NINE 2,400-VOLT, 100-TON LOCOMOTIVES
supplied to
THE HARBOUR COMMISSIONERS OF MONTREAL
are the most Powerful Four-axle, Direct-current, Electric Locomotives in the World.

The ENGLISH ELECTRIC Company Limited

HEAD OFFICE: QUEEN'S HOUSE, KINGSWAY, LONDON, W.C.2.
August, 1931. PRINTED IN ENGLAND. Publication No. M 73.
C. 20.

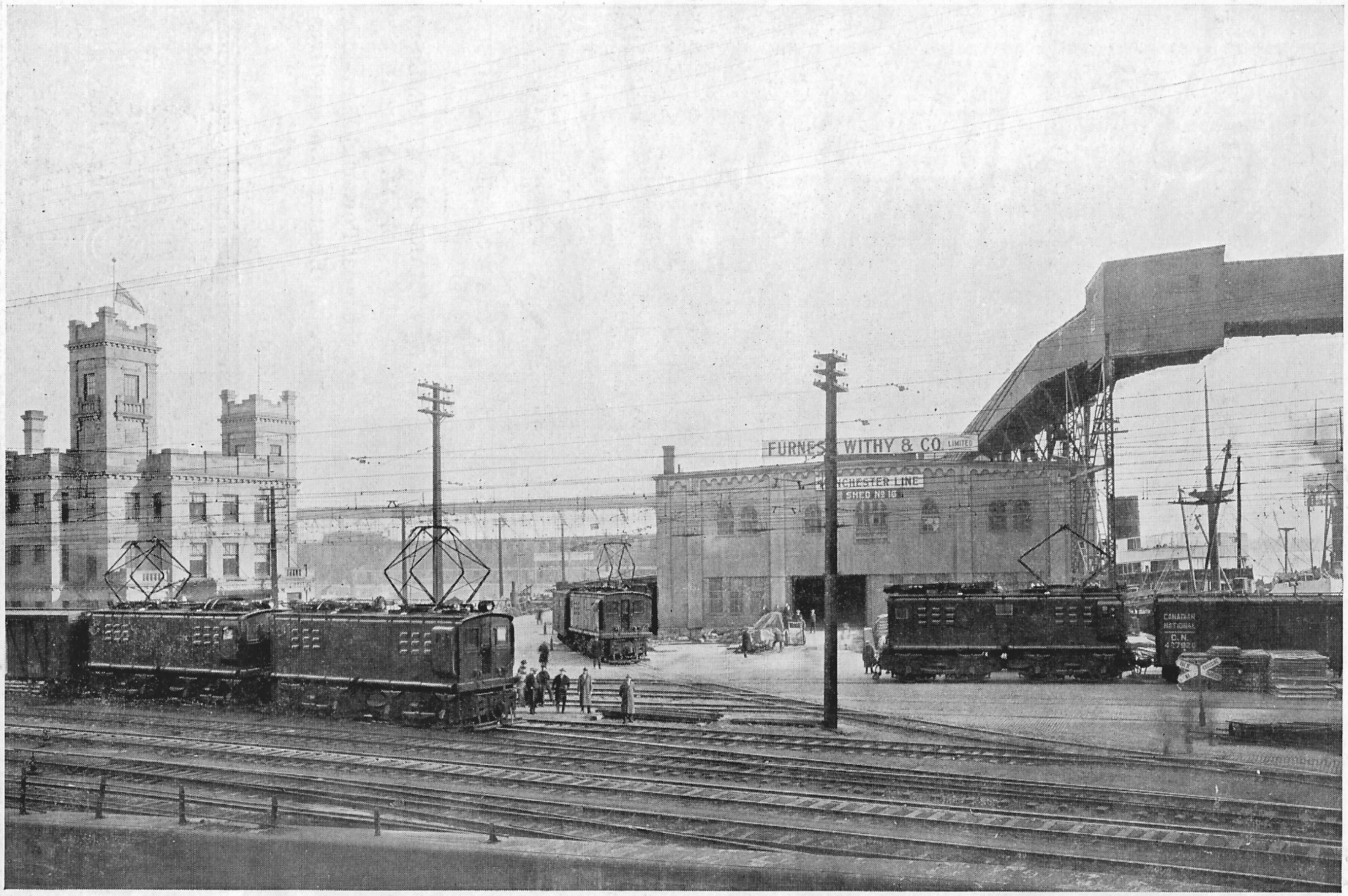


Fig. 1. Four of the Locomotives in service in the Port of Montreal.

PORT OF MONTREAL

ELECTRIFICATION OF THE HARBOUR LINES

ONE of the most interesting orders executed by The English Electric Company in recent years has been that received from the Harbour Commissioners of Montreal for the supply of electric locomotives and substation plant. In the first place it is a good example of the almost unlimited use that can be made of electric power, and particularly of its application to the complicated tracks of a large harbour. Its second point of interest lies in the design of the locomotives themselves, both on account of the high voltage of operation and because these locomotives are the most powerful four-axle freight locomotives in the world.

