Workshops of the Melbourne Tramways Board

The Melbourne and metropolitan tramways board operates the tramways throughout the Melbourne metropolitan area, with the exception of two routes which are under the control of the railways commissioners. At present the undertaking comprises both cable and electric tram services, but the general policy, which is now being carried out, is to convert the whole of the cable routes to electric traction. The electric services now cover 92 route miles of track, and the rolling stock comprises about 400 cars. The services are increasing steadily, both by reason of the conversions and on account of natural growth brought about by the expansion of the city. This means that there is a continual demand for new rolling stock in addition to the necessity for keeping existing stock up to the highest pitch of efficiency. In order to meet tne position the board has recently erected extensive workshops for the building and maintenance of electric tramcars.

The shops are situated at Preston, about five miles from the centre of the city. The present installation is designed for the maintenance of 600 running cars and building of 30 new cars per annum. Fig. 1 shows the general lay-out, which is so designed that extensions can be made without altering the flow of work in any way. The shops are arranged in four main groups: (1) engineering and electrical, (2) blacksmithing, platework and foundry, (3) woodworking and lifting, (4) painting. In addition there are stores, mess and recreation rooms and administrative offices. All the shops are of brick and steel construction and have corrugated iron roofing with south lighting. The height to the roof trusses is 19 ft. The paint shop is located on the western side of the area, as being the cleanest place. It should be entirely free of dust and smoke from the works, as the trades which use fire are grouped together on the eastern side of the area, and the prevailing winds are from the west. The main store is placed in the south-east corner in a position which is as near as possible to the centre of gravity of the employees at the works, and which is handy for the reception of goods. The timber stores are so located as to be convenient for receiving timber and handy to the woodworking shop. In the main timber shed is a cross-cut saw for cutting timber to length before it goes into the shop. The administrative offices are situated on the main frontage in a central position, and the mess and recreation rooms are close by.

The plan shows clearly the arrangement of tracks by means of which the cars are brought in and out and passed through the various shops. In the alleys between the paint and woodworking shops and between the lifting and engineering shops are electrically operated traversers. Each is driven by a 50-h.p. tramway type motor. Fig. 2 shows a car on one of the traversers.

Engineering Shop

The engineering and electrical shop is 256 ft. long by 180 ft. wide, and is floored with wood blocks set on concrete. The first two bays on the western side are for the truck shop and heavy machines. The remaining four bays are divided into two portions, the portion nearest the southern end being the machine shop including the tool department, and the northern portion the electrical shop. The truck shop and heavy machine bay are equipped with three 5-ton electric overhead travelling cranes, and in addition there are several 1-ton hand operated jib cranes attached to the roof columns. Fourteen sets of tracks run into the shop from the traverser alley and nine of these are equipped with pits 4 ft. 3 in. deep and 52 ft. long. The pits are 5 ft. wide at the bottom and are equipped with shelves along both sides for the accommodation or tools. Outlet plugs are provided for electric hand lamps and other equipment. Fig. 3 shows a cross section of a pit.

The southern portion of the truck shop is devoted to wheel work. The four southernmost tracks are crossed at right angles by another track which is used for the transfer of pairs of wheels. At each crossing is a pivoted pneumatic lift which raises the axle so that the pair of wheels may be swung on to either track. This portion of the shop contains two wheel lathes, one of which is a Niles Bement Pond machine of the latest type, with electrically operated tail stock, and pneumatic tool holders. There is also a Niles Bement Pond wheel press which forces the wheels on to the axles with pressure of 10 tons per diametral inch. Tyres are shrunk on to the wheel centres in this department also. At present a gas ring is used for heating the tyres, but an electric induction heater is being installed. In connection with this department a wheel park is laid down just outside the building at the south end. This is served by the traverser.

The heavy machine bay is not yet fully equipped, but the plant required in addition to that already installed is on order. The present equipment includes six 6-in. lathes, two 12-in. engine lathes, two combination turret lathes, a 12-in. slotter, shaper, Landis screwer, three-spindle drill, vertical drill, milling machine and disc grinder. Plant on order includes a 5-ft.

