MAIN ROADS

March 1958

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Cover Page

View of Deviation of Great Western Highway near Linden.

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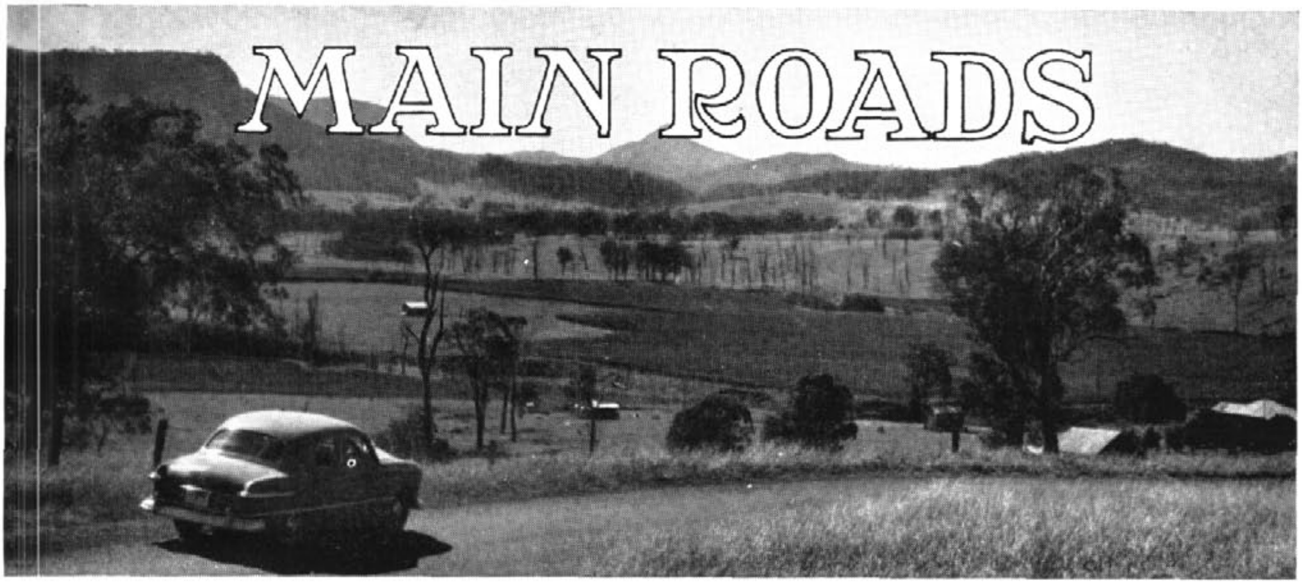

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Elimination of Hazards on the Great Western Highway over the Blue Mountains

Deviation near Linden

TWO narrow railway overbridges on very poor alignment, which have been the scene of many accidents, have been eliminated from the Great Western Highway by the construction of a deviation, 4,000 ft. long through rough sandstone country between Linden and Woodford on the Blue Mountains. In addition, the deviation, which was opened to traffic in December, 1957, has provided a much improved alignment and grading throughout the length affected.

The excavation and drainage work was carried out for the Department of Main Roads by contract by Eric Newham (Wallerawang) Pty. Ltd. and the pavement and certain other works were done by the Department by day labour. The contract work was commenced in October, 1955, and completed in November, 1957.

Design

The work was designed for a speed of 40 m.p.h. with curves of minimum radius of 600 ft. and maximum grades of 8 per cent. Provision was made for a gravel pavement, bitumen surfaced 22 ft. wide, with 5 ft. wide gravel shoulders.

Provision for Traffic

As the new work crossed the old route of the Highway at a number of places and levels varied considerably, it was necessary to provide temporary bitumen surfaced roads of a standard sufficient to carry the heavy and fast traffic using the Highway. The two overbridges eliminated from the Highway route as a result of the deviation will be retained in use to provide access for local residents to the township at Linden. Adjacent to one of the overbridges, the new work necessitated a cutting 22 ft. deep through the former road and it was necessary to provide a temporary detour 900 ft. in length to carry Highway traffic. This cutting has temporarily cut off one means of access to Linden although access is still readily available by another road. Work will shortly be commenced on the construction of a reinforced concrete bridge, 18 ft. between kerbs, to span this cutting and so restore normal access to the village.

Earthworks

The work involved the excavation of 61,200 cu. yds., approximately 90 per cent. of which was sandstone.

The Contractor tendered on the basis of using a percussion drill giving 6 in. diameter holes for 5 in. diameter explosives, together with a $3\frac{1}{2}$ cu. yd. shovel and 10 ton capacity trucks for removal of the spoil. Work proceeded on this basis from October, 1955, to June, 1956, during which period 28,700 cu. yds. were excavated.

The new work follows closely along the main western railway line, the distance between the railway and road

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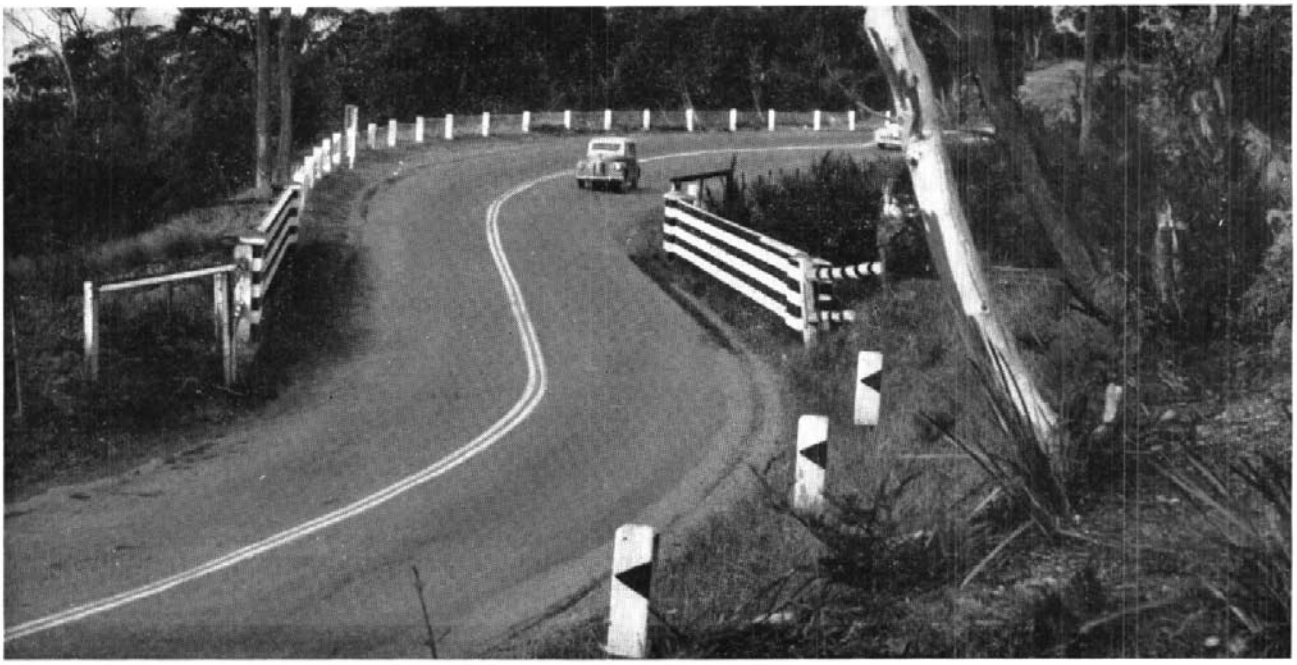
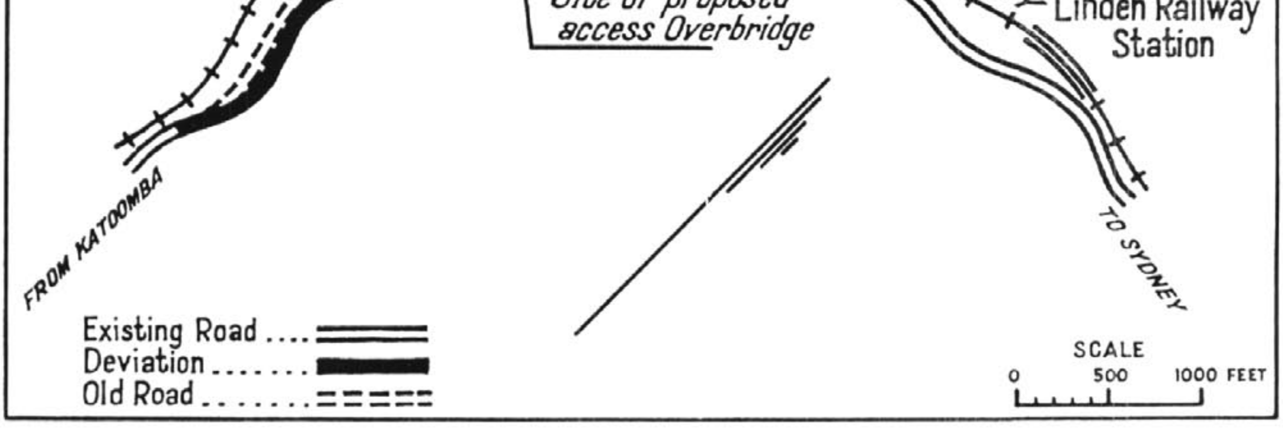
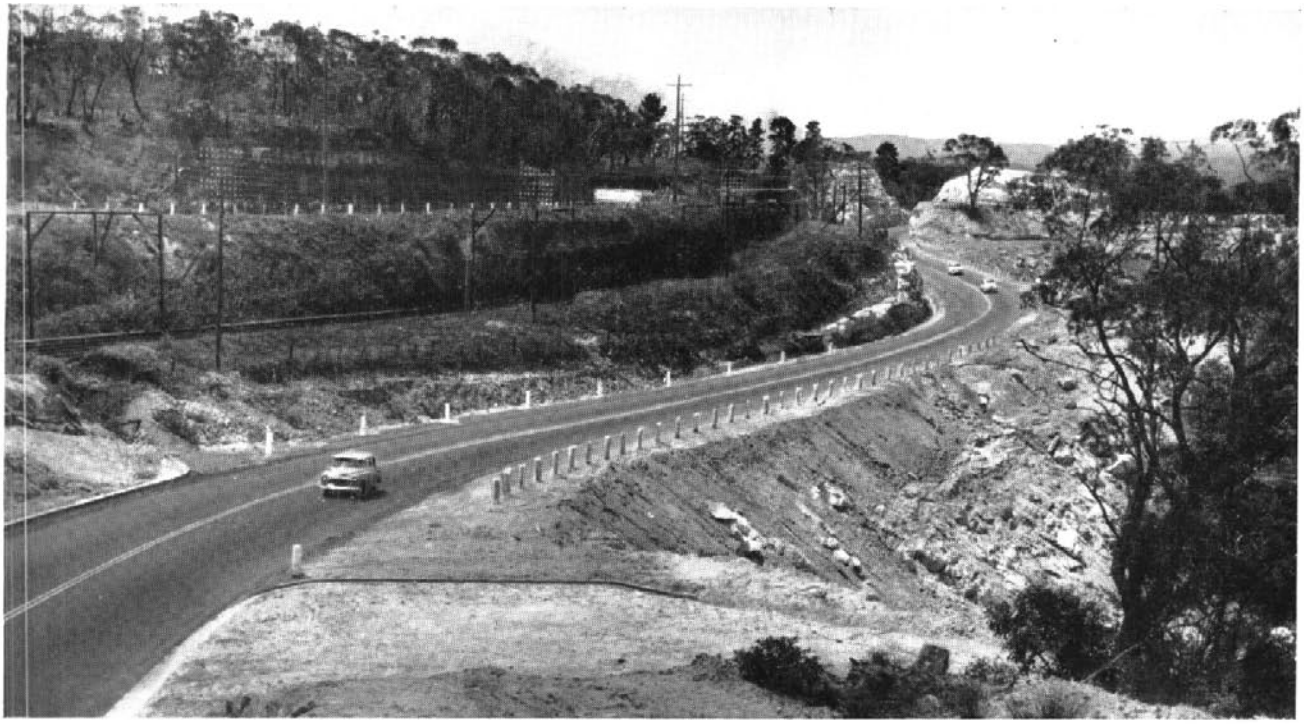


One of the two overbridges eliminated by the Linden Deviation.

cuttings being as little as 40 ft. The Railway Department checked vibrations on overbridges and railway cuttings with a vibrograph as the work proceeded and ultimately in June, 1955, set limiting maximum vibrations which could be permitted without endangering railway property. To keep within these limits, the Contractor had to revise the method of drilling and blasting and adopted jackhammer drilling and the use of smaller explosive charges. Smaller loading equipment was also put into use at this time. Throughout the duration of the work a tractor and 8 cu. yd. scoop unit was used where possible to shift the spoil, compaction of the embankments being effected by a sheepsfoot roller and final trimming and compaction of subgrade with a heavy powered grader and 12 ton roller.

In rock cuttings, the sub-base for the full formation width was shattered by blasting to a minimum depth of 2 ft. below subgrade level to provide better subgrade drainage.



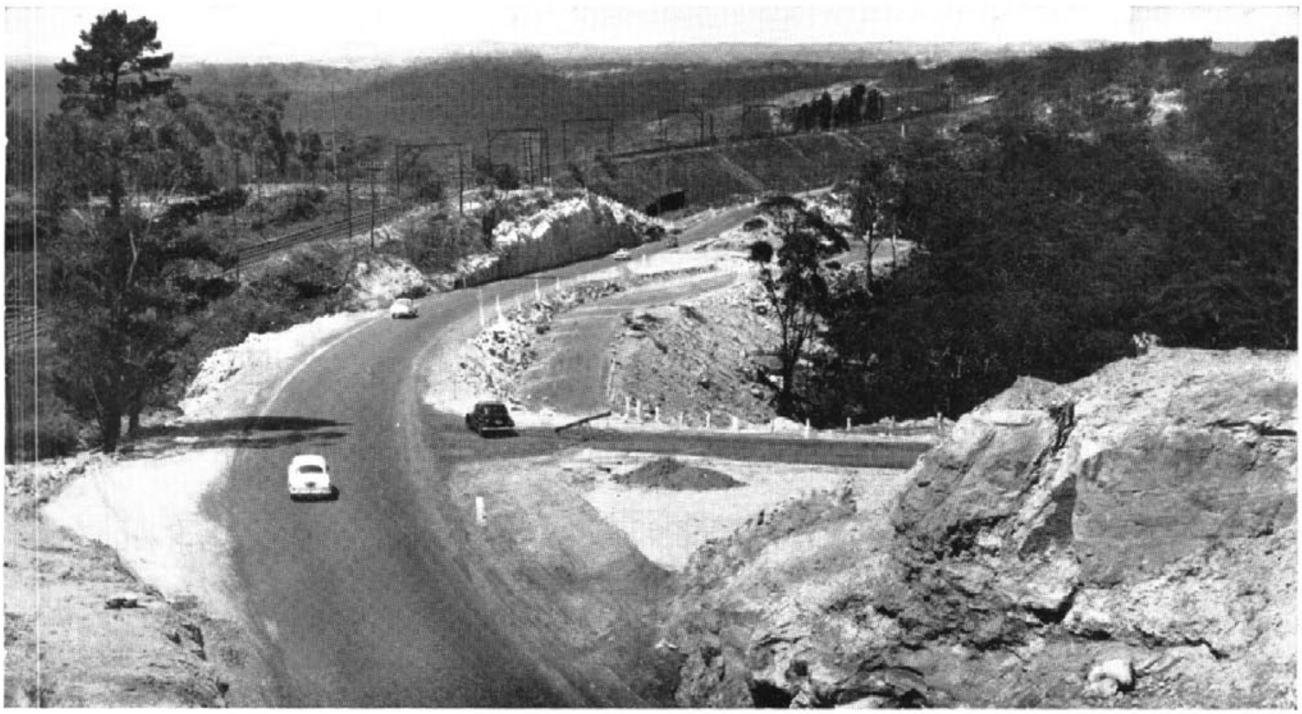


View of Linden Deviation showing, in distance, eliminated overbridge and cutting through old route of Great Western Highway.

The maximum depth of fill on the centre line was 35 ft. but due to the steep side slope the maximum difference in level between the finished work and the toe of the batter was 106 ft. Maximum depth of cutting was 47 ft.

Drainage

Five concrete pipe culverts were provided, the largest being of 36 in. diameter, 122 ft. in length. On the deep fills, the culverts were constructed on the flanks of gullies to economise on the length and to avoid



Looking east along the Linden Deviation.

excessive loading on the pipes. The diversion of a number of small water-courses was necessary to provide suitable inlet and outlet conditions. Subsoil drains totalling 4,000 lin. ft. were provided where necessary in box cuttings.

Pavement

A bitumen surfaced gravel pavement of compacted 5 in. thickness was provided. Natural gravel suitable for bitumen surfacing was not available and a laterite gravel stabilised with quarry grit was used. Approximately half the total quantity of gravel was stabilised in the gravel pit, the remainder being stabilised on the work. Mixing in each case was carried out using a drawn mixer. Field control of moisture content during final compaction and preparation of the gravel pavement was done by using the British standard compaction test, and the moisture content was checked by alcohol dehydration.

A multi-tyred pneumatic roller drawn by a wheeled tractor was used together with a heavy steel tyred roller for the compaction of the gravel, final shaping being carried out with a heavy grader.

The pavement was surfaced with hot bitumen (suitably fluxed) at the rate of .28 gallons per sq. yd., $\frac{3}{4}$ in. aggregate and $\frac{3}{8}$ in. aggregate being applied at the rates of 1 cu. yd. to 60 sq. yds. and 1 cu. yd. to 250 sq. yds. respectively. All aggregate was pre-coated at the rate of one gallon of tar per cu. yd. of aggregate.

Subsidiary Works

Chain wire protection fencing has been provided on curves and straights where the fill exceeds 15 ft. in height and guide posts have been provided as required at other locations.

To prevent scouring of the table drains and shoulders, concrete gutters have been provided where the grades are over 7 per cent. and the bitumen surface has been extended to the lip of the gutter.

Cost of Work and Supervision

The construction of the deviation, which will cost approximately £126,000, was carried out under the general supervision of the Department's Divisional Engineer, Chatswood, Mr. H. C. Macready.

