Oy Strömberg Ab

VALMET

RAPID TRANSIT TRAIN

Smallest train unit	2 cars
Gauge	1524 mm
Length of train unit over couplers	44200 mm
Width of car	3200 mm
Height of car	3610 mm
Max. speed	80 km/h
Acceleration and retardation	1,2 m/sek^2
Motors per train unit	8
Motor output á 85 kW	680 kW
Floor height above rail top	1070 mm
Wheel diameter	840 mm
Weight of service ready car	29 t
Seats in train unit	172

VALMET OY, TAMPERE WORKS, TAMPERE FINLAND
OY STRÖMBERG AB, PITÄJÄNMÄKI FINLAND

FINNISH RAPID TRANSIT TRAIN

Within a few years Helsinki will have the first urban rapid transit service in Finland. For this service, Helsinki Rapid Transit placed in October 1969 an order for a 6-car trial train with a group of Finnish industrial undertakings. The train consists of three 2-car units, each of which is also the smallest self-contained unit suitable for independant service. The first 2-car unit was completed in November 1971 and hauled to a 2.8 km long test track in Helsinki. The last 2-car unit having been completed in March 1972, tests and trial runs were begun with the 6-car train on the test track.

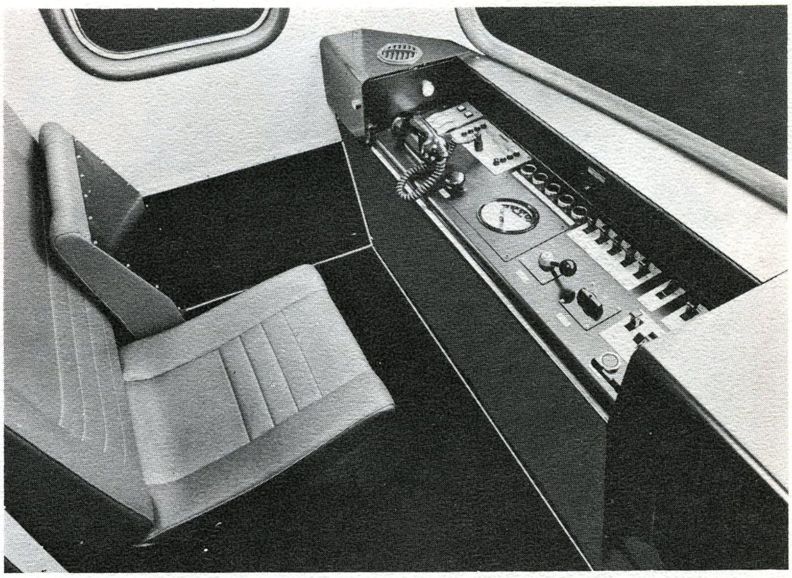
The objective in planning and building the train was to produce a vehicle for mass transportation which would be as light and up-to-date as possible and would meet the requirements set for effective, quick and flexible transportation of large numbers of people in urban circumstances. To attain this objective such technical solutions as

- light-alloy car body
- air suspension
- thyristor chopper control of traction motors

have been incorporated in the trial train.

The trial train was built at Valmet Oy Tampere Works. The share of Valmet in this joint project comprised the car body, interior furnishings and installation. The motors and electronics of the electric drive were supplied by Oy Strömberg Ab and the bogies jointly by Rauma-Repola Oy Lokomo Works and Oy Tampella Ab.

The trial train is designed for full automatic, i.e. driverless, service.



Driver's stand for manual train-control at either end of train unit.

Car with cushioned seats. Fluorescent lamps along centre line of ceiling.

Car with seats of hard, reinforced plastics. Lamps above windows. Route maps above doors and on surface of lamps in the middle of the compartment.

MECHANICAL PART

Both cars of the 2-car unit have the same main dimensions and equipment. They differ only in respect to the location of some devices such as pneumatic devices, compressor, motor-generator and batteries. Owing to the trial train being to some extent experimental, various alternative solutions have been incorporated in the cars.

The extreme ends of a 2-car unit are fitted with automatic couplers for a quick formation of 4- or 6-car trains. The short coupling between the two cars of a 2-car unit is coupled mechanically by means of a screw connection.