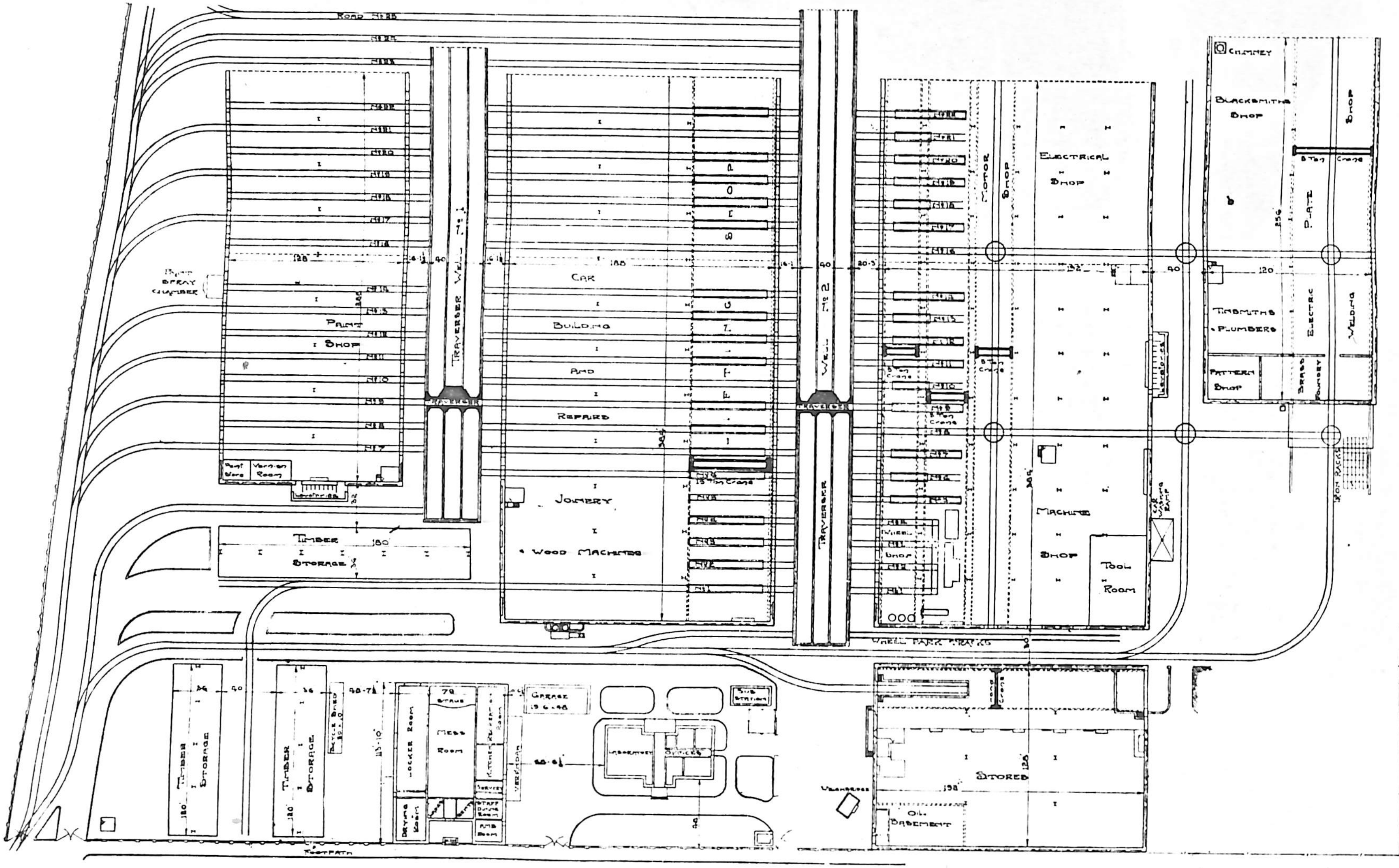

Fig. 1. General Plan of Melbourne Tramways Board's Workshops at Preston

At present the first section only of the shops has been constructed. The dotted lines crossing the paint shop, car building and repair shop, and engineering shops between tracks 14 and 16 represent the present north walls of these shops.

THE ELECTRICAL ENGINEER OF AUSTRALIA & NEW ZEALAND

radial drill, double-head shaper, vertical boring mill, cylinder grinder, capstan lathe, and motor-driven emery wheels. For the larger machines individual motor drive is used, and for the smaller ones group drive by 15-h.p. motors through line shafting supported on brackets hung from the roof trusses and fitted with roller bearings.

The tool room is partitioned off from the remainder of the shop, and in addition to providing storage for tools, contains grinding machines and other equipment for keeping the tools in order. The machines in this section are group driven by a 10-h.p. motor.