Sydney Harbour Bridge Account

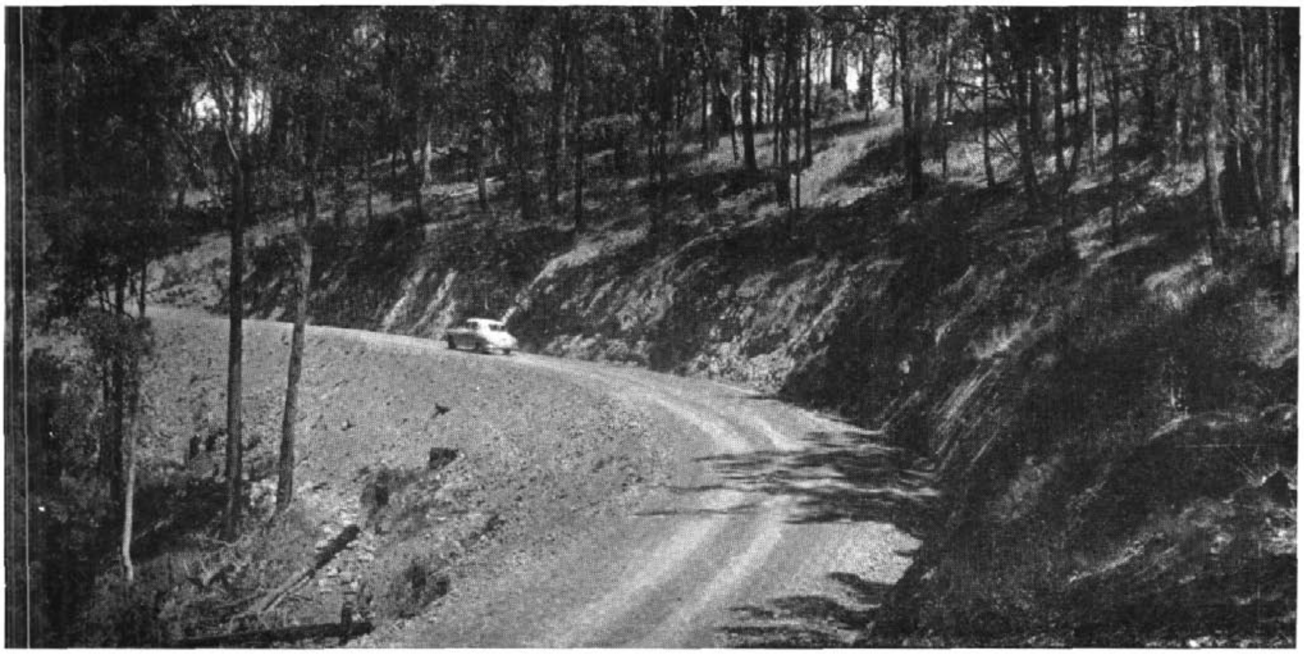
Receipts and payments for the period 1st July, 1957 to 31st December, 1957

Receipts

	£
Road Tolls ...	420,783
Contributions—	
Railway Passengers ...	69,483
Tramway and Omnibus Passengers	12,539
Rents from Properties ...	13,464
Miscellaneous ...	183
	£516,452

Payments

	£	£
Cost of Collecting Road Tolls ...		43,281
Provision for Traffic Facilities ...		2,332
Alteration to Archways ...		1,099
Maintenance and Minor Improvements ...		90,861
Provision of Additional Tollgates ...		6,884
Widening of Bradfield Highway (Western Side) to Accommodate Additional Tollgates ...		20,006
Improvement of Intersection of Bradfield Highway and Kent and Alfred Streets ...		4,500
Alterations of Toll Office and Tollgates ...		1,467
Administrative Expenses ...		2,027
Loan Charges—		
Interest ...	128,300	
Exchange ...	6,050	
Sinking Fund ...	51,570	
Management Expenses ...	440	
Flotation Expenses ...	24,390	
		210,750
Miscellaneous ...		4,312
		£387,519



Bulahdelah-Forster Main Road. Recent reconstruction work by Stroud Shire Council, four miles east of the Pacific Highway.

Improvement Works by Councils on Three Main Roads

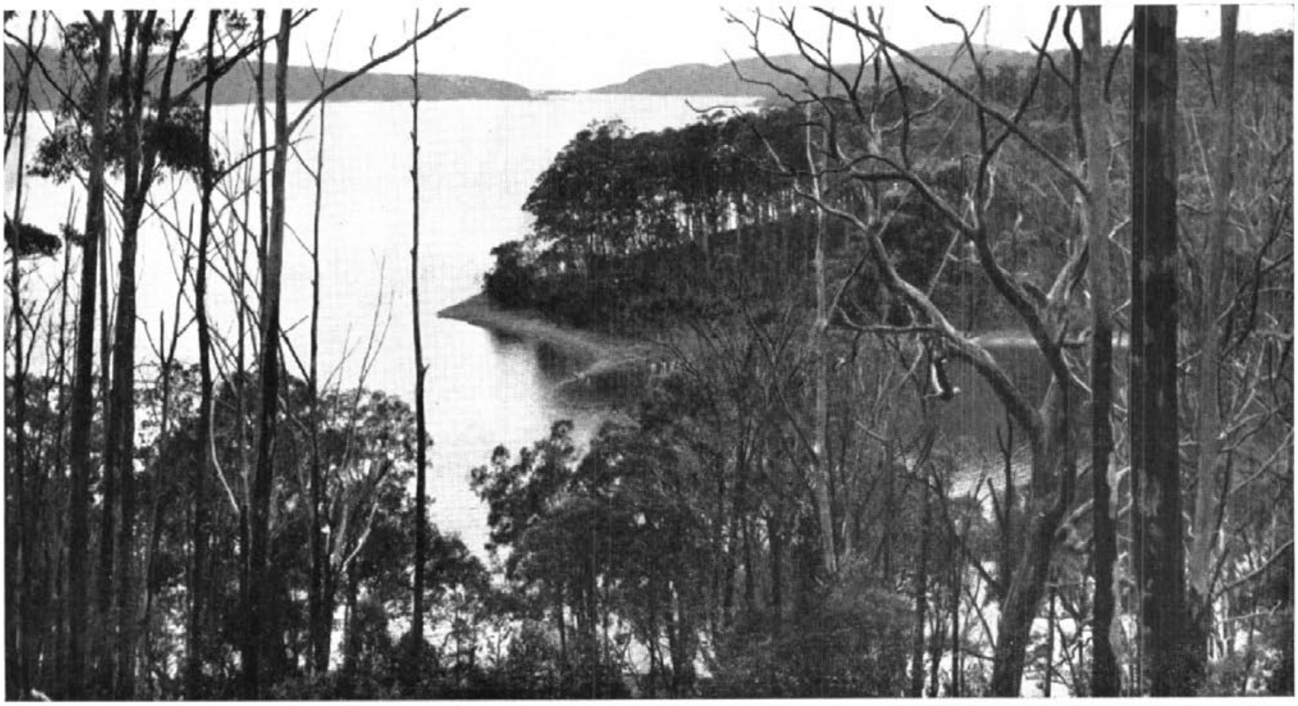
THE improvements on the three Main Roads described in this article have been or are being carried out by the Councils concerned either by day labour or by contract, the Department of Main Roads assisting the Councils by providing two-thirds of the cost of road works. Prior to bitumen surfacing, testing of subgrade soils and investigation, sampling and testing of gravel deposits to determine suitability were required and the Councils were generally assisted by the Department in the sampling and testing work.

BULAHDELAH-FORSTER-TUNCURRY-PACIFIC HIGHWAY (MAIN ROAD No. 111)

Main Road No. 111 is 54 miles long and commences just north of Bulahdelah on the Pacific Highway and passes through the Shires of Stroud and Manning to rejoin the Pacific Highway near Kappinghat Creek about nine miles south of Taree. The road skirts the Myall, Smith and Wallis Lakes over portion of its length and gives access to a number of popular lake and seaside tourist resorts between Bulahdelah and Taree, notably Forster and Tuncurry. Between Bulahdelah and the south end of Wallis Lake, the road passes through hilly timbered country with patches of rain forest; it then continues parallel and close to the coast to Tuncurry whence it passes through partly flat and partly through hilly country. Some earlier construction work on sections of the road was carried out with funds provided for the relief of unemployment in the years immediately preceding World War II.

Between Tuncurry and Forster, the Wallamba River which is the boundary between the two Shires, is crossed by ferry. To eliminate the ferry, a contract for the construction of a bridge has recently been let by the Department of Main Roads which is supervising the work on behalf of the two Councils. The bridge, at present in the early stages of construction to the tenderer's design, will be 2,075 ft. long, comprising 47 prestressed concrete spans of 42 ft. 6 in. and a steel span of 76 ft. which will be suitable for conversion to an opening span for navigation purposes in the future if necessary. The carriageway on the bridge will be 24 ft. wide and a footway 5 ft. wide will be provided.

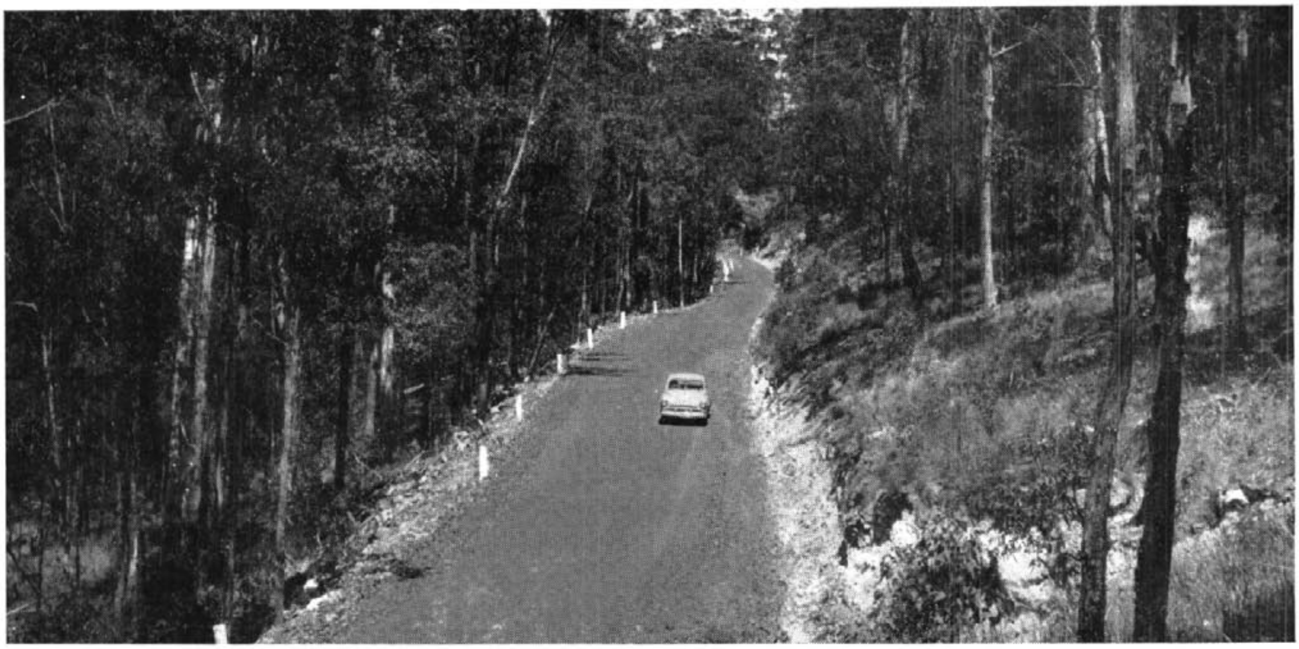
The length of Main Road No. 111 in the Shire of Manning is approximately 13 miles. On this length the Council has already provided a bitumen surface between Tuncurry and Black Head Road, a distance of



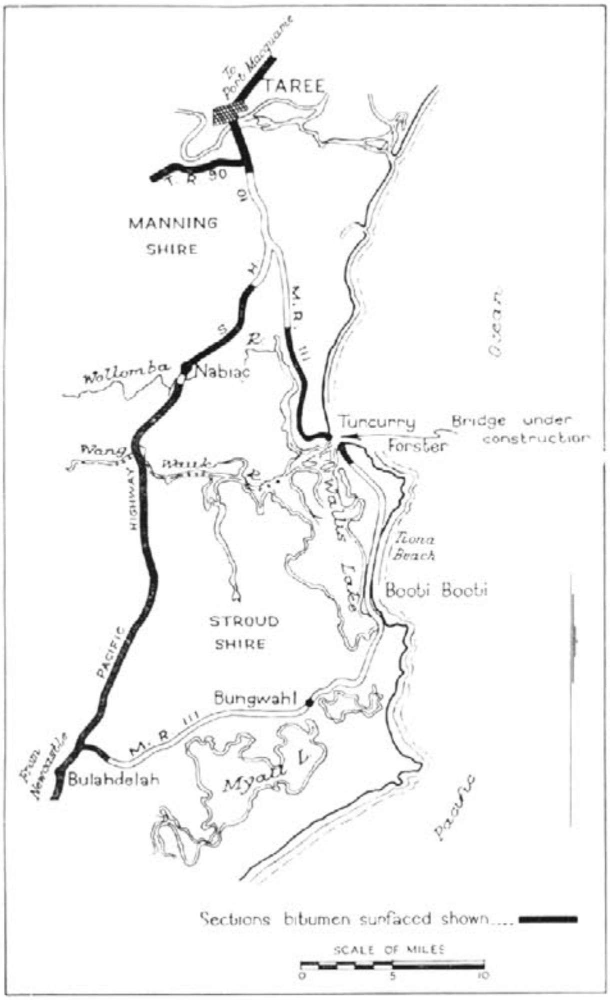
Myall Lake from Hewitt's Lookout on the Bulahdelah-Forster Main Road.

7.7 miles, and is now about to commence pavement reconditioning, in preparation for bitumen surfacing, from Black Head Road towards the Pacific Highway. It is expected that by the end of the current financial year Main Road No. 111 in the Shire of Manning, with the exception of a length of 2.5 miles, will have been bitumen surfaced. The cost of road work carried out and in hand amounts to approximately £44,000, of which the Department will meet approximately £30,000.

In the Shire of Stroud, a programme of progressive improvement of Main Road No. 111 is being undertaken by the Council with the object of providing ultimately a bitumen surface from the Pacific Highway near Bulahdelah to Forster, a distance of approximately 41



Bitumen surfacing recently completed by the Stroud Shire Council near Bulahdelah on the Bulahdelah-Forster Main Road.



miles. Between the Pacific Highway and Bungwahl, a length of 1.8 miles has been bitumen surfaced and two sections totalling 5.2 miles have been widened and improved preparatory to bitumen surfacing. At Bungwahl, Council is to undertake in the near future the reconstruction and bitumen surfacing of a length of 1.2 miles. Between Bungwahl and Tiona, a length of 3.5 miles has also been widened and improved by Council. Further north in the town of Forster, a bitumen surfaced pavement 1.2 miles in length has been provided.

The cost of road work recently completed and in hand on Main Road No. 111 in the Shire of Stroud totals approximately £61,000, towards which the Department will grant approximately £41,000.

CESSNOCK-TORONTO (MAIN ROAD No. 220)

Main Road No. 220 is the direct road connection between Cessnock and Toronto on the shores of Lake Macquarie, which is a major recreational area for the communities of the South Maitland Coalfields. It passes through the Municipality of Greater Cessnock and the Shire of Lake Macquarie.

At Mulbring, 10.25 miles from Cessnock, Main Road No. 220 is joined by Main Road No. 195 which serves Kurri Kurri, Weston, Abermain and adjacent centres of the Coalfields. From Toronto, traffic is dispersed to the various foreshore areas of Lake Macquarie by Main Roads Nos. 217 and 325 to the north and by Main Road No. 217 southwards to Wangi Wangi, Rathmines and other centres along the western shores of the Lake.

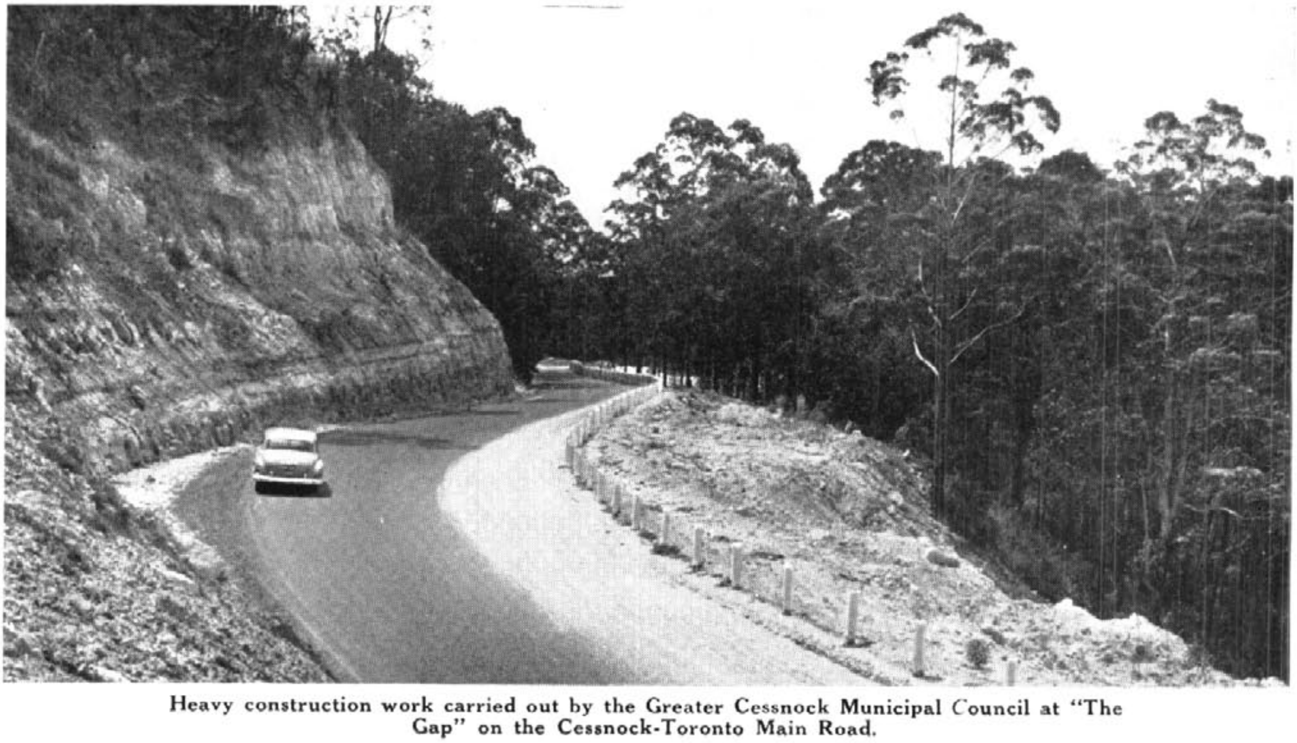
An earlier article in the September, 1952, issue of "Main Roads" dealt with the work which had been and was being carried out on Main Road No. 220 in the Shire of Kearsley which has since been incorporated

Reconstruction and bitumen surfacing carried out by the Manning Shire Council on the Tuncurry-Taree Main Road.

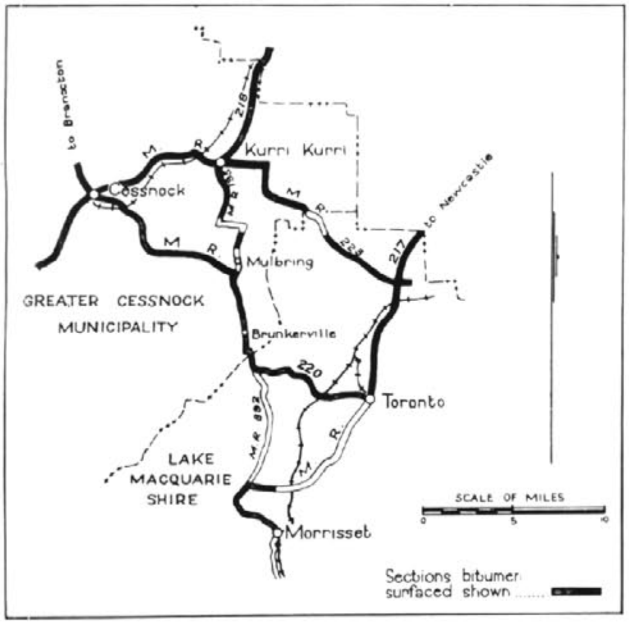
Reconstruction and bitumen surfacing carried out by the Lake Macquarie Shire Council on the Cessnock-Toronto Main Road.

in the Municipality of Greater Cessnock. At that time, the length between 5.23 miles and 8.00 miles from Cessnock had been prepared for bitumen surfacing. Council had commenced the reconstruction of the length between 8.00 miles and 10.30 miles and had completed reconstruction and bitumen surfacing between 10.30 miles and the boundary with the Lake Macquarie Shire at 15.75 miles from Cessnock.

