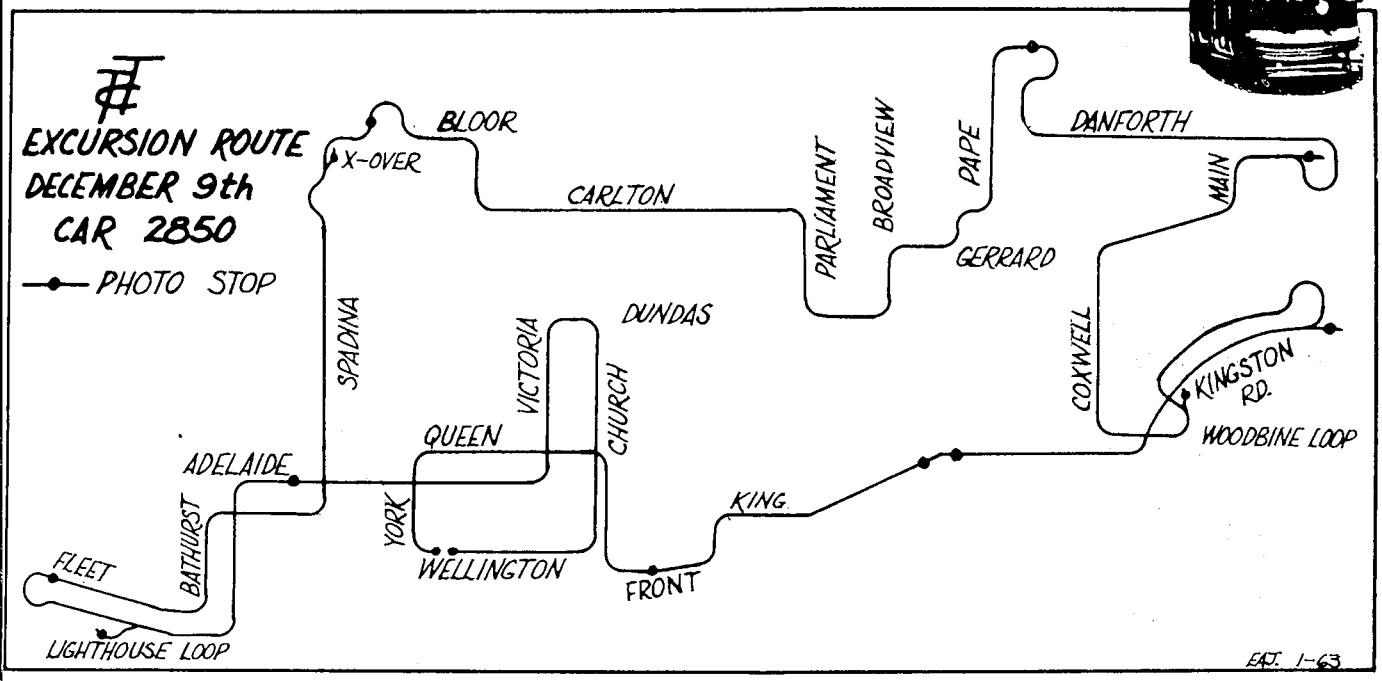
* The C.P.R. plans to build a 15½-mile branch line from Bredenbury, Saskatchewan (95 miles east of Regina on the main line) to the potash plant of International Minerals and Chemicals at Esterhazy (see Motive Power Notes).

* The City of Outremont, Quebec, a suburb of Montreal, plans to develop a 50-acre area now owned by the C.P.R. for an industrial estate of some 50 plants, as indicated in the accompanying diagram. The present railway yards on this land (Outremont Yard) were rendered largely surplus by the opening of the Cote St. Luc Hump Classification Yard. (Town planners seem to have omitted the line from Outremont to Park Avenue station in their diagram. It is presumed that this is still required. - Ed.)



T.T.C. HAPPENINGS





A total of 39 members and friends participated in the Society's last excursion of the 1962 season, which took the form of a four-hour tour of the east-end and central trackage of the Toronto Transit Commission, using small Witt no. 2850. The weatherman co-operated with the trip by giving us a bright, crisp day with just a trace of snow which had fallen the previous night.

Eleven photo stops were made, which satisfied even the most avid photographer. Some of the highlights of these stops included the Don River Bridge on Queen Street, which is scheduled to be rebuilt starting this February; Woodbine Loop, (here, passing pedestrians were startled by the rather unusual sight of about 15 stalwarts pushing 2850 along the track after its pole caught in the wires in the loop); Exhibition Loop and Lighthouse Loop. The new Lipton Loop on Gertrude Place was another highlight that caused a great deal of "neighbour interest". This stop marked the first occasion that a Witt had used the loop; it quite likely was the last, too!

As has come to be expected on our T.T.C. trips, everyone aboard thoroughly enjoyed the outing, and as the days of the small Witt in Toronto are rapidly drawing to a close, interest was expressed in at least one more such trip before they disappear. For more information on this, see the notices in the U.C.R.S. Announcements column.

* As of mid-December, the following small Witt cars were in storage at Russell Division:

2700, 2704, 2706, 2708, 2710, 2712, 2714, 2716, 2722, 2724, 2728, 2734, 2738, 2746 2752, 2756, 2760, 2772, 2774, 2776, 2782, 2796, 2800, 2810, 2812, 2814, 2818, 2824 2826, 2828, 2836, 2848, 2874, 2880, 2882, 2892.

Several of these cars had been damaged by fires set in them by local vandals, including 2714, 2716, 2708, 2810 and 2874.

