SYDNEY TRAMWAY MUSEUM

SAN FRANCISCO MUNICIPAL RAILWAY
D CLASS PCC TYPE STREETCAR

Instruction Manual for Car 1014

SYDNEY TRAMWAY MUSEUM

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1. INTRODUCTION

1.01 THE PCC CAR

In 1929, the Presidents of various electric railway companies in the USA met in conference to discuss the state of the industry. A Committee was set up to investigate means whereby major competition being faced by the surviving streetcar lines from road motor vehicles could be effectively countered.

This Presidents' Conference Committee (PCC) set about establishing guidelines for the design of a new streetcar to incorporate many of the desirable concepts embodied in motorbuses. A prototype car built to demonstrate the ideas of the PCC was delivered in 1934. It was quickly dubbed the "PCC Car" and the name has survived to describe vehicles with the general characteristics established by the Committee.

The San Francisco Municipal Railway ("Muni") took delivery of ten PCC cars in 1948. Designated type "D" with Nos.1006 to 1015 and nicknamed "Torpedos", they were double ended vehicles built by the St. Louis Car Company of St. Louis, Missouri. By June 1954, Muni had been granted permission to run single operator cars and the D cars were partially converted to single ended operation by panelling over the unused doors and modifying the car wiring.

In September 1982, the San Francisco PCC cars were finally withdrawn from service and stored, to be replaced by modern light rail vehicles. In late 1986, Muni made available car No.1014 as a gift from San Francisco to its "Sister City" of Sydney, the car on arrival being placed in the care of the Sydney Tramway Museum.

Fitted with radically different controls and requiring significantly different operating techniques, No.1014 has to be treated separately from the rest of the Museum fleet.

1.02 GENERAL DATA

Weight of car equipped	40020 lb	(18150 kg)
Seating capacity		52
Length	50ft 5in	(15.37m)
Width	9ft 0in	(2.75m)
Wheel Base	22ft 11in	(7.0m)
Wheel Diameter	25in	(0.6m)
Number and Type of Motors		4 x G.E.1220
Hourly rating per motor	55 hp	(41 kW)
Gear Ratio and Type of Gearing		43:6; Hypoid
Control		Floating
Parking Brake		Drive Shaft
Operation of Control and Brake		Automatic
Maximum Speed	40 mph	(65 km/h)
Maximum Acceleration Rate	4.75 mph/p/s	(7.65km/h/s)
Maximum Service Braking Rate	4.00 mph/p/s	(6.44km/h/s)

2. EQUIPMENT

2.01 TRUCKS

The trucks fitted to the car are known as the "B3" type and were manufactured by the St. Louis Car Company. They are of the frame-equalised design, i.e. the frame flexes to accommodate track irregularities. The motors are suspended on rubber blocked mounting beams and are mounted with their drive shafts at 90 degrees to the axles. The motor shafts are connected to the axles through two universal joints and a hypoid drive unit similar to an automotive differential unit.

Drive shaft brakes are mounted on the end of the motors and are expanding shoe type operated by Westinghouse Air Brake Company (WABCO) SE-2 type actuators mounted on the outside of the truck frame. Magnetic track brakes are supported on springs attached to the truck frame side members.

The car body sits on spring mounted, rubber dampened bolsters. The PCC truck does not have conventional radial bolster pads to control the body side motion but relies on a machine-fitted rigid kingpin with conical base. When fitted, the truck bolster becomes part of the car body and all tracking motion is absorbed by the large bolster spring and flexing of the truck frame.

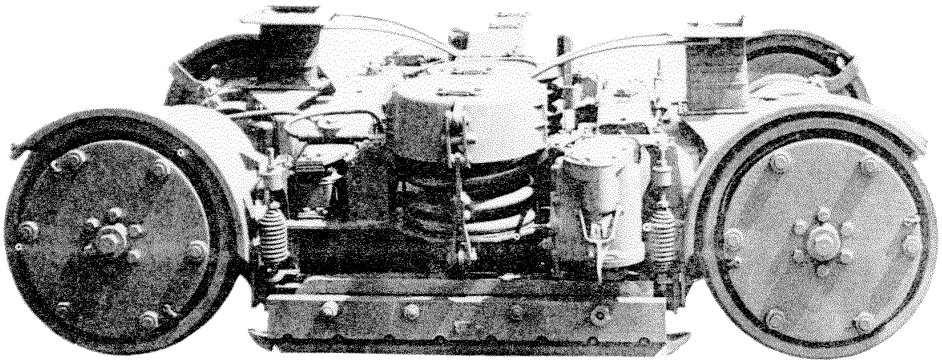

Fig 1: B3 Type Truck

The wheels are of the super resilient type and consist of a double sandwich of steel and rubber supported by two rows of bolts, one around the wheel hub and one around the wheel rim. These sandwiches support the wheel and tyre assembly and provide an exceptionally quiet and smooth riding characteristic. Negative current return is through two shunts (flexible metal straps) on each wheel.

2.02 MOTORS

Four motors drive the car, two motors being mounted on each truck. These motors are capable of absorbing as much as 400 hp and get the car off to a smooth and swift start. With the controller changed from an application of power to an application of the brakes, these same motors will produce as much horsepower acting as generators. This is known as dynamic braking and is further described under "Braking Systems".

The motors are 300-volt units connected in permanent series in each truck and the trucks are connected in parallel with each other. There is no series-parallel transitioning.

Because of their small size and high horsepower output the motors require forced ventilation to maintain a reasonable temperature during high current workloads, such as during acceleration and dynamic braking.