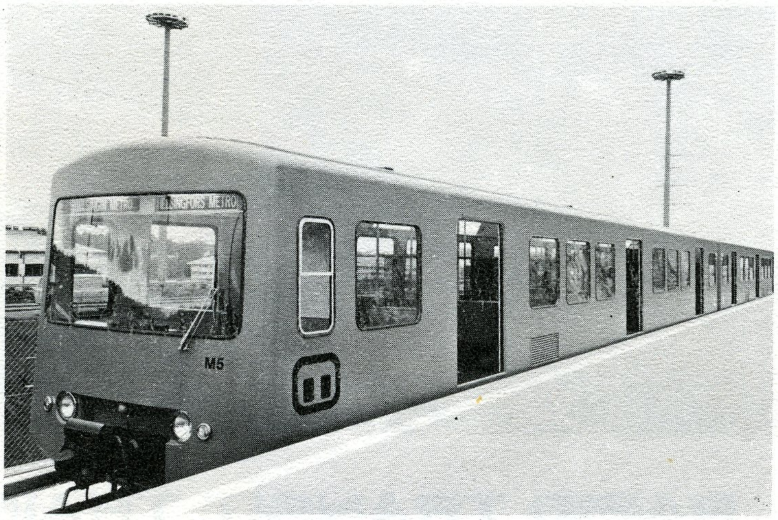
The car body is an arc-welded construction of light-alloy sections and sheets. The material of the sections and thick sheets is A1ZnMg1 and that of the thin sheets A1Mg3. The car bodies are insulated with glass wool except for one car which is sprayed with polyurethan foam. The inside walls are covered with light-alloy sheeting coated with a plastic material. The floor covering is of plastic sheet, with a grooved rubber sheet in front of the doors. The windows have hermetically closed double panes.

The seating arrangement consists of seats for two on one side and seats for three on the other side of the passage. The seats are cushioned and have plastic upholstery with the exception of one 2-car unit in which the seats are hard and for experimental purposes made of reinforced plastic.

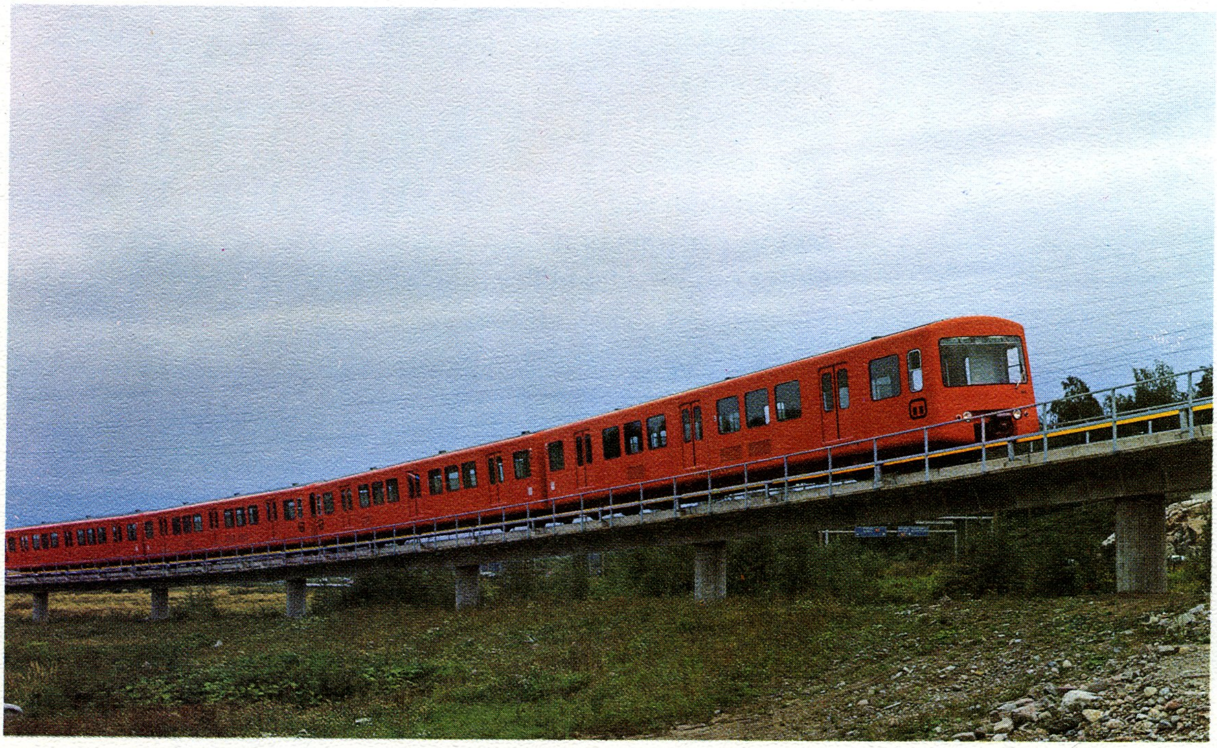
The pneumatically operated sliding doors are controlled from the control panel of the train.

