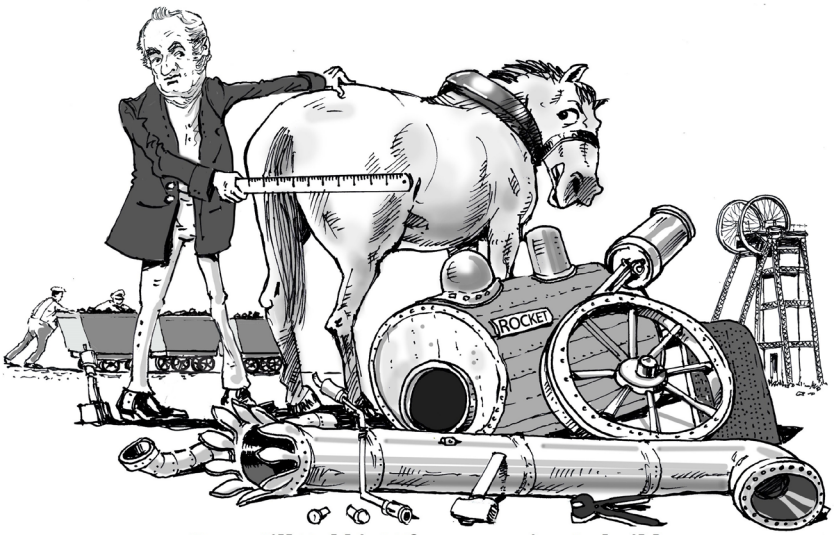


Keep still Dobbin! If we are going to build an iron horse the measurement must be right!

CHAPTER 16

LESSONS ABOUT LOCOMOTIVES

Imagine if the railway had just been invented. There would be computerised models and expert committees that would examine all aspects of the gauge requirements and the application of the technology of the 21st century. Experts from all disciplines would be invited to submit their evidence. Imagine then, the input from a Mr Stephenson from a Yorkshire address with the suggestion that the standard gauge for the new invention should be determined by measurement of the back end of a horse. Then contemplate the reaction of those learned gentleman, having so unkindly laughed the Geordie yokel out of the room, to find their computerised models delivered a figure that was close to the measurement of the arse end of a horse.

But our Mr Stephenson had not invented the standard gauge. It just happened that the gauge had been selected about 1780, at a time when the English collieries were putting down tramroads. But whether it was by intuition, good luck or careful observation, he found that gauge about right for his engines. He would live to see locomotives using his gauge, travelling at speeds of 60 miles per hour.

A very important point. The gauge measurement relates to the track and not the engine. The measurement of the distance between the wheel flanges of an engine or rolling stock is slightly less. Very early, Stephenson found that his engines needed a little slack. He could have redesigned the wheels, but he redefined the track – or was it that his 4 ft 8 in engine had pushed the rails apart half an inch?

Des Smith tells the story of a track machine that was ordered from a supplier for the Trans-Australian Railway. The specification was for the 4 ft 8½ in gauge. The supplier took that literally and the measurement of the distance between the wheel flanges was exactly that. When it was delivered it refused to move, with the wheels tightly jammed to the track.

Eric Harding had given four or five pages of his book to the matter of the origin of the 4 ft 8½ in gauge being derived from the chariot rutways of ancient Roman times. I have difficulty with Harding's logic but am quite comfortable with the notion that the chariot ways of Pompeii, and the tramroads of the English collieries, quite independently of each other, were designed, taking into account the size of a horse's back end. And I am quite certain that those dimensions have not changed materially in 2000 years.

Tim Fisher in his *Trains Unlimited* has a photograph of himself in the roadway of Pompeii. I quote from Tim's book:

> …the age-old contention that the width of the ruts in Roman roads became the benchmark for the famous Stephenson standard gauge of 4 foot 8½ inches. Is this true or false? Did George Stephenson then pace out the exact distance between the old remnant Roman ruts in the cobblestone main roads and then apply to that exact distance to his new railway lines? The answer is clearly no, yet curiously he ended up with a distance between the rails, as measured inside to inside, that was not very different…there are horse cart ruts in Pompeii around the 4 ft 8 inches width; indeed there are but the majority I measured at Pompeii were a good deal less than that (by more than 4 inches (110 mm).