2.03 EQUIPMENT LAYOUT

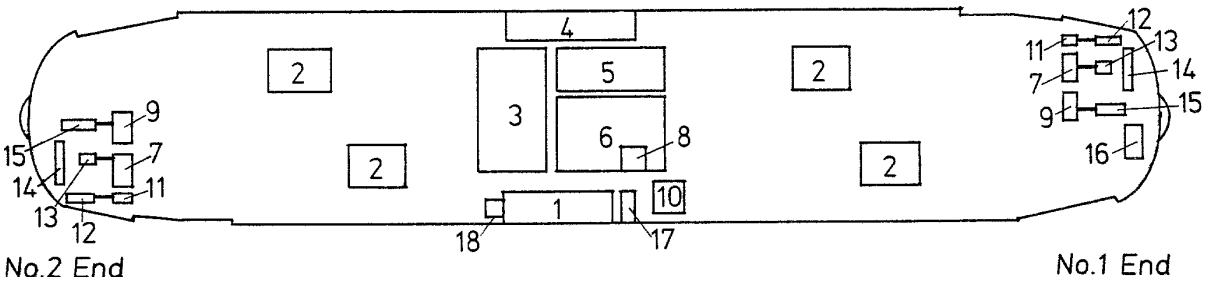

Fig 2: Electrical System and Door Identification Diagram

1. Battery
2. Traction Motors
3. Motor-Driven Controller
4. Motor Generator Set
5. Motor Resistors
6. Motor Control Contactors
7. Master Brake Controller
8. Limit Relay Switch
9. Master Power Controller
10. Line Breaker
11. Interlock Switch
12. Safety Interlock Pedal
13. Brake Pedal
14. Fingertip Control/Gang Switch
15. Power Pedal
16. Control Transfer Switch and Fuse Panel Locker
17. Motor Cut Out Switches
18. Battery Isolating Switch (on end of battery case)

2.04 K.M. CONTROLLER

The power and braking system used on this car is the General Electric K.M. all-electric "floating" controller, designated the GE 17KM12N6 type.

It is a commutator type resistive controller driven by a 32-volt pilot motor. During acceleration the brush arm on the unit shorts out 136 commutator bars in one direction and then returns to the starting position while inserting field shunting. The braking cycle consists of two complete sweeps of the commutator giving 272 increments. This provides extremely smooth acceleration and braking.

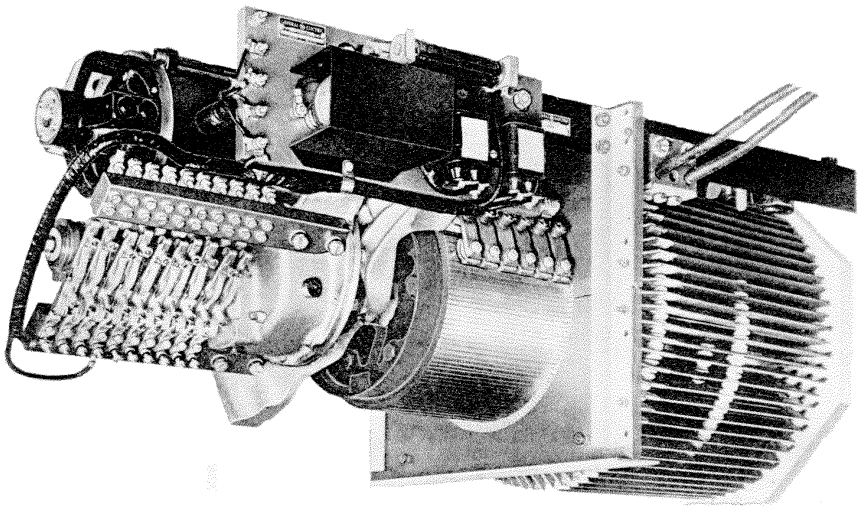

Fig 3: K.M. Controller

2.05 BRAKING SYSTEMS

The trucks are provided with three independent systems of braking: dynamic braking for service deceleration; mechanical motor drive shaft brakes for stopping and parking, and magnetic track brakes for emergency use.

The brake pedal controls the dynamic brakes and drive shaft brakes. The track brake is controlled by the brake pedal and safety interlock pedal.

Dynamic braking is effective only in bringing the car down to a speed of 4 mph (7 km/h). As the speed of the car approaches this, the mechanical brakes, mounted on the motor armature shafts, come into action bringing the car to a complete stop. Additional pressure may be required on the brake pedal to continue the stop as the dynamic brake eases. The drive shaft brake is also used as a parking brake.

In addition to the dynamic and drive shaft brakes, two battery operated magnetic track brake shoes are mounted on each truck one between each pair of wheels directly above the rails. Energising the coils in each shoe causes it to be forced down onto the rails by the induced magnetism.

A stoplight, mounted on the rear of the car in the direction of travel, is energised in all the operating positions of the brake pedal. With the brake pedal fully depressed, electrical circuits are completed for "balancing" all doors and sounding a buzzer.

The operations described above are under the control of the braking portion of the K.M. controller mounted beneath the floor of the car.

When a set of motors is cut out, the car loses dynamic braking. If this happens the car should not carry passengers and should be operated at low speed back to the depot, then treated as a defective car. The motor cutout switches are located at the No.1 end of the battery compartment and consist of two knife switches that open downwards.

2.06 OPERATOR'S DESK

Directly in front of the Driver is the Operator's desk. It has a gang switch com-posed of fourteen finger-operated switches. Three of these switches are spring return type, the remainder

are of the lock up - lock down type. Eight of the switches are door controls and are arranged in a sequence corresponding to the door positions. The four door switches on the Driver's left side control the doors on the left hand side of the car, those on the right of the panel control the right hand side doors, in the direction of travel.