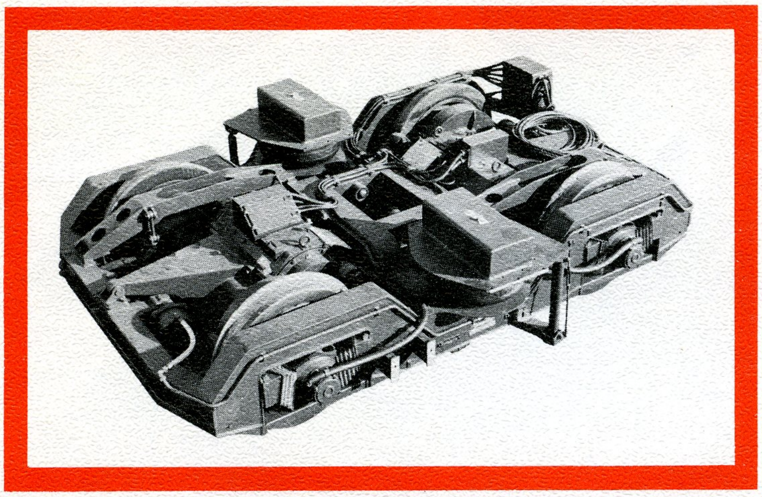
Heat energy generated by the braking resistors is used for heating the ventilation air of the car. The air is brought in from under the seats. The air is changed 30 times in an hour.

The bogies are fitted with air cushion bellows. The wheel-sets have rubber springs of Chevron type. Both axles of a bogie are driving axles. The power is transmitted from a hollow armature motor to the driving wheels over a cardan shaft fitted with flexible spring steel link couplings. Braking with full effect is achieved by means of resistance breaking down to a speed of 25 km/h. At speeds lower than this the pneumatically operated disc brake automatically also comes into action. There is one brake disc per axle.



The cars have each three wide entrance passages. The doors are 2-leaved sliding doors, free opening of entrance 1300 mm. The doors are pneumatically operated.





2-axled bogie. Both wheelsets driven by individual motors.

ELECTRIC PART

Electric power is collected at 750 V d.c. by means of collector shoes from a conductor rail running along the side of the track. The pneumatically operated collector shoes are mounted on the bogies at each end of the 2-car unit, one shoe on either side of a bogie. The series-connected motor pair of each bogie is fed by an own chopper. The excitation windings of all traction motors in a car are series-connected and fed by an excitation chopper. On take-off the armature choppers raise the motor voltage steplessly to full value, after which, beginning at the speed of 28 km/h, field weakening is carried out with the excitation chopper. The train has a maximum speed of 80 km/h, the average acceleration between 0 — 30 km/h is 1,2 m/s^2 and the average retardation is 1,2 m/s^2.