The reconstruction and bitumen surfacing of Main Road No. 220 in the Municipality of Greater Cessnock



Heavy construction work carried out by the Greater Cessnock Municipal Council at "The Gap" on the Cessnock-Toronto Main Road.



have since been completed at a cost of £76,500, of which the Department of Main Roads met £51,000.

In the Shire of Lake Macquarie, work was concentrated in the first place on a length of almost one mile from the Shire boundary towards Toronto. Realignment of this length necessitated the carrying out of very heavy earthworks, and a bitumen surface was provided towards the end of 1954. Reconstruction of the remaining length of gravel pavement, 2.8 miles, in Lake Macquarie Shire followed generally along the line of the existing road and was commenced late in 1955. Bitumen surfacing was carried out some twelve months later thus completing the bitumen surfacing over the full length of Main Road No. 220 between Cessnock and Toronto, a distance of 24½ miles. The cost of the work on these two lengths was £42,000, of which the Department of Main Roads provided £28,000.

For works in the Municipality of Greater Cessnock and the Shire of Lake Macquarie, the Joint Coal Board met that portion of the cost of the works normally borne by the Council.

WAGGA WAGGA-COOLAMON-ARDLETHAN (MAIN ROAD No. 240)

Commencing on the outskirts of the City of Wagga Wagga, Main Road No. 240 passes through the Shires of Mitchell and Coolamon and terminates at the Newell Highway near Ardlethan. Throughout its length of 55 miles, the road serves a prosperous wheat, chaff and fat lamb producing district situated where the south-western slopes merge into the plains of the Riverina.

The country is gently undulating, rising from an altitude of 609 feet above sea level at Wagga Wagga to 823 feet at Coolamon and falling again to 663 feet at Ardlethan. Works recently completed by Councils on this road have resulted in the provision of a hard dust-free surface between Wagga Wagga and Coolamon, a distance of 25 miles.

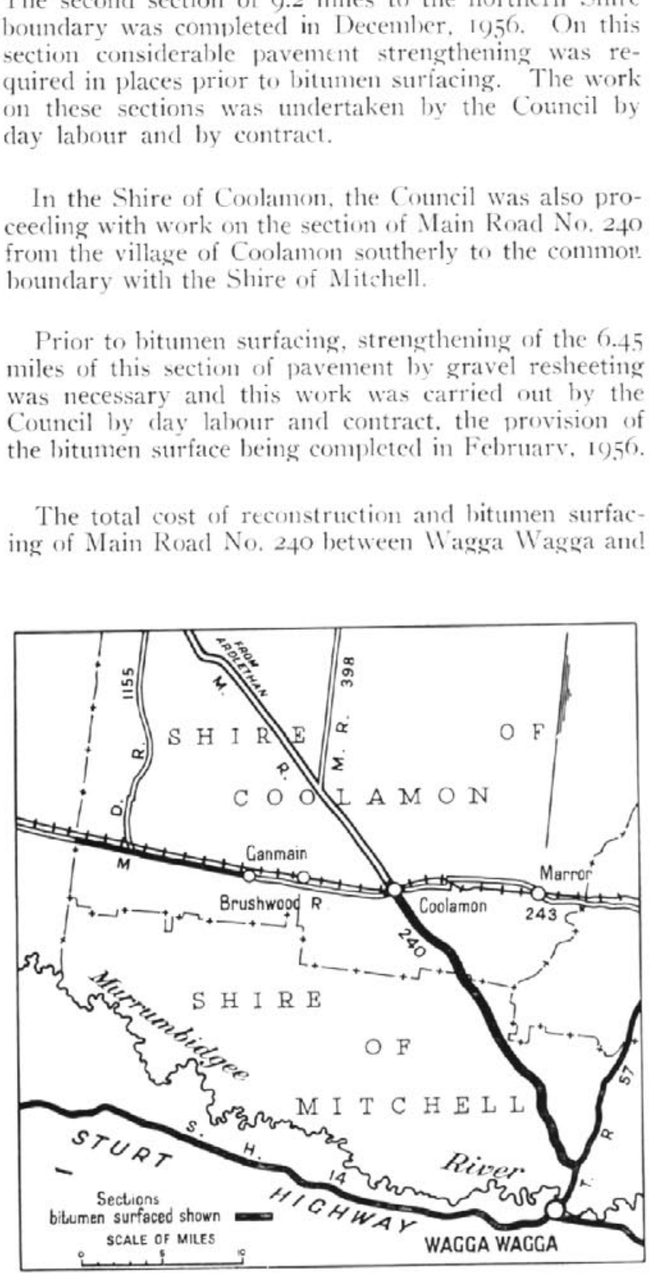
The first section of Main Road No. 240 to receive a bitumen surface was the length of 0.6 of a mile in the City of Wagga Wagga northerly from Trunk Road No. 57 to the boundary with the Shire of Mitchell.

The provision of a bitumen surface in the Shire of Mitchell was carried out in two stages, the first section being over 4.4 miles northerly from the Wagga Wagga City boundary and was completed in November, 1955. The second section of 9.2 miles to the northern Shire boundary was completed in December, 1956. On this section considerable pavement strengthening was required in places prior to bitumen surfacing. The work on these sections was undertaken by the Council by day labour and by contract.

In the Shire of Coolamon, the Council was also proceeding with work on the section of Main Road No. 240 from the village of Coolamon southerly to the common boundary with the Shire of Mitchell.

Prior to bitumen surfacing, strengthening of the 6.45 miles of this section of pavement by gravel resheeting was necessary and this work was carried out by the Council by day labour and contract, the provision of the bitumen surface being completed in February, 1956.

The total cost of reconstruction and bitumen surfacing of Main Road No. 240 between Wagga Wagga and



Reconstruction and bitumen surfacing carried out by the Mitchell Shire Council on the Wagga Wagga-Coolamon Main Road.

Coolamon amounted to £34,703 (City of Wagga Wagga—£963, Shire of Mitchell—£22,333 and Shire of Coolamon—£11,407) of which the Department of Main Roads provided £23,135.

Bridge over the Karuah River at Karuah on the Future Route of the Pacific Highway

A NEW bridge has been constructed by contract for the Department of Main Roads over the Karuah River at Karuah on the future route of the Pacific Highway.

A few years ago, it was decided to alter the route of the Pacific Highway from that passing through Stroud and Gloucester to that via Karuah, Bulahdelah and Nabiac. The reason for the change was greater directness, and because the country passed through better lent itself to the provision of a high class road. An additional advantage is that the new route will serve an area not served by rail and it will thus lead to the greater development of a vast area of productive country at present not well provided with transport. The timber and tourist industries will also benefit. The construction of the bridge over the Karuah River to replace the ferry crossing forms part of the Department's programme of the development of this new route of the Highway.

The new bridge at Karuah is 716 ft. long and 24 ft wide between kerbs and has a single footway 4 ft. 9 in. wide on the upstream side. The bridge consists of five steel truss spans of 120 ft. each and one of 65 ft. The trusses are shop welded and field bolted, high strength steel bolts having been used in making field connections. It has been general practice previously to use rivets for field connections, but the use of high strength bolts has come into operation overseas in recent years and the Karuah Bridge is one of the first steel truss bridges in Australia on which this method has been used; it greatly facilitated the connection of the steelwork.

New bridge over the Karuah River at Karuah.

The 65 ft. span in the bridge has been so designed that it can be converted to a vertical lift span should this become necessary in the future to provide for navigation of the river. The two flanking spans on either side of the shorter span have also been constructed so that towers to carry lifting gear and counterweights for a lift span can be added if necessary.

All the piers of the bridge are of reinforced concrete on reinforced concrete cylinders taken down to rock. The abutments are of reinforced concrete founded directly on the rock.

The bridge was designed by the Department of Main Roads and the construction work was divided into two contracts, one for the manufacture, supply and delivery of the steelwork and the other for the construction of the piers and abutments, the erection of the steelwork, the construction of the reinforced concrete deck and the final completion of the structure.

The contract for steelwork was awarded to the English firm of Horsley Bridge and Thomas Piggott Ltd. in the sum of £71,712. The manufacture of the steelwork was carried out at the Company's works at Tipton, Staffordshire, and the fabricated steelwork was shipped to Australia ready for assembly. The contract was supervised on the Department's behalf by the engineering staff of the Agent-General for New South Wales in London.

The contract for the erection of the steelwork and completion of the structure was let to Electric Power Transmission Ltd. for the sum of £274,888. The approaches at the Raymond Terrace side of the river were constructed by the Port Stephens Shire Council and those on the Tea Gardens side by the Department of Main Roads. The total cost of the bridge and approaches will be approximately £356,000.

Work at the site was under the immediate supervision of the Department's Divisional Engineer at Newcastle, and the bridge was officially opened to traffic on the 14th December, 1957, in the presence of a large gathering, by the Commissioner for Main Roads, Mr. H. M. Sherrard, at the request of the Councils of the Shires of Port Stephens and Stroud.

Sydney Harbour Bridge

Opening of Circular Quay Overhead Roadway

Changes in Traffic Pattern

IN the September, 1957, issue of "Main Roads" reference was made to an Origin and Destination Survey carried out in March of that year to obtain traffic data for the planning of traffic movements between the City and the suburbs on the northern side of Sydney Harbour when the Circular Quay Overhead Roadway opened to traffic.

The Circular Quay Overhead Roadway which was opened on 24th March, 1958, links Bradfield Highway with Macquarie Street, City, and is a part af the expressway system planned for the Sydney Metropolitan Area. It enables traffic between the northern suburbs and eastern suburbs to by-pass the city area. It also feeds traffic from the northern suburbs into the eastern part of the city without passing it through the central city area. The location of this roadway and its relation to the Sydney Harbour Bridge and the city area is illustrated in Figure 1.

The Harbour Bridge has, for a number of years, been operating at a capacity of approximately 5,000 vehicles per hour for the traffic flow in one direction in the morning and evening peak periods. To maintain maximum flow and to reduce accident hazards, regulations which prohibit the changing of lanes on the bridge in peak hours have been in force. Drivers have been permitted, however, to change lanes at will on the roads in immediate approach to the bridge.

It may be seen from Figure 1 that the Quay Overhead Roadway is so located that entry to it from the bridge is gained from the eastern bridge lanes and exit from it to the bridge is via the western bridge lanes. It is clear, therefore, that as regulations prohibit

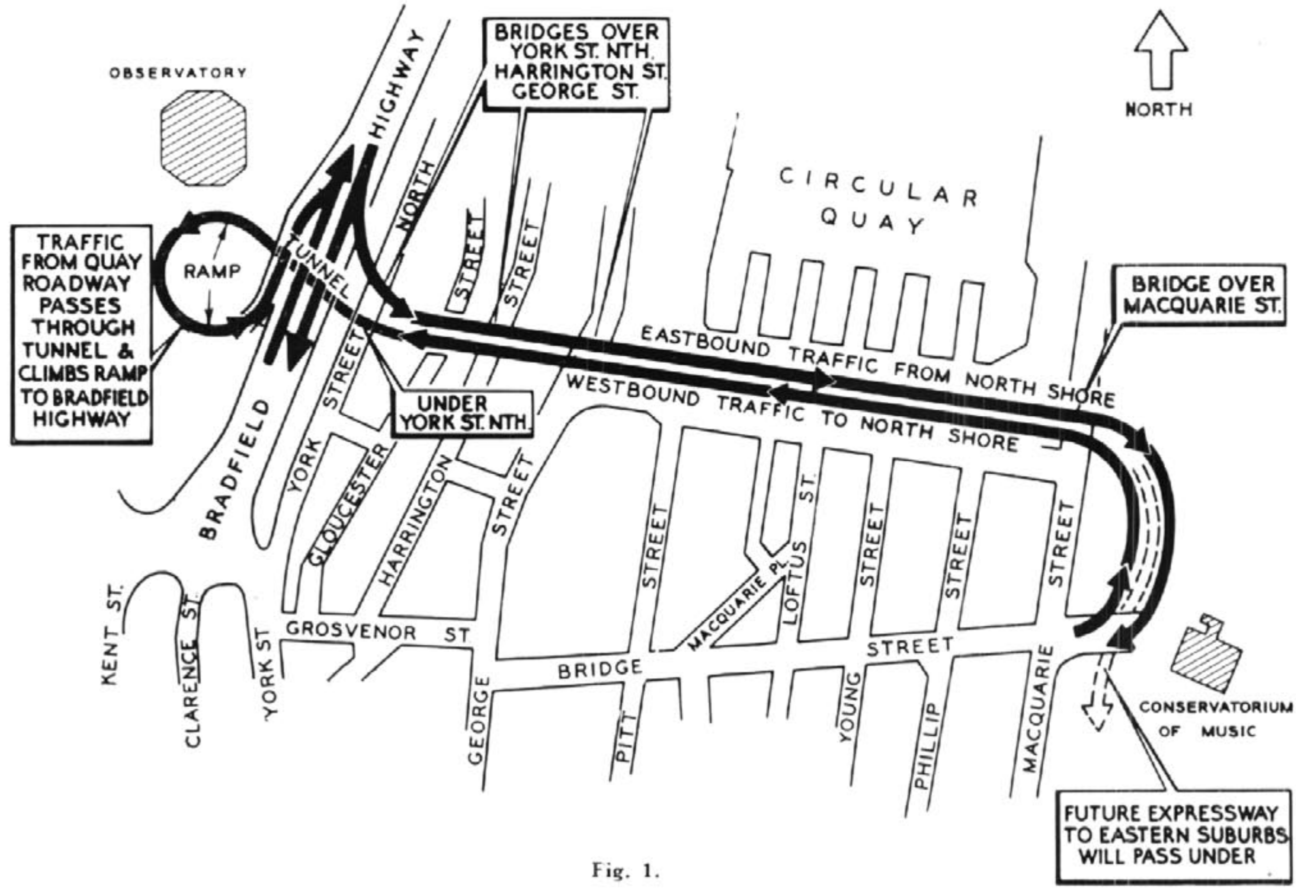


Fig. 1.

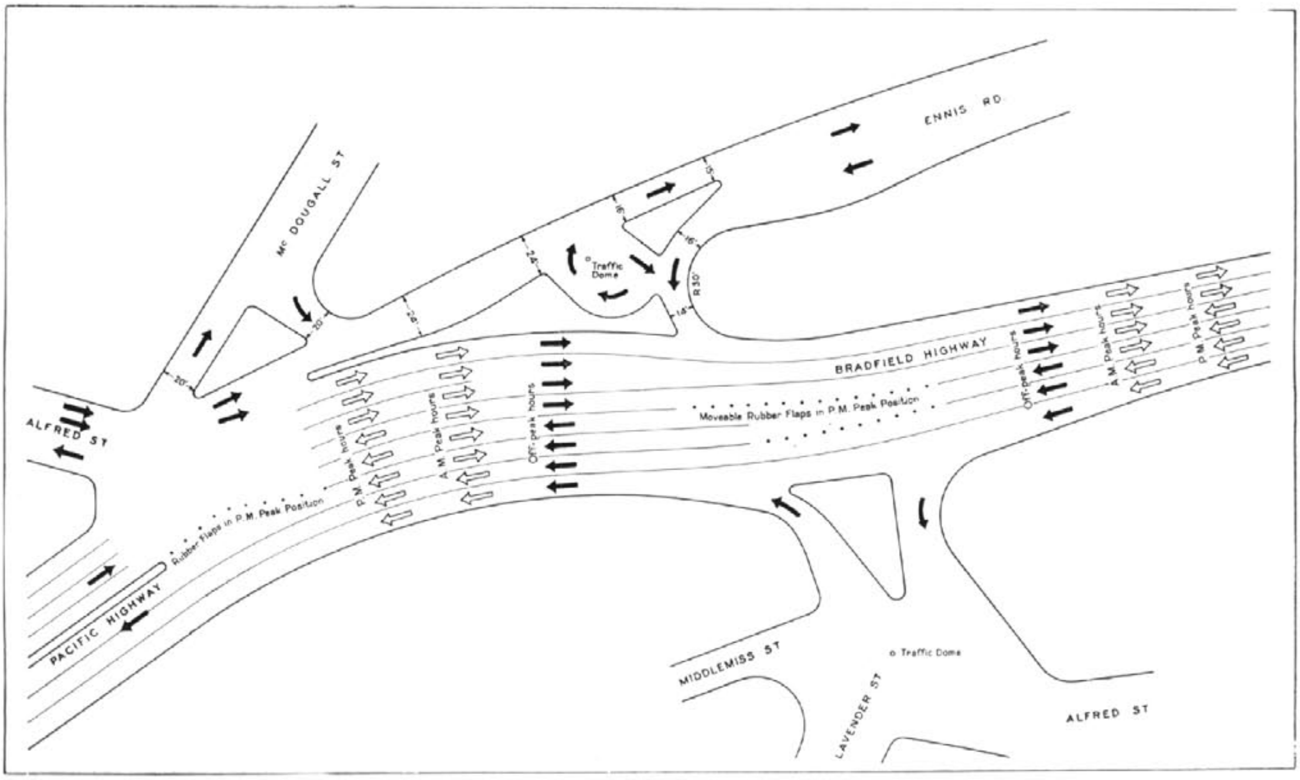


Fig. 2.

lane changing on the bridge, drivers, before reaching the bridge approaches, must select the bridge lane which leads them to their destination.

The Police Department, in consultation with the Department of Main Roads and other authorities concerned, prepared a scheme for the control of traffic in approach to the bridge and the regulations necessary to ensure that the approach routes and the new facilities will function efficiently. Briefly, the control procedure consists of directing traffic to routes in approach to the bridge which will lead it to bridge lanes suitable for its destination. The regulations required are the prohibition of parking or standing in streets where the full carriageway width is needed to provide maximum street capacity; provision for one-way flow in some streets and unbalanced flow in others; prohibition of right turns at some intersections where turning movements would seriously reduce the capacity of through traffic movements, and control of right turns where such turns are permitted.

It was clear from an analysis of traffic movements at the immediate northern approach to the bridge that the regulations and controls proposed on the northern side would not be fully effective without alteration to the road layout at the bridge approach. The Department of Main Roads therefore undertook to carry out the necessary road works and a description of the work undertaken is given below. The first improvements were put into effect on 25th November, 1957.

The traffic conditions on the northern approach during the a.m. peak period prior to 25th November, 1957, are shown in Figure 2.

It will be seen that traffic approached the bridge in four lanes in the Pacific Highway, two lanes in Alfred Street, and one lane from McDougall Street, and Ennis Road. Traffic in the Pacific Highway which included Government buses, private buses and large trucks, travelled over the Bridge in lane 1 (nearest the eastern kerb). To do this they weaved through traffic entering the bridge from Alfred Street and Ennis Road, thereby interrupting the flow of traffic from these streets. This traffic also merged with vehicles from the Highway at the start of the bridge lanes, and, as the demand increased, congestion tended to occur at the site with a consequent decrease in the rate of traffic flow across the bridge. Traffic crossed the bridge in four lanes and was passed through nine toll gates into Bradfield Highway.