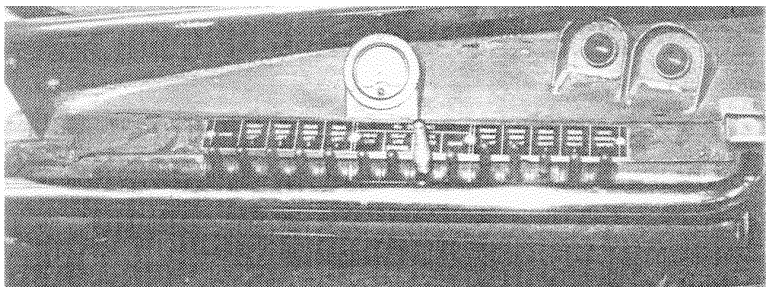

Fig 4: Operator's Desk

Separating the door controls are four dimmer, track switch and sander. The switch on the far left operates the warning gong, that on the far right the windscreen wiper. (The track switch is for working power-operated points, redundant on the Sydney Tramway Museum system.)

While this may seem to be a formidable array of switches, only the warning gong and door switches are in frequent use.

Above the gang switch at each end of the car is a small voltmeter. This indicates the voltage output of the M/G set. To the right of the meter are two indicator lights. On the left is the "Door Open" indicator; on the right is the "Drum Brake On" indicator. The "door open" indicator will glow while any door is wholly or partially open. The "brake on" indicator will glow when the drum brakes are applied. Both indicator lights must be out before the car can be moved. The brake light will not go out until the door light goes out because of the safety interlocking on the doors.

NOTE: Both gang switches are energised whenever the M/G set is operating. Door switches are interconnected and care should be taken to correctly set these when changing ends.

2.07 THE PEDAL CONTROLS

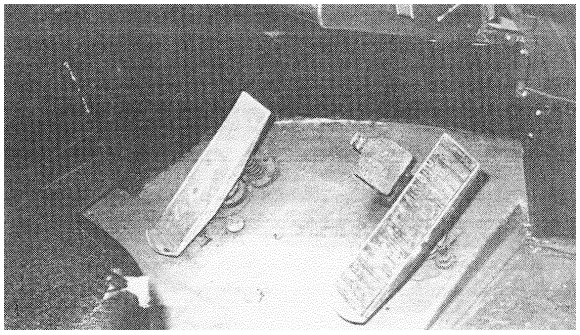

Fig 5: K.M. Type Controller - Operator's Pedal Layout

SAFETY INTERLOCK PEDAL (RHS): The safety interlock pedal (often referred to as "Dead-man's Control") must normally be depressed before the car can be started. It must not be released while the car is moving except during an emergency, otherwise the traction power will be shut off.

THE POWER PEDAL (LHS): The power pedal is an acceleration control, so regardless of the position of the pedal in the powering position; the car will continue to accelerate. The pedal position only changes the rate of acceleration. The further the pedal is depressed, the higher the acceleration rate. For this reason, the car is not to be used to push or tow dead tramcars.

The power pedal is connected by mechanical means to a master controller mounted below the floor at the driver's position at each end of the car.

THE BRAKE PEDAL (CENTRE): The brake pedal is used to set the main controller into a dynamic braking mode; it, too, is connected by mechanical means to a master controller mounted below the floor at the driver's position at each end of the car.

The master controllers can only be operated from one end of the car at any one time and are cut in or out of circuit by a rotary control transfer switch mounted in the control locker at the No.1 end of the car. They are electrically connected to automatic controls that operate the motor driven (K.M.) controller that, in turn, governs operation of the traction motors. Current in the motors during acceleration or braking is regulated by the relative positions of either the power or the brake pedals.

Interfering with or circumventing the Safety Interlock (Dead Man) equipment will result in prosecution by the Independent Transport Safety Regulator (ITSR) as it is a criminal offence, punishable by law with a fine and or jail sentence to interfere with this equipment.

2.08 REVERSER

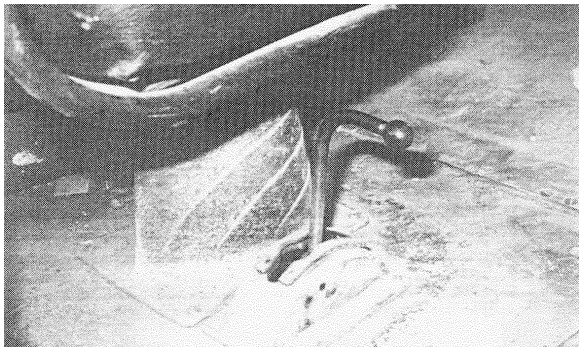

Fig 6: Location of Reverser

Situated on the floor to the right of the Driver's seat is the direction selector or reverser. The reverser has four positions: -

1. The conventional reverse.
2. Neutral lockout.
3. Forward.
4. A position past forward called the 'slug' position. This is an emergency brake position that should be used only in extreme emergency. To slug the car, push the reverser handle fully FORWARD. This has the effect of bypassing any resistance in the dynamic brake circuit giving full braking effect by short-circuiting the braking generators (traction motors). It has a similar effect to the fourth emergency on a conventional four-motor car.

If the car has been subjected to slugging it is to be treated as a failure and is NOT to continue in service until an inspection is carried out.

The reverser key can only be removed in the neutral position and cannot be moved to this position unless the brake pedal is in the PARK position.

The reverser at each driver's position is a master control and operates the main 'slave' reverser mounted beneath the floor in the K.M. control box. In some cases the main reverser may fail to throw to the opposite direction. If this happens there is a reset wire attached to the reverser accessible from outside the car beneath the battery compartment. To reset, pull the wire once.