ABOVE: Cartoon by Greg Judd.

BELOW: Tim Fischer in Pompeii in 2011. Attributed to Margaret Richardson and kindly supplied by Judy Brewer Fischer.

GLADSTONE LOCOMOTIVE DEPOT. 1 December 1965. T class narrow-gauge locomotive 245. The locomotive on the turntable is broad-gauge engine Rx 202. Gladstone usually had one broad-gauge Rx and two narrow-gauge T class locomotives in steam for shunting duties. Note the track arrangement leading to the turntable which was to ensure that the locomotive was perfectly balanced. **JLW.**

The *Rocket* weighed about 4½ tons. The early locomotives had their 'machinery' inside the frame and there was a belief that in order to go faster there needed to be more space for the cylinders and motion, and thus there needed to be a wider gauge. This was a factor in the emergence of wider gauges, the 5 ft 3 in, 5 ft 6 in and the 6 ft 2 in. Even George Stephenson admitted that if he was designing a railway again, he would go a little wider.

Then the locomotive engineers found that they could mount the cylinders on the outside of the frames. This allowed much larger locomotives with the largest, the 'Big Boys' of the Union Pacific Railroad, engines and tender, weighing 604 US tons. And the amazing thing is they could do it on the same gauge as that little *Rocket*. One wonders if the Union Pacific had the drawings on the table for a 'bigger boy' or had they reached the limit of what was possible with steam.

Narrow-gauge railways were typically built in terrain that dictated tight curves and steep gradients. Locomotives for these situations needed flexibility, traction and power. And the people who travelled on these steep and winding railways were not in a hurry. Their engines needed smaller driving wheels as they gave better traction. This presented a problem for the locomotive engineers. An additional problem was the constraint on the size of the steam generating components imposed by the smaller dimensions.

Traction is a product of the wheels gripping the rails which is transmitted into pull. Effective traction requires weight on the driving wheels. Traction can be improved by having more driving wheels. But an engine that is too heavy consumes most of its power in pulling itself up a grade. Those early narrow-gauge railways were usually built with light rails, and hence would not support heavier engines. Then there was the problem of curves. To add another set of driving wheels would extend the wheel-base. The solution to the locomotive needs of the narrow-gauge railways was not simply a scaled-down version of what was done on the broad gauge.

In the introduction of Chapter 1, we read about the conflict beween William Thow, the Locomotive Superintendent and Robert Patterson, the Assistant Engineer-in-Chief. Both of those officials ultimately left South Australia. Patterson eventually settled in Tasmania where he became involved in politics and the Leader of the Opposition. He did eventually make a half apology for his dealings with William Thow. Thow departed South Austalia in 1889. He had a long and productive career in New South Wales.

We have seen how the break-of-gauge produces an inefficiency flowing from the cost of transferring from one gauge to another and also the damage and loss associated with that. Here we consider another inefficiency.

Break-of-gauge stations generally needed a locomotive depot. There were two reasons for this. The break-of-gauge station was the terminus of two railway lines and possibly more. Terowie was an example of a situation where there was no other junction. The trains terminated there which required the engines to be turned, and take water and coal. There were generally barracks for the accommodation of the crew. The second reason is that a break-of-gauge station would need to have at least one shunt engine of each gauge to be in steam. The transfer of materials at the break-of-gauge required a constant shunting of trucks. There was an added inefficiency that these shunt engines spent a large part of the shift just simmering away, and of course there were the drivers and firemen who would spend hours just simmering away too.

Gladstone was also illustrative of another inefficiency. To provide the railcar service to Wilmington in the 1960s required the Bluebird railcar from Adelaide which was to Gladstone, where the passengers changed.

The Brill model 75 railcar provided the service on the narrow gauge from Gladstone to Wilmington. If there had been a broad-gauge line all the way to Wilmington there would have been no need for the railcar and its crew. There was also a doubling up of service vehicles such as brakevans, and if the traffic requirement was for a spare, be it locomotive, railcar or service vehicle there was another doubling up. It was always a feature of the break-of-gauge stations that there were sidings full of rolling stock that was going nowhere. It was there in case it was needed.

One of the advantages of the diesel-electric locomotive is that the bogies can be changed to convert from one gauge to another. It was a lot harder to change the steam locomotive from one gauge to another.