Previous to the complete electrification of the harbour, the Commissioners rented two electric locomotives from the Canadian National Railways for temporary use, as an experiment in electric traction ; subsequently they commenced operation with the first four of their own locomotives in the Spring of 1925. These machines, which were entirely built and equipped in England by the English Electric Company, are illustrated in Fig. 1, which shows a general view taken in the harbour.

The system of supply was finally settled at 2,400 volts direct-current, in order to conform to the existing supply on the Montreal tunnel section of the Canadian National Railways. Electric power is derived from motor-generators converting from a 12,100-volt, 63-cycle, 3-phase, A.C. supply to 2,400 volts D.C.

Simultaneously with the supply of the first four electric locomotives, the Company supplied two 1,000-kW. motor-generator sets, which together with an

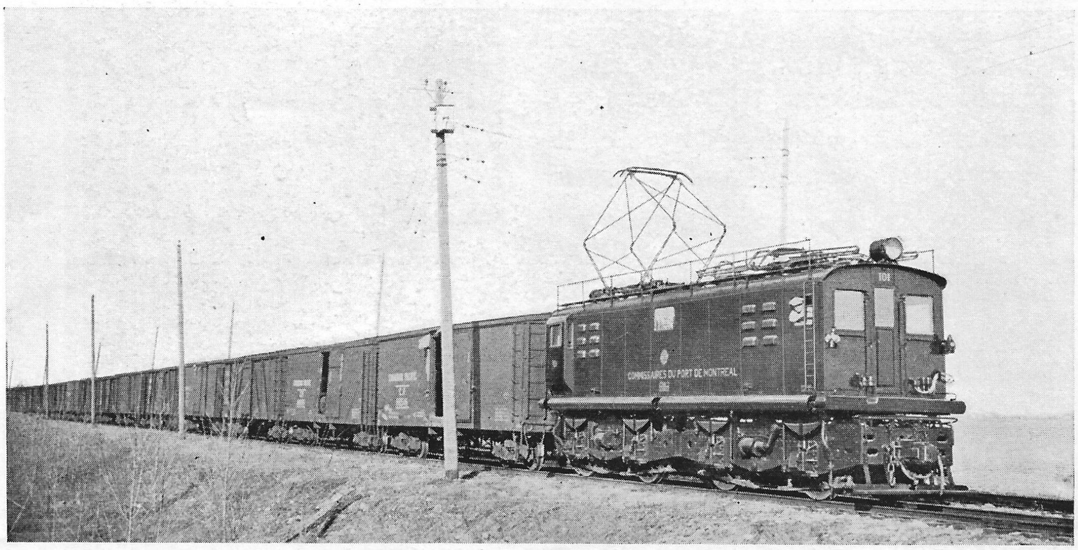


Fig. 2. 100-ton, 2,400-volt Locomotive hauling a 5,000-ton Train.

existing set of the same capacity, are installed in the substation of the port. These motor-generator sets feed the overhead conductors for the tracks, which consist of single 4/0 copper trolley wire with single catenary suspension. Span wire construction has been generally adopted owing to the very large number of tracks to be covered, and the whole of this work was carried out by the Harbour Commissioners' staff.

As mentioned above the supply of power for the locomotives was provided initially by three 1,000-kW. 2,400-volt motor-generators, the second and third of which were manufactured at the Company's Stafford Works. Two further sets of similar type, making four in all, were supplied later to a repeat order. Each unit consists of a 2,300-volt, 63-cycle, synchronous motor, coupled to two 1,200-volt D.C. generators, the latter being connected in series and the whole unit running at a normal speed of 756 R.P.M.

These machines are of standard "English Electric" construction and are designed to cope with the heavy overloads normal to a traction system. They are capable of carrying three and a half times full load for a period of five minutes. The generators are fitted with compensating windings to assist commutation during overload. The excitation for the motor and the generators is supplied by overhung exciters, one at each end of each set, and the field windings of the two generators are connected in series. Fig. 3 shows the first two machines in the substation at Montreal.