2.09 CONTROL LOCKER - No.1 END

This is located under the Operator's desk to the right of the car and contains switches and fuses as outlined below:

MOTOR GENERATOR SET SWITCH: In the top left hand corner; must be closed for the Motor Generator set to function.

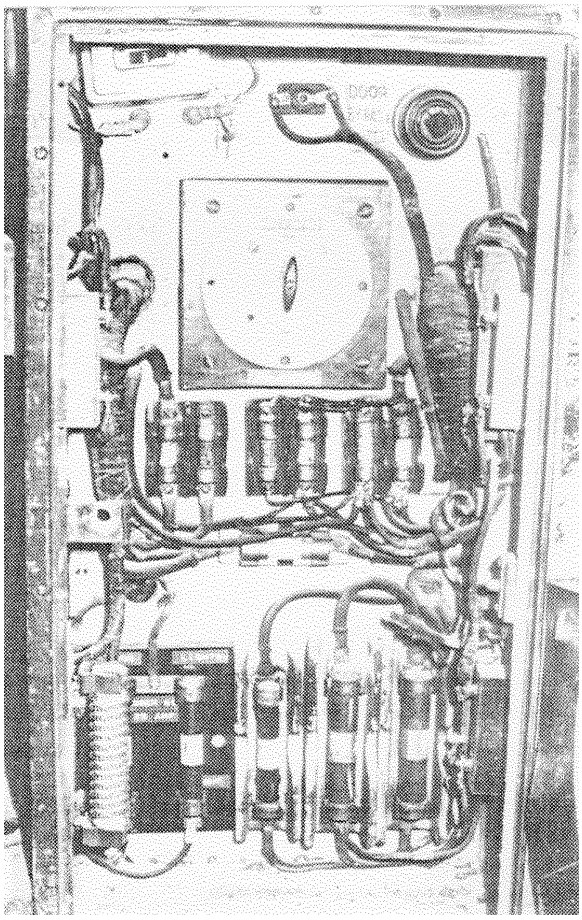

Fig 7: The Control Locker – No.1 End of Car

DOOR BYPASS SWITCH: In the top right hand corner; to be closed in emergency cases to bypass controls and allow the car to be operated with one or more of the doors partially or wholly open; to be used ONLY in the case of emergency and the car returned to the depot as soon as possible.

CONTROL TRANSFER SWITCH: The purpose of this switch is to select the required driving end pedal controllers. The switch is interlocked with a warning buzzer that will sound if the switch is left in the mid position or if the selected controller is not currently set (e.g. the park brake is off and the interlock pedal is not depressed).

FUSES: All fuses are located in this locker beneath the control transfer switch. A diagram of fuses is attached to the inside of the locker door. Spare fuses are located in a receptacle mounted on the door.

REMEMBER - both high and low voltage bare conductors are accessible in the locker. ALWAYS lower the trolley pole before changing any fuse.

2.10 MOTOR GENERATOR

The car is fitted with a motor-generator (M/G) set. This device is used for:

1. Supplying low voltage (32V) for control purposes and lighting.
2. Battery charging;
3. Cooling of equipment.

At each end of the M/G set a rotary impeller is fitted that blows air through ducts in the underframe to pressurise and cool the K.M. and the resistor compartments. It also force ventilates the traction motors.

The M/G set is located in the centre of the car accessible from the road through a lift up flap behind the <1-L-2> plate. An isolating switch is located in the No.1 end control locker.

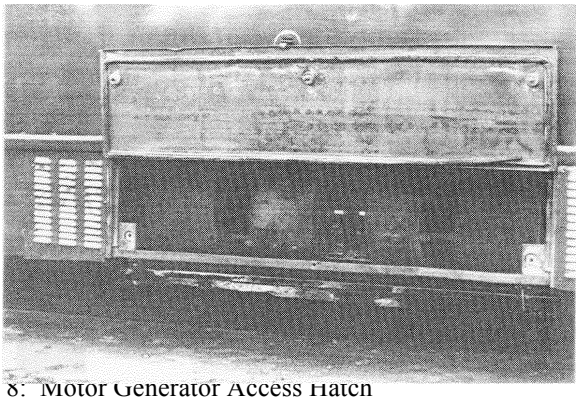

Fig 8: Motor Generator Access Hatch

2.11 BATTERY

The battery is installed primarily as a safety device supplying 32-volt control power for the dynamic brakes, drive shaft brakes and magnetic track brakes when the 600-volt power is not available (eg after dewirement, sub-station tripped off-line, etc.).

The battery is also used to activate the control systems. The M/G set control contactor has a 32-volt coil so if the battery is defective the M/G set will not operate and the car is a failure.

The battery is located in the centre of the car accessible from the road through a lift up flap behind the <2-R-1> plate and consists of four 8-volt batteries mounted on a rollout pallet.

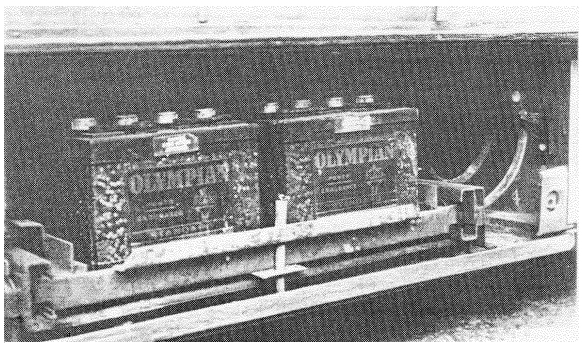

Fig 9: Battery Access Hatch with Motor Cut Outs at Right

2.12 LIGHTING

The saloon and destination box lights are wired into two traction voltage circuits and are switched at the No.1 end. One circuit is provided for each side of the saloon and includes two lamps in each destination box.