Here we look at locomotives that have been converted from one gauge to the other or have been designed for gauge conversion. Tasmania's first locomotive was also the first in Australia to be gauge-converted. It was the solitary engine of the Mersey and Deloraine Railway which had been the only example of the 4 ft 6 in gauge in Australia. Conversion is probably not the right word. It was a rebuild that occupied more than two years, resulting in an engine of 3 ft 6 in that had little resemblance to the original.

The K class of the South Australian Railways was designed by William Thow. It was a broad-gauge tank engine of which 18 were built and entered service from 1879. For reasons that are not clear, Thow applied the design to the 3 ft 6 in gauge. There was a solitary K52 that entered Service in 1884. It was put to work on the Port Augusta railway where it was more powerful than the W class that had had been the usual motive power on that line. The rigid wheel base did not work well on the tight curves through Pichi Richi Pass which caused it to derail. Being a tank engine would have caused some limitation of route availability. K52 was sent to Hamley Bridge, and later to Peterborough, where it was the yard shunter in those locations. Another oddity was that it had inside cylinders, possibly one of the few narrow-gauge examples.

South Australia was the only system where there was extensive mileage of broad and narrow gauge. In the 1920s the Western System (from Hamley Bridge to Moonta and Gladstone and connecting lines) was converted from narrow gauge to broad gauge.

THE GLADSTONE BLUEBIRD just beyond Salisbury. Mostly this was a 2-car service but could be up to 5 cars. The track closest to the camera was the line to Port Pirie that junctioned at that point. **JLW.**

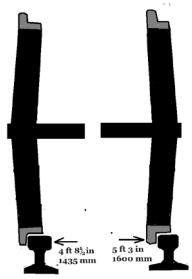
WILLIAM THOW'S K CLASS. It came in a broad-gauge version and and a narrow-gauge version. K52 was the solitary narrow-gauge example. It was not a success. It worked better going bunker first, which explains the cow-catcher at the rear. **NATIONAL RAILWAY MUSEUM**

That was expected to result in a surplus of narrow-gauge engines and a shortage on the broad gauge. Accordingly in 1922-3, five of the T class locomotives were converted from 3 ft 6 in to 5 ft 3 in gauge, thus being designated the Tx class. They were allocated to the Mallee lines, with loading equivalent to the Rx locomotives and by all accounts were successful. But in time there was a shortage of narrow-gauge motive power and in 1949 they were converted back to 3 ft 6 in.

The conference of Railway Commissioners in 1922 had directed that future construction of locomotives for the 5 ft 3 in gauge were to be designed in such a way that they could easily be gauge converted to standard gauge. That was effectively a directive to South Australia and Victoria to modify their designs. Victoria seems to have taken this task more seriously than South Australia. The Locomotive Superintendent of the SAR was Rushton. B F (Benjamin Franklin) Rushton, known to the apprentices at the Islington workshops as 'bloody fool Rushton'. He would have been incapable of making any modification, but the South Australian Government by this time (early 1920s) was so paranoid about the standard gauge that had it to declare a position on the matter, it probably would have been one of non-compliance.

It all changed at the end of 1922 with the arrival from America of W A Webb as Chief Commissioner. Soon South Australia had a new Chief Mechanical Engineer, Fred Shea, and Rushton was gone. Fred Shea produced the drawings for new locomotives that would be the most powerful in Australia. The definitive text regarding these locomotives is by Ron Stewien, in his series, *A History of the South Australian Railways, Volume 5*, Mountains, Mikados and Pacifics*.

Stewien described the technical details of these locomotives but there was no mention of them being built with consideration of conversion to standard gauge, but in his chapter on the 720 class, the first of which was in 1930. He notes that there was provision for conversion and there were dished driving wheels for the 720 class .



Dished driving wheels

The gauge is changed by reversing the position of the wheel on the axle.

LEFT. No 748 of the South Australian Railways would have traditionally been called a 'Mikado', but in the post-war environment was a 'MacArthur'. It's design very closely followed the 700 class of the South Australian Railways **GEOFF GRANT COLLECTION.**

BELOW. The Tassie Street Roundhouse of the Commonwealth Railways at Port Augusta. Two MacArthur locos, L80 and L81 are on the right (although it is not clear from the photograph if the one on the left is L81 or L84. The third locomotive on the left is a C class. **DOUG COLQUHUON, PHOTO COURTESY OF THE NATIONAL RAILWAY MUSEUM.**

David Burke, *Kings of the Iron Horse*, has written about Shea, more a biography than a technical commentary. The following is on page 121:

> All the new engines were built for easy conversion to standard gauge: wheels were dished…while brake hangers were cast with two separate fittings.