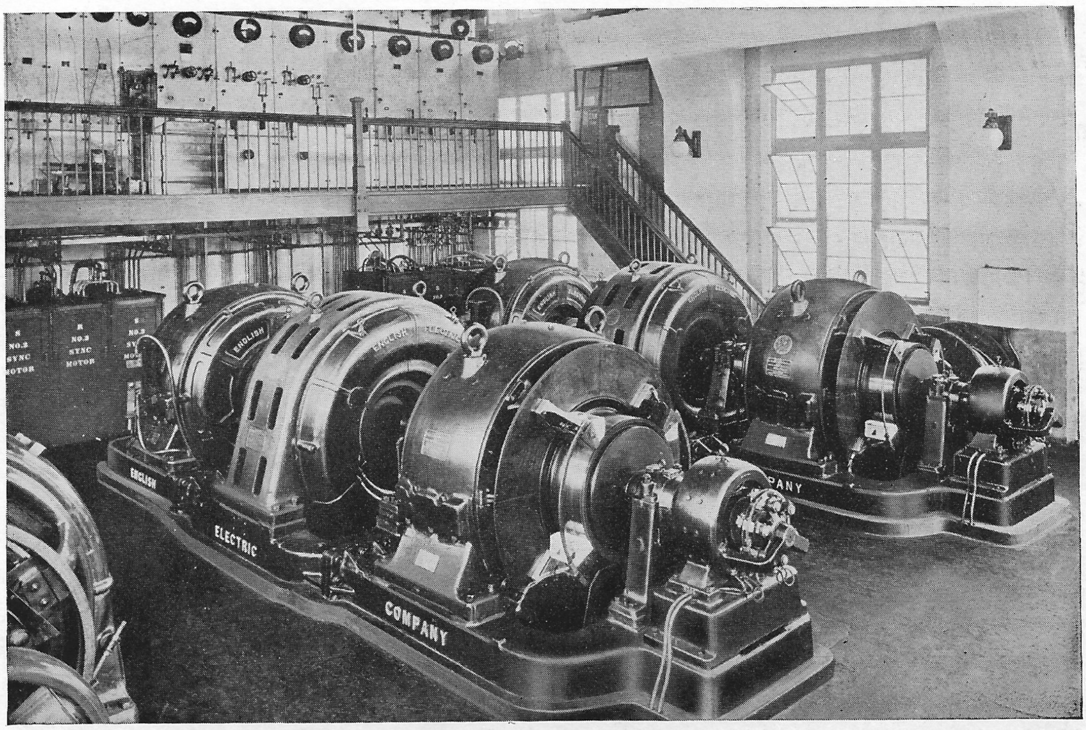


Fig. 3. Substation containing Three 1,000-kW. Motor Generators for supplying 2,400-volt D.C. Line.

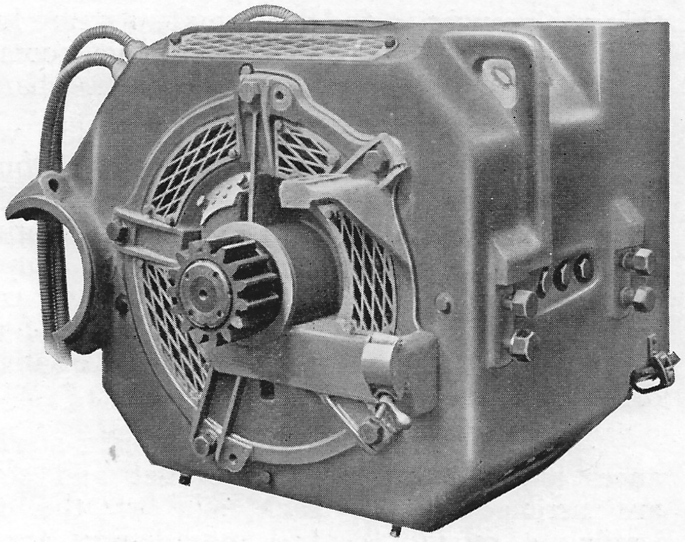


Fig. 4. 430 H.P. Traction Motor.

Special protective features have been embodied in these machines with a view to avoiding the possibility of flash-over due to short circuits on the system. The commutators are made of the same diameter as the armatures, and a propeller type fan fitted between the commutator and the armature provides a powerful air flow in an axial direction over the commutator surface. In addition, barriers of fireproof material protect the field windings and brush gear, and arc chutes are provided at the leading edge of each line of brushes. The purpose of the chutes is to cool and expel the gases generated by the flash; this is effected by drawing in cool air by the injector effect of the arc chutes and by the gases striking on a copper cooling plate. Accidental short circuits on the system have been without any detrimental effect on the generators.

The first order consisted of four locomotives and the second order of five, the machines for both orders being identical with the exception of one or two minor details. General views of one of the locomotives are shown in the frontispiece and Fig. 2. They are of the articulated double-bogie, four-axle type, and the superstructures are of the box cab design.

To enable shunting operations to be carried out safely and with a minimum of fatigue for the operator, special arrangements had to be made to provide a driving position from which the operator could have a view in both directions. The locomotives are, therefore, constructed with the usual driving position at one end, but at the other end the driver's cab projects on both sides so as to give a clear view up and down the track; this cab is fitted with duplicate controls, one at either side. This arrangement enables the operator to carry out all shunting operations from one end of the locomotive, the driving position at the other end being used only when it is the leading end on long hauls.

Each locomotive is equipped with four single-reduction twin-geared motors, one driving each axle; one of these machines is shown in Fig. 4. Each motor is capable of giving 430 H.P. at the one-hour rating, and is of the forced ventilated type, receiving air through a sliding joint from fans mounted on and driven by the motor-generator set in the body of the locomotive. The motors provide a tractive effort at the tread of the wheels up to 70,000 lbs. per locomotive, and as a result, the locomotives have been able to handle, as single units, the largest train that it has been necessary to bring into the docks. The heaviest train so far recorded that has been hauled, single handed, by one of these locomotives, weighed 5,240 tons;

this was brought to the docks by two steam locomotives and then taken over by one electric locomotive and hauled to the distribution point near the wharves.