A number of the cars stored at Russell have recently been sold to the Western Iron and Metal Company for scrap. The cars are no longer sent to George Street Yard for removal of trucks and underbody equipment, this job now being performed at the south end of tracks 21 and 22 at Russell Yard. The car bodies are then loaded onto a special dolly owned by the scrap company and hauled to the Unwin Avenue Disposal Area where they are dumped onto the ground. When a number of bodies has accumulated at the disposal area they are set on fire to remove the

wood parts and then cut into manageable pieces with a cutting torch.

The following cars reached Unwin Avenue prior to January 1st, 1963: 2706, 2710, 2746, 2752, 2756, 2760, 2800, 2810, 2826, 2874 and 2882.

In spite of the scrapping drive now under way on these cars, a number of them still find regular use on rush-hour runs on KINGSTON ROAD, BATHURST, FORT and DUPONT routes.

MAJOR CHANGES IN ROUTING OF KINGSTON ROAD TRIPPER

Effective Wednesday, January 2nd, 1963, considerable changes in the routing of the KINGSTON ROAD TRIPPER service of the T.T.C. went into being. The old route via King and Dufferin Streets to the Exhibition Loop was discontinued in favour of the following:

A.M. Rush Hour Service - From Bingham Loop, via Kingston Road, Queen and King to Roncesvalles Carhouse, returning via the same route.

P.M. Rush Hour Service - From Russell Carhouse, via Queen and Dufferin to Dufferin and King, thence via King, Queen and Kingston Road to Bingham Loop.

In addition to the above, there is an A.M. and P.M. Short Turn service, as before, via Queen and King, looping downtown via Church, Wellington and York Streets.

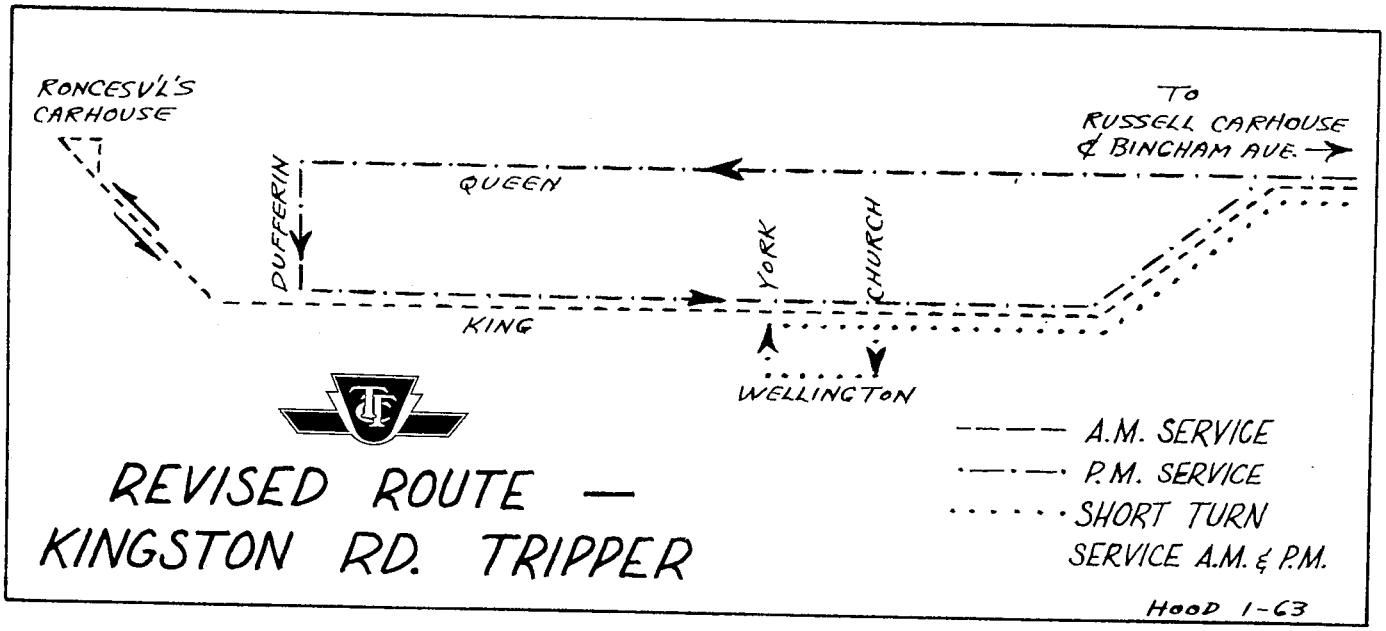
The changes were made for the following reasons:

(a) The A.M. extension to Sunnyside will help alleviate the overcrowding of KING cars eastbound between Sunnyside and Dufferin Street, caused by the abundance of apartment houses in the area, by providing an additional service between these two points.

(b) The P.M. routing will help ease congestion between Church and Bathurst Streets. The KING, BATHURST, FORT and KINGSTON ROAD TRIPPER services all operated west along this busy downtown section.

(c) Conditions have proved to be undesirable at the Dufferin Exhibition Loop with both the KINGSTON ROAD cars and the DUFFERIN bus using the loop at the same time.

In connection with the re-routing, an electric switch has been installed at King and Roncesvalles, north-west and north, leading across the intersection into the carhouse, and at Queen and Dufferin, west to south.



C.N.R. Report

* In a case of "history repeating itself", the C.N.R. Clarkson station, on the Oakville Subdivision 16 miles west of Toronto, was destroyed by fire early on Saturday, December 15th. This was almost two years to the day after the Scarboro station, on the Oshawa Subdivision, was gutted in an early morning fire, and as in the latter case, there was extensive loss of pre-Christmas express shipments which were in the station at the time.