It leaves us wondering if Shea's 1926 big engines did not have that provision, and David Burke's comment related to the 720 class.

In Victoria they found that the necessary modification of the K class would require a narrower firebox to fit within the smaller frame. To achieve the necessary firebox grate area would require the lengthening of the firebox, which in turn would require an extra pair of wheels. The outcome was the N class.

Similar modification to the C class resulted in the X class. In 1959 the Victorian Railways did a costing of the actual conversion process with the intention that they would actually convert one of the locomotives as a means of testing the practicalities and costing but the project never proceeded to that.

R766 of the Victorian Railways was the only locomotive of its class to be converted, which was completed in 2022. It now operates in the Hunter Valley.

Apart from that early Tasmanian example, there were only two Australian railway systems where the gauge conversion of locomotives could have had application. The South Australian Railways and the Commonwealth Railways. The latter had both standard gauge (from Port Pirie to Kalgoorlie) and narrow gauge (to Alice Springs).

The Commonwealth Railways never converted a locomotive from one gauge to another, but it is appropriate to here consider the origin of their L class, which was a copy of the 700 class of the South Australian Railways. The 700 class had been a highly successful broad-gauge design that entered service in 1926. It was a good general purpose locomotive that was able to haul passenger trains or slog away with a heavy goods on a branchline. It was designed by Fred Shea for the lighter lines laid with 60 lb rail.

*Ron Stewien set out to cover the topic in 10 volumes. Volumes 1, 4 & 5 were produced but not in that order. He died in 2013.

Of the three classes of big engines introduced in 1926 class leader No. 700 was the first to enter service, and was the last survivor, long after Shea's glamour engines, the Mountain type 500 class and the Pacific 600 class, had all finished by the early 1960s. No. 700 made its last run in June 1968.

After the war Fred Shea was Managing Director of Clyde Engineering in New South Wales. An order was placed by the Federal Government for 40 locomotives that were to go to China. The design that was chosen was based on the 700 class. One of the modifications was that these locomotives would be 4 ft 8½ in gauge. The communist revolution brought an end to this project which was about half completed. The Government put some pressure on the Commonwealth Railways to take some of these locomotives. 10 went to the Commonwealth Railways as their L class. Five of those were never put in steam and the ones that did enter service saw little use. The remaining 10 at Clyde Engineering were completed as 5 ft 3 in gauge and went to South Australia as their 740 class.

Some mention needs to be made of the locomotive designs applied to meeting the specific needs of narrow-gauge railways. In Chapters 4 and 7 we had seen the origin of the Fairlie engine. It had some shortcomings but there have been enough of these examples to have been of sufficient benefit to their owners to see them in operation in the present time. There have been the Climax, Shay, Abt, Fell and the Mallet, most of which made a presence in Australia in forestry or mining applications.

AN AUSTRALIAN STANDARD GARRATT at Peterborough.The South Australian Railways acquired six of these that became the 300 class. This is No. 303. These ASGs were not popular with engine crews. Their design had included flangeless front driving wheels with the intention that they would be able to negotiate sharp curves but it made them prone to derail. **DOUG COLQUHUON, FROM THE NATIONAL RAILWAY MUSEUM.**

But no treatise on the topic would be complete without the inclusion of the Garratt. Every Australian State could claim some ownership of the Garratt story.

Chapter 11 had introduced us to Herbert William Garratt and his design for an articulated locomotive that would provide the answer for the narrow gauge. Unfortunately, it arrived late in the history of locomotive design, was slow to gain acceptance, and just when the world was beginning to appreciate its worth, the era of the diesel-electric locomotive had arrived.

The world's first Garratt locomotive was the K class of the Tasmanian Railways for the 2 ft gauge. There were two of these locomotives that entered serice in 1910. After Tasmania, the Garratt next appeared in Western Australia.

