TRAMWAY SIGNALLING IN AUSTRALIA.

Noel F Reed (Hon FIRSE)

Signalling as a means of safe operation of railways originated many years ago to allow trains of considerable weight and speed to travel safely along a railway. In the early years on double lines, trains followed each other on a time interval basis. On single line railways where trains could travel in either direction, the early railways operated with comparative safety by strict observance of pre - prepared timetables. In areas where trains travelled only at low speed the 'line of sight' principle was followed and is still used at selected locations. Street tramways are in the same low speed category so timetable working and 'line of sight' safe working is the generally accepted practice.

Directing trains on various different routes was another requirement and in the early years, it was necessary for attendants (known in USA as 'switch tenders') to be located at the various junctions to ensure that points were set correctly. Eventually systems were devised to control a number of points and signals at busy stations from a central position and interlocking was used so that conflicting directions could not be given. Most tramway systems commenced with none of these technical developments as they were essentially for low speed street public transport. Sydney tramways developed rather differently as apart from several early horse drawn tramways, steam trams were introduced for mass public transport. Steam trams could consist of a small locomotive or 'steam tram motor' hauling a 'tram-train' of one, two or three passenger carriages. Following the opening of the first steam tramway from the northern end of the city to the main Sydney Railway station, other steam tramways were built into suburbs to the west, south and east. The principle route to the west of Sydney is along Parramatta Road which passes close to Sydney University next to which a cutting had been excavated to reduce the grade against outbound traffic which was initially horse drawn. An early steam tramway was built to Annandale and the reduced gradient through the cutting allowed greater loads to be carried on the steam trams. Branch tramways were later built to Glebe Point and Balmain and the junctions to these lines were on this rising gradient through the cutting. The main steam tramway to the west was later extended to Leichhardt and a branch tramway was built to Abbotsford on the shore of Parramatta River.

The points at most NSW tramway junctions and crossovers were operated from mechanisms developed from the railway style weighted levers on which a heavy weight could be 'thrown over' to change the position of the point blades and keep them in this position until it was 'thrown over' the other way. These weighted 'throw over' railway style levers were used extensively in tram depot yards and on reserved track sections where they did not cause hazards to street traffic. For junctions and crossovers on roads carrying other traffic, the weight mechanism was housed in a shallow pit beneath the track. The weight of this mechanism was 'thrown over' by means of a long handled 'point hook' inserted through a slot above the weight. This became the standard type of point operation on all NSW tramways as the equipment was designed and built by the railway interlocking branch. At some junctions which had considerable road traffic, the facing points were operated from a railway interlocking type lever, often housed in a small pointsman's hut on the adjacent footpath. Such railway type levers were in use at some city locations and also at the Norton and Marion Street junction in Leichhardt until final closure of the Abbotsford tramway.

First Tramway Signal Box . In 1893, the first tramway signal box in Sydney was introduced to control the closely spaced junctions near Sydney University for the routes to Newtown, Glebe and Forest

Lodge. Control of the facing points from this signal box eliminated the need for outbound steam trams to stop while the conductor set and reset the points. At a later period , the junction at Newtown Rd (now City Rd) closest to the city was controlled from a separate signal box and the Glebe and Forest Lodge (later Balmain) routes were controlled from another railway type signal box near the University gates. This signal box was in turn replaced by a standard elevated tramway signal box above the footpath midway between the Glebe and Balmain Junction facing points. Other early tramway signal boxes of railway style were later built at Railway Square and Harris St Junctions which were at the principal railway–tramway interchange location near Sydney Railway Station.

King Street signals. Sydney's original cable tramway along King Street to Woollahra was on a rising grade for out bound cable trams. Consequent on the square crossings with electric tramways at Elizabeth, Castlereagh, Pitt and George Streets where visibility between King Street and the cross streets was limited by buildings, it was desirable to avoid any emergency stopping of cable trams with a possibility of their 'dropping the rope' and experiencing difficulty in continuing. Mechanical banner signals on posts were provided at these crossings so that an attendant could have better control of the cross traffic. Mechanical banner signals at the Pitt and George St crossings were later replaced by colour light signals controlled from elevated signal boxes. The mechanical banner signals at Elizabeth and Castlereagh Sts crossings remained in use until the closure of the King St tramway and the opening of the terminal loop at Queens Square.

Standard Tramway Elevated Signal Boxes. In order to give tramway signalmen a better view of approaching traffic and to avoid obstruction to pedestrians on the footpaths, elevated signal boxes were introduced at many junctions. These signal boxes were mounted on small gantries above the footpath to allow pedestrians to walk below. Instead of large railway type signal boxes with interlocking equipment in a room below the floor, a compact tramway lever frame, later known as Type K was designed to be totally accommodated within the signal box. The lever quadrants of the Type K lever frames were just above knee height from the floor with mechanical interlocking between the levers. Electrical contacts for control of the signals from the 600 volt traction power supply were located on the other side of the levers below the front windows of the signal box.