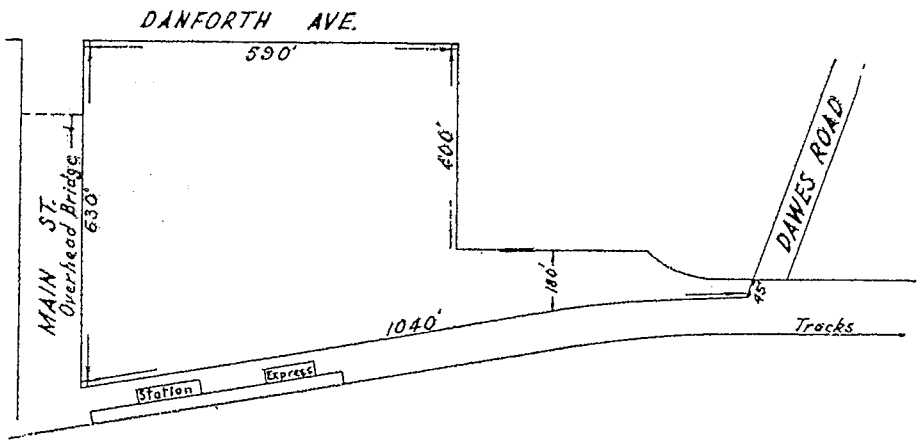
The Clarkson fire reportedly originated from a defective oil burner and broke out one hour after the station had closed for the night. The destruction was quite complete and the blaze took some five hours to bring under control, a nearby lumber yard being endangered during the height of the blaze.

* Referring again to Scarboro station, the latest change in the still temporary accommodations at this location is the removal of the express office to the C.N.R. freight shed on Warden Avenue south of Eglinton Avenue, and served by a spur track from the C.N.R.'s "Geco Loop" line. The two car bodies formerly used for express office and storage purposes have been removed, and only body 68636 is in service, as the operator's office, at the junction of the Oshawa and Uxbridge Subdivisions.

* The spur line of the Oshawa Railway on King Street West in Oshawa, which serves three coal and oil companies, will probably be removed to a point east of Simcoe Street during 1963. The City of Oshawa has been agitating for some time to have the C.N.R. remove this spur which presently passes through the town's main intersection. Imminent success in this endeavour would appear to be indicated by the introduction of a bill in the Ontario Legislature during December authorizing the city to pay the three companies served by the spur line $30,000 in compensation for the loss or damage resulting from the removal of railway facilities; the companies at one time demanded $300,000 in compensation. As the railway, the city and the companies are now in agreement, approval of the Board of Transport Commissioners to the abandonment appears to be just a formality.

* The C.N.R. has applied to the Board of Transport Commissioners for authority to close the station at King City, mile 22.7, Newmarket Subdivision. A letter to local councils from the Board indicates that they are considering the approval providing that the C.N.R. appoints a local express agent to handle parcels. Two protest meetings of local councils were held with C.N. officials during November.

* Redevelopment proposals for railway owned land continue to be in the news. The C.N.R. has advertised for proposals to lease and redevelop the area at the southeast corner of Danforth Avenue and Main Street in the east end of Toronto. The area is now occupied by a lumber company and a fuel supplier. The bulk of the area lies directly north of the C.N.R. Danforth station and has 1040 feet of frontage on the Oshawa Subdivision, as shown in the diagram at the left. The C.N.R. advertisement specified that submitted proposals must maintain access to and a parking area for the existing station.



* A capsule chronology of the Great Slave Lake Railway progress is as follows:

RAILWAYS OF SCANDINAVIA — FINLAND

At Pasila engine shed, near Helsinki, no. 586 was seen heading a train of 4-wheeled passenger cars. The engine was built in 1919 by Schwartzkopff of Berlin.