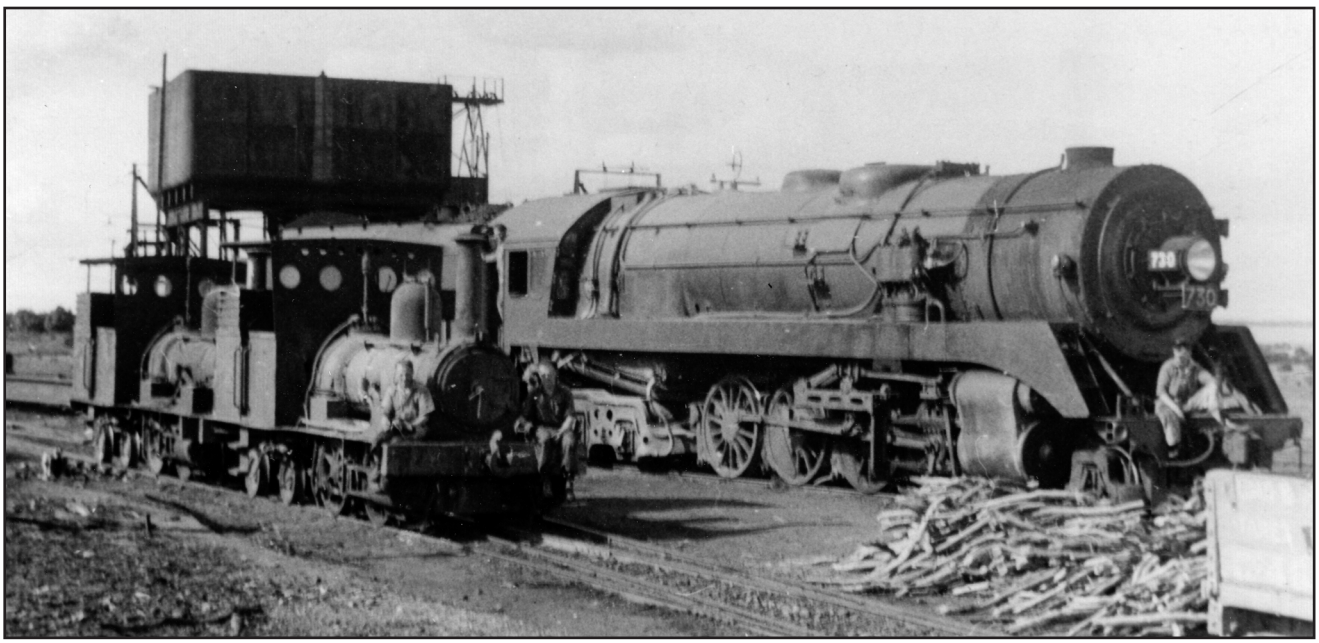
The war brought a need for additional motive power on narrow-gauge lines, and particularly those in the north of Queensland. This was the origin of the Australian Standard Garratt which was designed and built under the auspices of the wartime Commonwealth Land Transport Board.