600 volt DC electrical cables between the signal box and the various signals were suspended overhead above the tramway span wires because in the early period, only heavily insulated power cables were suitable for underground use. Electric banner signals housed in circular 'drum shaped' cases were used at many interlocked tramway junctions prior to 1920. Developments with improved electric lamps resulted in the later design of "new pattern" tramway signals on which the horizontal and vertical banner positions were replicated by horizontal and vertical rows of red lamps. In the early twenties after railway colour light signals had been proved satisfactory for daylight use, the original 'drum shaped' tramway electric banner signals were rebuilt as two aspect colour light signals with the red and green lenses fixed horizontally at the front . Many of the early tramway signals were equipped with a short 'chimney' at the top for ventilation as large resistors connected in series with the signal lamps emitted considerable heat .

The smallest of the elevated signal boxes at simple double line junctions had four levers for the operation of the facing points and three signals. A typical installation of this size was at Elizabeth and Park Sts Junction. Signal boxes at triangular junctions typically had six or more levers. Some typical triangular junctions were at Elizabeth and Liverpool St , Elizabeth and Foveaux St , Waverley Depot

and City Road Junctions. The largest of the elevated signal boxes were at Fort Macquarie Depot (20) and at Newtown Bridge Junction . Some installations had police indicators with four or six coloured lights to allow a police officer on 'point duty' and the tramway signalman to co-ordinate their operations in controlling traffic.

The very last Sydney tramway signal box in operation until February 1962 was at Kensington Junction where the Coogee and La Perouse routes diverged. This junction could be approached by trams at higher than normal street speed on a private right of way. It was also an important location where many trams shunted en route to the Randwick Tramway Workshops. The junction points were equipped with a facing point lock and lock-bar of railway style and there was a unique junction indicator to advise drivers of approaching trams of the route which was set.

Several tramway signal boxes which controlled signals only had levers of the slide type which could be accommodated in a small cabinet. These lever frames were designated "Type L' and were also used at several signal boxes where the points were powered hydraulically by town water pressure. Hydraulic operation was used at locations where mechanical point rods could not be used at wide intersections. The signal boxes at the East Circular Quay balloon loop and the junction at King & George Sts used hydraulic power. The slide type point levers controlled water valves which admitted town water pressure to tubes beneath the road out to hydraulic point cylinders linked to the point blades. The hydraulic cylinders were usually located in kerb side cabinets, but they could also be fitted close to the points themselves. The signal box at East Circular Quay had hydraulic points in use until the loop was closed to allow for the construction of the railway across Circular Quay. The lever frame from Circular Quay signal box was later modified for use in a new signal box at the Queen's Square balloon loop which was built as the final city terminus for trams to Watsons Bay.

The largest "Type L" lever frame was located on the Ryde tramway in the control cabin of the former Gladesville Bridge across the Parramatta River. This frame had ten levers for control and interlocking of the various functions of the swing span at the city end of the bridge. This swing span was regularly opened to allow the passage of vessels including ferries , tug boats with barges and the small collier ships which transported coal to the gasworks at Mortlake. Several levers were used for control of tramway signals at each end of the bridge as trams were not permitted to pass on the bridge.(29) There were also colour light marine signals for control of the movements of vessels requiring to pass through the open span of the bridge. The electric motors for the various functions of this bridge were powered from the tramway 600 volt DC traction power supply via feeder cables from the Rozelle substation. Following the closure of the last section of the Ryde tramway between Rozelle and Drummoyne, a small motor generator was used to power the bridge equipment until it was replaced by the present concrete arch bridge.

Electric Tramway Points. Points at many tramway junctions in Brisbane and Melbourne were controlled remotely by drivers of approaching trams. The usual procedure to set points for the curved route was to approach with 'power on', and for the straight route to approach with 'power off'. The current drawn by the tram's motors was detected and caused large solenoids housed in a 'street box' to change the position of the points . Many tramway junctions in Melbourne still use electric points but with electronic control by drivers of approaching trams.

It is not generally known that electric tramway points were used in Sydney over one hundred years ago. The junction of the Eastern Beaches and Botany tram routes at Chalmers and Cleveland Streets was equipped with electric points but their operation was unusual. The facing points could be changed by the driver's power controller of electric trams, but conductors of steam trams which still operated on some routes had to operate the points by a kerb side manual switch. The advent of coupled 'O' class trams which operated in multiple unit with two poles on the trolley wire could have resulted in derailments at such a junction and the electric points were removed from service. In the fifties there was a proposal by the chief tramway engineer to operate remote facing points at Elizabeth and Hay Street Junction electrically on request by drivers of coupled trams approaching with 'power on or off'. The driver's request was to be registered in the signal box at Elizabeth & Goulburn St and the points would be controlled by that signalman. It was an ingenious scheme, but it was never placed into operation due to the subsequent closure of tram routes.

