shown in tubes of a diameter of 25 mm. or more. The motion is considered to be due to the varying removal of the impurity and the altering charges on the walls of the tube.

The use of luminous tubes for advertisement signs is growing with rapidity; but what is needed to ensure general adoption of this principle for lighting is a tube which can be made to give any desired color, and which can be plugged into the ordinary socket fed by mains current. Rapid progress towards this goal is being made. Already Dr. Spanner has shown examples of tubes in Europe and America which have electrodes coated with various barium salts, such as the aluminates and zirconates and barium oxide mixtures, so that they can be run from 110-volt mains. A high efficiency has been claimed for these. The tubes are made of a specially resistant glass of high boric acid content, which does not blacken under the influence of the metallic vapors which are used at the filling. For instance, a mixture of zinc, sodium and mercury gives a white light much like daylight, while cadmium gives a bluish-red light.

Since these tubes consume upwards of 1 amp of current, considerable difficulties are met with in their commercial manufacture in order to obtain a long life as well as retain a high efficiency. It seems imperative to introduce a resistance or choke in the lamp circuit so as to control the current, with the result that the overall efficiency suffers. Nevertheless, much research is taking place on these kinds of lamps in the laboratories of our leading electrical companies, and there is every reason to hope that present difficulties will be satisfactorily overcome, and another great advance in lighting efficiency made in the near future.

Modern Tramcars for Melbourne

Design for Reduction of Noise, and Construction With Electric Welding

The latest tramcars built by the Melbourne and metropolitan tramways board have been designed with the special objects of improving the riding qualities and reducing noise, and the expected improvements have been more than realised. These cars, which are known as the W3 class, have been built to the same general outline as the standard car, known as the W2 class. They have been designed and built under the supervision of the board's chief engineer, Mr. T. P. Strickland, M.I.E.E., by his staff at the tramway workshops, Preston, Victoria.

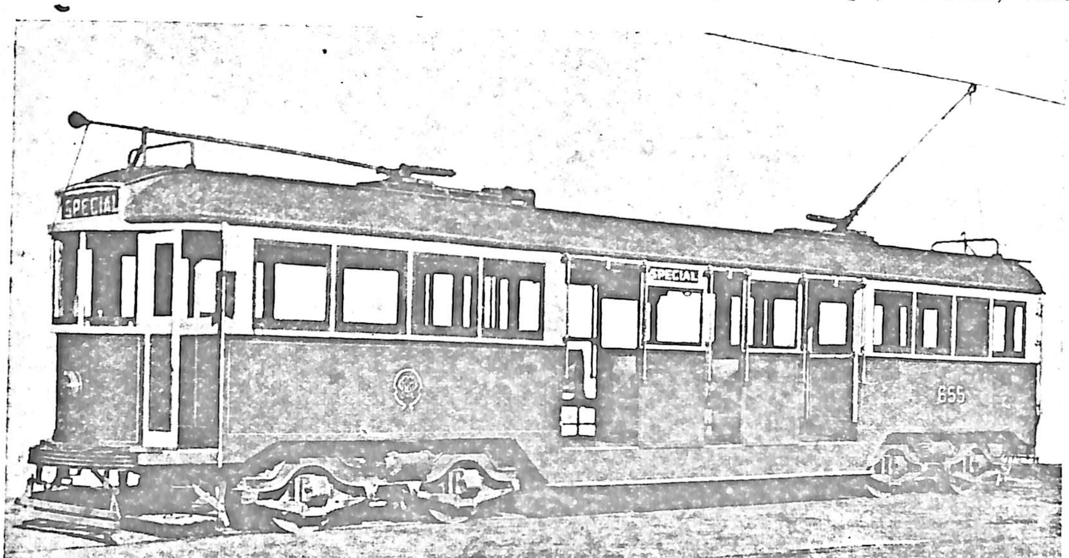

Fig. 1. Class W3 Bogie Car of Melbourne and Metropolitan Tramways Board

Principal Dimensions:

Length over bumpers, 47 ft.
Length over corner posts, 40 ft. 8 in.
Width over pillars, 7 ft. 6 in.
Width over footboards, 9 ft.
Height, rail to roof, 10 ft. 5 in.

Truck centres, 28 ft.
Truck wheel base, 5 ft. 9 in.
Wheel diameter, 2 ft. 9 in.
Seating capacity, 52.
Crush capacity, 150.

Fig. 1 shows one of the new cars ready for the road. It is 47 ft. long, 7 ft. 6 in. wide over pillars, and 9 ft. wide over footboards, 10 ft. 5 in. high from rail to roof and weighs 15 tons

14 cwt. The seating capacity is 52 persons, but the total crush loading capacity is 150 passengers. There are three entrances on each side to the smoking compartment, which has cross bench seats to accommodate 16 persons. The entrances are not provided with doors, but have canvas weather blinds fitted to spring rollers for use in wet weather. Saloons open off either end of the vestibule and are provided with sliding doors. The windows, which drop their full depth, have louvre blinds fitted, and the seats are made of three-ply moulded forms.

