virtually as if it possessed resistance only. Such a line constitutes a tuned circuit which resonates at the frequency of the applied voltage. It would be difficult to realize this in practice as at the normal frequency of 50 the transmission distance would have to be 1,850 miles. This limitation of great length could be got over by the 'compensated line' system, where a series excitation scheme is artificially loaded with series capacitance. One successful application of this method was from a substation of the New York Power and Light Corporation at 33 kv. installed in 1928. The chief disadvantages of using large static condensers is their expense and their liability to damage by over-voltage.

Another possible method would be to load the line at intervals with shunt reactors, after the manner of the Pupin loading coils used in telephony, over underground cables. Such a dual compensated line would behave as if it possessed resistance only.

OPERATION AND DESIGN OF TROLLEYBUSES

A PAPER by G. F. Sinclair, of the London Passenger Transport Board, on the trolleybus system was published by the Institution of Electrical Engineers on November 9. The trolleybus has been adjudged by the Ministry of Transport an electric vehicle, and its construction and operation are governed by the Ministry's regulations. These allow the vehicles to be built one ton heavier than other forms of road passenger vehicle. They can be designed with large seating capacities with accommodation up to seventy passengers.

The cost of maintaining a 70-seater trolleybus is not greater than that of the much smaller unit, the Diesel bus. On a mileage basis the capital charges on the vehicles, taken over a period of twelve years, assuming similar seating capacities, show little difference when the two types are compared. The average energy consumption for trolleybuses operating on an intensive service is approximately 2·75 units per car mile, measured at the substation. The price of direct-current energy varies from 0·5*d.* to 0·8*d.* per unit. At the higher figure the cost per ton-mile is high compared with the Diesel bus, but at 0·5*d.* per unit the comparison is favourable to the trolleybus. For passenger services in densely populated areas, the vehicle with comparable costs, which can perform the cycle of starting and stopping to pick up and set down the greatest number of fare-paying passengers in the least time, will produce economies. The high acceleration of the trolleybus due to the overload capacity of its motor gives the facility for operating high schedule speeds. The ability to marshal vehicles in different areas is also a great convenience. In the everyday movement of the people on the road to and from their work, the use of non-stop vehicles plays little part. The travelling public have shown their appreciation of the comfort in travel, the fine riding qualities and quiet operation of these vehicles. The residential population and business people on the routes served by trolleybuses have greatly benefited from their smooth and quiet running.

Among the many points interesting to all electricians touched on by Mr. Sinclair is the production of electric charges on trolleybuses, and the methods of suppressing the interference with radio transmission signals, whether of sound or vision broadcasts. In service, the electric charges may be produced by the friction of the tyres on the road surface, by the rise of potential due to the inductive kick from the contactor coils, possibly by the mutual induction from the currents in the transmission mains, or lastly when a leakage occurs from the power circuits to the body of the car. It has to be remembered that it is only in very special circumstances that these conditions can arise. In any event they present little inconvenience to the travelling public. Consider a rubber-tyred vehicle with a metal or composite body; the generation of a charge depends largely on the road surface. With dry clean granite sets, voltages up to 900 can be measured by an electrostatic voltmeter immediately after the vehicle comes to rest. If the roads are asphalt or tar-macadam, only zero readings will be obtained. When the circuits of the electrical equipment are broken, the inductive charges may give voltages up to 300. Neither of these types of charges necessitates special precautions, as the frequency of loading or unloading passengers prevents high static charges from being built up. The use of 'low resistance' tyres, of about 2,000 ohms measured from the tread to the wheel rim, provides satisfactorily for earthing these charges.

It is the possibility of electrical leakage from the 600-volt circuits which has to be guarded against—the vehicle being in reality unearthed. The Ministry of Transport regulations require a daily test of the insulation of each trolleybus. The test is carried out after the vehicle has completed each day's service. Testing apparatus is located at the entrance of the depots. This enables the test to be carried out with the trolleybus in the condition in which it has been operating, an especially important point in wet or snowy weather, as the insulation resistance varies largely with the climatic conditions. For convenience in testing, the frames of the individual 600-volt units are connected by means of cables to a common testing receptacle, which is mounted at the back of the trolleybus underneath the platform. The nightly test is between the conductors and the body or chassis, the secondary insulation being short-circuited. Every fourteen days, each high-voltage circuit is tested individually, including all insulation whether primary or secondary. The insulation of the platform consists of a rubber mat secured to the floor boarding by an adhesive. The handrails have an insulated covering and are provided with secondary insulation, the combined arrangement giving insulation readings of 'infinity'.

The British Standards Institution has recently published a specification setting out the three methods used for reducing the electrical interference with radio broadcasting, etc., generated by the trolleybus equipment. The results of large-scale experiments carried out in London for preventing interference by trolleybuses are described.

On a fleet of more than 1,600 trolleybuses in London, the use of carbon 'shoes' to collect the current from the overhead wires is general. The success of the carbon collectors is due largely to the lubrication of the conductors.

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