The lamps are 30 volt Edison screw type connected 20 in series. They are of a special construction containing a bypass resistor. If a filament burns out, the resistor comes into circuit maintaining power to the remaining lamps in the circuit. If a lamp goes out it is recommended that the lights be turned out as soon as possible because continued operation of the lamps with one lamp out will shorten the life of the other lamps considerably. The saloon/destination box light switch is located underneath the operator's desk to the right of the gang switch.

Headlights, tail and stop lights are on 32 volt circuits and are controlled at each end according to the direction of travel. Step well lights are also operated from the 32-volt supply and are illuminated whenever the particular doors are opened.

2.13 DOORS

The doors on the car are power operated bi-fold type doors that open OUTWARD. (As originally built, the car was fitted with inward opening doors but these were altered by Muni for safety reasons.) It should be noted that when open, the doors project a significant distance beyond the car's loading gauge.

The Driver controls the operation of the doors. Under normal circumstances the car will not move until all the doors are closed. An indicator light on the operator's desk glows whenever any door is opened. This light should be out before the car can be moved. Under normal conditions, when the doors are powered, they are electrically locked in both the open and closed positions. The drive motors act as the locking mechanism.

When the drive motors are de-energised, the doors are said to be "balanced" and in this condition can be opened and closed by hand.

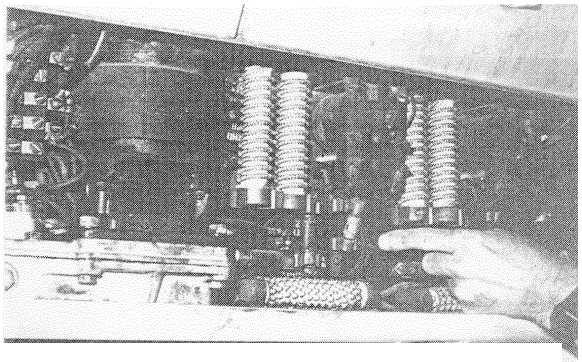

Fig 10: Door Fuse Shown Partly Released

In the event of a door malfunction preventing the car from moving, the door bypass switch may be closed. If a malfunction does occur, the journey should be completed and then the car taken out of service. To isolate a defective door, pull down the trolley pole, turn off the M/G set and remove the fuse directly

under the relay as shown. The fuses and relays are located behind a lift flap over the respective doors. This will allow the door to be moved by hand as required.

NOTE: Before moving the car make sure that the defective door is closed as much as possible to reduce the risk of fouling on line-side structures, etc.

REMEMBER: This car is one of the longest and widest in the fleet and has considerable overhang on curves, so clearances are critical, especially if a defective DOOR IS NOT CLOSED PROPERLY.

2.14 OPERATOR'S SEAT

The seat is fully adjustable to suit different Operators' driving requirements. An arm situated on the seat base adjusts the height. The backwards and forwards adjustment is controlled by a small crank handle located on the front of the seat. The seat back has three positions for back angle adjustment.

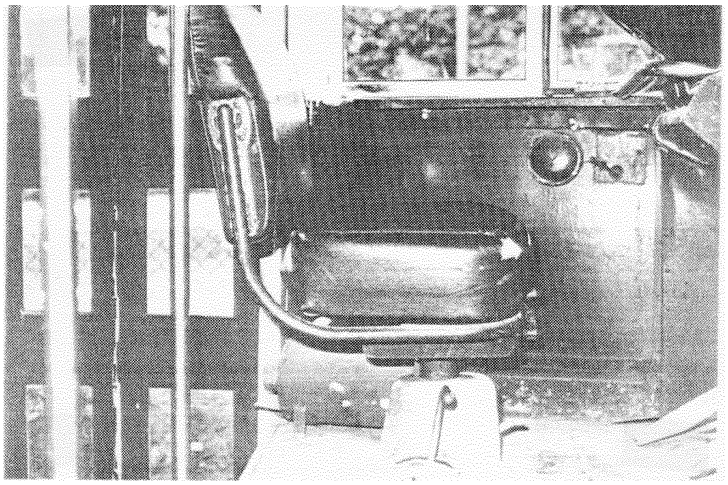

Fig 11: Operator's Seat – at Right

2.15 SALOON SEATS

The main saloon seats are of the rotating reversible type. To rotate the seat pull the seat back towards the centre aisle then grasp the other side of the seat back and continue the motion until the seat faces the opposite direction.

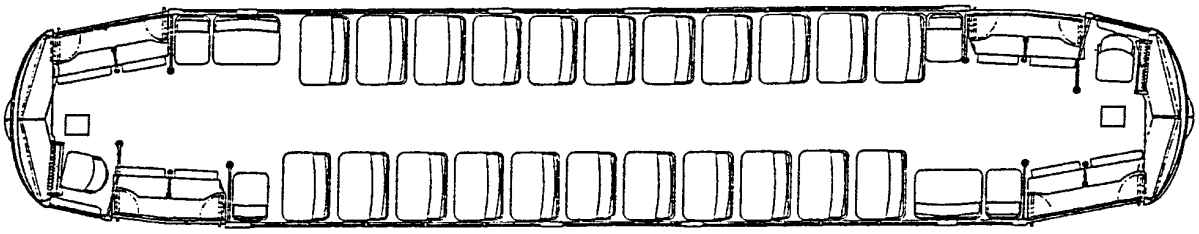

Fig 12: PCC Car Seating Arrangement

NOTE: An entire row of seats can only be reversed by starting at the end the seats are facing.

2.16 TROLLEY POLES

The trolley poles on this car are the longest in the fleet and are fitted with carbon insert collector shoes. These poles appear to overhang the end of the car but in fact are set back a short distance from the bumper bar vertical alignment. Care should be taken when closing up on another car, especially when stabling against interstate cars in the depot, to prevent the poles touching and energising the car in front.