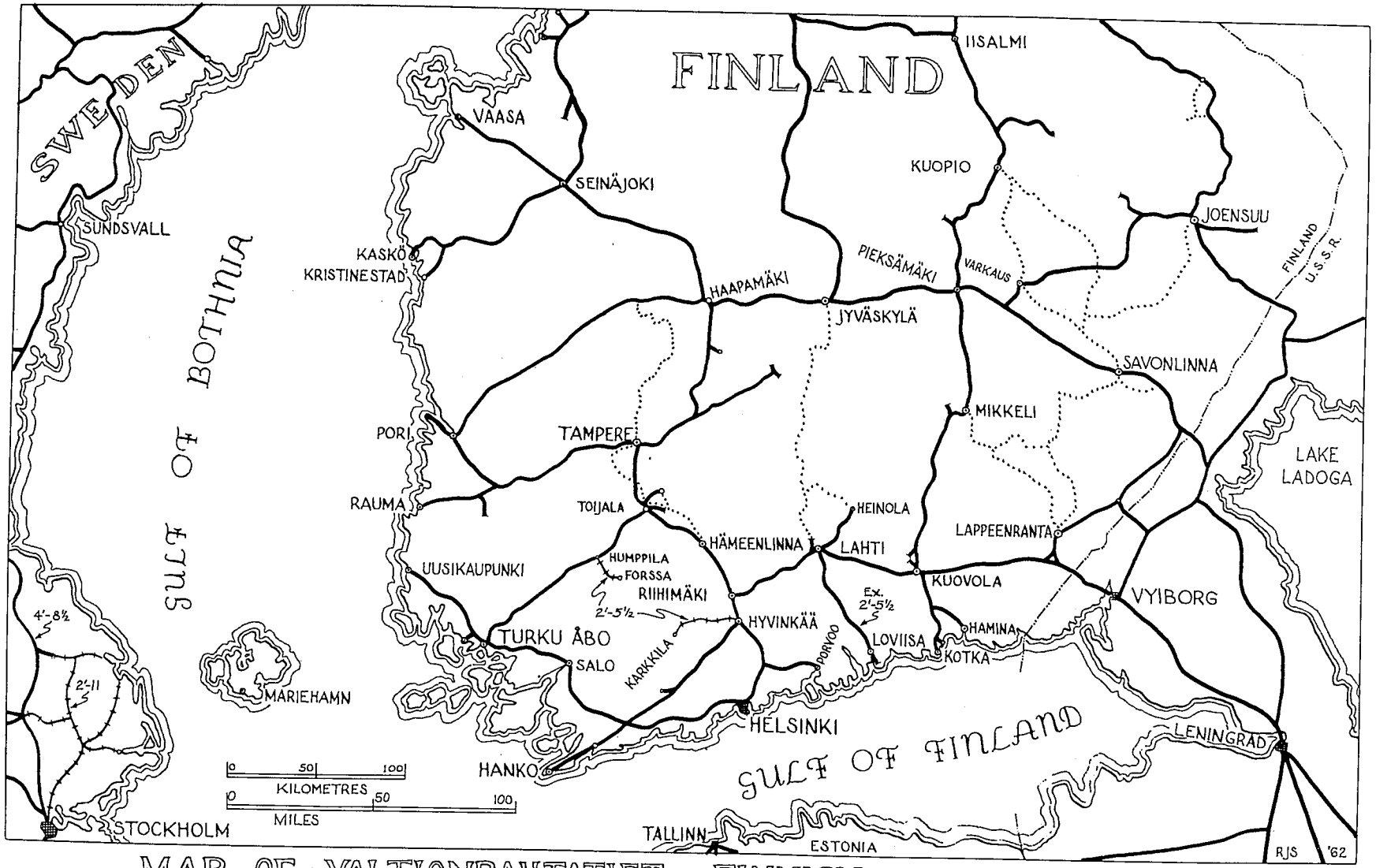
By Robert J. Sandusky
Photos by the Author

After leaving Helsinki, a circular route was taken east to Kuovola, north to Pieksämäki and Kuopio, west to Jyväskylä, Tampere and finally Turku Åbo. The northern towns are a bit away from the usual travel routes but are worthwhile visiting because of V.R's interesting upcountry operations and the scenic attractions of the lake systems.

At Hyvinkää shops one of V.R's five 0-10-0T's was in steam. This series is structurally indentical to the suburban 2-8-2T. In for shopping were several U.S. looking 2-10-0's, part of 20 built for USSR by Baldwin and Alco in 1946-7. With a change in coupling apparatus any of these machines would look quite at home on North American rails. They are the only locos with swinging bells and, not surprisingly, automatic stokers.

Stored in the scrap line was a rare little 1903 2-6-0 with cabbage stack, air pump and 6-wheel tender with cordwood racks, a true remnant of the past. It appeared to be the last survivor of over 200 such machines built in Switzerland, U.S.A., Sweden and Finland between 1886 and 1904. As a contrast to it were 4 massive 4-6-4T passenger locos which looked somewhat more elaborate than the usual Finnish design. As it turned out they were built by Henschel in 1941 for the Estonian Railways but wartime requirements sent them to Finland instead. All are now retired.

The next hop was made in two short stages and served as an introduction to the two main types of railcar. A train of small DM-7 class, Valmet railbuses was taken to Riihimäki. They are similar in design and seating to the TGOJ electric cars. The tubular steel seats add a spartan touch to the interiors. These cars bounce a great deal as they approach their 95 km/h top speed and one does not envy the itinerant, ubiquitous food vendor as she pilots her large basket of goodies over the rough passage between cars. Vestibule doors are controlled by passengers who use sets of buttons inside or outside the car. Any inadvertently left open are closed from master control after starting. Following this was a run to Lahti in one of the larger DM-4 cars, also built by Valmet and less numerous than the DM-7. The former can haul 3 matching trailers or a pair of standard carriages, though acceleration is low under these conditions.



MAP OF • VALTIONRAUTATIET • FINNISH STATE RAILWAY

RAILWAYS 4'-8½ OR 5'-0 NARROW GAUGE INLAND STEAMER ROUTES .....

The main line through Lahti was built from Riihimäki to St. Petersburg (Leningrad) during famine years. It was designed to connect with inland lake transportation at Lahti and Lappeenranta and was completed in 1870. Upon arrival at Lahti we were treated to the sight of an 0-6-0T woodburner shunting in front of the large brick station. It looked quite incongruous beside the modern control tower nearby.