The locomotives are arranged for working in multiple-unit if required. The control equipment is all-electric, embodying the camshaft control principle developed by The English Electric Company. The essential points of this control are its simplicity, the absence of finely regulated valves and complicated interlocks, and the closing and opening of all control contactors in definite sequence by means of an electrically driven camshaft.

The control apparatus, the main starting resistances and the motor-generator set and compressors, are arranged down each side of the locomotive leaving a straight central passage-way from end to end. The resistances, which are specially rated for shunting service, are housed in four compartments situated at each corner, thus giving an even weight distribution. They are of the grid type built up in frames and supported by mica-insulated steel bars.

The high-tension control equipment is mounted entirely in one large control compartment which is, however, further sub-divided to form separate compartments for the lightning arresters, the choke coils, and for the apparatus controlling the auxiliary machinery.

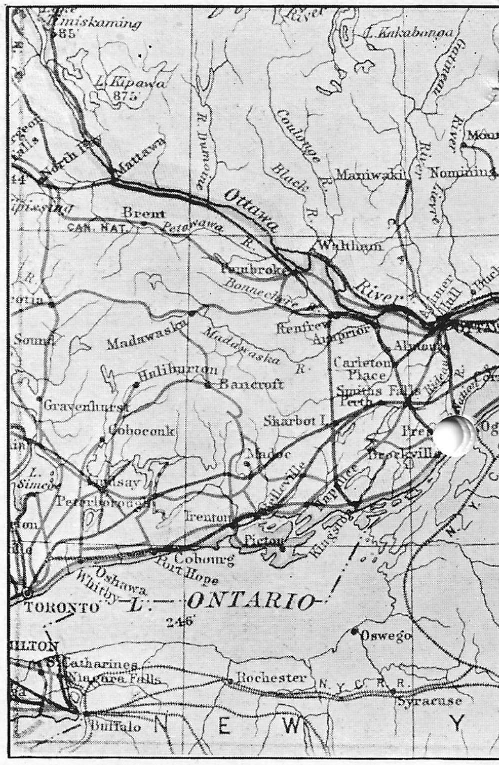
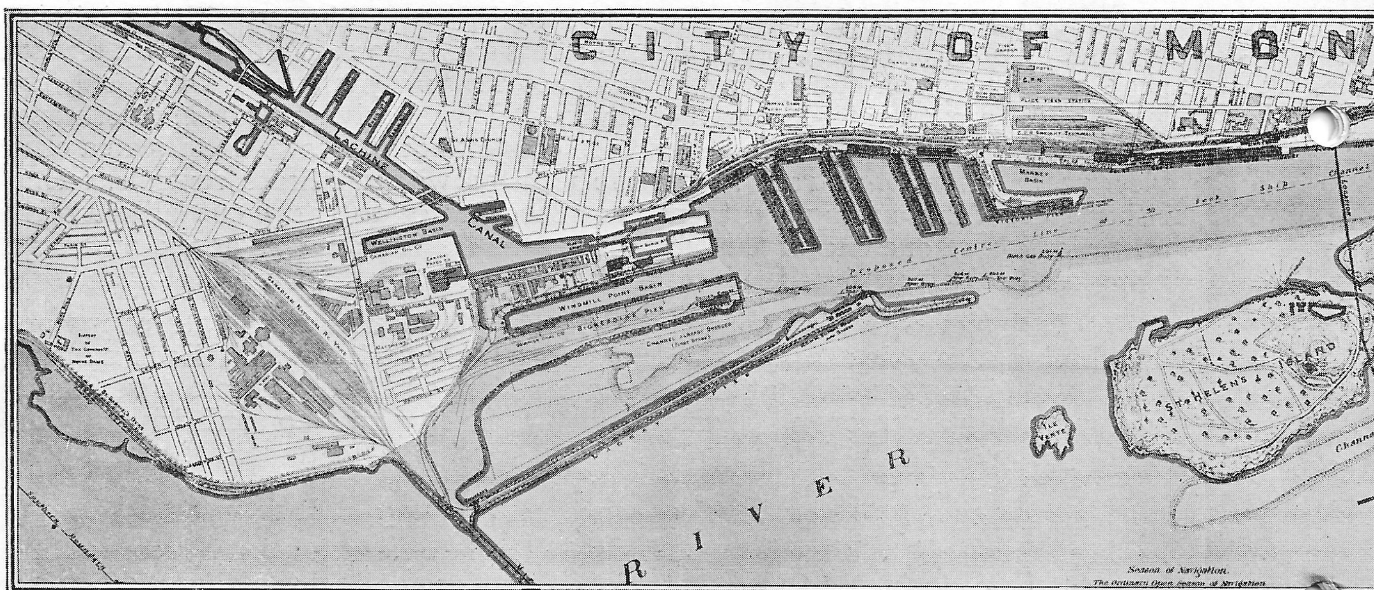
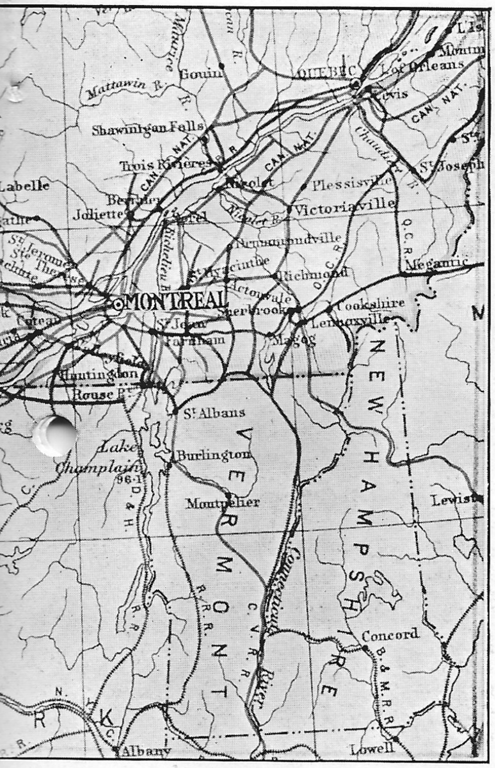