Running poles backward, "spear poling", is not recommended because the carbon shoes are prone to snag on certain overhead fittings causing damage to the collector shoe supports, poles, pole bases, etc. and the overhead wiring.

The trolley ropes are anchored to a device known as a trolley catcher. This works on the same principle as an automatic car seat belt and prevents the trolley pole springing up to its maximum height in a dewirement and causing damage to the overhead and the collector shoe.

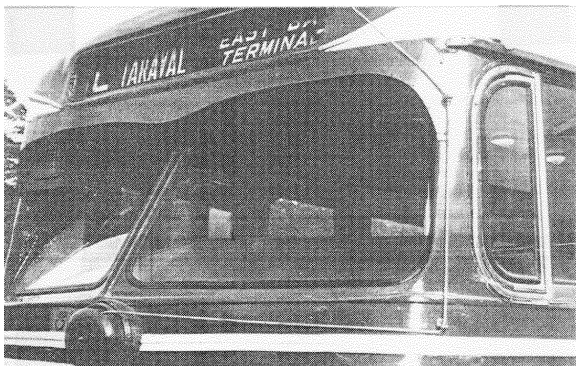

Fig 13: Position For Idle Pole Trolley Rope

If a dewirement occurs, the trolley pole will move up only a short distance before the catcher locks. To reset the catcher pull the pole down. The catcher will unlock and roll in the slack rope. Place the pole back on the wire. The rope on the idle front pole is stowed as shown.

2.17 COMMUNICATION CORDS

The communication cords are installed above the passenger windows for the length of the car, between the doors on both sides of the car. The cords operate buzzers at both operators' positions. They are mounted on the wall below the operator's armrest and are of a different pitch to the emergency buzzer, which is mounted on the left side wall of the control locker under the operator's desk.

3. OPERATING THE CAR

3.01 PREPARATION

Listed below are a series of steps to be followed when preparing the car for traffic: -

1. Check the defects book for previous entries; visually inspect the exterior of the car for any damage, etc.

2. Check the operation of the lifeguards and resetting of the lifeguards.

3. Check that all drive shaft brake actuators are engaged by ensuring that the hook shaped handle on each actuator is positioned down and in. Check that there are no loose shunts on the wheels. Report any defects.

4. Close the battery isolator switch (to Up).

5. If the car doors are closed, proceed to the No.1 end door **R1**. Pull the handle which is mounted on the door out and towards the right, this will cause the door to fold into the open position.

6. Examine the driver's switches. NOTE: If the **R1** door switch is not set to "Open", when the M/G set switch is closed the door will immediately close. Ensure all unnecessary switches are OFF and the brake pedal is in the PARK position. The PARK position is with the safety interlock pedal up and the brake pedal latched DOWN about half of its travel or approximately 3 inches (75 mm). In order to place the pedal in the PARK position, hold the interlock pedal down with the left foot, push the brake pedal down about two thirds of its travel, release the interlock pedal and allow the brake pedal to rise. This will latch the brake pedal down at about half of its travel and apply the parking brakes.

7. Raise the trailing trolley pole to the overhead wire and ensure that the overhead is energised.

8. Open the No.1 end control locker and select the appropriate direction control. Close the M/G set switch. This will start the M/G set and energize the control system. Ensure that the "door bypass" switch is OFF. Shut and secure the locker door.

9. Place the reverser handle in position and select direction.

10. Close all doors, using the control switches. Ensure that the door indicator light goes out.

11. Before moving the tram, check the operation of the Safety Interlock (Dead Man) equipment by removing the left foot from the Safety Interlock pedal and pressing the right foot down on the Power pedal. The tram should NOT move. However if it does, immediately fail the tram and record the problem on the *Tramcar Pre-operation Checklist sheet* (STM6031).

12. Depress brake pedal slightly, depress safety interlock pedal fully, allow brake pedal to rise fully, sound warning gong and if all is clear to start, depress power pedal.

3.02 MOVING THE CAR

Before power can be applied to the motors, and the car set in motion, the following action is required: -

1. All doors must be closed.

2. Interlock pedal must be held down.

3. Brake pedal must be in the "Off" position, i.e. fully released.

4. Power pedal must be depressed at least part way, to the line breaker "closed"/minimum acceleration rate position.

3.03 ACCELERATING THE CAR

The rate of acceleration is determined by the position of the power pedal. Automatic notching of the controller is governed by the manner and distance to which the power pedal is pushed down. Proper manipulation of the power pedal is left to the driver's judgment, as the operation of the car is dependent on the various conditions encountered.

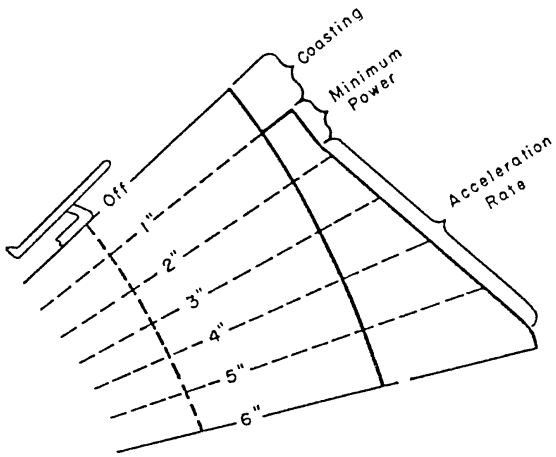

Fig 14: Power Pedal Application Diagram

3.04 COASTING

By removing the foot from the power pedal the controls are automatically set up for coasting with the car running at any speed.