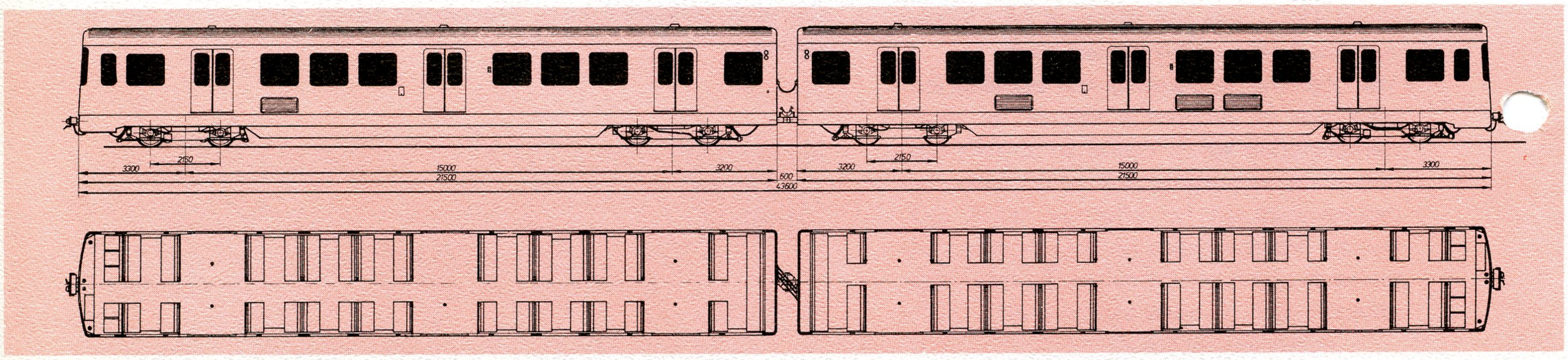
The train is designed for automatic traffic operation or control, although it can be operated by a driver at his control stand at the end of the car, if necessary.

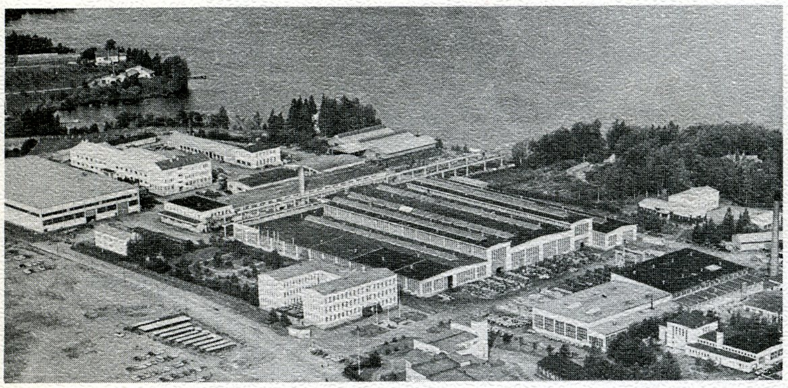
The power source for the control and auxiliary circuits of each 2-car unit is a motor-generator which generates 127/220 V 100 Hz three-phase. This powers directly the fan motors and lighting and is rectified for the 110 V d.c. control circuits and for charging the battery. Each 2-car unit is provided with an alkaline battery of 40 Ah with 86 cells.

All cars are provided with fluorescent lighting. In four cars the lamps are arranged along the centre line of the car and in two cars on either side above the windows. For emergency reasons the lamps at the doors have inverters of their own supplied by 110 V d.c.

The train is also provided with facilities for communication between cars and with the central control.

Both ends of the 2-car unit are provided with destination indication.