Fig. 5. Map of Montreal and surro

Fig. 6. Map showing d





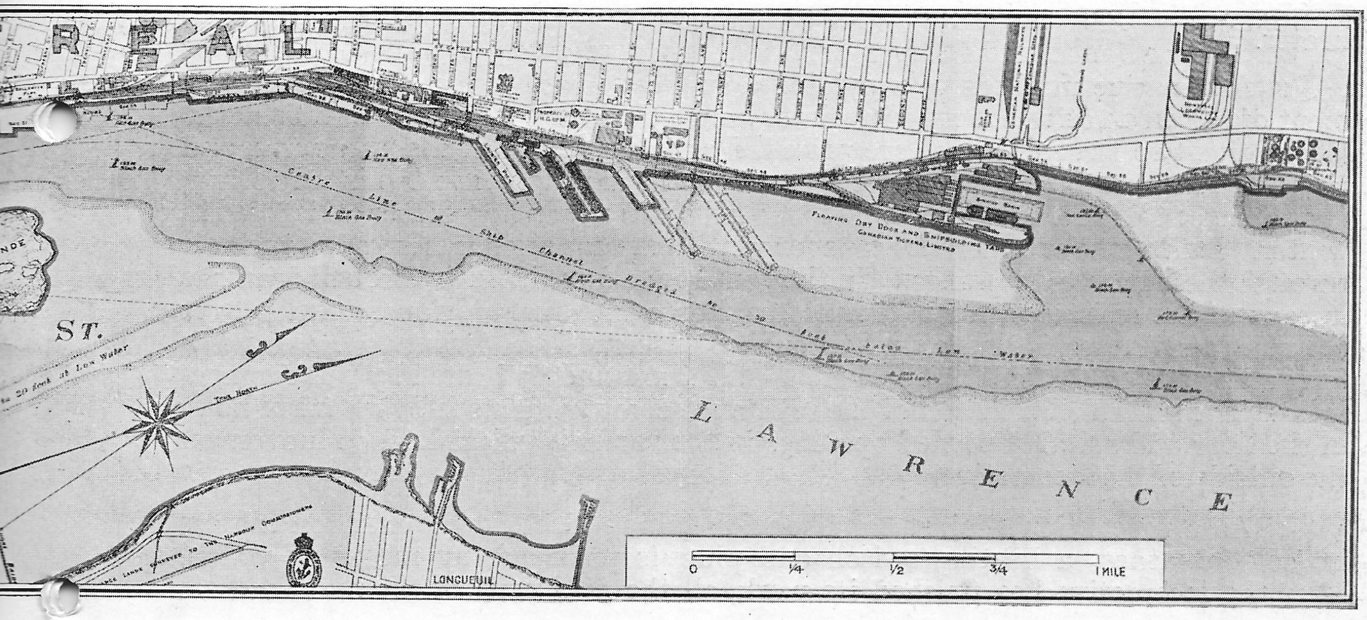
...ing country showing Main Railways.

The high-tension control compartment is protected by substantial sliding doors which are interlocked with the main switch in such a way that they cannot be opened whilst the switch is closed, and the switch cannot be closed if the doors are open. The opening of the inner door to the auxiliary high-tension compartment is similarly interlocked with the auxiliary high-tension switch. Fig. 8 shows the main high-tension control compartment with the camshaft-driven contactor groups in the foreground.

In accordance with the standard design of "English Electric" camshaft control, all operating current is broken by two line breakers in series, and the current is not broken on the camshaft controller itself. Complete protection is given to the equipment by a main circuit-breaker connected in front of the line breakers and operated by its own overload coil and by two overload relays, one in the circuit with each pair of motors. This main circuit-breaker can, in addition, be tripped by the operator from each driving position in case of emergency by means of a push button.