The problem of leading the re-routed traffic to its proper bridge lanes was also common to the problem of reducing congestion at the start of the bridge lanes. The solution arrived at is shown in Figure 3. The median divider on the Pacific Highway was removed

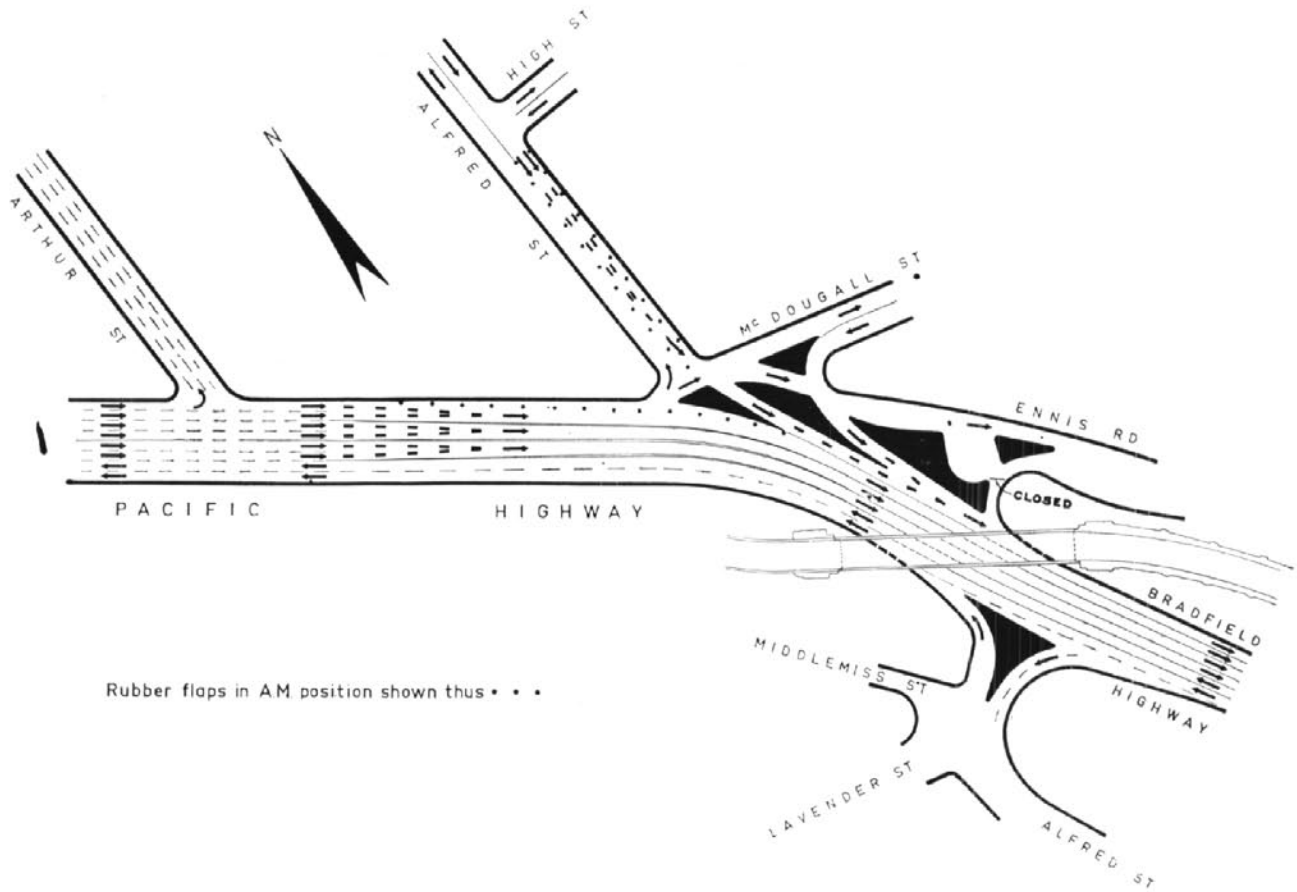


Fig. 3.

for a distance of approximately 800 ft. between Walker and Alfred Streets to make six lanes available for south bound traffic in the morning peak period. Between Arthur and Alfred Streets these six lanes were reduced to three by merging two lanes into one, and the three lanes so formed connect with bridge lanes numbers 2, 3 and 4. In this way the former crossing and weaving movements in Pacific Highway were replaced by an orderly merging movement. The buses and heavy vehicles entering the bridge from the Pacific Highway were re-routed from bridge lane No. 1 to lane No. 2 (from the east). This eliminated the need to hold Alfred Street traffic while the heavy vehicles crossed Alfred Street to enter the eastern bridge lane. The alterations in Pacific Highway meant that bridge lane No. 1 would have to be fed completely by traffic from Alfred Street, McDougall Street and Ennis Road. With the former arrangement (Figure 2) Ennis Road and McDougall Street traffic merged before entering the bridge approach and then joined with the Alfred Street traffic when suitable gaps occurred. This movement was necessarily a slow one and if retained in the revised scheme could have seriously impaired the capacity of No. 1 bridge lane. The solution adopted was to close the entry from Ennis Road and divert traffic from that road to McDougall Street. A new connection was then provided from McDougall Street which permitted its traffic to merge smoothly and at a reasonable speed with the traffic from Alfred Street, the Alfred Street traffic having previously merged from two lanes to one before leaving that street.

In addition to the work on the northern side two additional toll gates making eleven in all were opened to southbound traffic.

Opening of the Quay Overhead Roadway has necessitated further re-routing of traffic to ensure that only those drivers wishing to use the Quay Roadway will enter the bridge from either Alfred Street or McDougall Street. The re-routing however, has not required any further road works at the northern bridge approach.

The average peak hour (7.45 a.m. to 8.45 a.m.) volume of traffic crossing the bridge in the four lanes inbound on three Fridays prior to 25th November, 1957, was 5,385 vehicles. For the three Fridays subsequent to 25th November, 1957, the average peak hour volume was 5,687. As the widths of the bridge lanes are only 10 ft. for the two kerbside lanes and 9 ft. 3 in. for the four remaining lanes, the peak hour volume per lane after 25th November, 1957, was exceptionally high. The maximum flow for four lanes in one direction for any complete hour counted was 6,008 vehicles between 7.45 a.m. and 8.45 a.m. on 29th November, 1957. The highest lane volume counted was lane 4 (from east)

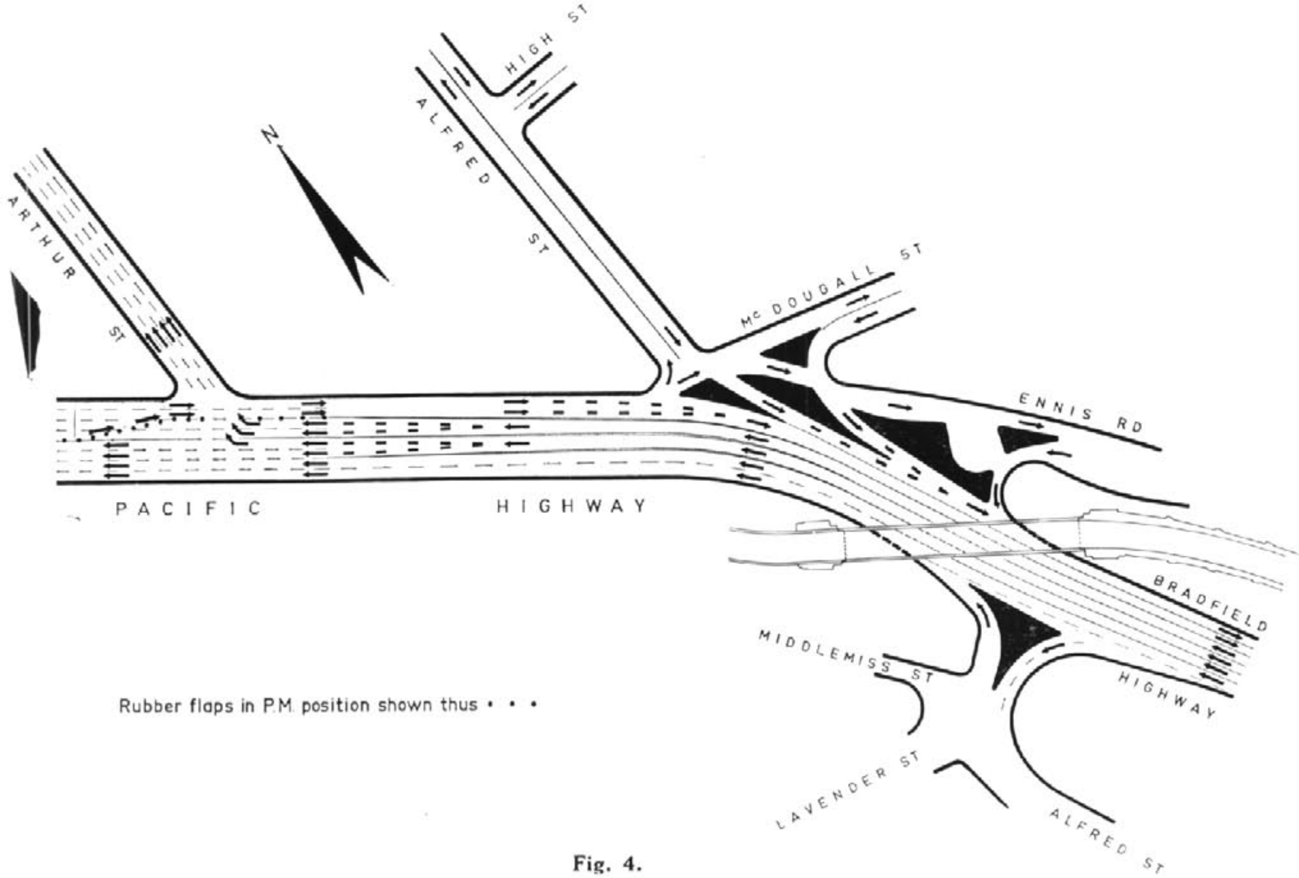


Fig. 4.

Fig. 5. Morning peak hour prior to 25th November, 1957.

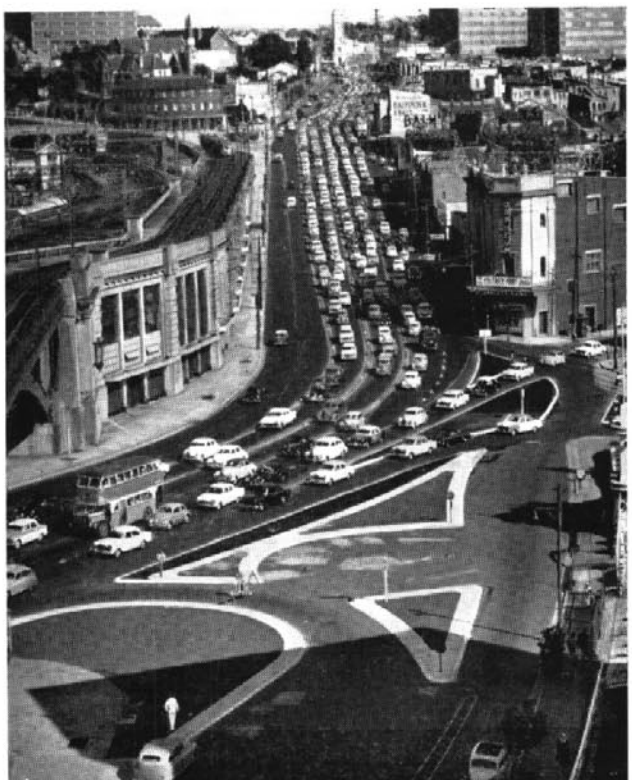


Fig. 6. Morning peak hour after 25th November, 1957.

Fig. 7. Evening peak hour after 25th November, 1957.

between 7.45 a.m. and 8.45 a.m. on 29th November, 1957, when 1,869 vehicles were recorded. One pleasing and surprising feature of the new arrangements was that buses and other heavy vehicles in lane 2 did not cause a drop in the peak hour volume in this lane. There was also a noticeable rise in peak hour volume in lane 1, the average for three Fridays before and after 25th November, 1957, being respectively 1,150 and 1,357 vehicles per hour.

To reduce interruptions to southbound traffic flow in the morning peak period northbound traffic in Pacific Highway is not permitted to turn to the right until north of Miller Street. In addition to the right hand turns north of Miller Street this traffic has two other alternative means of proceeding east, one by leaving the bridge at Lavender Street and turning back under the bridge at the Burton Street subway to Broughton Street, and the second alternative by proceeding along Pacific Highway, turning left at Blue Street and then crossing the Highway via Miller Street.

In the p.m. peak, unbalanced flow arrangements are again adopted on the Harbour Bridge, there being four lanes outbound from the City and two lanes inbound. Before the introduction of the new arrangements, traffic proceeding to the east and north-east turned to the right mostly at Alfred Street. Although the traffic was turned into two lanes, there was insufficient storage area within the intersection to handle adequately all vehicles which could be turned to the right in one turning phase. As a result congestion occurred in bridge lanes Nos. 3 and 4 (from the west) and queues often extended for several hundred yards southwards across the bridge.

The p.m. arrangements adopted to overcome the difficulties described above are shown in Figure 4. The right hand turn into Alfred Street is eliminated, all turning vehicles being diverted to either Arthur Street or Walker Street. In Pacific Highway the merging areas of the morning flow become diverging areas for northbound traffic in the evening. In this way large storage areas are provided for vehicles waiting to turn to the right. Traffic which crosses the bridge in lane 4 must turn at Arthur Street, while traffic from No. 3 lane may turn at that street or may proceed to Walker Street to make its turn. These new arrangements have proved to be most successful and it is seldom that a vehicle is compelled to wait for more than one phase before being able to turn to the right.

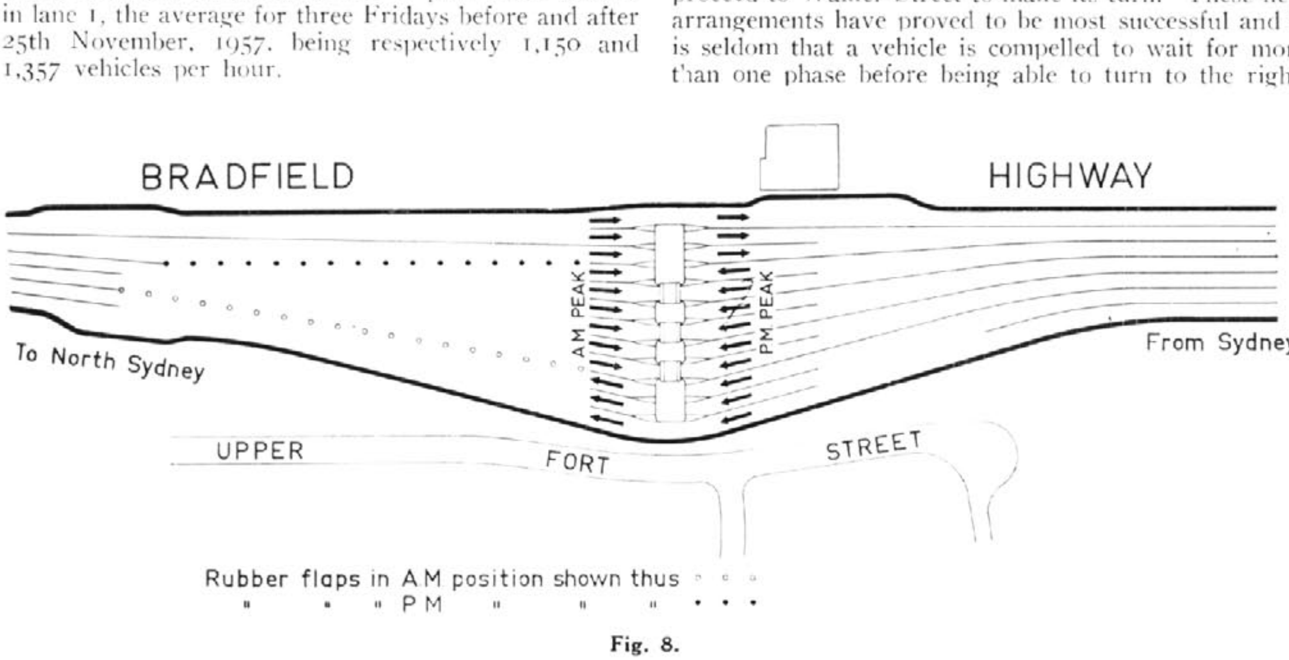


Fig. 8.

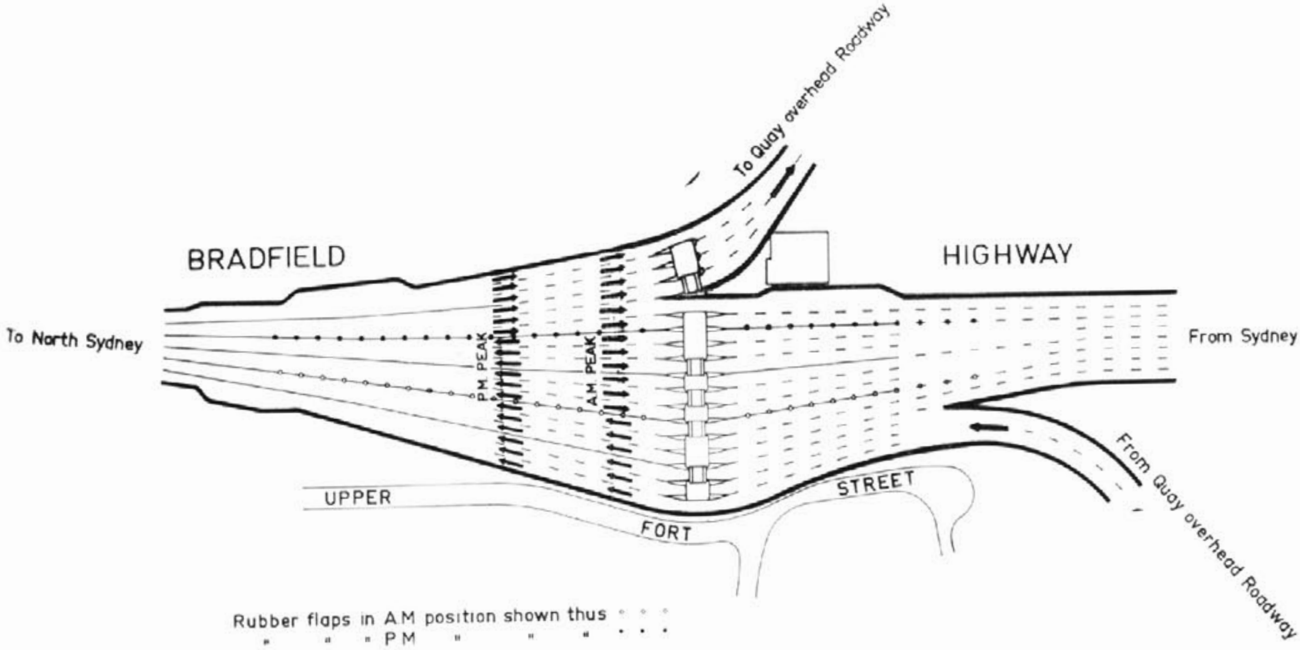


Fig. 9.