The bodywork of these cars has been built of steel, electrically welded, the woodwork being used only for interior facings on the steelwork.

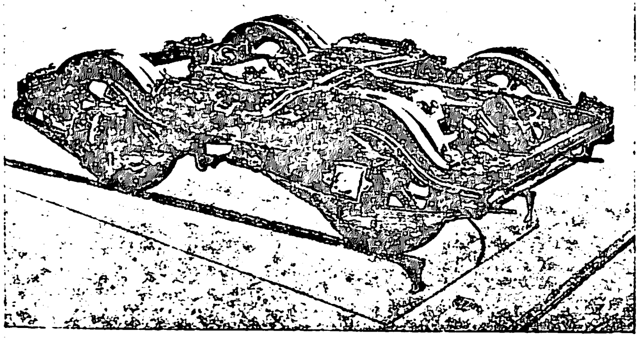

Fig. 2. Truck for W3 Car

Considerable strength combined with lightness has been achieved with this design, about $2\frac{1}{2}$ tons in weight having been saved over the wooden superstructure on a steel underframe for the same design of car. The sills are of $3\frac{1}{2}$ in. x $2\frac{1}{2}$ in. x 5/16 in. angle steel, the belt rail is 2 in. x 2 in. x 5/16 in. angle, and the cant rail is 3 in. x 2 in. x $\frac{1}{4}$ in. angle. The pillars are of $1\frac{1}{2}$ in. x $1\frac{1}{2}$ in. x 3/16 in. tee section, and the roof ribs are of $1\frac{1}{4}$ in. x $1\frac{1}{4}$ in. x 3/16 in. tee section. The bolsters are of the box type built up with 10 in. x 7/16 in. top and bottom plates, and 8 in. x $\frac{1}{4}$ in. web plates strengthened with ribs, the whole electrically welded together. The cross members are 4 in. x 2 in. x 7.09 lb. channel section, and the end sills 7 in. x $2\frac{1}{8}$ in. x 9.75 lb. channel. Panels are 14-gauge and the letter board 16-gauge steel, all electrically welded to the pillars.

The roof is of 5/16-in. ply wood covered with Caledonian roofing, the roof sticks are of Australian blackwood, and the interior finish of the ply wood roofing is Australian walnut. Tongue and grooved Baltic pine $\frac{3}{4}$ in. thick forms the flooring, which is covered with roofing felt in the saloons and wood slats in the smoking compartment. Aluminium angle finishing pieces are fitted to all doorways and along the footboards, both to reduce wear and to show up the edges at night. Polished plate glass, 3/16 in. thick is used for the end windscreens, while on the remainder of the car 26-oz. mechanically-drawn glass is used. The sashes and louvred blinds are made to run in extruded brass sections, screwed to the pillars to form the sash guides.

The bulkhead framing and doors are made of Tasmanian mountain ash, panelled with Queensland maple. The cross bench seats in the smoking vestibule, and the saloon seats, are built of Tasmanian mountain ash and blackwood framing around three-ply moulded forms. Outside the car has been finished in green and cream enamel. In order to allow the use of 33-in. diameter wheels in the trucks the step heights have been graduated. The height from rail to footboard is $15\frac{3}{4}$ in., from footboard to floor of vestibule $13\frac{1}{4}$ in., and from vestibule to saloon 9 in.

An entirely new design of bogie truck, shown in Fig. 2, has been developed in connection with this car. This truck is new to tramcar design in that the springing has been made similar to motor car practice, i.e., long, semi-elliptic springs clamped to the axle boxes and attached to the truck frame or chassis by shackles, through which the drive is taken. This arrangement eliminates the use of horn guides, and thereby cuts out a considerable amount of noise. The maximum size wheels used in tramcar operation, viz., 33 in. diameter, have been used. Large wheels give much smoother rolling action along the rails than small ones, which reduces the impact at crossings and special work and the noise of the rolling action on the rails. The large wheels also have less tendency to corrugate the rails. Each truck is fitted with two 40-h.p. motors giving equal traction on each wheel. The swing links for the bolster have been made $12\frac{1}{2}$ in. long as compared with $10\frac{1}{2}$ in. on the smaller wheel trucks, giving a better riding condition for the car body.

The materials used in construction have been selected to give the minimum of weight for the strength required. All castings where strength and wearing are required have been made of steel, and others, such as axle box lids, of aluminium. All springs have been made of alloy spring steel. Electric welding has been availed of where possible in the construction of this truck. The bolster is built up in box section with top and bottom plates $\frac{1}{2}$ in. thick and web plates $\frac{1}{4}$ in. thick, and electrically welded with No. 10/8 run along all four edges.