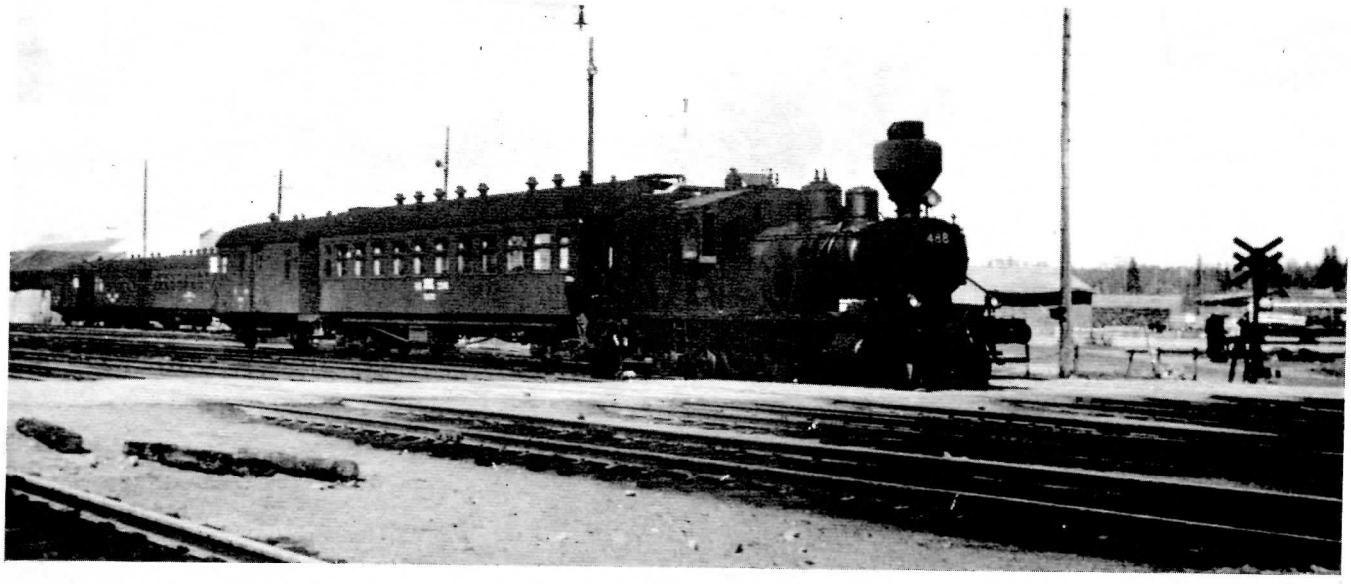
With much fussing and steaming, 0-6-0T no. 787 switches flatcars destined for the U. S.S.R. at Hyvinkää. The two headlamps are acetylene-powered!

One of Finland's narrow gauge railways used to pass through Lahti. The 2'-5½" Loviisa and Vesijärvi became a broad gauge branch in 1960, but just across the street from the station was an L. & V. train on display, still resting upon a short length of the original line. A few cans of paint would improve the appearance of loco #7, an Orenstein & Koppel 2-8-0, one boxcar and a "konduktöörivaunu". A few other traces of the line could be seen in town.

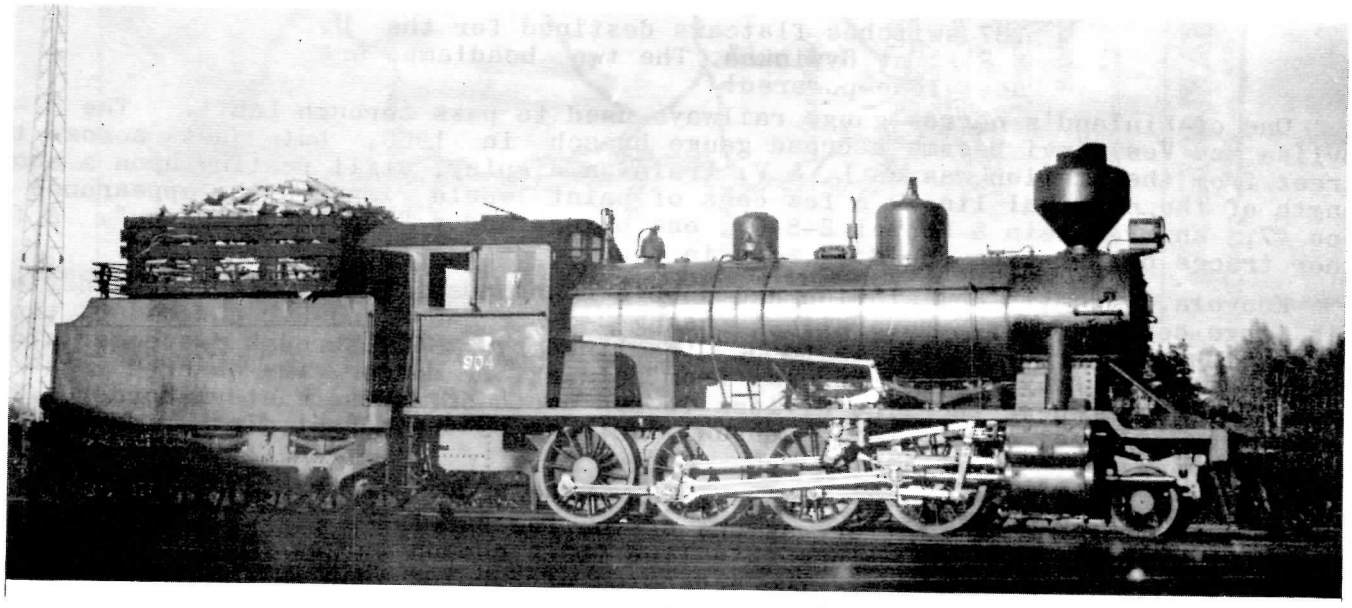
Kuovola, with its new station and double roundhouse, is an important junction. This large centre of steam operation, using 2-8-2, 4-6-2, 4-6-0 and 0-6-0T types (along with another 0-10-0T), is to be dieselized by 1964. Through passenger stock of the Soviet railway system, running from Helsinki to Moscow, was observed passing through Kuovola (where the line divides to run north or to the eastern border). The heavy, green, steel cars were an unusual contrast to the normal diet of dark brown on V.R's wood-sheathed carriages.