VALMET OY

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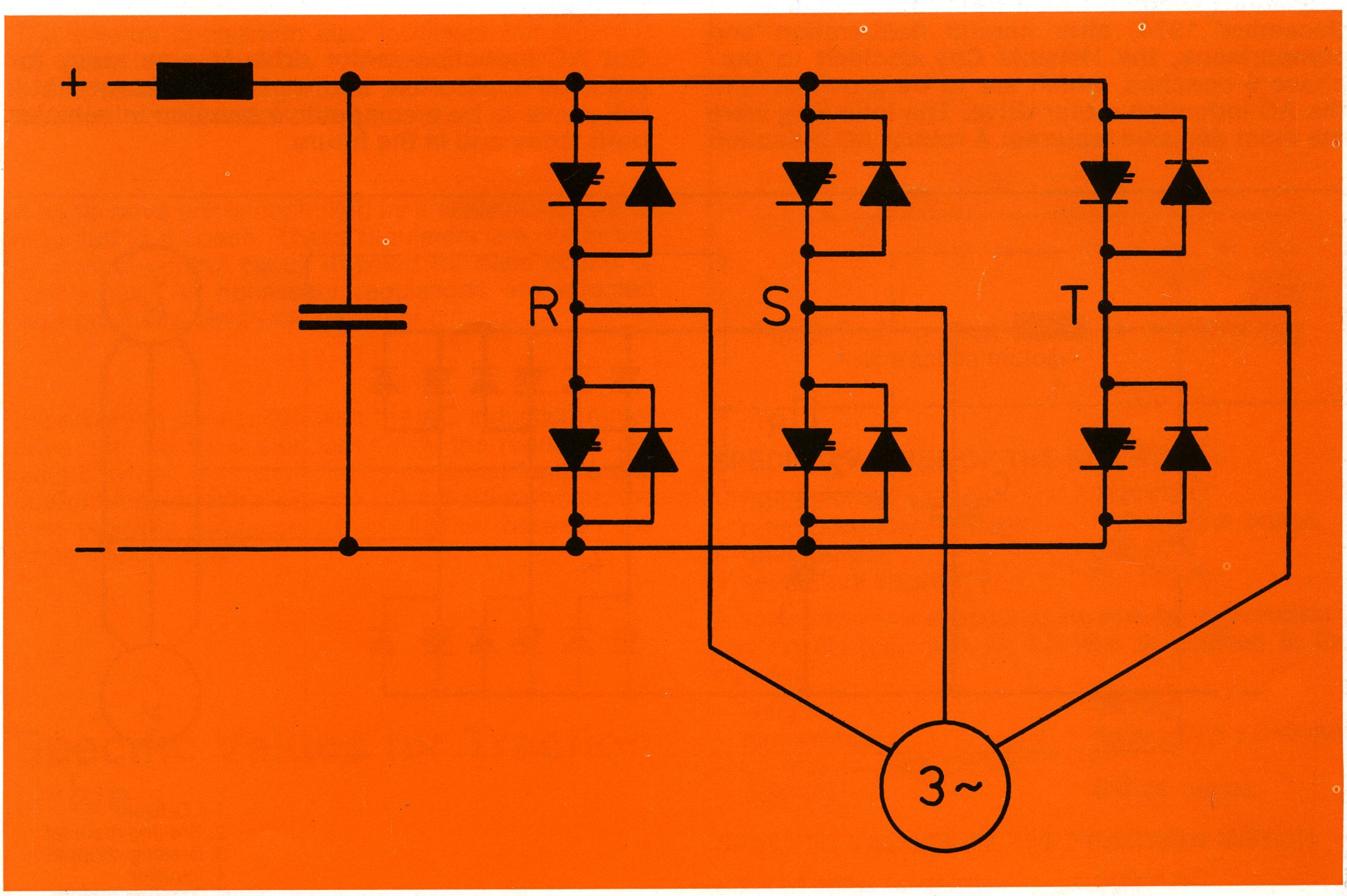
Inverter controlled AC Induction Motor Drives in Vehicles