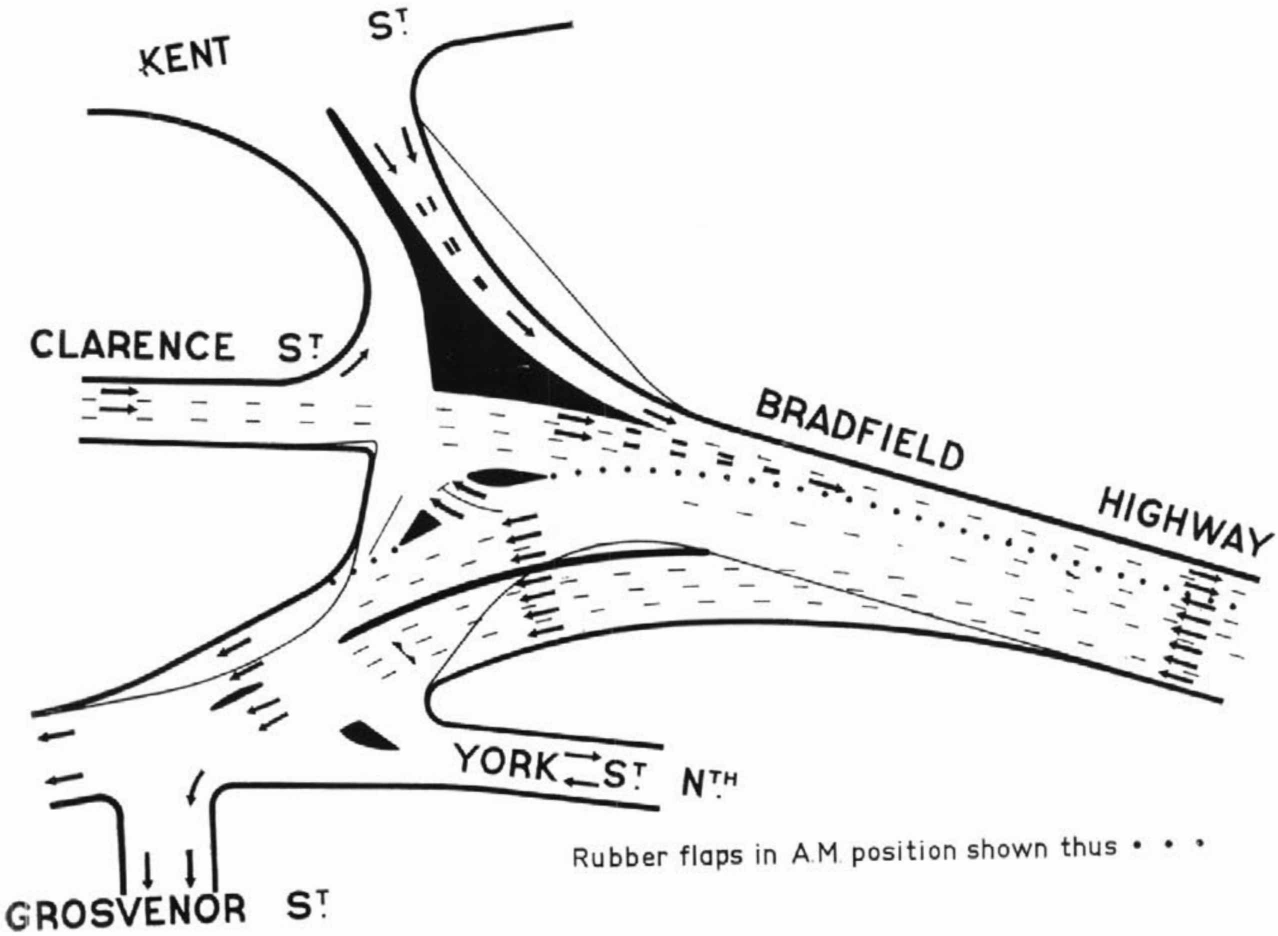


Fig. 10. Traffic flow in morning peak hour.

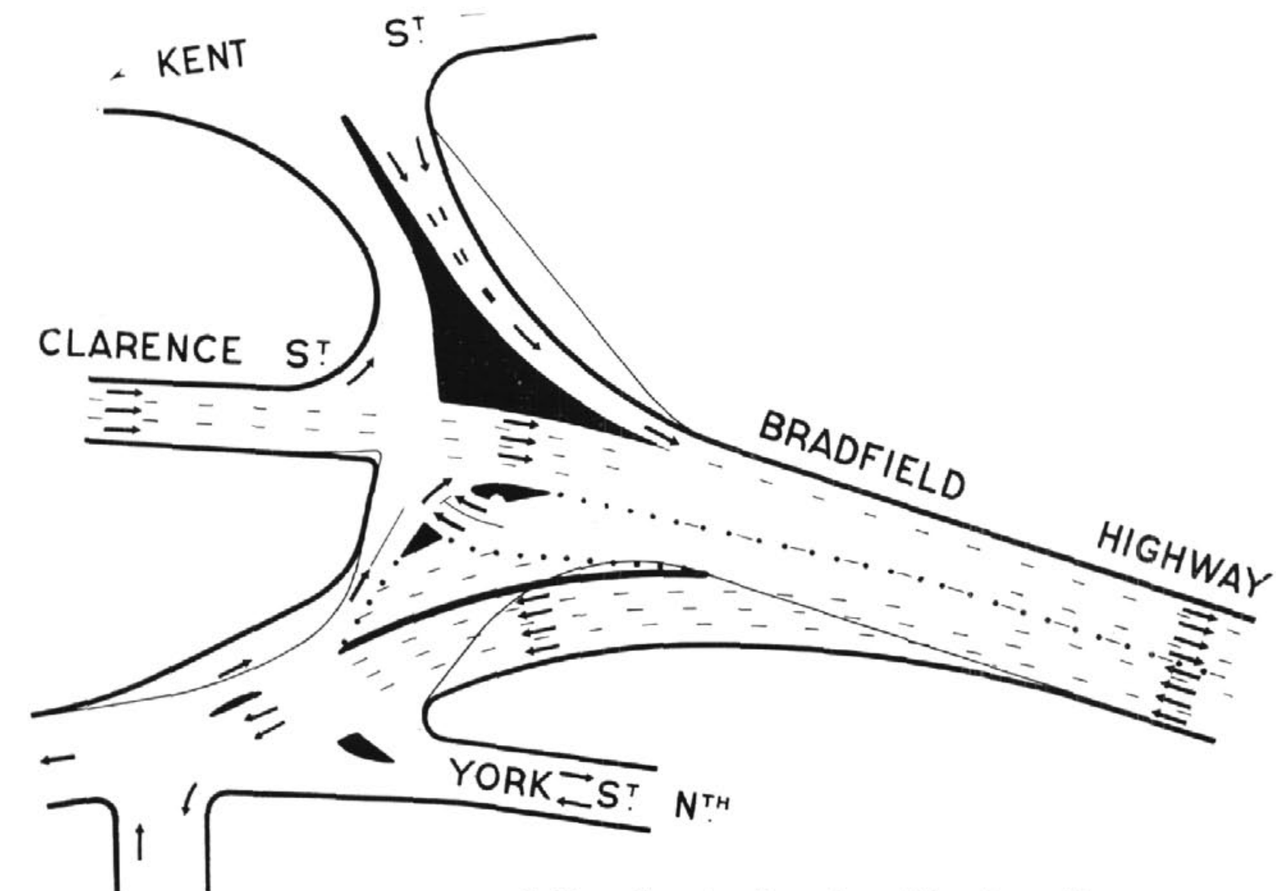


Fig. 11. Traffic flow in off-peak periods.

Photographs showing morning and afternoon conditions on the northern approach prior to and following the 25th November are illustrated in Figures 5 to 7.

At the toll barrier conditions existing prior to 25th November, 1957, are shown in Figure 8. A total of twelve gates were available for traffic, and during peak periods nine were opened for the direction of heaviest flow, three being sufficient for the minor flow. The possible capacity of a toll gate manned by one collector is 600 vehicles per hour. While the nine gates could handle southbound flow in the morning peak period, it was obvious that additional gates would be needed if the flow onto the bridge was increased by the new arrangements. Accordingly, two additional gates were made available for southbound traffic after 25th November. Northbound traffic during morning peak periods was able to retain three gates by utilising two of the new gates being provided as a part of the Quay Roadway works.

The distribution of traffic to toll gates is not even as there is a tendency for vehicles coming out of the bridge lanes to continue in a relatively straight path to the toll gates. Due to the present location of the barrier in relation to the bridge, vehicles have to move a considerable distance to the right to use the westernmost gates. The result is that the eastern gates tend to be surcharged while the western gates run freely.

As a part of the Quay Roadway works six additional toll gates have been provided as shown in Figure 9. The layout of these gates is such that traffic can be led more directly from bridge lanes to toll gates, three gates being allocated to each bridge lane by suitable lane markings. The total gate capacity provided for each bridge lane is 1,800 vehicles per hour which is the maximum expected rate of flow in any lane. It is expected that this rate of flow is only likely to be sustained in lanes 3 and 4 which carry almost 100 per cent. passenger car traffic.

The arrangements which now apply during morning and afternoon peak periods with the Quay Roadway opened to traffic are shown in Figure 9.

In addition to improvement on the northern approach and at the toll barriers the layout of the intersection

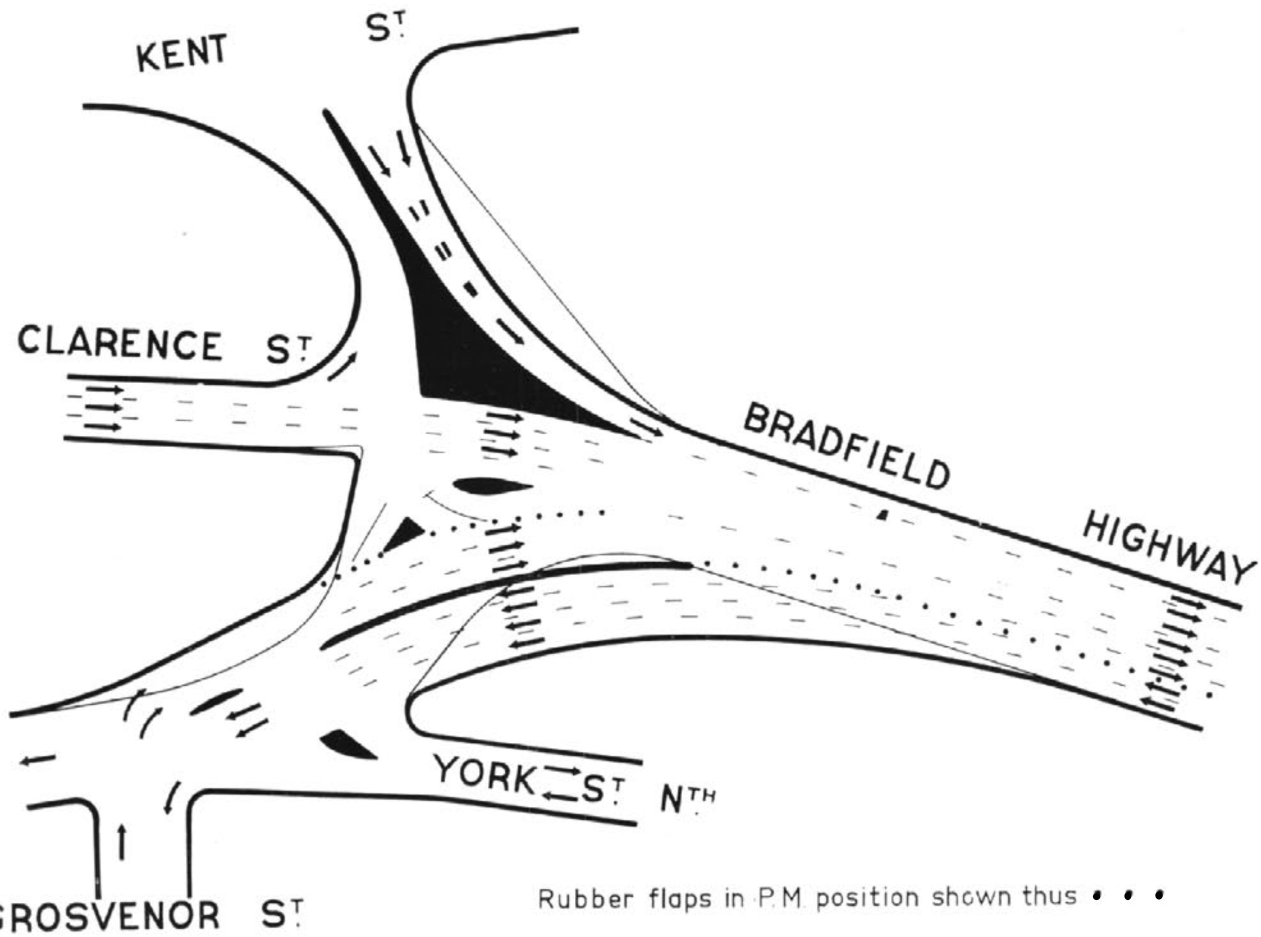


Fig. 12. Traffic flow in evening peak hour.

of the Bradfield Highway with City streets is also being altered, the new layout being shown in Figures 10, 11 and 12.

The intersection of the Quay Roadway with Bridge and Macquarie Streets has been designed by the Sydney City Council.

The volume of traffic now crossing the Sydney Harbour Bridge averages over 60,000 vehicles per day with peak days approaching 80,000 vehicles. The Quay Overhead Roadway is the first of the works needed to divert part of this traffic from the city. The extent to which the new roadway has reduced congestion in city streets has not as yet been analysed. It is expected however, that its full value will not be realised until the Eastern Expressway is built as an extension of the Quay Roadway.

New bridge over Prospect Creek at Lansdowne on the Hume Highway. Old Lansdowne Bridge in background.

Three New Main Road Bridges

THREE new bridges of interest opened to traffic on Main Roads in recent months are over Prospect Creek at Lansdowne on the Hume Highway, over Glennies Creek at Camberwell on the New England Highway, and over Wollombi Brook at Payne's Crossing on the Wollombi-Singleton Road. A brief description of each of the bridges follows:—

Bridge over Prospect Creek at Lansdowne on the Hume Highway

This new bridge over Prospect Creek is a reinforced concrete arch span, and is situated alongside the historic stone arch bridge built by David Lennox in 1836. The new bridge was specially designed by the Department of Main Roads with the advice of Professor Leslie Wilkinson to blend with and be complementary to the older structure. The new bridge, of the open spandrel type, is of the same rise and span as the old bridge. It is 222 ft. long, and has a carriageway 24 ft. wide and footways 6 ft. wide on each side; the arch span is 118 ft. in length.

The new bridge was built for the Department of Main Roads by contract by Messrs. Hornibrook, McKenzie Clark Pty. Ltd. at a cost of approximately £50,000, under the general supervision of the Department's Metropolitan Engineer, Mr. L. W. Hawley. The approaches were constructed by the Department of Main Roads by day labour. The bridge was opened to traffic on the 18th December, 1957.

This additional bridge and its approaches form part of the duplication of the Hume Highway between Sydney and Liverpool, additional lengths of which are being opened to traffic by the Department of Main Roads from time to time. Southbound traffic uses the new bridge and approaches, and northbound traffic the old bridge and carriageway of the Hume Highway.

Bridge over Glennies Creek at Camberwell on the New England Highway

Designed and constructed by the Department of Main Roads, the new bridge over Glennies Creek is 276 ft. long and 28 ft. wide between kerbs. It is a three span continuous girder reinforced concrete structure, the centre span being 90 ft. long and the end spans each 75 ft. long. These spans are amongst the longest hitherto built by the Department. Piers and abutments are of reinforced concrete, the abutment and first pier at the Singleton end being founded directly on rock and the other pier and abutment being supported on reinforced concrete cylinders taken down to rock.

The construction of the bridge and approaches, which will cost approximately £100,000, was carried out under the general supervision of the Department's Divisional Engineer, Newcastle, Mr. R. J. Butler. At the request of the Patrick Plains Shire Council, the bridge was opened officially to traffic on the 14th December, 1957, by the Commissioner for Main Roads, Mr. H. M. Sherrard.

The new bridge replaces a timber truss structure opened to traffic 63 years ago.

Bridge over Wollombi Brook at Payne's Crossing on the Wollombi-Singleton Road

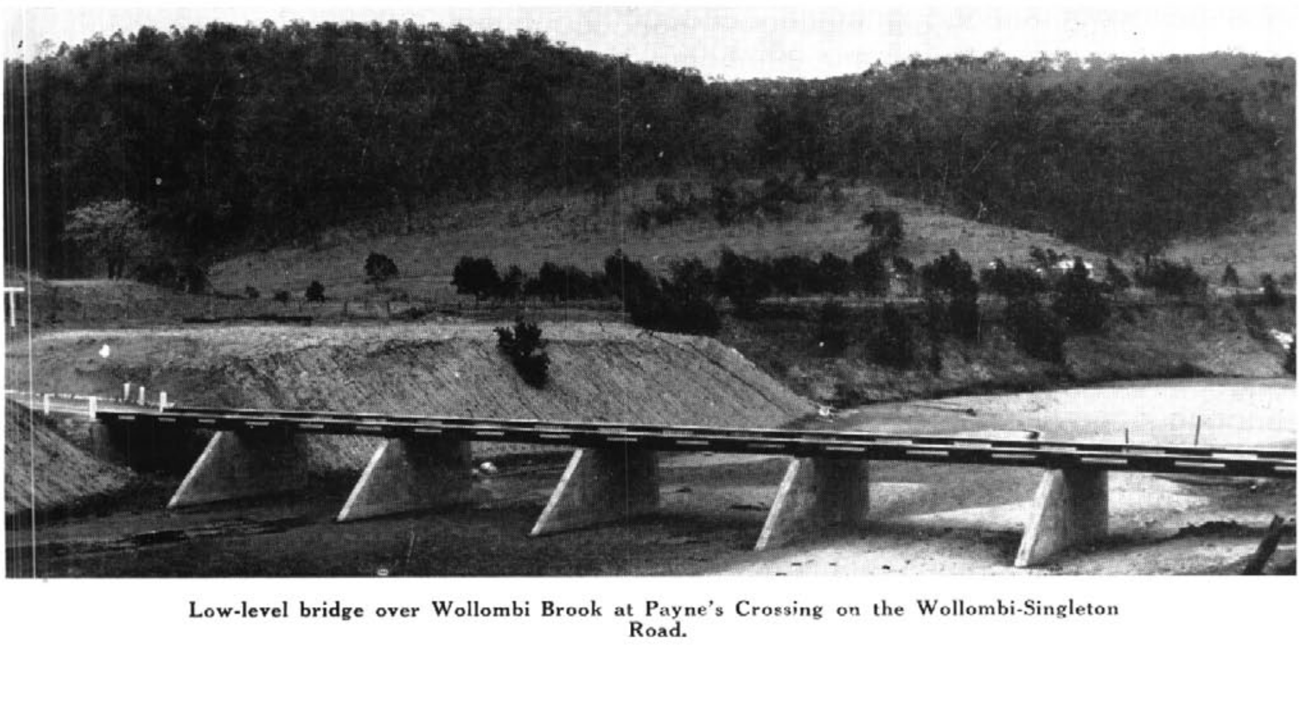
Several unusual features have been incorporated in the new low level bridge at Payne's Crossing recently completed by the Greater Cessnock Municipal Council and designed by the Department of Main Roads.

New and old bridges over Glennies Creek on the New England Highway.

Its deck is of laminated timber construction, that is it consists of planks on edge as compared with round girders and transverse deck planks found in the ordinary timber bridge. This type of construction will give a minimum of obstruction to the flow of water when the bridge is submerged in times of high flood. The piers of the bridge are of concrete supported on reinforced concrete piles, and the upstream edges of the piers have been sloped so as to aid in passing floating timber over the bridge in times of high flood. Another special feature of the bridge is that it has been so designed that the deck can be raised readily if necessary should the bed of the river rise on account of the accumulation of sand and other material, as has occurred lower downstream.