Moving north to Mikkeli produced more woodburners; a 2-6-4T yard switcher and a retired 2-8-0. The latter was one of the few survivors of V.R's second order of 2-8-0's, built in 1903. Along this line it is common to see water towers built integrally with cordwood sheds. The economics of burning wood in Finland have been justified by the necessity for the country to import its coal and oil from Poland, Russia, France and Britain. (Judging by the remarks of one driver the imported coal is not always of the best steaming quality.) V.R. hauls many trainloads of wood for its own consumption and one eye-catching feature at some terminals (notably Pieksämäki) is the enormous reserve of cordwood, stacked in orderly piles which resemble

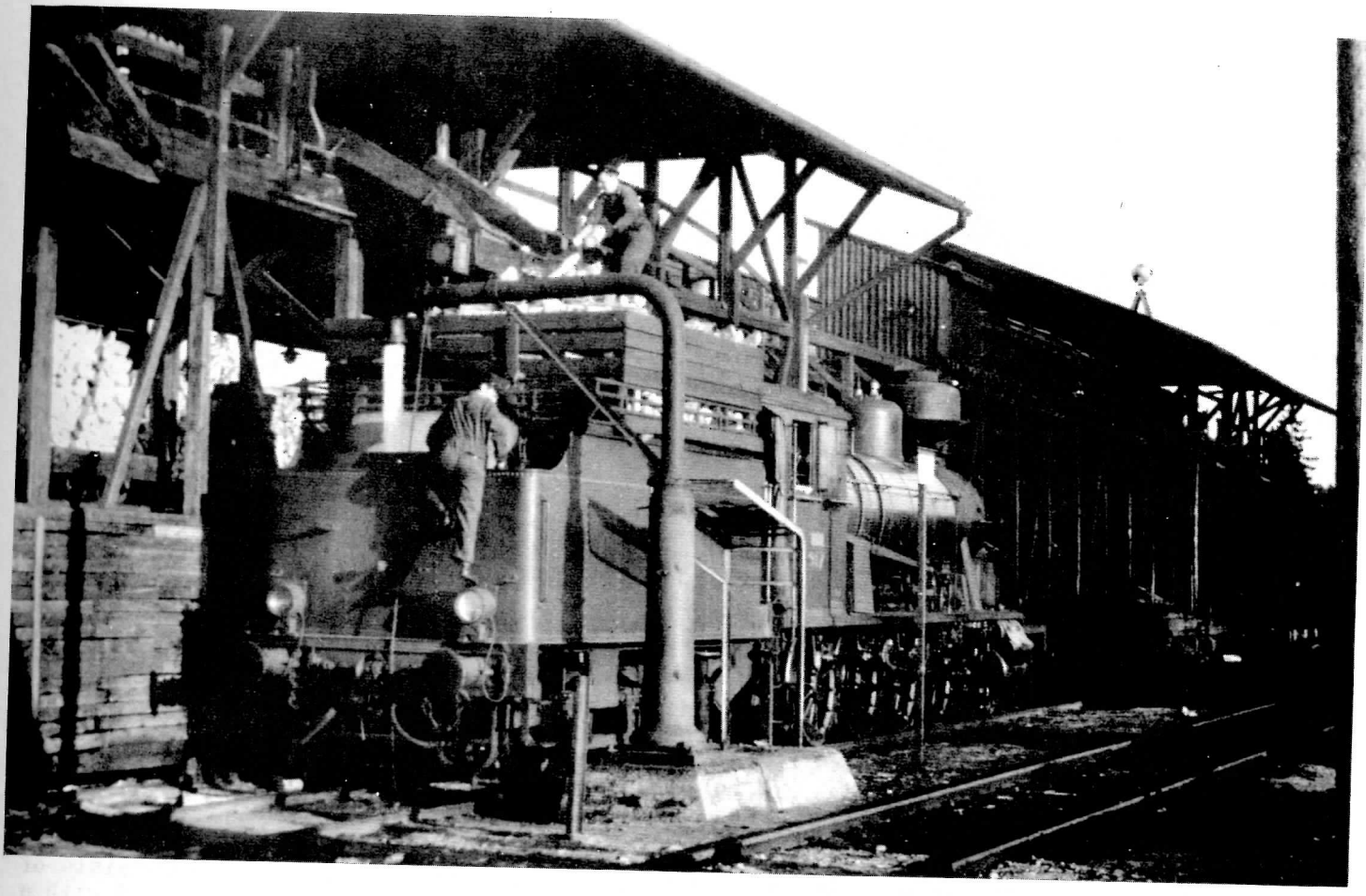
low, wooden sheds with peaked roofs. Various classes of 4-6-0 and 2-8-0 (including some of the newest 1944 2-8-0's) are fitted with balloon stacks. In addition, many of the older types use acetylene headlamps, (two on the pilot beam and often a third on the smokebox), fed from a master cylinder mounted on one running board. Several such engines were being fueled quite expeditiously at Pieksämäki by means of a combination coaling and "wooding" tower from which 4-wheel carts on the upper level spilled their contents down a chute into the tender at the same time as water was being taken from a trackside standpipe.



No. 488 of Finnish Railways is seen shunting passenger cars at Mikkeli. The engine was built at Tampere in 1909.



A wood-burning 2-8-0 in 1962? No. 904 of the Finnish Railways was built in 1928 by NOHAB, and was seen at Pieksämäki.