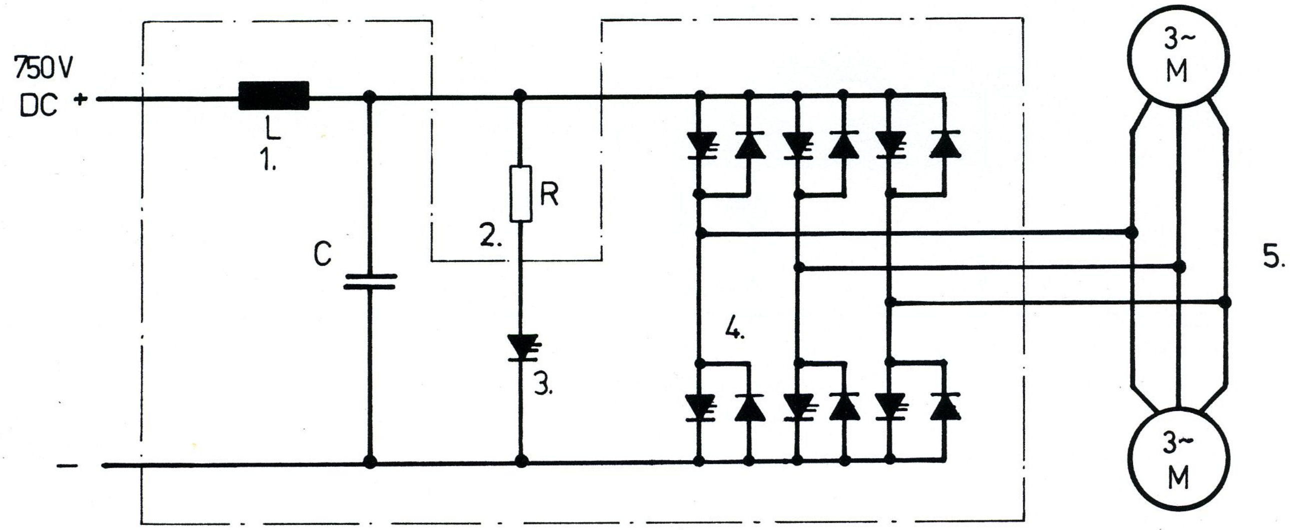
Strömberg

Brochure 772 WW 125 75-03

Inverter controlled AC Induction Motor Drives in Vehicles

Oy Strömberg Ab has long had the thyristor-inverter controlled AC induction motor drive under intensive study and development. The traction motor drives of electric vehicles have been the primary objective. After successful prototype test runs it was possible in the beginning of 1974 to offer an AC induction motor drive to the Helsinki City Metro Office for their new metro coaches. In December 1974, after careful deliberation and comparisons, the Helsinki City decided to purchase 6 coaches, which are to be provided with the AC induction motor drive. The following were the most decisive features: A robust AC induction motor as a traction motor is sure to require very little maintenance and, above all, the total weight of the drive proved to be extremely favourable. Further mention can be made of the excellent properties of this drive in regard to the avoidance of slide and slip. In the Helsinki Metro this is of special importance, as most of the metro track runs in the open.

Our AC induction motor drive is now ready for practical application, and we feel confident that it will prove to be a competitive solution in vehicles both today and in the future.



1. LC-filter
2. Braking rheostat
3. Braking chopper
4. Inverter
5. Traction motors

Fig. 1. Principle connection diagram of a bogie drive unit

Operating Principle of a Bogie Drive

In the principle connection diagram shown in fig. 1, the motor pair of each bogie is supplied by its own bogie drive, as in the Helsinki Metro. Naturally, the bogie could be of a single-motor type as well. The main part of a bogie drive is the inverter which converts the DC-voltage into an AC-voltage of suitable size and frequency. By means of this AC-voltage it is possible to adjust the AC induction motor speed steplessly from zero to maximum. The function of the inverter is based on the well-known pulse-width-modulation technics and on the forced commutated thyristors.

An LC-filter necessary for the inverter is also included in the bogie drive unit. A braking chopper and a separate braking rheostat are required for the electrodynamic braking. The braking rheostat is connected to the heating system of the coach, where the power dissipation of braking is then utilized. The rheostatic braking is effective down to zero speed as indicated by fig. 3.

The inverter connection also facilitates the regenerative braking without any changes in the circuit connection, which is a significant advantage when compared with many other circuit connections.

A bogie drive unit is controlled by a separate regulator mounted in a coach. These regulators are controlled by central control circuit intented for each coach or coach pair. All necessary regulations are effected through these electronic regulator circuits.

Especially in connection with the AC induction motor drive, the electrical axis formed by the regulator circuits between the motors is an essential feature that guarantees, together with the AC induction motor, the best possible utilization of the friction between the wheels and the rail.

Specific Values for Traction Drive

TRACTIVE AND BRAKING EFFORTS

The characteristics given represent one coach or four motors. The transmission ratio is assumed to be 7.2 and the wheel diameter 800 mm.