Tramway Single Line Operation. – In the NSW steam tram period, various routes to outer suburban locations were initially opened as single track with comparatively widely spaced crossing loops. Subsequent population increase and the electrification of various routes required the provision of additional crossing loops and finally many lines were duplicated. Due to the comparatively long distances between crossing loops, the railway style of 'staff and ticket' working was applied because 'line of sight' operation was not always suitable unless the tram route was relatively straight and level. Some tram routes were never completely duplicated so staff and ticket working remained almost to the end of tramways in NSW. There were several short sections of gauntlet track on the Wallsend and Narrabeen lines on which staff and ticket operation was used.

To avoid confusion, different types of staffs were used on consecutive single line sections. Several long routes had many crossing loops and there were designs for eight distinctive staff types. The electrified Manly to Narrabeen tramway which was closed in 1939, had seven single line sections so most of the available staff types were in use. In the early years of the Watsons Bay line, there were a considerable number of consecutive single line sections with staff and ticket working.

Tramway Single Line Block Signals.—Block signals operated by contacts on the trolley wire were developed for use on tramway single line sections of considerable length or where visibility for line of sight operation was restricted. When a tram was about to enter a single line section, the trolley wheel would pass a contact to cause a brief electrical impulse to be sent to the signal system. This would cause the display of a green signal light for the tram and a red signal light at the opposite end of the section. The simplest signal of the signal systems functioned usually for just one tram at a time through a section. Other block signal systems included counting mechanisms which would register by trolley wire contacts, the number of trams entering a section. The same number of trams 'counted in' to a single line section had to be 'counted out' at the other end of the section before it was considered clear and ready for a tram movement in the opposite direction.

Many of the tramway block signals used in Australia were built by the Forest City Electric Company in England. Signals of these types or similar copies were used on tramways in Brisbane, Melbourne, Adelaide and Hobart where some signals could count up to ten trams passing in and out of a section. The Victorian provincial city tramways in Geelong, Ballarat and Bendigo used simpler non-counting signals. If several trams were to proceed through a section, all except the last would carry a

white disc at the front to denote 'Car Following' The Perth tramways used American manufactured Nachod signals which could count up to fifteen trams in and out of a section.

The Sydney tramways had just one pair of American single line block signals manufactured by the United States Electric Signal Company. These signals were originally installed at each end of the Iron Cove Bridge on the Ryde line because trams were not permitted to pass in opposite directions. The automatic signals were not considered suitable at Iron Cove and were later replaced by standard manually controlled tramway signals at each end of the bridge. The United States Electric Co block signals were later installed to control tram movements on the single line between Cooks River terminus (Tempe) and the Wolli Creek per-way sidings. Apart from employees' trams this single line was mostly used for non passenger movements of ballast motors and water sprinkler trams which could run at random periods of the day or night without regular timetables.

The most comprehensive system of tramway block signals was introduced in 1932 with the opening of the Sydney Harbour Bridge and the use of platforms at Wynyard underground station as a city terminus for trams on the isolated lines north of the harbour. The tunnel sections between Sydney Harbour Bridge and Wynyard Station had railway style two aspect track circuit controlled automatic colour light signals to warn tram drivers of another tram closely in front. These tunnels had electric lighting for maintenance purposes but they were not continuously illuminated. Two crossovers were provided in a wide section of the tunnels and these were controlled from a small power interlocking in a tiny signal box within the tunnel. The crossovers were operated by compressed air similarly to railway points at busy locations, and they allowed trams to arrive and depart on either of the two platforms. Illuminated tram departure indicators were installed at Wynyard to inform passengers of the destinations of trams which in peak hours would be often close together at the platform. The last new tramway signal box in Sydney was in 1937 at George and Hay St Junction near where the present Sydney Light Rail line crosses George St. The junction was built for a loop through Hay, Parker and Barlow Sts to allow 'short working' of George St trams during peak hours and events near the Town Hall. The signal box was of the then popular 'art deco' style and its design was identical to the small railway signal box which was also built in 1937 at Civic station, Newcastle.

Elevated signal boxes were used at a number of city tramway junctions in Brisbane, Melbourne and Adelaide. Some Brisbane signal boxes used hydraulic points, those in Melbourne used American style 'interlockers' with electric points and some junctions in Adelaide had mechanical lever frames similar to the Sydney Type K. Electric points and signals were used in Adelaide at the 'Grand Union' junction of King William Street and North Terrace.

Tramway Signal Preservation. Consequent on the closure of the tramways in Sydney and Brisbane, a number of signalling artefacts were put aside for preservation in museums. Many of these can be used for operational use and display or for static demonstration. Tramway signal boxes of local styles have been preserved in museums at Brisbane, Sydney and Adelaide.