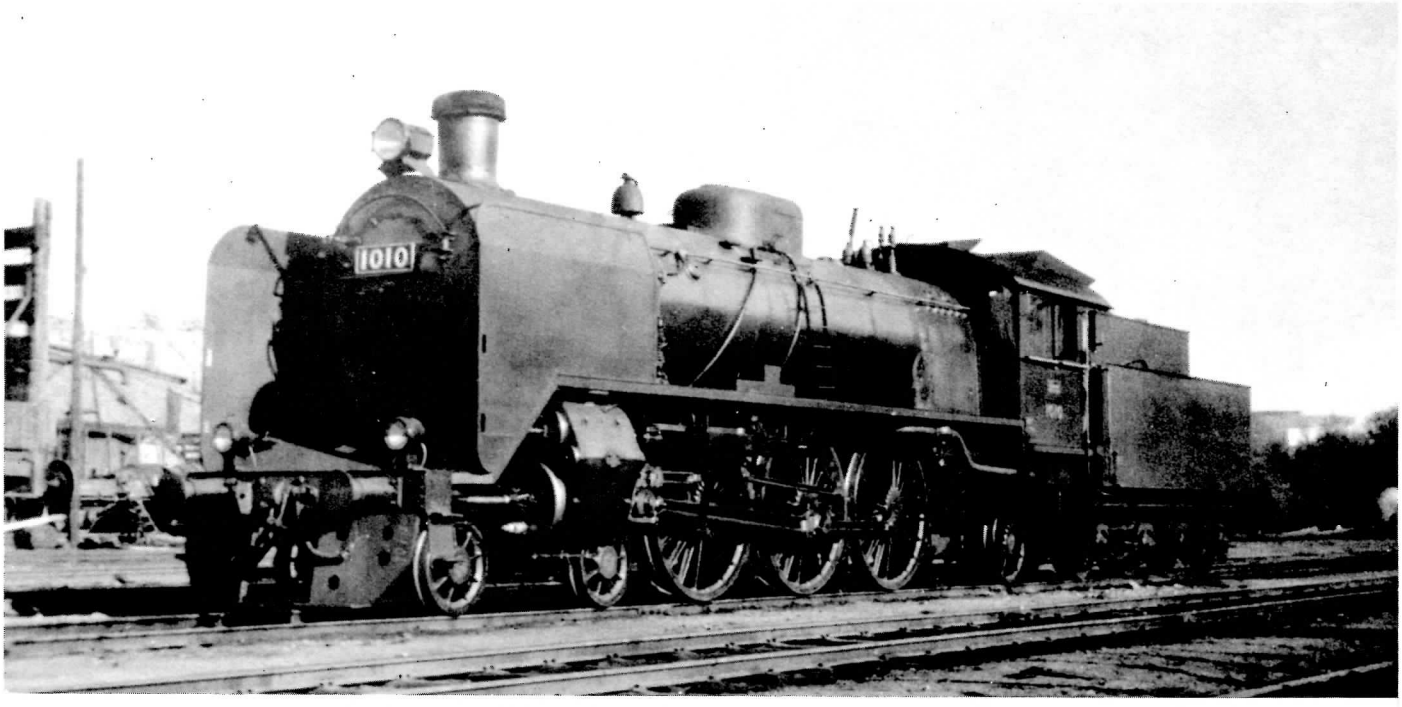
2-8-0 no. 917, a Lokomo product of 1931 is seen wooding up at the wooding plant at Pieksämäki.

Service by mixed train was sampled next as a 4-6-0 headed up one of the 8 trains per day which run from Pieksämäki north through Kuopio. Several 2-8-0's emitting white clouds of birch smoke were crossed on the way up. Kuopio has a busy roundhouse and backshop where the spare shunter is a tiny Borsig 0-4-0T. A 1917 Alco 2-8-0 was found there, looking like a refugee from a tropical banana road, along with another 1903 2-8-0 being held for V.R's historical collection. Steamer services operate as far north as Kuopio, their draught being limited to 2.4 metres.

The return to Turku was punctuated by stops at Jyväskylä and Tampere. Jyväskylä is at one end of a long lake (is there a Finnish town that isn't?) and close to the station is the inevitable steamer landing. In this case it is the starting point for a 100km cruise south to Lahti. The railway line from the east to this town was built for strategic reasons just after World War I and became part of a secondary east-west route. Tampere, a large and clean industrial city, is also well -endowed with steamer routes to the north and south. It is a centre of much rail activity (but no tram system) and recommended overnight accommodation is the Emmaus which overlooks the main line station and yard.

No doubt the Tampere-Helsinki line would have been included in recent electrification proposals placed before the Finnish Parliament, had the plans been approved. It now appears that V.R's future is complete dieselization by 1970. Heavier rails are continuing to be laid as part of the overall improvements to the system and larger locomotives of up to 2800 h.p. are planned for future deliveries.

Passing through Humppila, south of Tampere, one of the two remaining 75cm lines, the Jokioisten, was seen branching off to Forssa. Several transporter wagons were in the yard. These low vehicles enable 5' gauge wagons to be moved over the branch line.



V.R. no. 1010 is a class Hr-1 passenger engine built by Lokomo in 1940. The "extra cylinder" in the cylinder saddle is only a snifter valve.

At Turku Åbo, there was time to tour most of the tram system which consists of three metre-gauge lines. The transfers issued on the cars are imprinted with a small route map showing transfer points and making it quite easy to get about. Route 3 described a loop around town while nos. 1 & 2 projected branches out from it in two opposite directions. Route 1 was the domain of the newest double - truck cars, built in Finland in 1956, while 4-wheelers of uncertain age were serving the other two lines. All trackage was street running or side-of-road.