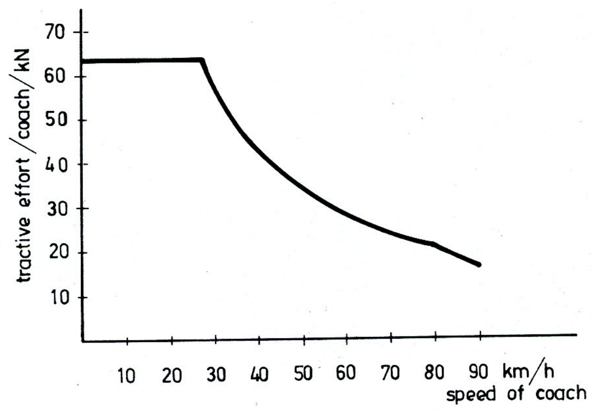


Fig. 2. Tractive effort of a coach provided with four traction motors

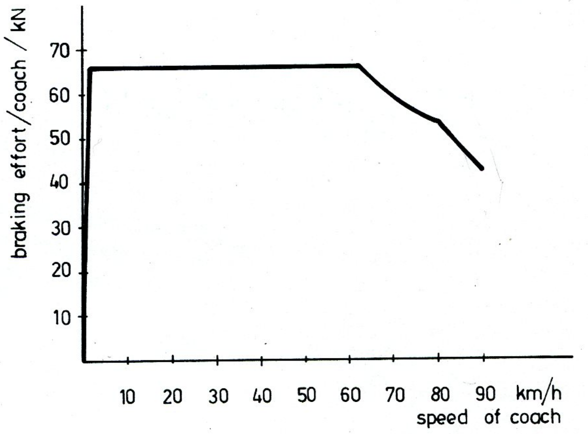


Fig. 3. Braking effort of a coach provided with four traction motors

SPECIFIC VALUES OF THE INVERTER

– rated primary voltage	750 V DC
– rated secondary voltage	560 V AC 3 phase
– rated output	300 kVA
– secondary frequency	0 – 130 Hz

A bogie drive unit in accordance with fig. 1, including a braking chopper and an LC-filter in addition to the inverter.

– weight	660 kg
– dimensions	1600 x 875 x 610 mm
– cooling air (max. 35°C) quantity	0.6 cu. m/sec.

SPECIFIC VALUES OF THE TRACTION MOTOR

– rated primary voltage	560 V AC
– rated output	125 kW
– rated frequency	68 Hz
– rated speed	1990 rpm
– weight	550 kg