As the car slows down the controls slowly reverse. The controls are then automatically set to "float" so the car is always ready for either power or braking. Any amount of power or braking may be applied instantly regardless of the speed at which the car is travelling.

After changing ends on a hill and no power is required to move the car in the new direction, the car will coast for a short distance then come to a hard stop. This is due to the K.M. controller being still set for braking and the motors electrically reacting. This effect will disappear after an application of power. When coasting down a hill, the car will not coast any faster than the speed to which it was accelerated under power.

3.05 SERVICE BRAKING

A short movement of the brake pedal produces a minimum amount of dynamic braking immediately. A fast, smooth stop may be made by depressing the brake pedal about 3 inches (75 mm) of its travel.

When comparing the smooth application of the dynamic brake with the customary

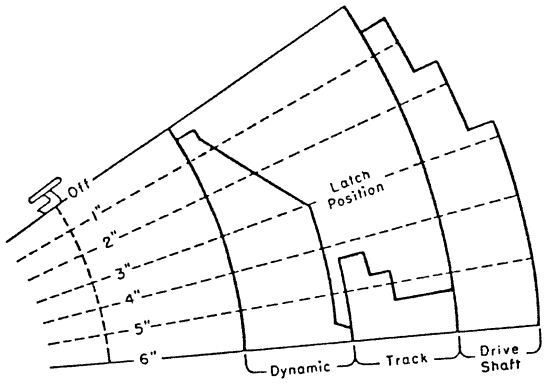

Fig 15: Braking Pedal Sequence

grab of an air brake shoe, the Driver may be led to believe there is not much power in this method of braking. After making a few stops with the car, the Driver will become accustomed to the power present in the braking system. Reference to the he diagram above "Braking Pedal Sequence" will show that the rate of braking is proportional to the amount of pedal travel.

3.06 MINIMUM POWER OR SWITCHING

The all-electric PCC car is not intended to run at slow speed, but rather to start rapidly, run at maximum speed, and stop quickly. However, at times traffic conditions may require operation of the car at slow speeds.

In order to obtain a slow rate of speed, depress the power pedal just far enough to apply power. With the pedal held at this point, the car will slowly pick up speed. If conditions continue to require slow speed, it may be necessary to alternately apply power and coast.

Closing up on another car or obstruction will require judicious use of power application, coasting and braking. Safe operation of the car will come with experience in this mode of operation.

3.07 EMERGENCY BRAKING

Unless it is absolutely necessary, the track brake should not be used as it brings the car to a rough stop. It should be held in reserve during normal operation and used only in an emergency.

If it becomes necessary to use emergency braking, the brake pedal should be pressed down through its full travel. This will latch the brake pedal down and sound a buzzer that will continue to operate until the pedal is unlatched and normal braking restored.

During the interval that emergency braking is applied, all doors on the car become "balanced" allowing them to be opened manually.

3.08 PARKING THE CAR

When the car is stopped for a short time, such as when discharging and loading passengers, the PARK position on the brake pedal may be used.

If the car is to be left unattended for any length of time, place a chock under the front wheel of the tram and turn the M/G set switch to off.

3.09 CHANGING ENDS

Apply the brake in the PARK position as described. Move the reverser handle to the neutral position and remove. Open the No.1 end control locker door and rotate the control transfer switch to the 180° position from its previous setting. Shut and secure the locker door then change the trolley poles.

NOTE: Ensure that the new trolley pole is on the wire before the old trolley pole is lowered. Because the M/G set is on line and drawing current, this will reduce the risk of damage due to arcing between the trolley shoe and the overhead wire.

To prevent excessive door operation during changeover select the appropriate door switches at the new driving end then proceed to the former driving end or instruct the Conductor to do so to ensure that all switches are in the off position. If this is not done the doors will not close and the car cannot be moved. Insert the reverser handle in the new driving position and select forward.

3.10 RETURNING THE CAR TO THE DEPOT

Because the car cannot be driven against the brakes, extreme care must be taken to stable the car safely in the depot.

After stabling the car in the proper location, the following procedure is to be followed: -

1. Place the brake pedal in the PARK position.
2. Turn off all control switches, except the door control **R1** that is to be left on at the No.1 end.
3. Remove the reverser handle.
4. Turn the control transfer switch to the direction the car will be next moved.
5. Turn off the M/G set, and saloon lights (if on).
6. Exit from the car through door **R1** and close manually.
7. Open the battery isolation switch (to Down).
8. Pull trolley pole down and stow the rope as shown in figure 13.
9. Report, in the defects book, any trouble encountered during the operation of the car.

4. UNUSUAL OPERATING CONDITIONS

4.01 SLOW SPEEDS AND WEAK BRAKES

Slow accelerating speeds and apparently weak brakes are usually caused by poor rail conditions. These conditions should be taken into consideration when applying power or braking the car. If full power is applied and the rails are "slick" (slippery, greasy, etc), wheel slippage is apt to occur. Braking should be used with greater care on slick rails. Correct application of brakes will give the maximum of braking effort without causing the wheels to slide.

4.02 HARD BRAKING

Become familiar with the amount of braking effort necessary to stop the car without causing discomfort to the passengers. Do not attempt to brake the car by allowing the safety interlock pedal to release.

4.03 REVERSER SLUGGING

Unless some brake failure has occurred, more braking effort is obtained by an emergency application of the brake pedal than would be obtained by slugging with the reverser.

Slugging on the reverser is permissible only when malfunctioning of the regular braking system occurs. This method should be used only when a collision is inevitable.