The electrical shop is situated at the northern end of the building. As it uses only light machine tools and equipment, it can easily be moved when the shops are extended as planned,

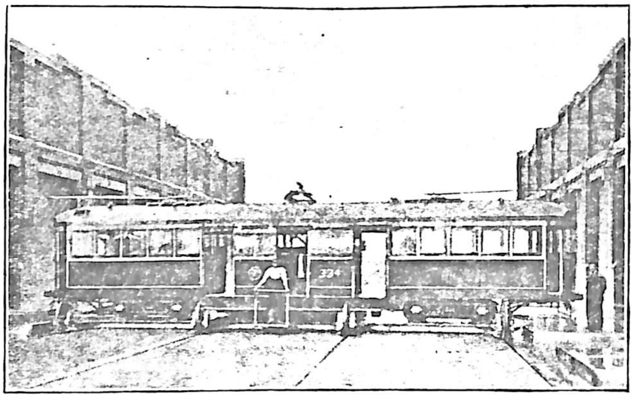

Fig. 2. Class W. Bogie Car on Traverser

to a corresponding position relative to the rest of the works. The equipment includes several light machine tools, plant for armature winding, a special bench for making up sets of wiring for the tram cars, a dipping tank, impregnating plant and baking ovens. Between the electrical shop and the truck shop is a small section devoted at present to electric arc welding. The welders, however, will be moved to the blacksmith's building when complete.

Blacksmiths' and Plate Shops

The building housing the blacksmiths', plate and pattern shops, and the foundry is at present under construction. It is to be 120 ft. wide by 256 ft. long. It will be equipped with a 5-ton electric overhead travelling crane running the full length of the plate shop and extending over the foundry and the places where the electric welders are to be located and the iron racks situated. The blacksmiths' and plate shops will be floored with ashes and the foundry with red brick. The pattern shop will have a floor of wood on concrete and will be provided with a second floor for storage of patterns. This shop will be equipped with a band saw, hand jointer and lathes. The plumbers will be located in this building also, at the south end of the blacksmiths' shop. The outside walls of the building are to be constructed with hinged shutters to allow of maximum ventilation in hot weather.

Woodworking and Lifting Shop

Across the traverser alley from the truck shop is the lifting bay, which is part of the woodworking shop. There are 14 sets of tram tracks in this bay, corresponding to those in the truck shop. Ten of them run right through the body building section of the woodworking shop, nine communicating with the traverser alley between that shop and the paint shop. The southernmost track communicates with the timber storages. The tracks in the lifting bay are equipped with pits similar to those in the truck shop.

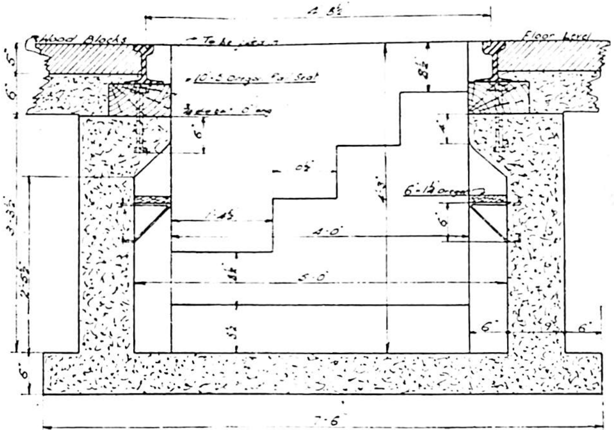

Fig. 3. Cross Section of Pit

The bay is served by a 15-ton electric overhead travelling crane having two 7½-ton crabs fitted with bridle stirrups and special hooks for lifting the car bodies. The stirrups span the car, and the hooks fit under the side sills and lift the body from the trucks. When a body has been lifted the trucks are taken in tow by a Fordson tractor and run across the traverser into the truck shop. The tracks on which the traverser runs are, of course, at a somewhat lower level than the car tracks. Concrete ramps are therefore provided between the sets of car tracks so that the tractor can run across the traverser alley. These ramps are very convenient also in allowing other traffic to cross the alley without having to negotiate any steps.

When the trucks have been removed the car body is lowered on to special wheeled trestles and pushed into the body section for overhaul. Cars are dismantled thus for a complete overhaul after every 100,000 miles or three years of service.