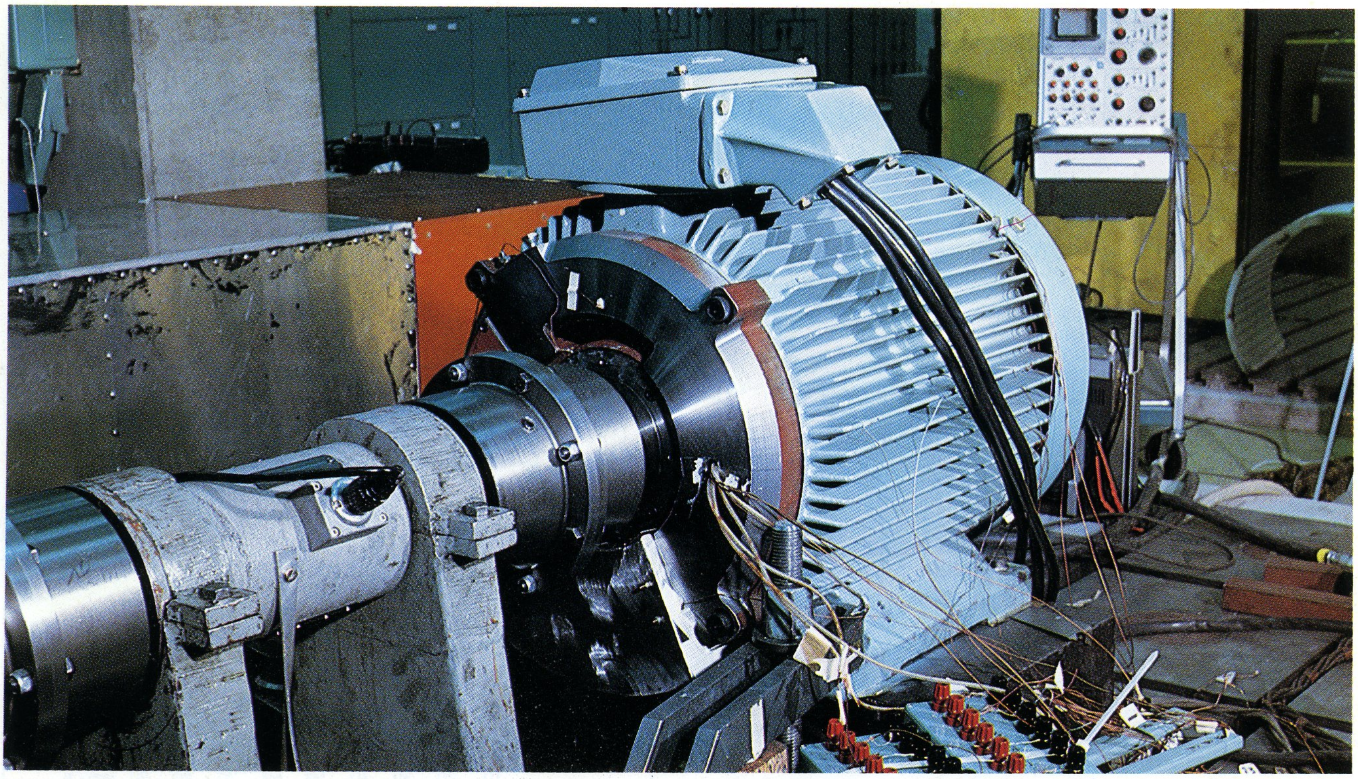


Fig. 4. Testing of traction motor prototype in the testfield

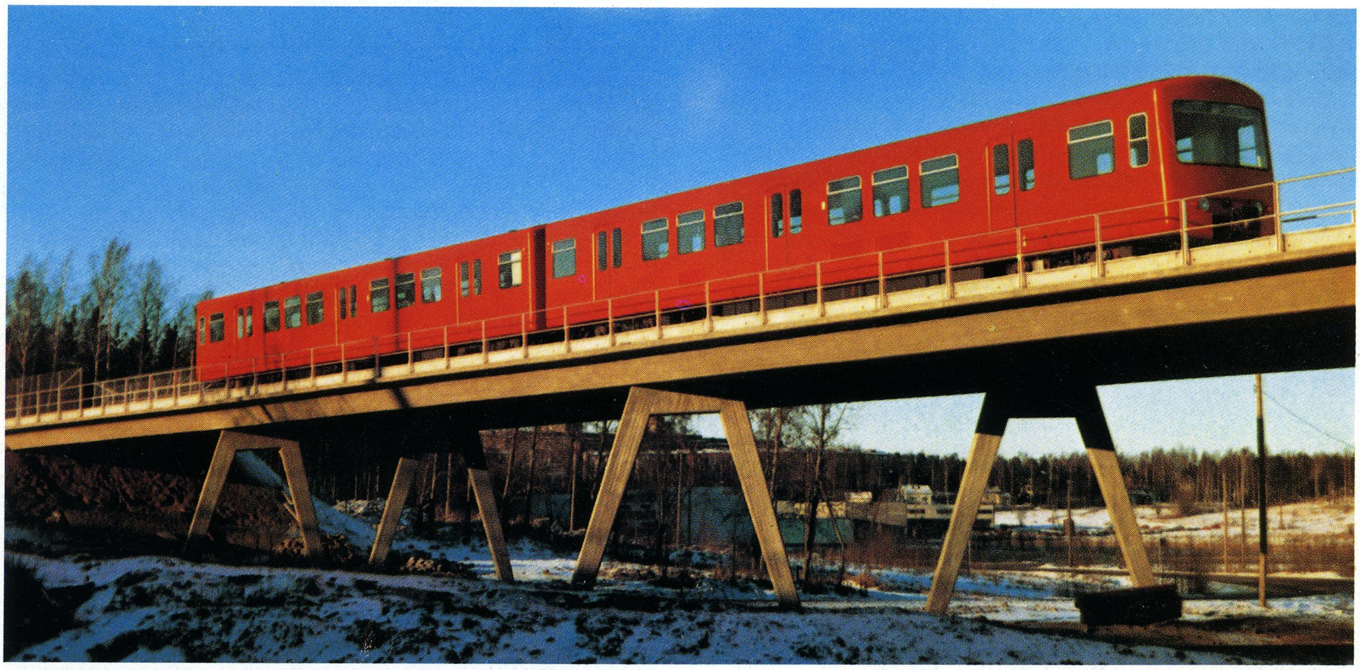


Fig. 5. 2-car unit rapid transit train in Helsinki

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