DESCRIPTION OF THE STATIC CONTROL UNIT

D I A G R A M

STATIC CONTROL UNIT FOR TRAMWAYS PCC

1. Electronic supply panel PAS

This panel houses the transducer which measures the motor current and the various devices necessary for producing the voltages used by the regulating system.

The battery voltage is applied at 8 Amps as soon as one of the selector switches is placed in the "ON" position, and current is supplied to :

- terminal 8J, protected by a 10A fuse (F3), which supplies the anti-skid card (J13)
- terminal 8B, protected by a 10A fuse (F1), which provides for :
  - the supply to the power circuit of the 40V - 3A control adapter of the pilot motor (J2)
  - the supply to the instruction-generating pedal circuits
  - the P+ supply to the pilot motor excitation via an adjustable resistor (R22)
  - the supply to the voltage-forming board via a 4A fuse (F2).

The voltage-forming board supplies :

- the 40V d/c + and - voltages for feeding the acceleration regulating card (J1)
- the 24V + and - voltages for feeding the control circuits of the 40V - 3A adaptor card (J2)
- the 24V - 800 Hz voltage for feeding the deceleration-skid card (J7)
- the 80V - 800 Hz voltage feeding the circuit formed by the motor-current magnetic measuring transducer and the measuring card (J4).

A micro-relay mounted on the undulator controls the proper working of the unit and, in the event of any failure, actuates the auxiliary relay RZ.

2. Generation of the motor-current instruction

The voltages stabilised at +12V d/c required for the supply of the instruction-generating circuits are obtained by using two circuits, each consisting of a 120-ohm 10W resistor and a Zener diode type Z X 12.

When the selector switch in the manned position is placed to the "ON" position, a stabilised voltage is applied to the measuring circuits of the pedal positions of the relevant driving position.

This position measurement is achieved, for each pedal, by means of a potentiometer whose wiper position depends on the extent to which the pedal is depressed. The positive voltage picked up at the wiper is referred to as "motor-current instruction" and is routed to the acceleration regulating card.

The regulating potentiometers located in the control box allow adjustment of that instruction voltage to the required value at the maximum and minimum positions of depression of the pedal used.

The circuits forming the motor current instruction in traction and in braking are totally independent of one another and the choice of the instruction to be used is achieved by a reverser micro-relay, the coil of which is energised by the signal directing closing of the traction relay of the power equipment.

Micro-relay de-energised = braking current instruction
Micro-relay energised = traction current instruction.

3. Motor current measure (TR + J4)

The motor current measure voltage, the image of the current flowing in the traction motors, is obtained from a magnetic transductor (TR) associated with a step-up transformer and an adjustable resistor. This voltage is passed, after rectification, to the acceleration regulator card (J1) and the polarity is negative. The relationship of motor current to measure voltage may be adjusted by a potentiometer located on card J4.

4. Coasting measure.

A tachometric alternator driven by one of the traction motors delivers a voltage proportional to the speed of the vehicle.
The current produced by this alternator is rectified and passed to a circuit comprising on the one part the coasting rheostat of the accelerator and on the other part an adjustable resistance of which the voltage at the terminals, used in negative polarity, is called the "coasting measure".

The relationship of coasting current to measure voltage may be adjusted by a potentiometer located on the control box.

5. Coasting monitoring (J4)

An electronic tumbler governed by the coasting measure constantly verifies the presence of that measure and in case of failure of the circuit, blocks the coasting comparator branch of the acceleration regulator card, de-energises the auxiliary coasting monitoring relay (RSD), de-energisation of which causes automatically:-

in free coasting, passage of the equipment to braked coasting coupling (minimum braking)

in series traction, forced transition to series parallel coupling.

6. Rheostatic braking current monitoring (J4). A second electronic tumbler, governed by the motor current measure, or by the logic signal 35F, controls feed of the coil of relay LO.

Under traction or coasting conditions, with wire 35F supplied with current, the tumbler is tripped whatever the motor-current measurement condition.

Under braking conditions, with wire 35F "dead", the absence of motor-current measurement would cause the release of the electronic tumbler, and as a result the release of the rheostat braking monitoring relay (LO). The electronic tumbler has a $\pm$ 0.5 second delay on release to cover, without sudden operation, the time required to energise for braking the traction motors.