The new bridge is 200 ft. long and comprises seven spans, five being 30 ft. long and two 25 ft. long. It replaces a structure destroyed by floods. The construction of the new bridge was carried out under contract by the Greater Cessnock Municipal Council. The total cost of the bridge and approaches approximated £35,000 towards which the Department of Main Roads provided about £26,000.

The new bridge was opened officially to traffic on the 21st September, 1957, by the Commissioner for Main Roads, Mr. H. M. Sherrard, at the request of the Greater Cessnock Municipal Council at a ceremony presided over by Alderman A. Slack. In conjunction with the function, a picnic sports meeting was arranged by the Broke Agricultural Bureau and the Wollombi Parents and Citizens' Association.



Low-level bridge over Wollombi Brook at Payne's Crossing on the Wollombi-Singleton Road.

Street Traffic Control Signals

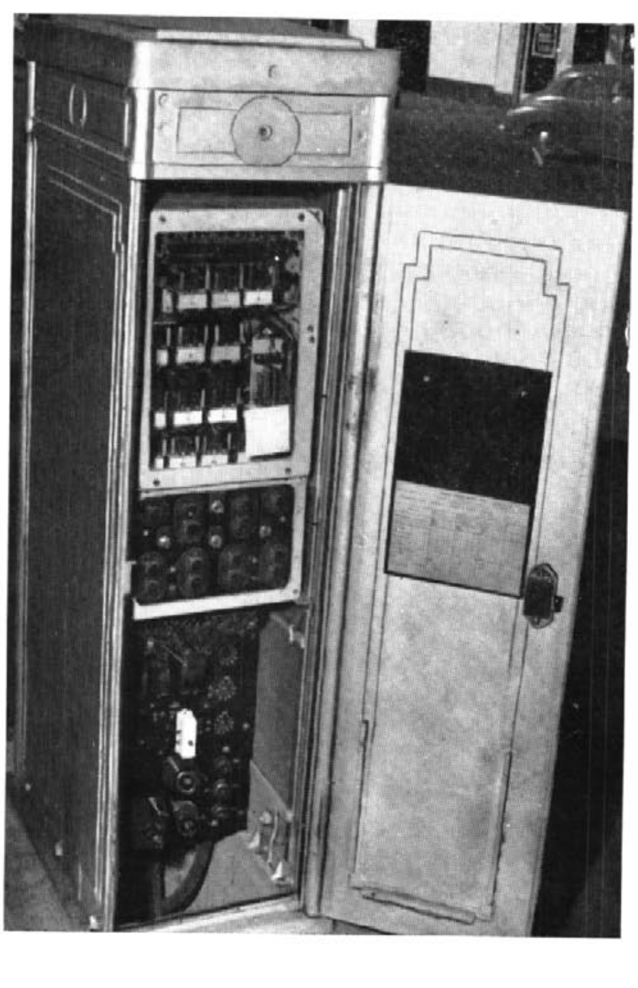
By R. A. French, A.S.T.C., Department of Motor Transport.*

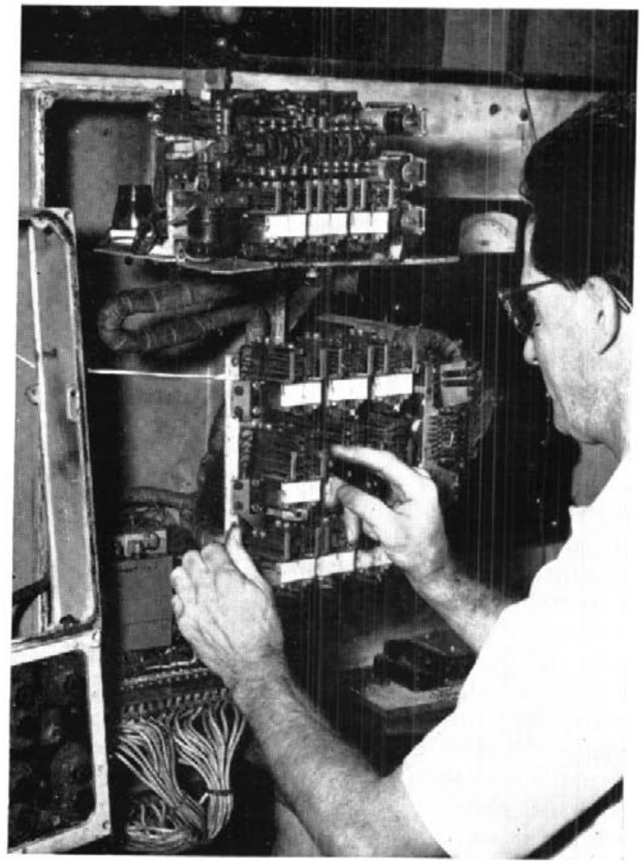
(*Continued from "Main Roads", December, 1957.*)

3. Control Apparatus.

This is possibly the main component of the installation consisting of electrical recording and switching apparatus housed in a weather-proof metal case. A typical three-phase controller and housing and a close-up view of the controller components are illustrated by photographs on this page.

The controller's function is to receive electrical impulses initiated from the detectors, store them until appropriate and thereafter operate the mechanism to indicate the green, amber and red aspects on the signal lanterns.





(a) Principles of Operations.

The basic operating function of a vehicle-actuated controller is as follows:—

(1) In the absence of actuation, the green aspect remains in favour of the traffic phase on which the last actuation occurred.

(2) Transfer of the green aspect from any traffic phase does not occur until the expiry of a safe minimum green period.

(3) Transfer of the green aspect from any traffic movement takes place only after a proper amber clearance period, and when necessary an additional "All-Red" period.

* This article is published by courtesy of the Commissioner for Motor Transport. Opinions expressed are those of the author.

(4) Detector actuation by traffic on the phase having the green aspect, causes the retention of that aspect on that phase for the appropriate vehicle extension period from the time of actuation, subject to the possible expiration of the maximum green period.

(5) Detector actuation by traffic on any phase having the red (STOP) aspect, establishes a demand which causes the transfer of the green aspect to that phase or those phases on the occurrence of the first traffic gap on the phase having the green aspect. This transfer takes place only after expiry of the minimum green period, and, in the event of no traffic gap, upon expiry of the maximum green period.

(6) When a demand has been registered on a phase having the red aspect, successive detector actuation (spaced less than one vehicle extension period) on the green phase does not retain the green aspect for longer than the maximum green period.

(7) The timing of the maximum green period commences when the first demand is registered on a traffic phase not having the green aspect.

(8) Detector actuation by traffic approaching an amber aspect establishes a demand.

(9) When a "Maximum change" occurs on a phase, a demand for the return of the green aspect to that phase is automatically registered without actuation with the controller.

(10) An arterial (revertive) feature is provided, which, when used, will maintain a demand automatically and return the green aspect to any traffic phase or phases desired. This feature is introduced in accordance with the functional requirements herein.

(b) The Timers.

Before an analysis is given of the vehicle-actuated operation and the methods by which the various functions outlined above are attained, attention must be directed to the timing system adopted.

This is fundamental and is perhaps the only method by which the many functions may be so simply attained.

The basic circuit is shown in Figure 3 in which Y.R.A. is a variable resistance, Q.A. a condenser, F.A. a gas discharge diode and T.A. a relay.

In this arrangement a direct current voltage is connected to the points marked positive and negative. After an interval, which is dependent upon the value of resistance Y.R.A., the condenser will charge to the applied potential. The rate of charge is inversely proportional to the resistance and may be expressed in the form—

$$Ec = E\left(1 - e^{\frac{-t}{RC}}\right)$$

Where Ec = Voltage across the condenser terminal at t seconds after, potential E is applied.

E = Applied D.C. potential.

t = Time in seconds after voltage is applied.

R = Resistance Y.R.A. in ohms.

C = Capacitance Q.A. in farads.

e = Exponential function.

The gas discharge diode F.A. has the property of conducting practically no current until the voltage across its anodes reaches a point at which the gas ionizes. Upon ionization the diode conducts current and operates relay T.A. The ionizing value of the diode is placed at 63.2 per cent. of the applied voltage E. Other circuit parameter constants are selected so as to simplify the calculation of the required value of Y.R.A. to give any particular interval between zero charge and ionization voltage, i.e., every 200,000 ohms variation of resistance Y.R.A. represents a variation of 1 second.

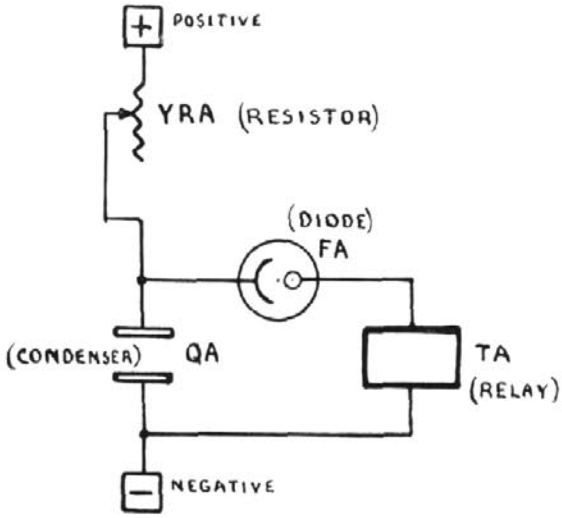


Fig. 3

It will therefore be apparent that the variable resistance Y.R.A. constitutes a simple time varying switch. Figure 4 shows the relationship between voltage E, appearing at condenser terminals Ec and Time t sec. for various value of Y.R.A.

The simplest type of control is a unit which controls two phases of traffic as at a right angle intersection. Two basic timing circuits are used together to give the time period control functions.

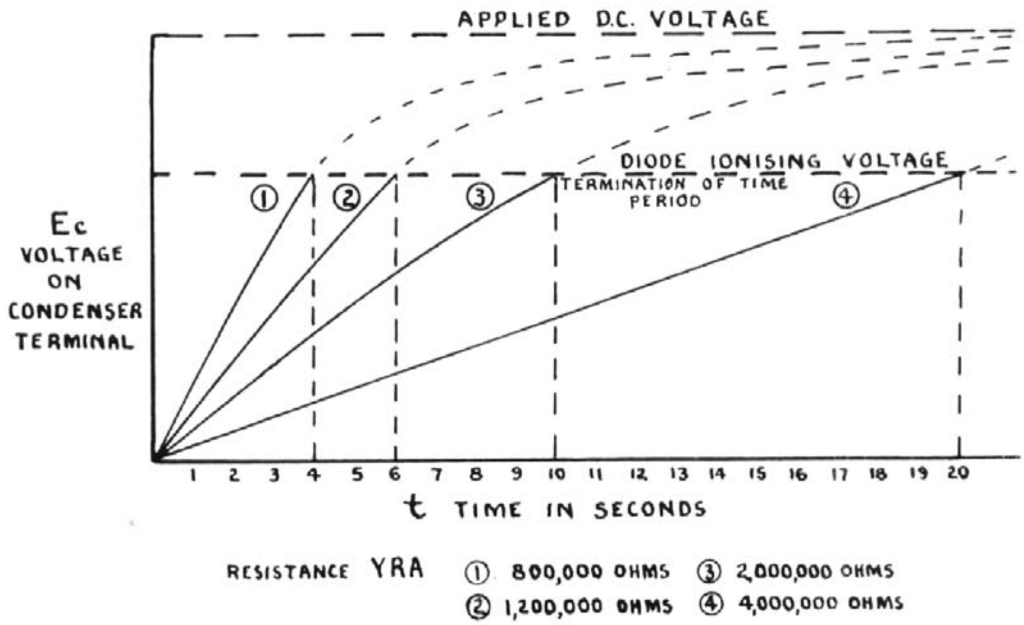


Fig. 4

The general components of the controller are illustrated in Figure 5 which is the line diagram of its components.

The Interval Timer controls the periods defined hereunder as Initial Interval, Vehicle Interval and Amber Interval.

(1) Initial Interval is a predetermined interval of the green aspect which enables stationary vehicles to get into motion at the Stop Line and to accelerate to normal speed.

(2) Vehicle Interval immediately succeeds the initial interval and is the extendable green aspect period as defined in the operational functions. It is designed to provide a time extension of the green aspect to permit a vehicle to travel from the detector to the centre of the intersection.

The Initial Interval plus one Vehicle Interval is the minimum green period.

(3) The Amber Interval is the clearance interval and has been standardised at 3 seconds in this State.

The Maximum Timer controls the maximum period for which a continuous stream of traffic may hold the green aspect before surrendering it to waiting cross traffic.

The presence of vehicles is recorded in the controller by the operation of the phase road relays following the actuation of the appropriate phase detectors. The operation of a particular road relay will either—

(1) Record a demand for its green aspect and introduce the maximum timer on the phase having the green aspect, or

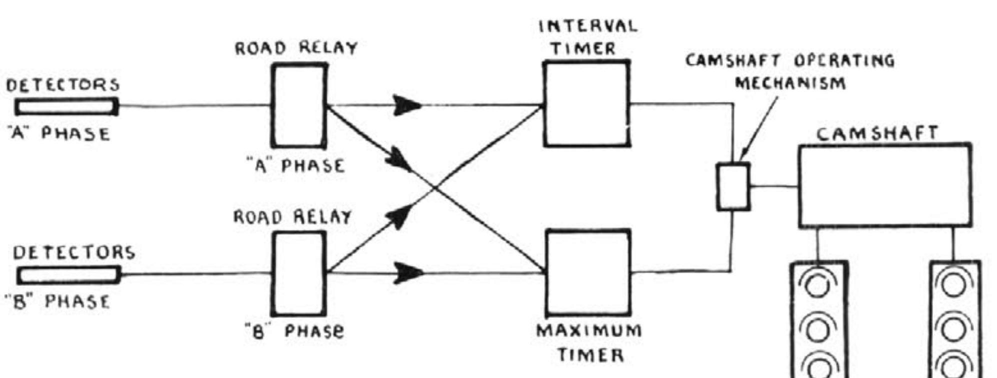


Fig. 5 Line Diagram Of 2 Phase Non-Density Controller

(2) retain its green aspect for a vehicle interval, subject to the expiry of the maximum green period.

The signal lamps are controlled by a camshaft sequence switch.

The time limit for each interval is predetermined in seconds and a typical setting for a two-phase non-density control is as follows:—

	A *Phase.*	*B* *Phase.*	*Remarks.*
Initial Interval ..	6 sec.	6 sec.	Controlled by Interval timer
Vehicle Interval ..	6 sec.	6 sec.	
Amber Interval ..	3 sec.	3 sec.	
Maximum Interval	40 sec.	25 sec.	Controlled by Maximum timer

Assuming A phase has just received the green aspect and there are no demands for B phase, the initial interval will time, and provide a period for stationary vehicles to get into motion. On its expiry the vehicle interval will be introduced.

The interval timer is inoperable due to no demands being recorded on B phase. However, the condenser Q.A. is allowed to charge and be discharged by the actuation of the A phase detector which ensures that A phase green aspect will be retained for at least a vehicle interval after each A phase actuation. This is an essential protection as a B phase demand is likely to occur at any time.

On the actuation of the B phase detectors, the B road relay completes the circuits for the interval timer which immediately starts searching for the first gap in traffic of a vehicle interval duration and introduces the maximum timer to A phase which, in the event of no gap in A phase traffic, will eventually cause the surrender of the green aspect to B phase.

Figure 6 shows the operation in graphical form of the Interval and Maximum Timers in relation to traffic demands.

On the expiry of the maximum green period for A phase a demand is automatically registered for A phase, as a continuous stream has been interrupted. The amber aspect is displayed for 3 seconds to clear the intersection of A phase traffic for the passage of B phase traffic. On the expiry of A phase amber period the green aspect is received by B phase and red is shown on A phase. The initial interval for B phase will allow

