P.C.C. - By F. R. THOMPSON

G. E. FLOATING CONTROL:-

This control follows the essential principles of P.C.M. control, the main difference being in the motor controller which utilizes a stationary commutator with a revolving brush arm for cutting out sections of the accelerating resistance in the place of cam-operated contactors. Sections of the resistance elements are connected between adjacent bars of the commutator, and as the brush arm moves around the commutator, a small section of resistance is cut out in passing from one bar to the next.

This arrangement provides extremely smooth acceleration as each step of resistance cut out is so small that it is impossible to obtain suddenly any great changes in current and tractive effort.

By means of a novel scheme of connections, the commutator resistance is used twice during an accelerating cycle. This is accomplished by using an external resistor section and transfer switch as indicated.

A blower forces air over the resistor for the purpose of cooling it after it has been heated during acceleration and dynamic braking.

P.C.C.

4 - 55 H.P. motors connected permanently, two in series for the 600 V circuit. The motor is of the high-speed design and is connected through a universal coupling to a gear unit mounted on the axle.

The truck side frames are composed of two seamless steel tubes held in position by cast-steel brackets welded into one complete assembly. The brackets form yokes to support the propulsion motors.

P C C CAR DRIVE

Is a right-angle drive with the motor rigidly suspended in the truck frame cross-member. The motor is of the high speed design and is connected through a universal coupling to a gear unit mounted on the axle. The gear unit is of the type used in automotive construction and includes a hypoid gear set. It is offset from the centre of the axle for reducing the truck dimensions. There is one equipment for each axle.

P C C CAR EQUIPMENT

The PCC car weighs 33,600 lbs (15 tons) and is equipped with four 55 HP motors connected permanently - two in series for the 600 volt circuit. The PCC cars use battery power for the control.

Braking equipment on the PCC cars - The specifications of the car designed under the supervision of the Electric Railway Presidents Conference Committee calls for three systems of brakes, which are applied in normal service stops by means of a foot controller. These are dynamic, the magnetic-track, and the wheel tread air brakes. At the higher car speeds a slight movement of the pedal produces deceleration by means of dynamic braking, an additional depression of the pedal produces dynamic plus magnetic-track braking, and full depression of the pedal produces emergency braking with all of the three systems.

During a normal service stop the braking rate desired is selected by the pedal depression and the car speed is retarded by means of dynamic braking with magnetic-track shoe braking until the speed reduces to about 5 miles per hour. At this speed the dynamic braking becomes ineffective and the wheel-tread air brakes are applied automatically, the two being interlocked so that the wheel-tread brakes cannot be applied (except in emergency) so long as the dynamic braking is effective.

The wheel construction at present requires that that friction braking on the wheel treads be used as little as possible. This equipment is built so that the maximum rate of braking will not exceed 4.75 miles per hour per second. It will give an average service-braking rate of slightly less than 4.75 miles per hour per second and an emergency-braking rate of 8 to 9 miles per hour per second.

ELECTRIC BRAKES

There are five classes of electric braking that are important. These are:-

- Emergency Dynamic Braking
- Service Dynamic Braking
- Magnetic Braking
- Eddy Current Braking
- Regenerative Braking

Emergency Dynamic Braking:-

On any vehicle driven by a direct-current electric motor it is possible to obtain a form of braking by reconnecting the motor so that it will act as a generator when driven by the stored energy of the car. The conversion of mechanical energy into electrical energy and the dissipation of that electrical energy through resistance, or other means, provides a very effective retarding force.

In case of failure of the normal brakes on a car, it is possible to accomplish dynamic braking by the operation of the controller and reverser. When a car is coasting without power, there is a slight residual magnetism in the field poles of the motors, and there is a tendency to generate voltage in the armature in a direction to de-magnetize the field.

If, however, the reverser setting is in a position opposite from that for the direction in which the car is moving, the voltage set up in the armature tends to send a current through the field in such a direction that the field magnetism is increased and the motor builds up as a series generator.

On a car with two or four direct-current series motors, the fields may be reversed and the control arranged to connect two of the motors in parallel, and arrangement that gives a closed series circuit of the two motors when they are not connected to the power supply.

Because two motors cannot be built identical electrically, one motor will build up more quickly than the other and will reverse the current through the field of the second motor. The result is a condition of one motor acting as a generator in a closed circuit with the other motor. A heavy current flows because the only resistance is that of the two motors in series and the wiring between them. Since the unit acting as a motor is connected for the opposite direction of car motion a retardation of the car results.

This circuit known as the "bucking motor circuit" fulfils the requirements for dynamic braking; but it is exceedingly crude though effective, and produces extremely severe strains on the motor and drive.

These strains sometimes result in complete failure of the equipment and this circuit should only be used in extreme emergencies.

<u>Service Dynamic Brake:-</u>

In the preceding discussion on emergency dynamic braking, it was pointed out that if a resistor is introduced into the closed circuit of series generators, and the resistor is arranged with a series of steps, a graduated braking that is adaptable to service application may be obtained. This resistor may be of the standard accelerating type, consisting of chrome-nickel or allegheny metal ribbon, or of grids. The number of steps varies with the application, and the number for car applications usually ranges from four to six, but occasionally is as high as nine steps.

Dynamic braking depends on car motion; hence it will not bring the car to a complete stop, and air or other brakes must be used for finally decelerating from a speed of about four miles per hour to standstill, and then holding the car at rest.