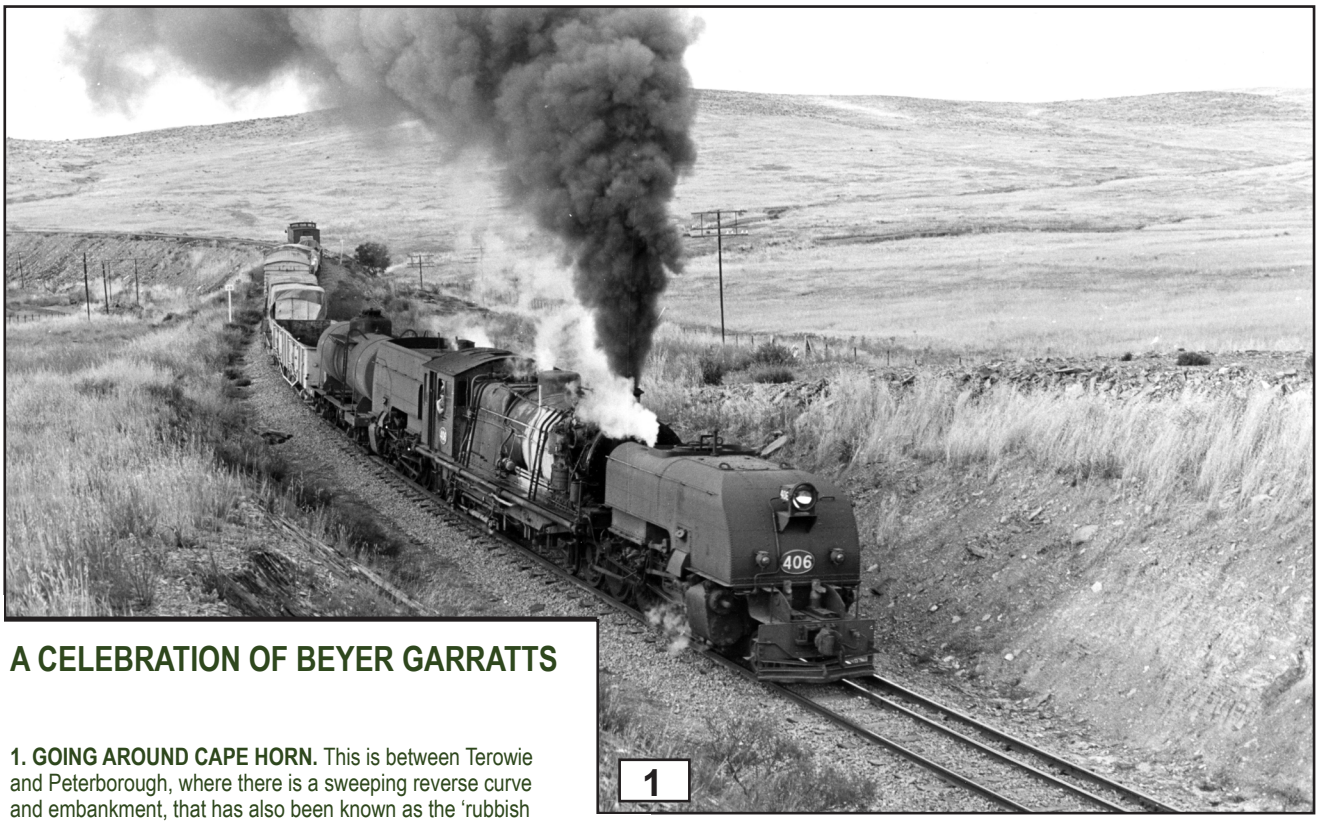
57 of these 'ASGs' were built with construction spread across most states.

It is understandable that a design and construction process undertaken in haste in wartime conditions would result in some shortcomings. There were problems with the ASGs and they were unpopular with many engine crews and ultimately became the subject of a Royal Commission. One has survived and is being restored to operation at the Bellarine Peninsula Railway in Victoria. Post-war was a brief celebration of the Beyer Garratt but their triumph was cut short by the diesel locomotive. *Australian Railway History*, January 2023, has the whole of that edition covering the history of the Garratts in Australia.

The last word on the Garratt is told by Ron Stewien who has written of the ultimate dream Garratt which was schemed in 1951. Frank Harrison, Chief Mechanical Engineer of the South Australian Railways postulated a broad-gauge Garratt, of 4-8-2+2-8-4 that was 114 ft 7 in over end sills and was to develop 83,560 lb of tractive effort. (Compare that to 32,600 lb of Harrison's streamlined 520 class, 51,0000 lb of the SAR 500 class Mountain Type as built, and 59,000 lb of the AD60 class Beyer Garratts of the New South Wales Government Railways). Some Garratt!

CONTRAST IS THE OPERATIVE WORD HERE. At Terowie. Two narrow-gauge V class engines (each about 15 tons) and locomotive 730 (232 tons). **FROM THE LIONEL NOBLE COLLECTION.**