7. Acceleration regulator (J1)

The regulator consists of two input comparators.

a) the motor current comparator which receives the positive instruction coming from the pedal unit and the motor-current negative measurement.

b) the coasting comparator supplied by a permanent positive instruction and coasting negative measurement.

Since the two voltages applied at the input of a comparator are of opposite polarity, any imbalance between them causes the appearance at the output of a signal whose polarity is that of the higher of the inputs and whose value is dependent on the existing deviation.

The output (or "error") signal is used to control the regulating mechanism which then supplies an amplifier control voltage whose value determines the rotation speed of the pilot motor and whose polarity determines the direction of that rotation.

The logic signals T and F coming from the slaving circuits of the vehicle indicate the traction, braking or coasting modes initiated by the power equipment to obtain :

T and F "dead" (coasting)

The motor-current comparator is locked out

The coasting comparator is in service

Sequence Comparator	Error	Pilot motor Reverse
CS + > MS -	+	
CS + = MS -	0	Stop
CS + < MS -	-	Forward

F "live" (braking

The motor-current comparator is in service

The coasting comparator is locked out

Sequence

Identical to that for coasting

T "live" (traction)

The motor-current comparator is in service

The coasting comparator is locked out.

Sequence

Comparator	Error	Pilot motor
CS + > MS -	+	Forward
CS + = MS -	0	Stop
CS + < MS -	-	Reverse

A third logic signal, reference V, is used at low vehicle speed to delay the changeover to braking regulation so as not to regulate the braking current until after the definite energising of the motors as series generators.

Finally the acceleration regulating mechanism also covers the regulation of the pilot motor whose role is to monitor the achievement of the desired rotation speed and to limit the current supply to the pilot motor so as to protect the circuit of the 40V - 3A adapter and the armature of the pilot motor in the event of meachanical jamming of the accelerator.

8. 40V - 3A reversible adaptor (J2)

This adaptor provides, from the battery voltage, the necessary power supply to the pilot motor armature. It is controlled by the signal coming from the acceleration regulator and, depending on the polarity of that signal, supplies the pilot motor armature in the required direction to obtain the desired direction of rotation.

Since the value of the adaptor output voltage is proportionate to the input signal voltage, the speed of rotation of the pilot motor does in fact remain under the control of the acceleration regulator.

Two auxiliary inputs (K and L), controlled by the accelerator forward and backward end-of-travel stops, provide for locking out the adaptor in the desired direction.

These two inputs are likewise used to prevent the pilot motor from operating in the event of wheel-slip.

9. Wheel-slip deceleration (J7 + FL1)

The card consists of two identical circuits each controlling a group of 2 motors in series.

The voltages at the terminals of each of the 2 in-series armatures are continuously compared with those obtained by 2 resistors bridge-connected to the terminals of the said armatures.

Any difference in speed between the two armatures is reflected in a voltage difference which, detected by the deceleration circuit, causes a microrelay to trip.

The insensitivity of the relay to tripping and release can be adjusted so as to select the voltage deviation range compatible with safe and accurate working.

The tripping of the micro-relay sends a positive logic signal to the anti-skid circuit.

Part of the bridge connection and the filter capacitors are housed in a moulding, itself mounted above the electronics pack.

10. Anti-skidding (J13)

The function of this circuit is to take action affecting various circuits of the vehicle, should the deceleration circuit come into operation, for the purpose of preventing any wheel-slip detected.

Action taken includes :

on the appearance of the deceleration signal

- direct locking of the accelerator on the position occupied at the time of deceleration. This locking is achieved by acting on the forward and reverse circuits of the pilot motor supply adaptor in the electronic relay.
- direct supply to the sand-boxes
- direct locking of the relay (LO) in the tripped position so as to prevent, when braking, the possible application of the drum-brakes during skidding.
- for braking only, the slightly delayed application of the shoe-brakes

on the disappearance of the deceleration signal

- direct unlocking of the accelerator and of the relay (LO)
- direct release of the shoe-brakes
- delayed de-energisation of the sand-boxes.