The side frames for the first of these trucks were made in cast steel, but these proved to be rather heavy, and the mild steel side frame, as shown in Fig. 3, was developed. These are made by using a piece of 7 in. x $3\frac{1}{2}$ in. x 15 lb. I-beam. The process of manufacture in these frames is interesting and may be briefly described. First, a section is cut away from the web by oxy-acetylene flame. The top and bottom flanges are then bent to the correct shape, the web being cut away allowing the angle smith to carry out the work very much more easily than bending the full 7 in. depth of section. The difference of length between the top and bottom flanges, after bending, is about 2 in., which represents the amount of draw that would have had to take place had the web not been cut away. After forging to shape, the web is again joined together by electric welding, and the whole section is thus made solid once more. It is only the use of electric welding that has made this job practicable. Side frames thus made have proved to be cheaper than the steel casting and have the advantage of being lighter and more ductile and homogeneous.

The braking on these trucks also is a departure from the conventional design of fitting one brake cylinder on the car body, and operating through foundation brake rigging to the brake gear on the trucks. On the new design the brake cylinders have been fitted upon the trucks and operate directly upon the brake beams. Clasp brakes have been fitted to the wheels, and although this is standard practice in railway rolling stock, it is new on tramcar design. The advantages found with the clasp brake, as compared with the single shoe brake, are smoother retardation, less tendency to skid the wheels, and only half the consumption of brake shoes per annum for the same class of car. The air cylinders are connected to the straight air brake system through a relay valve by a flexible hose. The hand brakes operate for one truck only and are not interconnected throughout the car. The use of the two brake cylinders on each truck eliminates a heavy brake cylinder on the car body, and all the brake levers, rods, pins, etc., with their loss of efficiency, weight and noise.

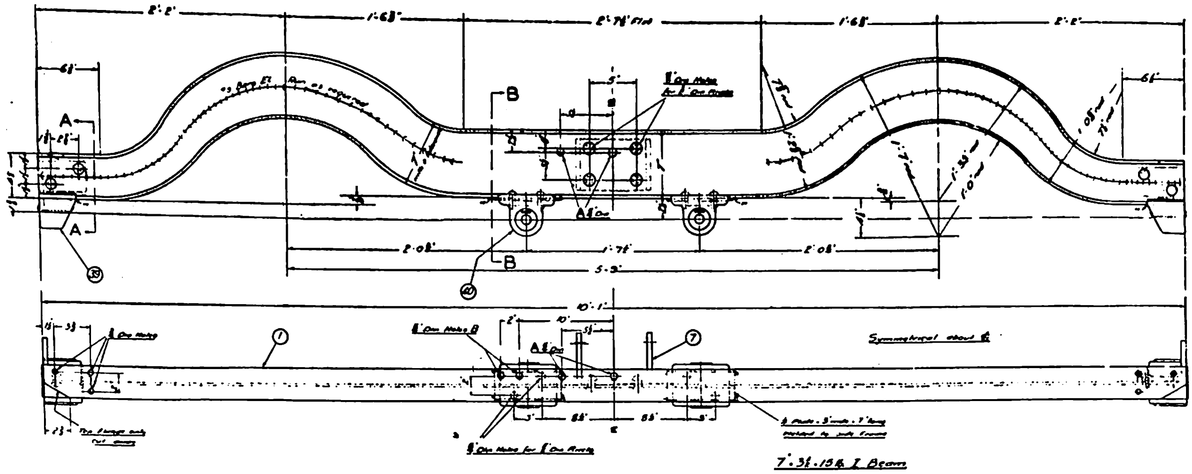

Fig. 3. Rolled Steel Sideframe of Truck

The car is equipped with four 40-h.p. Metropolitan-Vickers motors, made in Australia. The gear ratio is 13/77, and the free running speed is 28 m.p.h. The schedule speed works out at 11 m.p.h., with eight stops of 5 sec. each per mile. The power controllers are of the G.E. K.35J.J. series-parallel type, and were made in Australia. The line breakers are English Electric, type No. 6 form C., the compressor is the Westinghouse D.H.16, and the motorman's valves are Consolidated Brake type "C." The hand brake, trolley bases and destination signs are of the board's own design.

STEAM BUS IN AUCKLAND

In February, 1931, the Auckland transport board put into service a passenger bus equipped with a steam power plant built in accordance with the patents of Mr. Abner Doble, in place of a petrol unit. This vehicle has now completed 12,943 miles on passenger service and about 6,000 miles in connection with the tuition of drivers, and has given great satisfaction. The fuel cost is about 2d. a mile for the crude oil used, as against 3½d. for a petrol bus, and there is much less wear on the tyres than with a petrol-driven vehicle. Considerable savings have also been effected on maintenance.

The steam vehicle has very rapid acceleration and deceleration, and it is able to complete a journey in a shorter time than a petrol bus. The silent and smooth acceleration, the flexibility of the vehicle in traffic and the absence of noise and vibration have been the subject of favorable comment by patrons of the bus.