The woodworking shop, including the lifting bay is 256 ft. long by 180 ft. wide, and is floored with wood blocks set on concrete. Fig. 4 is a general view of this shop. The machines are installed in the south-west corner and are provided with an exhaust system to carry off the shavings and sawdust, the pipes of which are set in channels cut in the floor. The machines are so grouped that the shavings and sawdust are kept separate. They are delivered through cyclone separators into storage bins. The shavings are burnt in a destructor and the sawdust bagged for use in the depots. The machines include a breaking down saw, circular saw, universal saw, two morticers, shaper, drum sander, small sanding machine, buzzer, four-sided moulder, two jointers, boring and routing machine, louvring machine, tenoner, and dowelling machine. Individual drive is used throughout, and the motors are all set below the floor.

when washing down cars. The remainder of the floor is of jarrah. At one end of the shop is a paint store and varnish room with a gallery above. There is also a spray paint chamber with exhaust fan. As will be seen from the plan, four of the tracks from this shop run right through on the side remote from the traverser and curve into the single track running to the entrance to the works. By means of these the finished cars may be run straight out into service.

Portable adjustable trestles of the board's own design are used for the work of car painting. These may be run alongside the cars wherever required and the height of the working platform adjusted as may be most suitable. The paint-

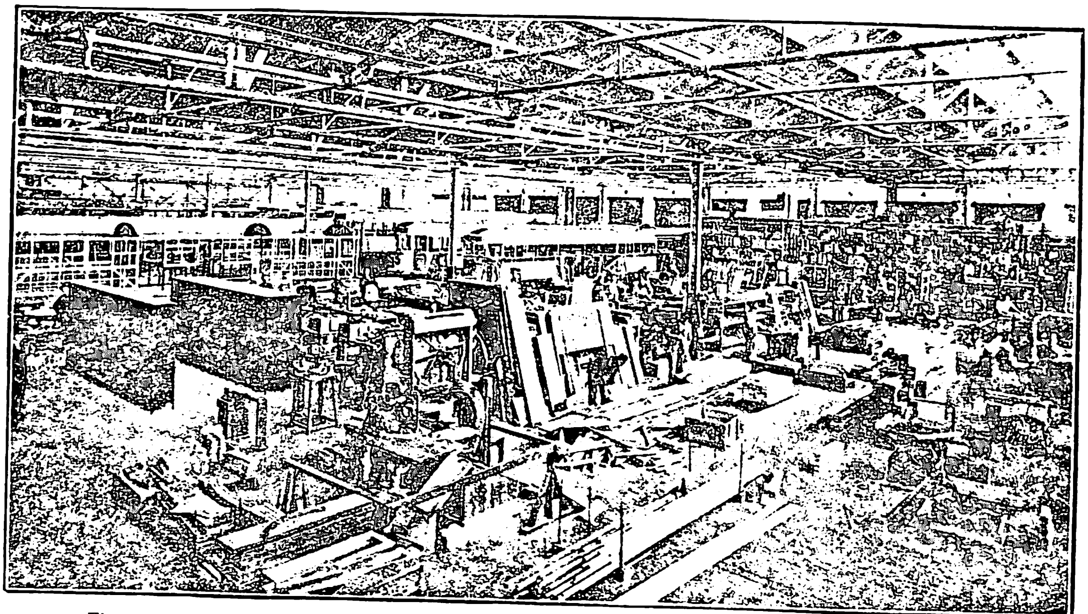

Fig. 4. General view of Woodworking Shop, with car building and repair section in background

Adjoining the woodworking section is the car body section, and these two carry out both repairs to old car bodies and the construction of new bodies. A feature of the maintenance service is that parts are made for stock and kept all ready for fitting into position to replace damaged sections. The car bodies are standardised as much as possible so that the parts are interchangeable. Portion of the body section is set apart for upholstery work. At present the new car department is turning out on the average two new class W bogie cars, similar to that shown in Fig. 2, every three weeks.

The paint shop is 160 ft. long by 120 ft. wide, and is provided with eight tracks, each of which will carry two bogie cars or three single truck cars with ample margin for working on the ends. The floor is constructed of concrete and wood. The concrete is set between the track rails and extends to 18 in. on either side. Along these side portions channels are formed for drainage

work on all cars in service is touched up every 18 months. The paint used is mixed in the shops and the varnish is of Australian manufacture.