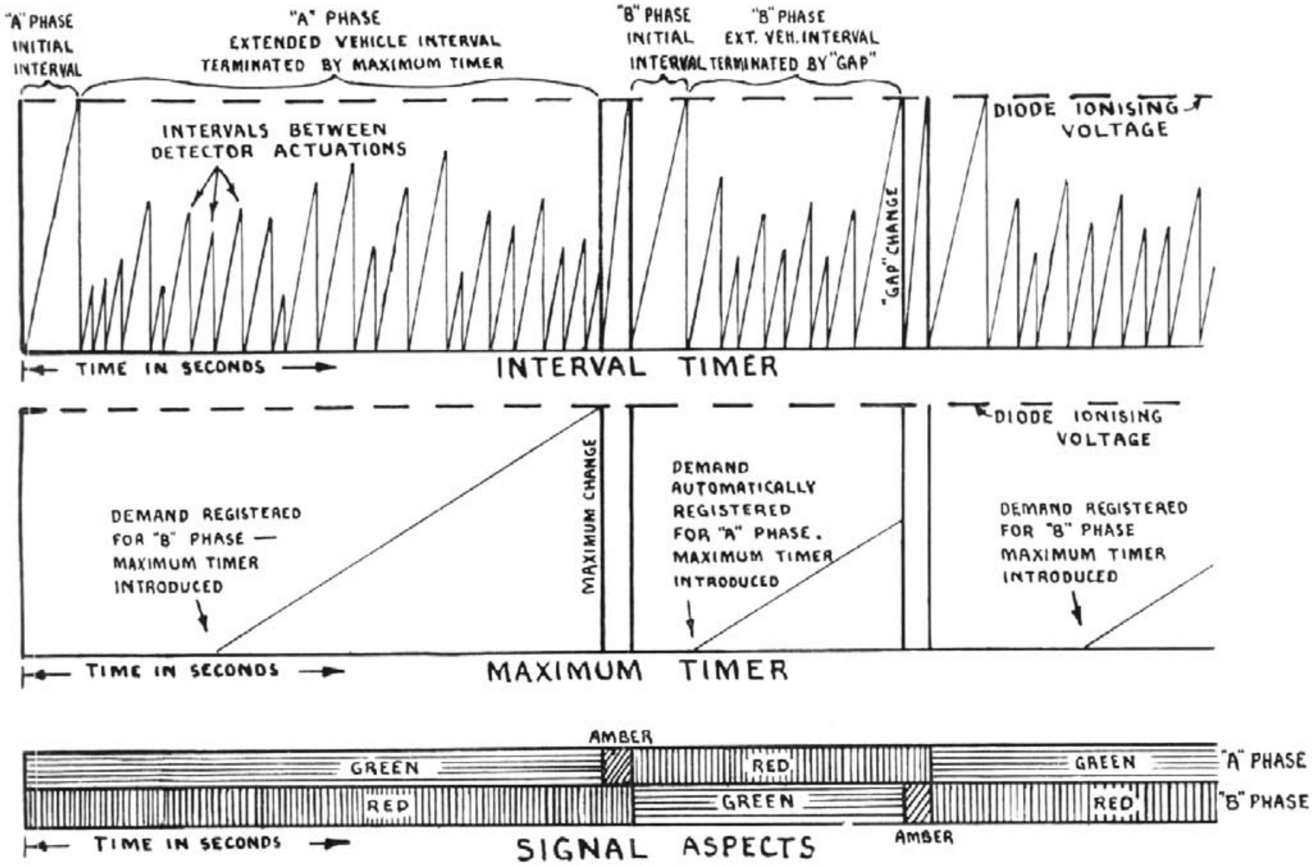


Fig. 6

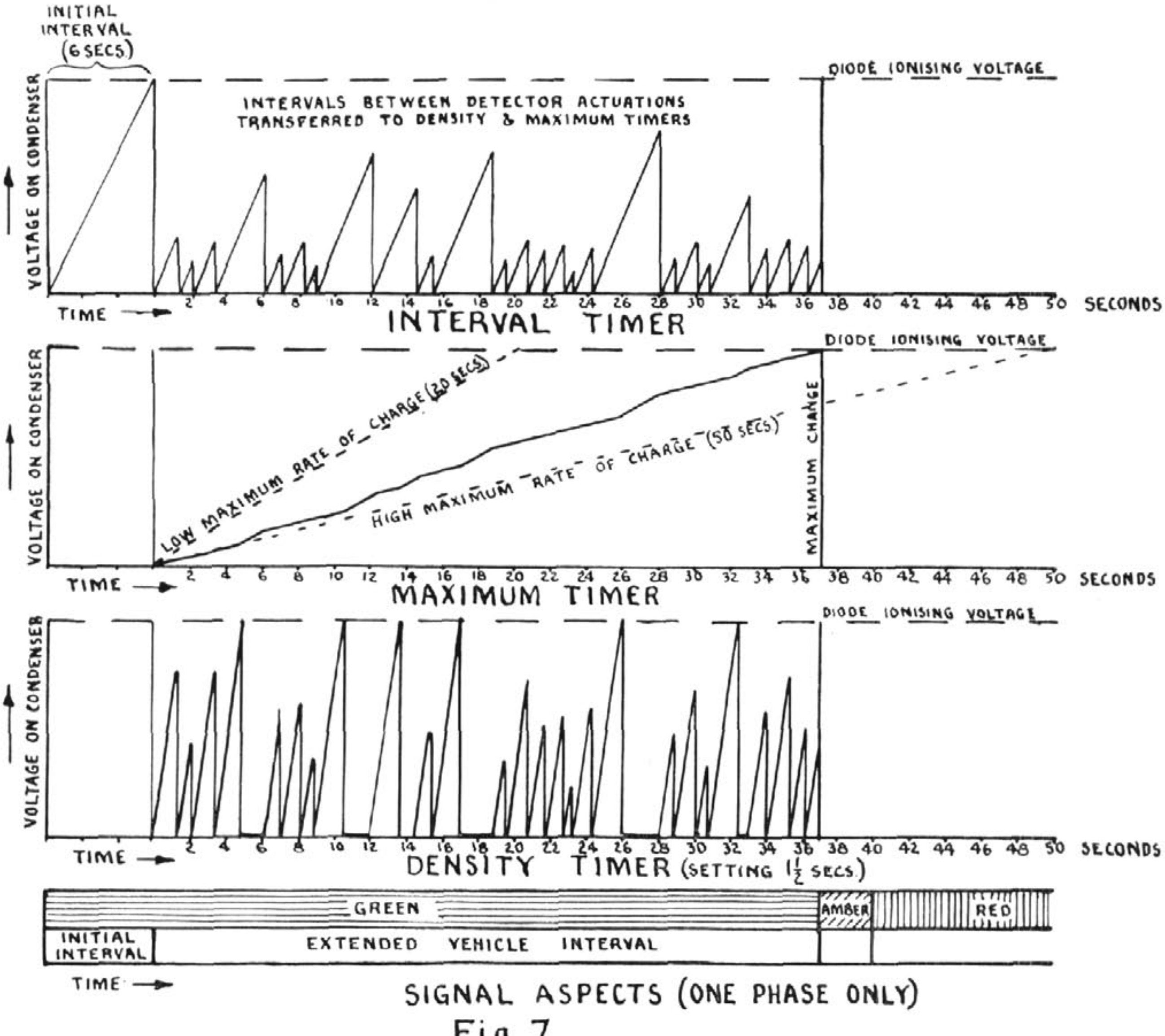


Fig. 7

B phase traffic to start and accelerate followed by the extendable vehicle interval.

As a demand has been registered for A phase the vehicle interval timer will immediately start to search for a "Gap" in B phase traffic. On the first gap or the expiry of the maximum interval the green aspect will be transferred to A phase.

It is readily seen that the cycle lengths vary somewhat coarsely in proportion to the traffic flow. This arrangement is known as non-density control. Developing from non-density control is density control which has initial, vehicle and amber intervals as above; however, the maximum interval is varied in accordance with the density of vehicles appearing in the traffic streams.

This feature is attained by the introduction of another basic timer, known as the density timer, which varies the rate of charge to the maximum timer condenser. This condenser is charged by one of two different predetermined resistors—one a fast charge for low density and the other a low charge for high traffic density. Each resistor is selected automatically in accordance with the operation of the phase vehicle detector and the density timer. Figure 7 illustrates the operation of the three basic timers for one phase in determining one phase period for a continuous flow of traffic which varies in density, assuming a demand is recorded for the opposing phase.

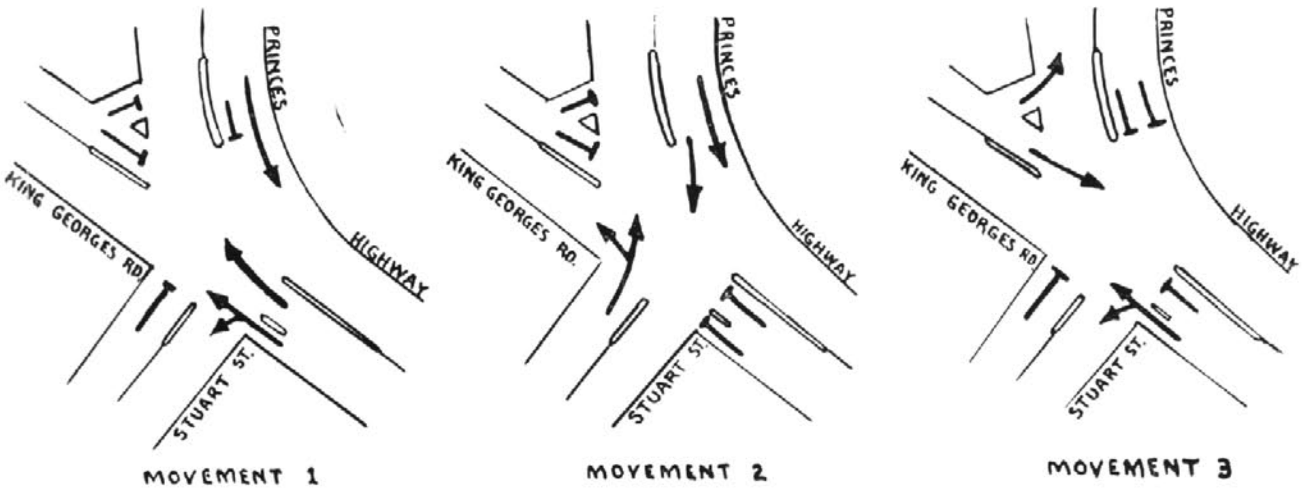


Fig. 8a. Typical 3 Phase Movements

Interval settings are as follows:—

Initial Interval	6	seconds
Vehicle Interval	6	seconds
Amber Interval	3	seconds
High Maximum	50	seconds
Low Maximum	20	seconds
Density	1½	seconds

After each actuation of the phase detectors the interval timer will be reset to zero. The maximum timer will be charged for a period at the high maximum rate depending on the successive detector actuating. Should the period between actuation exceed 1½ seconds the low maximum rate will be introduced for a period which is the difference between the density period and the period between actuations. If the period between actuations is less than 1½ seconds the maximum timer will be charged at the high maximum rate. On each actuation the density timer is reset to zero.

The lower the density setting, the more closely the maximum timer will vary with the traffic flow, and the greater the range may be between maximum settings. Of course there are practical limits of density setting which will ensure maximum phase periods consistent with the volume and density of the traffic flow. This is governed by the headway times of the vehicles and the number of lanes of traffic under control. The lower the headway times and the greater the number of traffic lanes, generally, the lower the density setting.

By careful selection of the timer settings it is readily seen that the green aspect periods and therefore the cycle times follow closely the prevailing flows of traffic.

Multiphase Control.

The application of vehicle actuation to multiphase control schemes involves considerably more complexity than is associated with two-phase control. It must be capable of varying the duration of the green aspect period to suit traffic, omitting unwanted cycle parts in the absence of traffic, and at the same time maintaining the standard signal sequence when transferring the green aspect from one phase to any other.

However, with complexity of control comes flexibility which allows infiltration of movements, and a number of different combinations of movement. For example, a standard 3-phase controller fitted with

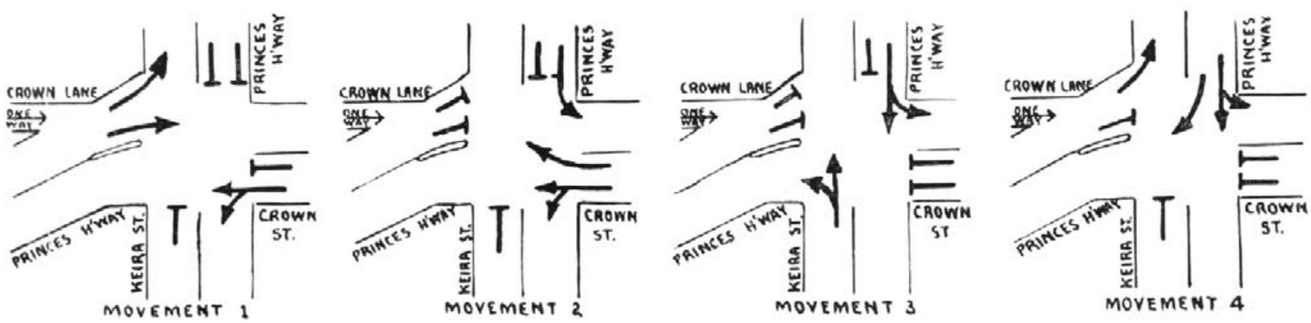


Fig. 8b Typical 4 Phase Movements

satellite relay groups is capable of controlling six different combinations of traffic movements.

Up-to-date multiphase controllers have been manufactured to control seven phases at the one junction. In New South Wales the maximum number of phases under control is four.

Figures 8a and 8b show typical 3 and 4 phase movements.

General Principles of Multiphase Control.

The principles of three-phase controllers are illustrated in the line diagram in Figure 9. For additional phases it is only necessary to add detecting groups and auxiliary phase relay groups.

On the actuation of a detector demanding a green aspect the time period of the phase having the green aspect will be in accordance with traffic requirements on that phase as previously described. The road relay recording the demand transfers it into the appropriate Auxiliary Group at the same time causing the timing circuits to operate through the sequence group to force the change at the appropriate period.

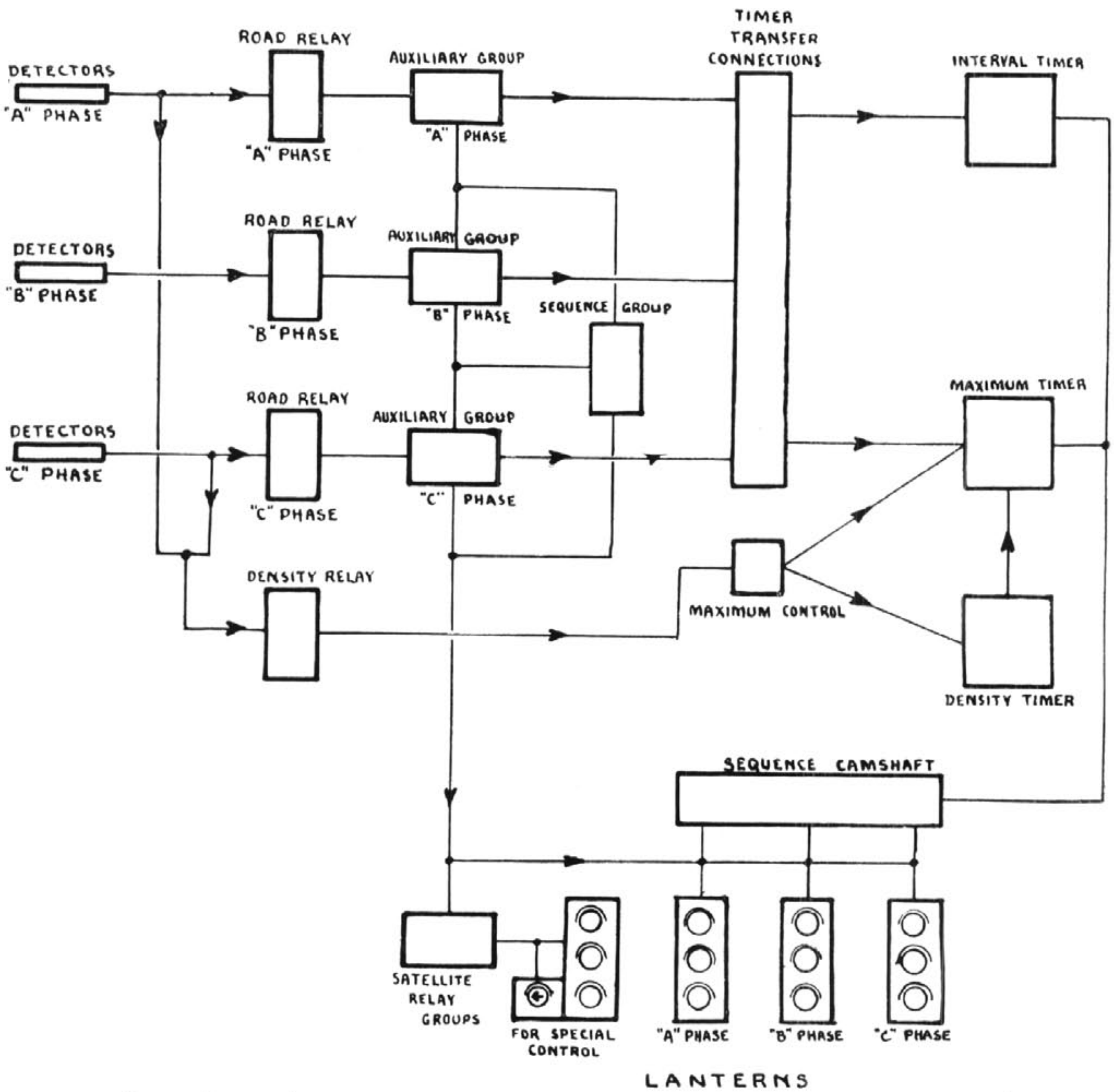


Fig. 9 Line Diagram Of 3 Phase Density Controller

After the expiry of the Amber Interval on the phase losing the green aspect, the sequence camshaft, through the timer transfer connections, starts searching for the phase under demand, and once found the auxiliary group interrupts the search and transfers the timers to that phase, together with the green aspect through the lamp control circuits, and, if appropriate, density control through the maximum control group. This function in any multiphase controller takes less than one second to complete.

If there is a demand on each phase the phase sequence will be A.B.C. In the absence of a demand on any one phase that phase will be omitted from the sequence.

Conclusion

In conclusion it can be stated, that whilst in this article a particular form of vehicle-actuated system has been described, the fundamental requirements are the same for all systems, although the results may be achieved in different ways.

The development of the application of street traffic signals to the more complex intersection will lead to more efficient and safer movements of traffic generally. There are few intersections to which traffic signals cannot be applied satisfactorily. Intersections which, a few years ago, were thought to be beyond the capacity of signals have been controlled. For instance, in Sydney, the intersections of Parramatta Road and Norton Street, and Prince's Highway and Canal Road are both controlled by signals handling over 30,000 vehicles through the junction in a ten-hour period under three-phase control.

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RECEIPTS AND PAYMENTS—MAIN ROADS FUNDS

For the period from 1st July, 1957, to 31st December, 1957

Heading	County of Cumberland Main Roads Fund	Country Main Roads Fund
	£	£
Receipts—		
Motor Vehicle Taxation (State Government) ...	857,084	3,428,335
Petrol Taxation paid to the State by the Commonwealth Government ...	477,600	1,928,649
Contributions by Councils ...	404,626	10,710
Repayable Loan Moneys (State Government) ...	......	75,000
State and Commonwealth Authorities for Special Works ...	62,000	115,894
Miscellaneous ...	136,296	82,567
Total Receipts...	£1,937,606	£5,641,155
Payments—		
Maintenance and Minor Improvements—		
Ordinary Works ...	516,144	2,558,046
Construction and Reconstruction—		
Ordinary Works ...	1,133,378	2,606,684
Special Works carried out on behalf of State and Commonwealth Authorities ...	9,333	96,701
Loan charges (Repayment of Principal and Payment of Sinking Fund, Payment of Interest, Exchange, Management and Flotation Expenses) ...	......	111,371
Purchase of Assets, other than Plant and Motor Vehicles ...	21,251	50,552
Administrative Expenses ...	94,061	219,200
Suspense Items, including purchase and operation of Department's Plant and Motor Vehicles ...	......	(—) 136,328
Miscellaneous ...	36,239	88,062
Total Payments ...	£1,810,406	£5,594,288

Highway Engineering and Traffic Engineering

Programme of Courses for 1958 at the University of Technology

The Department of Main Roads has received advice from the respective Professors of Highway Engineering and Traffic Engineering that the following arrangements will apply to the courses for these subjects during 1958. In each case, the course will commence with the opening on the 26th May, 1958, of the second term of this year's session at the New South Wales University of Technology.

HIGHWAY ENGINEERING

The courses to be conducted are:—

(*a*) a full-time post-graduate course of one year's duration leading to a Master of Technology degree;

(*b*) an evening course of two years' duration leading to a Master of Technology degree.

It is hoped in 1959 also to run an undergraduate course of just over 200 hours' duration which will take the form of one of five optional subjects in the fourth year Civil Engineering Degree Course. It is also hoped at a later date and as the need arises to add post-graduate Diploma courses of similar duration to those in (*a*) and (*b*) above and shorter courses on specialised aspects of Highway Engineering.

General Scope of Course for Master of Technology Degree

A new departure will be made in the courses in that it will be possible in courses (*a*) and (*b*) to obtain a Master's degree for formal course work together with a project. Whilst it is proposed to emphasize Australian conditions, the course will deal mainly with the fundamental principles of Highway Engineering and thus the student's studies will fit him to carry out highway work in any part of the world. The results of the latest research in the United States of America and the United Kingdom will be incorporated and due emphasis will be given to the latest science of Traffic Engineering in which lectures will be given by the newly created School of Traffic Engineering at the University of Technology. The application of scientific principles to road construction has been developed only comparatively recently and this, no doubt, is due to the large number of diverse and somewhat intractible problems associated with it. Road materials are of a heterogenerous nature and they vary immensely in their properties but, in respect of this, recent advances in soils technology and road pavement design have gone a considerable way towards advancing the design of road pavements beyond a matter for the engineer's judgment.

It will be the aim of these courses to emphasise the scientific approach to road design and the soil mechanics aspect of road engineering and the location, choosing and testing of road materials will be covered thoroughly. An important section of the course will be devoted to bridge design in reinforced concrete, pre-stressed concrete and steel.

In addition to the formal course work, the student will be set a project for which he will be provided with topographical plans of an area of countryside, including some existing roads and the construction of new roads. The length of road involved will traverse open country, thick bush country, a mountain range and will link two large towns and several villages. All the various aspects of highway design, including bridge design, the design of grade separation crossings, roundabouts, and minor road junctions, design of drainage facilities, the choice of route having regard to geometric factors, soil conditions, and availability of materials will be incorporated. Finally, the student will be required to write a report of a type similar to that which would be submitted by a Consulting Engineer to a public authority.