Opposite to the high-tension control compartment are situated the motor-generator set and compressors. The motor-generator set consists of a 50 H.P., 2,400-volt motor driving a 16 kW., 120-volt generator and also two fans, each of which supplies ventilating air to two of the

...s of Montreal Harbour.



traction motors. The generator supplies current for control and lighting, and also for the two compressor motors, each driving a 50 cu. ft. compressor, which are synchronised so as to operate together.

Fig. 7 shows a general interior view of a locomotive. It will be noted that the arrangement adopted for the apparatus gives not only an ample passage-way through the locomotive, but ready access to all pieces of apparatus.

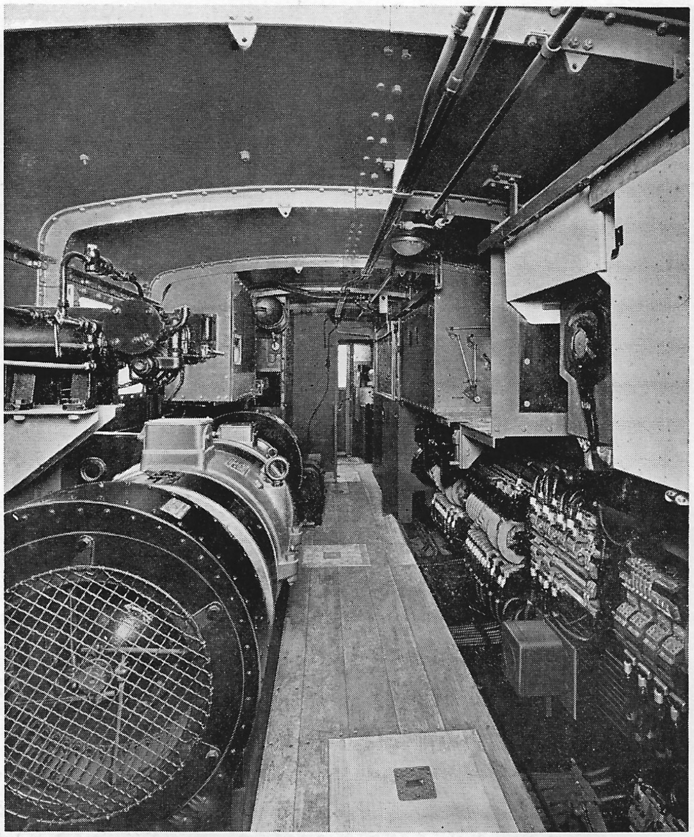


Fig. 7. Interior of Locomotive, showing Motor Generator and Fan Set.

The questions of adequate ventilation and heating call for special consideration in the case of a climate such as that of Montreal. On account of the extreme cold, all windows are of double glass, and the driver's cabs are heavily lagged with heat insulating material and suitably lined. Each cab is warmed by means of a 6-kW., 2,400-volt heater.

Alternative methods of providing a supply of air for the central compartment of the locomotive are used in winter and in summer. In the side walls of the locomotive two large openings are provided and fitted with slat type louvres, and these openings can be completely closed on the inside by means of hinged folding type shutters. The normal procedure is to keep these open in summer and closed in winter. During the summer, the fans for ventilating the main motors draw their air through these louvred openings. In the winter, the fans draw air through openings in each of the resistance compartments, and air which has previously passed over the main resistances, is thus drawn through the locomotive. Owing to the very low temperature of the outside atmosphere the air is not unduly heated by this arrangement. The normal ventilation of the resistance compartments is by means of holes in the floor and suitably cowled openings in the roof, also plain hooded louvres on the outside of the locomotive.

As a precaution against condensation taking place in the traction motors in cold weather, a heating switch and plug is provided by means of which, after the locomotive has finished its work, all the field coils of the main motors can be connected in series and plugged directly on to an outside 220-volt supply.

The two driving compartments of the locomotive are entirely separated from the central portion by means of hinged doors. Each of the three master controllers, two in one driver's cab and one in the other, provides eleven series and eight parallel notches, and of course "forward" and "reverse" positions. To the right of each controller are situated the driver's brake handles and also sanding valves arranged to sand the locomotive in either direction from any driving position. There are also mounted within the driver's reach, the push button for emergency operation of the circuit-breaker, the main control switch, and whistle and bell valves. The ammeter and pressure gauges are mounted on panels directly in front of the driver.

The driving windows are large and give a perfect field of view. The end windows are provided with two window wipers, operating from diagonal corners, which together sweep the whole surface of the window ; the windows giving a rear view from the larger driving compartment are similarly fitted.