The store is of similar construction to the workshop buildings, but the floor is elevated 3 ft. above the general ground level to facilitate loading and unloading of material. The building is 192 ft. long by 128 ft. wide. One bay is set apart for heavy material and is served by a 2-ton hand traversing crane with an electric hoist block. A dock is provided into which vehicles can run. The light material store is completely equipped with all-steel shelving, and is divided into sections: mechanical, electrical, general and construction. The stock is kept on the unit pile system, which gives a complete tally of everything. A basement is provided in the south-east corner for oil storage. Bowser pumps are being erected on the main floor above this for drawing the oil from the storage tanks.

The administrative block is a two-storey brick building. It accommodates the workshop administrative staff, and the rolling stock and workshop designing staff, and houses a well-equipped laboratory for research into such technical problems as arise from time to time in tramway operation. Adjacent to the administrative block is the substation which supplies power to the works. It is equipped with two 300-kv.a. transformers.

The S.L. Type High Tension Cable*

High tension cables, i.e., cables working at pressures of 33,000 volts and upwards, have in the past caused a good deal of anxiety to manufacturers and users owing to their liability to fail after working satisfactorily for some time. Investigations have disclosed that the failure may be attributed to unsymmetrical distribution of electrical stresses and to inclusion of air or other gas in the dielectric, which gas becomes ionised. Several suggestions have been made for the design of a three core cable in which this destructive action could be prevented. In the Hochstadder or H type cable the individual cores are covered with a tightly adhering conducting film, and the core coverings are in contact with one another and with the lead sheath of the cable. The S.L. type has each core separately lead sheathed, and the cores are assembled with reinforcing strands into a cable which has no enclosing lead sheath over the whole, but merely an appropriate armoring.

The advantages of metal sheathed core cables over ordinary cables may be summarised as follows:—

(1) The long-time failures experienced on plain 3-core cables have been found to originate in core-to-core faults and not between core and earth. The metal-sheathed-core cable has a larger core-to-core thickness for a given diameter of cable than the plain three-core type.

(2) The presence of the metal sheath prevents direct core-to-core faults, and in case of failure from any cause the breakdown takes place to earth, which is an advantage from the operation point of view. The fault current can be limited by earth resistance in the neutral.

(3) The electric stress is uniformly radial in all parts of the dielectric and consequently normal to the surface of the paper.

(4) The whole of the dielectric subjected to stress is homogeneous. There are no wormings or packings in the electric field.

(5) Separation of the cores by mechanical distortion of the cable, or by thermal expansion, cannot introduce voids into the dielectric under stress. Should the cores become separated from one another by a small fraction of an inch from any cause whatever, the conducting sheath moves with the core, and the space that is formed is outside the field and out of contact with the dielectric.

(6) The metal sheaths facilitate the carrying of the heat away from the centre of the cable, which is the hottest and, therefore, the most dangerous part.

The particular advantages of the S.L. type of cable over other metal sheathed types and ordinary cables are as follows:—

(a) In the S.L. type large diameter lead tubes are avoided, resulting in better mechanical construction.

(b) Owing to the greater mass of metal surrounding the individual cores, the cooling effect and consequently the current-carrying capacity is greater for the S.L. type than for the others.

(c) For use in hilly country where there may be a considerable head of oil in the cable, the S.L. type with its small-diameter lead sheaths and absence of worming spaces filled with oil has obvious advantages.

(d) In the S.L. type it is possible to use longitudinal steel reinforcing strands or pilot cables in the scores between the cores and outside the dielectric.

(e) The S.L. type permits of freer impregnation, each core being impregnated separately.

The mechanical advantages of the S.L. type are illustrated by a bending test in which a length was bent the standard number of times backwards and forwards on a barrel only nine times its own diameter (instead of 12 times as in the B.E.S.A. test). The resulting distortion was negligible.

A disadvantage claimed is the presence of undesirable currents in the lead sheaths, owing to their enclosing the separate conductors and being cut by the rotating magnetic flux. However, investigations have proved that the sheath losses are negligible and that the presence of the separate sheaths, instead of increasing the temperature rise and cutting down the current carrying capacity of the cable, has the opposite effect to a marked degree. The actual increase in current carrying capacity for the same temperature rise of an S.L. cable over the ordinary type has been found by test to be 12 per cent. In this respect the S.L. type cable has an advantage over the H type cable also.

*From a paper by P. Dunsheath read before the I.E.E., London.