4.04 APPLICATION OF DRIVE SHAFT BRAKES

Application of the drive shaft brakes is obtained in the following manner:

1. Automatically at the end of a normal braking cycle.

2. Opening the main control switch.

3. Releasing the safety interlock pedal.

4.05 RELEASING DRIVE SHAFT BRAKE

If the drive shaft brakes fail to release after operation of the Brake Pedal switch the affected brake may be released by: -

1. Putting the reverser handle into neutral.

2. Leaving the car and seeking the nearest brake actuator.

3. Lifting the hook shaped handle fitted to the brake actuator up and outward. This will free the drive shaft brake mechanism.

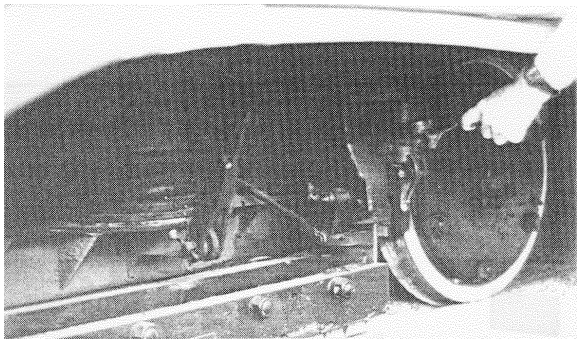

Fig 16: Drive Shaft Brake Release

4. Returning to the operator's position, selecting the forward direction and attempting to release the brakes. If the brake light remains ON, reset the actuator and repeat the procedure for each brake actuator until the brake light goes out to indicate when the brakes are released.

5. Leaving the defective brake released. The car can be run normally as the dynamic brake is not affected by the drive shaft brake condition.

Since the drive shaft braking effort has been reduced by one quarter, due care must be exercised when bringing the car to a stop.

Defective brakes should be reported immediately on returning the car to the depot.

If an internal power or any other failure prevents the release of the drum brakes, the car is a failure and must be TOWED DEAD.

4.06 TOWING THE CAR

In the event that the car must be towed, proceed as follows: -

1. Couple the car to the towing vehicle using the correct tow bar. This tow bar is stowed beneath the bumper bar at the No.2 end. The towing point is centre of the bumper bar.

2. Cut out both sets of motors. The M/G set control switch can be left on; this will prevent emergency application of the drive shaft brakes. These brakes can be applied, if needed, by a qualified person in the car whilst being towed. The reverser is to be set in the direction of travel.

3. If the car has to be towed with the trolley poles down, release all drive shaft brakes at the actuator handles. NOTE: Brake actuator handles must not be operated unless the car is either coupled to the towing vehicle or properly chocked.

4. Turn all control switches off, M/G set switch off. Turn the control transfer switch to the mid position. Remove the reverser key and manually close all doors.

5. Proceed to tow car under the procedures for towing and propelling defective vehicles and equipment.

4.07 ACCESS TO THE ROOF

Climbing on to the roof of the car should be avoided as much as possible. Because the car has an all steel body, any work done on the car roof, eg. Replacing broken trolley ropes, servicing, etc., should be done with both trolley poles down.

The access steps to the roof are located at each end of the car next to the near side front door, or, next to the number. Try to remain on the timber walkway or the rubber step treads where practicable.

NOTE: Apart from a broken trolley rope, there is no reason for traffic staff to climb onto the roof.

– see procedure *Climbing onto Roofs of Trams* (STM6018) for details of locations of accesses to the various tram roofs.

4.08 BROKEN TROLLEY ROPE

In the event of a broken trolley rope, the pole with the broken rope can be either placed on the wire or under the hook by using a pair of rubber gloves stowed in the No.2 end control locker. The car should be withdrawn from traffic until the rope is replaced.

5. TROUBLESHOOTING

5.01 SITUATION 1 - M/G SET ON, BUT NOT RUNNING

1. Turn on saloon lights. If lights do not shine, then -
2. Check to see if trolley pole is on a section insulator. If not, then power is off.
3. Check that battery isolation switch is On (Up).

4. Power off. Turn off M/G set until power is restored; leave saloon lights on.

5.02 SITUATION 2 - POWER ON, BUT M/G SET NOT RUNNING

1. (Bell or buzzer may sound.) Replace first fuse at right, top row, No.1 end control locker.

2. Pull pole down, then replace centre fuse, bottom row (600 volts).

3. If M/G set is still inoperable, fail the car and tow it dead back to depot.

5.03 SITUATION 3 - M/G SET ON AND RUNNING, CAR WON'T START

1. Check all doors are closed and indicator light is out.

2. Check control transfer switch, No.1 end control locker.

3. Operate reverser pull wire under battery compartment on right side of car.

4. Turn door by pass switch, No.1 end control locker.

5. Replace single horizontal fuse between two rows of vertical fuses, No.1 end control locker.

6. Replace fuses second and third from the right, top row, No.1 end control locker.

5.04 MOTOR TROUBLE

When the overload relay switch shuts off power two or three times, the car has motor trouble. The motor can be cut out by operating one or other of the two knife switches in the right side of the battery compartment.

Cut out one set of motors and try to move the car. If the overload relay operates, cut off power, restore the first switch and open the other. Try to move the car. If overload relay operates, the car is a failure. If it can be driven, it must be returned to the depot as soon as possible.

NOTE: Dynamic braking is not available with one set of motors cut out; drive shaft brakes and magnetic track brakes still function and the car may be driven back to the depot with extreme care. Call for standby tram to offload passengers from disabled car if possible.

5.05 REVERSER TROUBLE

1. Check the transfer switch, No.1 end control locker.

2. Operate pull wire under battery compartment.

3. Check reversers under Driver's seat at both ends for proper alignment; one neutral, the other in forward (or reverse, if necessary). If trouble cannot be cleared in five minutes, fail the car and arrange for it to be towed dead back to depot.

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