All the cables inside the control compartments are carried on cable racks, and where they cross the floor they lie between the main floor of the locomotive and a false wooden floor, which extends throughout the passage-ways and the driver's compartments. The motor cables are brought into connection boxes fitting flush with the floor of the locomotive, as shown in the illustrations, the covers being easily

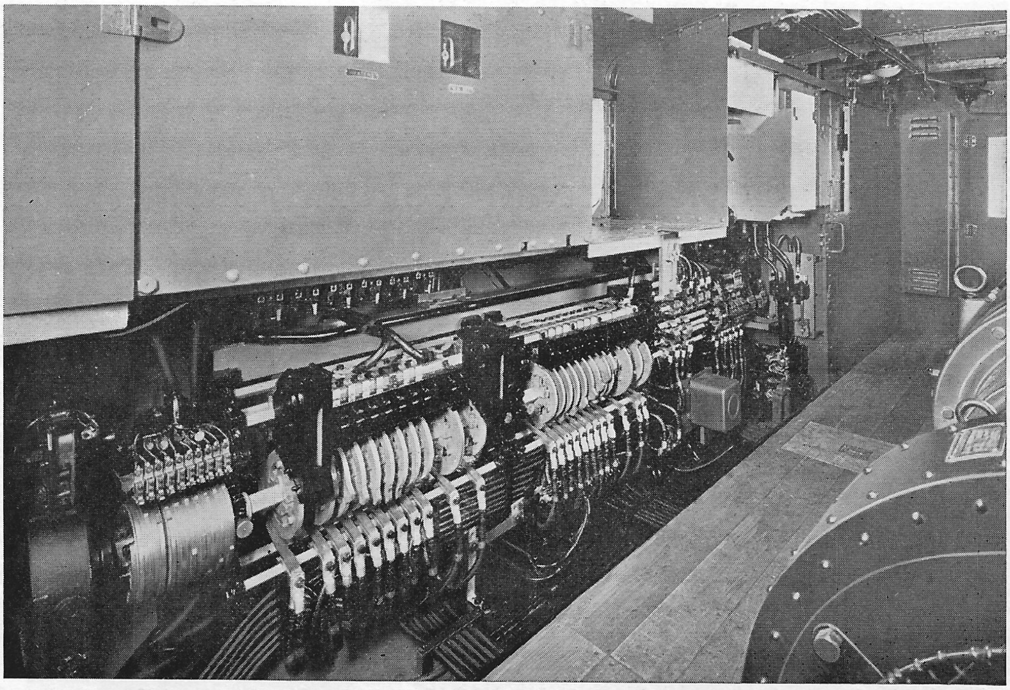


Fig. 8. High-Tension Compartment and Camshaft Controller.

removable so that all motor connections can be attended to from the interior. The resistance cables are brought up to a terminal bar at the bottom of the compartment, and connection is made to individual tappings of the resistances by means of bare copper strip.

Fig. 9. Unloading Locomotives at Montreal.

The first four locomotives went into service early in February, 1925, and were so highly successful that an order for five more was placed towards the end of 1925, and these commenced operation in August, 1926.

It is not without interest to direct attention to the fact that although built and equipped in England, these locomotives have been fitted with all the details necessary to conform to standard Canadian practice. Only those who are acquainted with the operating conditions in the two hemispheres will appreciate to the full how many points of difference there are in the small details, and how important these variations are to the apparatus.

Petrol-Electric Locomotive.

In 1929 The Montreal Harbour Commissioners ordered from The English Electric Company a general service locomotive as shown in Fig. 10 for repair and construction work.

The locomotive now supplied had, of course, to be a self-propelled unit, since one of its important uses will be in connection with repairs to the overhead line. It is, therefore, of the Gasoline-electric type. In general design it is of the box cab type mounted on two equal wheel bogies, on one of which are mounted two standard traction motors.

The motive power is supplied by a 100-H.P. 6-cylinder engine, coupled to a 52-kW., 500-volt main generator and a 120-volt auxiliary generator. The motors are driven from the 500-volt generator, and the driving controller is arranged with 12 notches, by means of which very fine variation in speed can be obtained up to the maximum normal speed of 12 m.p.h. in either direction, when hauling a load up to 50 tons.

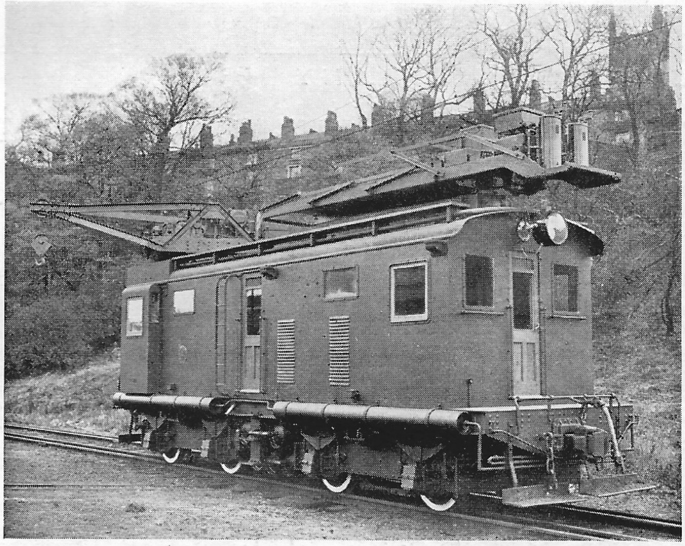


Fig. 10. 54-ton General Service Locomotive for Montreal Harbour.