Composition of Courses

The broad composition of the courses for the Master of Technology Degree will cover six main subjects, viz., Road Location and Design, Pavement Design and Soils Analysis, Road Construction, Bridge Design, Traffic Engineering and Miscellaneous Matters, such as Road Maintenance, Highway Law, Specifications, etc.

The lectures will be given by the University staff and by well-known experts in their respective fields.

Qualifications for Admission and Fees

The minimum requirement for admission to the courses leading to a Master of Technology degree will be a first degree (normally in Civil Engineering) of any recognised university. In exceptional circumstances, students not possessing the requisite first degree may be admitted if they can produce evidence that they have reached a sufficient standard to benefit from the course and with the approval of the Faculty of Engineering. When at a later date it is possible to hold courses leading to a Diploma in Highway Engineering, entry to the courses will be granted to those possessing a recognised diploma or other suitable qualification.

To enable students to carry out research work for a higher degree, in addition to the normal course work, it is proposed to establish a research organisation within the School of Highway Engineering. The laboratory facilities of the School of Civil Engineering and other schools of the university will be available to students and it is also proposed to create new laboratories for the School of Highway Engineering.

The fees for the courses leading to a Master of Technology degree will consist of a registration fee of £2, a course fee of £90 and an examination fee of £3.

Applications for enrolment in any of the courses should be addressed to the Registrar of the New South Wales University at Kensington.

TRAFFIC ENGINEERING

The following full-time courses will be conducted:—

(*a*) A course on Traffic Planning and Control—one term's duration.

(*b*) A course leading to the degree of Master of Technology in Traffic Engineering—three term's duration.

Traffic Planning and Control

This course is designed principally for persons already concerned with traffic problems, e.g., engineers in highway departments and in city and municipal councils; officers of transport agencies and planning and enforcement authorities, transport and supply officers of the armed services.

It is limited to three months' duration with the special object of facilitating the sponsorship of students by their employers. That it is a full-time rather than an equivalent part-time course is due to the fact that its geographical coverage is on an Australia-wide basis.

The course contains a lecture programme which covers the basic theory of traffic behaviour; the applications and practice of traffic engineering, including the planning and design of experiments to collect and test traffic data; lectures on the operational analysis of highway and other traffic systems, with a view to providing a quantitative approach to problems of traffic estimation, economic analysis and optimum employment of various transport systems.

In addition to these particular traffic engineering aspects, short courses of lectures in the fundamentals of highway design and in city and regional planning are included. To ensure a thorough understanding of the basic characteristics of traffic problems, an introductory course is given in statistics.

In addition to lectures and tutorial work, a considerable number of traffic studies in the metropolitan area will be included. For example, in the inaugural course, students carried out a major "before-and-after" study of the effect of the changeover from trams to buses on the traffic flow in Pitt Street, Sydney.

Master of Technology in Traffic Engineering

Studies for this degree follow the same general pattern as outlined above for the short course, but permit considerably more emphasis to be placed on the theoretical aspects and a great deal more time to be devoted to tutorial and design problems. In addition, the last term of the course will be given over to a major traffic investigation.

The first term will be common with the Traffic Planning and Control course; in the second term, advanced theoretical aspects, tutorial exercises and design problems will be undertaken; the third term will be taken at the beginning of the 1959 academic year and will be devoted to the major investigation.

Qualifications for Admission and Fees

(*a*) *The course in Traffic Planning and Control.*

A degree or equivalent qualification in engineering science, town planning or other appropriate discipline; consideration will also be given to people without formal qualification but who possess graduate standing and have had experience in transport and traffic planning and control.

(*b*) *Master of Technology Degree Course.*

A first degree of high standing in engineering or science; consideration will also be given in special cases to graduates in other disciplines.

The fee for the course in Traffic Planning and Control is £30. For the Master of Technology Degree, the fees will be registration £2, course £90 (or three payments of £30 per term) and graduation £3. Applications for enrolment in either of the courses should be addressed to the Registrar of the New South Wales University of Technology at Kensington, Sydney.

Tenders Accepted by Councils

The following tenders (exceeding £3,000) were accepted by the respective Councils during the months of October, November and December, 1957 :—

Council	Road No.	Work	Name of Accepted Tenderer	Amount
				£ s. d.
Ashford S. ...	137	Bitumen surfacing between 17·4 m. and 21·0 m. north of Inverell.	Emoleum Australia Ltd. ...	3,651 7 5
Barraba S. ...	63	Pavement reconstruction between 10 m. 4,600 ft. and 12 m. 1,725 ft. south of Barraba.	Jackson Bros.	9,848 3 0
Bibbenluke S. ...	19	Pavement construction between Bombala and Nimmitabel.	Hume Road Constn. and Earth Moving Co.	11,937 14 0
Bogan S. ...	8	Pavement reconstruction and construction of pipe culverts approx. 31 m. west of Nyngan.	Furney and Johnston ...	5,305 4 9
Bogan S. ...	8	Supply, delivery and spreading of gravel, loam and sand west of Nyngan.	G. Gillham	9,576 15 11

Tenders Accepted by Councils—*continued.*

Council	Road No.	Work	Name of Accepted Tenderer	Amount £ s. d.
Cockburn S. ...	1,093	Reconstruction between 0 m. 3,700 ft. and 2 m. 3,700 ft. west of Trunk Road No. 63 towards Somerton.	W. H. Marshall	4,694 5 0
Condobolin S. ...	57	Erection of superstructure for timber beam bridge over Murie Creek.	Central Construction Coy....	5,571 3 0
Coolamon S. ...	243	Loading and delivery of 6,000 cu. yds. of gravel ...	W. J. Winnett and Sons ...	4,425 0 0
Demondrille S. ...	379	Supply and delivery of 1,770 cu. yds. of aggregate between 2·71 m. and 11·41 m. from Murrumburrah	Leevers and Croghan ...	4,779 0 0
Demondrille S. ...	379	Supply and delivery of 30,000 gallons of bitumen between 2·71 m. and 11·41 m. from Murrumburrah.	Shell Co. of Aust. Ltd. ...	3,934 19 2
Gilgandra S. ...	205	Construction of approaches to bridge over Uargon Creek	A. C. Stephens and Sons ...	6,130 5 11
Goobang S. ...	61	Supply, delivery and spreading of 8,291 cu. yd. of gravel.	A. G. Neal	3,042 6 11
Goobang S. ...	348, 350, 354	Supply, delivery and spreading of 15,484 cu. yds. of gravel.	E. A. Short	6,047 2 8
Severn S. ...	12	Bitumen surfacing between 3·0 m. and 5·8 m. east of Glen Innes.	Construction Services Pty. Ltd.	3,475 3 2
Severn S. ...	382	Bitumen surfacing on length of 2 miles	Construction Services Pty. Ltd.	
Shellharbour M....	88	Cement stabilising between 1·70 m. and 2·4 m. and between 3·35 m. and 3·70 m. from State Highway No. 1 at Macquarie Rivulet.	Stabilisers Ltd.	3,539 3 4
Snowy River S....	286	Bitumen surfacing	Allen Bros. Pty. Ltd. ...	3,197 3 1
Tamarang S. ...	72	Reconstruction between 6·7 m. and 16·9 m. north of Quirindi.	Gwydir Gravels	13,827 16 0
Tenterfield S. ...	9, 16, 24	Supply and delivery of 683 cu. yds. of ⅜-in., 915 cu. yds. of ½-in., and 1,455 cu. yds. of ¾-in. aggregate.	Construction Services Pty. Ltd.	11,304 13 7
Tenterfield S. ...	9, 16, 24, 290	Bitumen surfacing and resurfacing	Construction Services Pty. Ltd.	10,005 16 8
Waverley M. ...	2,047	Supply and delivery of up to 1,500 tons of ready mixed concrete.	Ready Mixed Concrete (N.S.W.) Pty. Ltd.	5,874 7 6
Yallaroi S. ...	63	Bitumen surfacing from 4·2.m to 6·6 m. and 6·9 m. to 7·4 m. north of Warialda.	Emoleum Australia Ltd.	3,410 8 10

Tenders Accepted by the Department of Main Roads

The following tenders (in excess of £3,000) were accepted by the Department of Main Roads during the months of October, November, and December, 1957:—

Work or Service	Name of Accepted Tenderer	Amount £ s. d.
State Highway No. 9—New England Highway. Shire of Cockburn. Manufacture, supply, delivery and stacking of concrete bridge units for bridge over Sandy Creek 11 m. north of Tamworth.	Humes Ltd.	3,146 16 0
Shire of Warringah. Main Road No. 164. Pittwater Road. Manufacture, supply, delivery and stacking of concrete bridge units for bridges over Narrabeen Lagoon.	Humes Ltd.	6,483 4 0
City of Newcastle. Main Road No. 108. Newcastle-Stockton Ferry Service. Supply of up to 6,500 tons of coal.	A. H. Hough Pty. Ltd.	16,575 0 0 plus 8d. per ton weighbridge charge.
Haulage of bulk tar and creosote for 1957–58	Bitumen Freight Lines Pty. Ltd....	4,400 0 0 (estimated).

MAIN ROADS STANDARD SPECIFICATIONS, DRAWINGS AND INSTRUCTIONS.

NOTE: Drawings are prefixed by letter "A", instructions are so described; all other items are specifications or forms. Year of revision, if within last 10 years, is shown in brackets.

Form No.

ROAD SURVEY AND DESIGN.

A 478, A 478A Specimen drawings, country road design.
A 478C Specimen drawing, flat country road design.
A 478B Specimen drawings, urban road design.
A 1645 Stadia reduction diagram.
355 Design of two-lane rural highways. (Instruction.)
369 Design of urban roads. (Instruction.)
288 Design of intersections. (Instruction.) (1952.)
402 Design of acceleration and deceleration lanes. (Instruction.)
499 Design of kerb-lines and splays at corners. (Instruction.) (1952.)
A 1614 Widening at points of "A" sight distance.
A 83 Earthwork quantity diagram.
A 1640 Mould for permanent mark block.
Manual No. 2—Survey and design for main road works*
Policy for geometric design of rural roads—State Road Authorities*.

STREET DRAINAGE.

243 Integral concrete kerb and gutter and vehicle and dish crossing, and drawing. (A 134A.)
245 Gully pit and drawings: with grating (A 1042); kerb inlet only (A 1043); with grating and extended kerb inlet (A 1352) extended kerb inlet (A 1353), (1956).
A 190 Gully grating.
A 1418 Concrete converter.
A 3491 Perambulator ramp.
A 3536 Mountable type kerb with reflectors.

CULVERTS.

138 Pre-cast concrete box culvert (1957) and drawing: 12 in., 18 in., 24 in., and 30 in. high (A 3847).
206 Reinforced concrete culvert (1948) and instruction sheets. (A 304, A 305, A 306, A 359.)
A 1012–20 Single cell reinforced concrete box culvert: 6 in. to 1 ft. 3 in. (A 1012); 1 ft. 4 in. to 3 ft. (A 1013); 4ft. (A 1014); 5 ft. (A 1015); 6 ft. (A 1016); 7 ft. (A 1017); 8 ft. (A 1018); 9 ft. (A 1019); 10 ft. (A 1020); 11ft. (A 1020A); 12ft. (A 1020B).
A 1021–29 Two cell, reinforced concrete box culvert: 6 in. to 1 ft. 3 in. (A 1021); 1 ft. 4 in. to 3 ft. (A 1022); 4 ft. (A 1023); 5 ft. (A 1024); 6ft. (A 1025); 7 ft. (A 1026); 8 ft. (A 1027); 9 ft. (A 1028); 10 ft. (A 1029);
A 1031–36, A 1038, A 1040 Three cell, reinforced concrete box culvert: 6 in. to 1 ft. 3 in. (A-1031); 1 ft. 4 in. to 3 ft. (A 1032); 4 ft. (A 1033); 5 ft. (A 1034); 6 ft. (A 1035); 7 ft. (A 1036); 8 ft. (A 1038); 9 ft. (A 1040).
25 Pipe culverts and headwalls, and drawings: single rows of pipes: 15 in. to 21 in. dia. (A 143); 2 ft. to 3 ft. dia. (A 139); 3 ft. 6 in. dia. (A 172); 4 ft. dia. (A 173); 4 ft. 6 in. dia. (A 174); 5ft. dia. (A-175); 6 ft. dia. (A 177); Double rows of pipes: 15 in. to 21 in. dia. (A 211); 2 ft. to 3 ft. dia. (A 203); 3 ft. 6 in. dia. (A 215); 4 ft. dia. (A 208); 4 ft. 6 in. dia. (A 207); 5 ft. dia. (A 206); 6 ft. dia. (A 213). Treble rows of pipes: 15 in. to 21 in. dia. (A-210); 2 ft. to 3 ft. dia. (A 216). Straight headwalls for pipe culverts: 15 in. to 24 in. dia. (A 1153) (1957).
A 1 Joint for concrete pipes.
A 142 Inlet sump for pipe culvert 3 ft. dia. or less. (1947).
139 Timber culvert (1950) and drawings, 1 ft. 6 in. high (A 427); 2 ft. (A 428); 3 ft. (A 429); 4 ft. (A 430); 5 ft. to 8 ft. high (A 431).
A 1223 Timber culvert 20 ft. roadway. (1949.)
A 3472 Timber culvert 22 ft. roadway. (1949.)
303 Supply and delivery of pre-cast reinforced concrete pipes.

BRIDGES AND FERRIES.

18 Data for bridge design. (1948.)
371 Waterway calculations. (Instruction.)
300 Pile driving frame, specification for 25 ft. and drawings for 50 ft. (A 209); 40 ft. (A 253); and 25 ft. portable (A 1148).
A 3693 Pontoon and pile driving equipment.
164 Timber beam bridge (1947) and instruction sheets, 12 ft. (A 3469); 20 ft. (A 70) (1949); and 22 ft. (A 1761) (1949).
326 Extermination of termites in timber bridges. (Instruction.)
350 Reinforced concrete bridge. (1949.)
495 Design of forms and falsework for concrete bridge construction. (Instruction.)
314 Regulations for running of ferries. (1955.)
A 4 Standard bridge loading. (Instruction.) (1957.)
A 26 Waterway diagram. (1943.)
A 1886 Arrangement of bolting planks. (1948.)
A 45 Timber bridge, standard details. (1949.)
A 1791 Timber beam skew bridge details. (1949.)
A 3470, A 3471 Low level timber bridge, for 12 ft. and 20 ft. between kerb. (Instruction.) (1949.)
A 1216 Running planks.
A 1207 Reinforced concrete pile—25 tons. (1945.)
A 1208 Reinforced concrete pile—35 tons. (1957.)
A 1621 Reflector strip for bridges.
Highway Bridge Design Specification of State Road Authorities.*

FORMATION.

70 Formation. (1955.)
513 The design of sub-soil and sub-grade drainage. (1957.)
A 1532 Standard typical cross-section.
A 4618 Flat country cross-section, Type A. 1955.
A 4619 Flat country cross-section, Type B. 1955.
A 4620 Flat country cross-section, Type C. 1955.
A 4621 Flat country cross-section, Type D. 1955.

Form No.

A 1101 Cross-section one-way feeder road.
A 1102 Cross-section two-way feeder road.
A 114 Rubble retaining wall.

PAVEMENTS.

71 Gravel pavement. (1949.)
228 Reconstruction with gravel of existing pavement.
254A Supply and delivery of gravel.
72 Broken stone base course. (1956.)
216 Telford base course.
68 Reconstruction with broken stone of existing pavement to form a base course.
257 Haulage of materials.
65 Waterbound macadam surface course.
230 Tar or bitumen penetration macadam surface course, 2 in. thick.
66 Tar or bitumen penetration macadam surface course, 3 in. thick.
125 Cement concrete pavement, and plan and cross-section. (A 1147.)
A 380 Galvanised iron strip for deformed joint.
A 381 Bituminous filler strip for transverse expansion joint.
493 Supply of ready mixed concrete.
266 Asphaltic concrete pavement.

SURFACE TREATMENT.

93 Surfacing and resurfacing with bitumen, tar-bitumen mixture, or tar. (1957.)
466 Fluxing of binders for bituminous flush seals and reseals. (Instruction.)
351 Supply and delivery of cover aggregate for bituminous surfacing work (1957.)
354 Road-mix resealing. (1949.)
397 Fluxing for tar road-mix reseal. (Instruction and chart.)
A 1635 Fluxing chart for bitumen road-mix reseal.
167 Resheeting with plant-mixed bituminous macadam by drag spreader. (1951.)

FENCING AND GRIDS.

141 Post and wire fencing (1947) and drawings: plain (A 494); rabbit-proof (A 498); flood gate (A 316).
143 Ordnance fencing and drawing. (A 7.)
144 Chain wire protection fencing and drawing. (A 149.)
246 Location of protection fencing. (Instruction.)
224 Removal and re-erection of fencing.
A 1705 Plain wire fence for use in cattle country.
A 3598 Wire cable guard fence.

ROADSIDE.

A 1337 Concrete mile post, Type A.
A 1338 Concrete mile post, Type D.
A 1366 Standard lettering for mile posts.
A 1367 Timber mile post, Type B1.
A 1368 Timber mile post, Type B2.
A 3497 Timber mile post, Type B3.
A 2815 Concrete kerb mile block.
A 1420 Steel mould for concrete mile posts.
A 1381–3, A 1452–5 Tree guards, Types A, B, C, D, E, F, and G.
Manual No. 4—Preservation of roadside trees.

MATERIALS.

296 Tar. (1949.)
337 Residual bitumen and fluxed native asphalt.
305 Bitumen emulsion. (1953.)
349 Light and medium oils for fluxing bitumen. (1948.)
A 27 Slump cone for concrete.
A 178 Mould for concrete test cylinder.
76 Design of non-rigid pavements. (Instruction.)
Manual No. 3—Materials.*

TRAFFIC PROVISION AND PROTECTION.

121 Provision for traffic (1954) with general arrangement (A 1323), and details (A 1325) of temporary signs. (1947.)
252 Supply and delivery of guide posts.
253 Erection of guide posts. (Instruction.)
A 1342 Temporary warning sign, details of construction.
A 1346 Iron trestle for road barrier.
A 1341 Timber trestle and barrier.

PLANT.

A 1414 Gate attachment for lorries with fantail spreader.
A 1450 Half-ton roller with pneumatic tyres for transport.
A 2814 Two-berth pneumatic tyred caravan.
A 2828 Multi-wheeled pneumatic tyred roller.
A 2976 Fantail aggregate spreader.
A 3530 Benders for steel reinforcement.
A 3547 Steel bar cutter.

CONTRACTS.

24B General conditions of contract, Council contract. (1956.)
342 Cover sheet for specifications, Council contract. (1950.)
64 Schedule of quantities form.
39 Bulk sum tender form, Council contract. (1946.)
38 Bulk sum contract form, Council contract.
193 Duties of superintending officer. (Instruction.)
498 Caretaking and operating ferry.

All Standards may be purchased from the Head Office of the Department of Main Roads, 309 Castlereagh Street, Sydney. Single copies are free to Councils except those marked *.

Sydney: A. H. Pettifer, Government Printer—1958.

State Highway System
of the
State of New South Wales

Area of New South Wales, 309,433 square miles.
Length of public roads within New South Wales, 124,913 miles.

MILEAGE OF MAIN AND DEVELOPMENTAL ROADS, AS AT 30th JUNE, 1957.

State Highways	6,526
Trunk Roads	4,191
Main Roads	11,778
Secondary Roads (County of Cumberland only)	77
Developmental Roads	2,640
	25,212
UNCLASSIFIED ROADS, in Western part of State, coming within the provisions of the Main Roads Act	2,292
TOTAL	7,504