(To be concluded next month)

MOTIVE POWER NOTES

* It is reported that 25 steam locomotives are at present stored at the Canadian Pacific's Angus Shops in Montreal. These engines, none of them even remotely fit for service, include: 4-4-0's 29 and 144; 4-6-0's 424, 490, 492, 842, 894, 999 1088 and 1095; 4-6-2's 1201, 1227, 1270, 2409, 2454 and 2231; 4-6-4's 2816, 2827, 2839 and 2858; 4-4-4 no. 2928; 2-8-0 no. 3388; 2-8-2's 5361 and 5405; and 0-6-0 no. 6271. Eight of these locomotives will ultimately be displayed at the Canadian Railroad Historical Association's museum project at Delson, Quebec. The numbers of these units include 29, 144, 492, 999, 2231, 2928, 3388 and 6271.

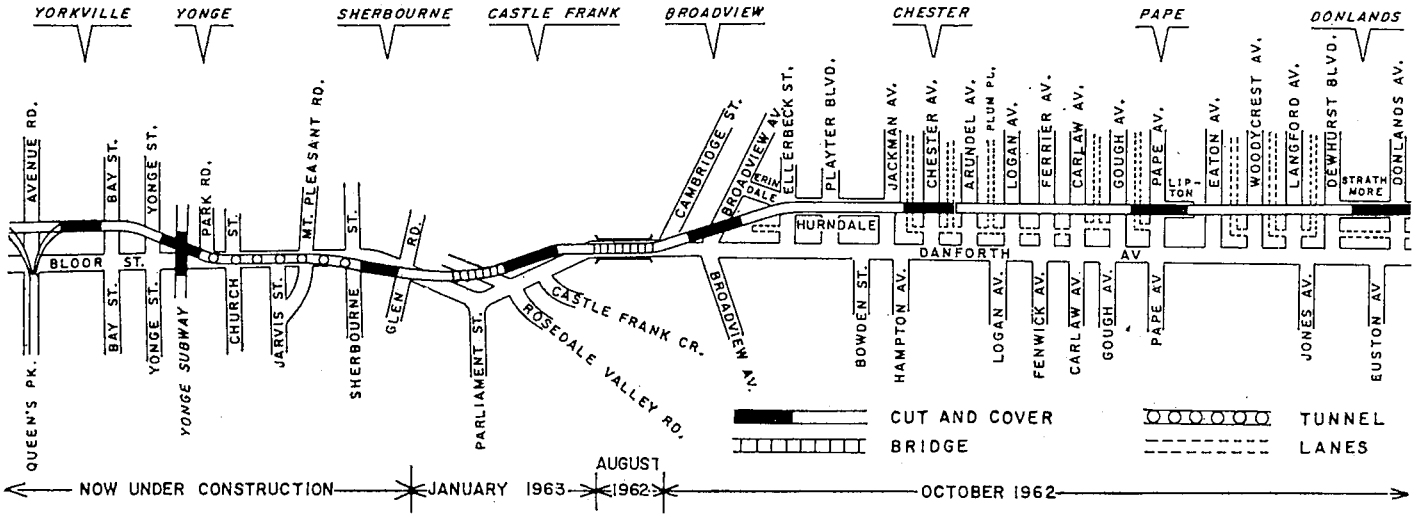
(G.A. Matheson)

* Two more freight motors are reported to be sold by the Canadian Pacific. G.R.R. 226 and L.E.& N. 337 have had pilots, poles and traction motors removed prior to their trip to the Iowa Terminal Railway at Mason City, Iowa. This 10-mile switching and coal-hauling road already has 7 electric locomotives, but none as heavy or powerful as the two they may be buying from the Canadian road.

(W.E. Miller)

* C.N.R. 4-6-0 no. 1533, which had been in storage at Allandale for the last two years, was recently shopped and repainted at Spadina roundhouse prior to its shipment to a buyer in the United States, reportedly in the Philadelphia area.

Two other contracts were recently awarded on the Bloor project, being those bearing numbers D-2A and D-3. The former, awarded to Dineen Construction Company, involves the building of Sherbourne Station, lying between the east side of Sherbourne Street and Glen Road (see diagram), while the latter contract went to C.A. Pitts General Contractor, Ltd., and covers the section from the Glen Road bridge to the west end of the Prince Edward Viaduct, including the Rosedale Ravine covered bridge (see Newsletter 196, page 59).



* The T.T.C. has asked its Subway Construction Branch and Board of Consulting Engineers for a new technical and financial report on ways and means to speed up construction of the Bloor-Danforth subway so that completion could be achieved in 1965 instead of 1967-68, including the recently proposed extensions to Royal York Road and Warden Avenue. There has been heavy political pressure recently for consideration of this by the Commission.

* Although operation on the Spadina rapid transit line is probably still a good many years in the future, the first piece of construction on the facility will actually be undertaken during 1963. A contractor recently engaged for the building of the underpass structures for the Spadina Expressway north from Lawrence Avenue will construct the Lawrence rapid transit station as part of the overall job at this location.

* Construction of a two-storey shopping centre over the T.T.C. Davisville subway yard and carhouse, a project much feared by local railway enthusiasts, has been delayed by the Ontario Municipal Board, which has referred the matter back to the Toronto City Council to deal specifically with objections of neighbouring residents who are particularly disturbed over a proposed road access to the development through a residential area from Chaplin Crescent. Accordingly, a few more months of free entertainment may be seen from the Chaplin bridge before construction destroys the panorama forever.

MEMBERS' ADVERTISEMENTS

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