The engine runs at a speed of 1,200 r.p.m. and is fitted with an automatic control device which maintains this speed to within plus or minus 2 per cent. between no load and full load. The radiator is fan cooled and mounted inside the locomotive cab; cooling air is drawn from underneath the locomotive and the hot air is expelled through the roof. There is a driving compartment at each end and a central compartment housing the engine and generators, and the auxiliary machinery.

On the roof of the locomotive are mounted a jib crane and a collapsible swinging gantry. These are electrically operated, the current being obtained from the 120-volt generator.

The driving cab at one end of the locomotive is designed to give the driver a view to the rear, as in the case of the main locomotives, and all driving is done from this end.

Canadian National Railways.

The English Electric Company has also supplied camshaft control equipment and four 190 H.P. traction motors for each of two 60-ton, 600-volt, 0–4–4–0 locomotives for the Niagara, St. Catherines, and Toronto Section of the Canadian National Railways.

Fig. 11 shows one of these locomotives in service.

Fig. 11. Locomotive in Service on the Canadian National Railways.

ENGLISH ELECTRIC

THE ENGLISH ELECTRIC COMPANY LIMITED

Works: BRADFORD. COVENTRY. PRESTON. RUGBY. STAFFORD.

HEAD OFFICE: QUEEN'S HOUSE, KINGSWAY, LONDON, W.C. 2.

CABLES: "ENELECTICO, LONDON."

INLAND TELEGRAMS: "ENELECTICO, WESTCENT LONDON."

TELEPHONE: HOLBORN, 6966. PRIVATE BRANCH EXCHANGE.

BRANCH OFFICES IN THE UNITED KINGDOM.

BELFAST - QUEEN'S BUILDINGS, 10, ROYAL AVENUE.

BIRMINGHAM - - CENTRAL HOUSE, NEW STREET.

BRADFORD - - - - PHŒNIX WORKS, THORNBURY.

BRISTOL - - - - - - 14/16, BALDWIN STREET.

CARDIFF - - - - - - - 89, ST. MARY STREET.

EDINBURGH - - - - - - - - 71, GEORGE STREET

GLASGOW - - - - 200, ST. VINCENT STREET, C. 2.

MANCHESTER - - - - - - - - 196, DEANSGATE.

NEWCASTLE - - - - - - - - - CARLIOL HOUSE.

SHEFFIELD - FOSTER'S BUILDINGS, 22, HIGH STREET.

BRANCH OFFICES ABROAD.

BRAZIL - - AVENIDA RIO BRANCO NO. 22, RIO DE JANEIRO.

INDIA - - CLIVE BUILDINGS, 8, CLIVE STREET, CALCUTTA.

INDIA - - GRAHAM ROAD, (BALLARD ESTATE), BOMBAY.

INDIA - - 28, GENERAL PATTERS ROAD, MOUNT ROAD, MADRAS.

JAPAN - - 14, NI-CHOME, MARUNOUCHI, KOJIMACHI-KU, TOKYO.

S. AFRICA - 11 & 12, NATIONAL BANK BUILDINGS, SIMMONDS STREET, JOHANNESBURG.
SIEMENS BUILDING, 86/88, LONG STREET, CAPE TOWN.

STRAITS SETTLEMENTS & F.M.S. 3, HALE STREET, IPOH, PERAK, F.M.S.

ASSOCIATES ABROAD.

AUSTRALIA - SIEMENS (AUSTRALIA) PROPRIETARY, LIMITED, 257, CLARENCE STREET, SYDNEY, AND 20, QUEEN STREET, MELBOURNE; ALSO AT ADELAIDE AND BRISBANE.

CANADA - - ENGLISH ELECTRIC COMPANY OF CANADA, LTD., GEORGE STREET, ST. CATHERINES, ONTARIO.

EGYPT - - ASSOCIATED BRITISH MANUFACTURERS (EGYPT) LIMITED, BUILDING "B," SHARIA EMAD EL DIN, CAIRO.

FRANCE - - CONSTRUCTIONS ELECTRIQUES DE FRANCE, 9, AVENUE D'ORSAY, PARIS (7è).

N. ZEALAND CORY-WRIGHT & SALMON, DOMINION FARMERS' INSTITUTE, FEATHERSTON STREET, WELLINGTON, AND BAGNALL'S BUILDING, ANZAC AVENUE, AUCKLAND.

S. AMERICA—

ARGENTINE, PARAGUAY, URUGUAY—
PARSON & CROSLAND, LTD., & EVANS THORNTON & CO., CALLE DEFENSA 465, BUENOS AIRES.

CHILE, BOLIVIA, PERU—
PARSON & CROSLAND, LTD., represented by GEORGE C. KENRICK & CO., CASILLA 495, VALPARAISO.

BRAZIL — PARSON & CROSLAND, LTD., represented in SAO PAULO by WESSEL LAWSON & CO., LTD., and in PERNAMBUCO by I. NERY DA FONSECA.