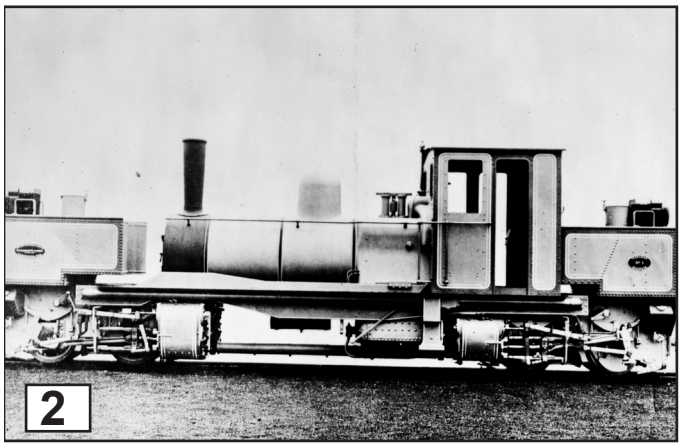




1

A CELEBRATION OF BEYER GARRATTS

1. GOING AROUND CAPE HORN. This is between Terowie and Peterborough, where there is a sweeping reverse curve and embankment, that has also been known as the 'rubbish dump'. This was where locomotive ash from the Peterborough depot was tipped down the side of the embankment. The 1 in 50 gradient would limit train loading and made this a popular spot for photographers. This photograph was taken only a short time before the broad gauge came into operation as the mixed-gauge track has the ballast packed down and all three rails are shiny. **FROM THE COLLECTION OF LIONE NOBLE.**



2

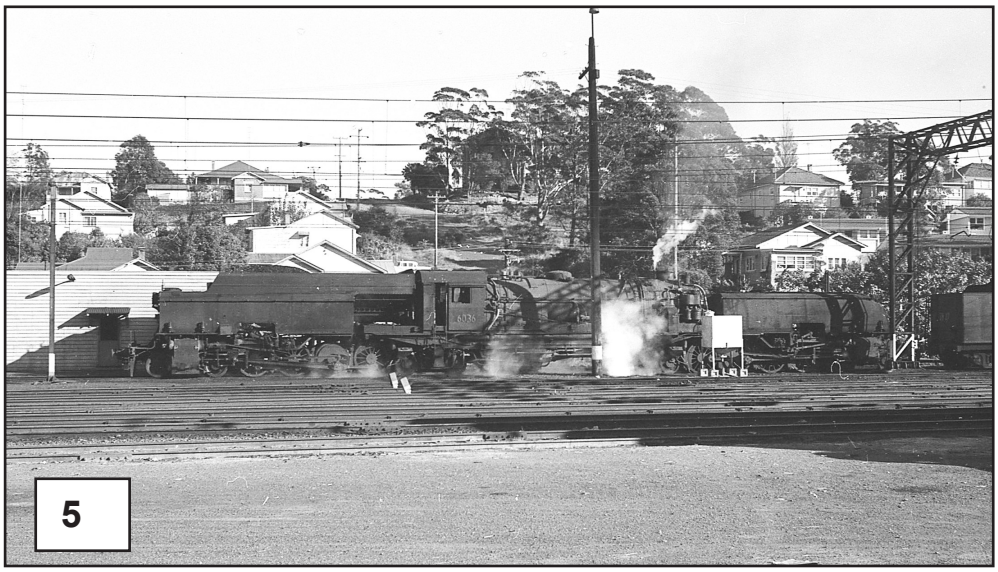
2. THE WORLD'S FIRST GARRATT. K1 of the Tasmanian Government Railways was in service in1910. There were two that had been built by Beyer Peacock & Co of Manchester. They were 2 ft (610 mm) gauge for the North-East Dundas Tramway. Beyer Peacock & Co became aware of K1 and purchased it for scrap value and repatriated it. More recently it has been restored to operating status. **PUBLIC RECORDS OFFICE VICTORIA**

3. THE QUEENSLAND RAILWAYS 1000 CLASS. There were 30 of these Garratts that went into service in Queensland in 1950. They were very similar to the 400 class of the South Australian Railways.

PHOTOGRAPH COURTESY OF THE NATIONAL RAILWAY MUSEUM

3

4. GARRATT G42. In1926 the Victorian Railways purchased two of these locomotives for use on their 2 ft 6 in narrow-gauge lines. The line to Beech Forest was the last of Victoria's narrow-gauge railways to remain in regular operation. It closed in 1962. Fortunately there was not a hasty dispatch of the locomotives to the cutter's yards and G42 is now operational on the Puffing Billy Railway. This photograph is of the last train on the Beech Forest line. The locomotive headboard is inscribed *AUSTRALIAN RAILWAY HISTORICAL SOCIETY - BYE BYE BEECHIE - 3.3.62.* **PHOTOGRAPH FROM THE COLLECTION OF THE NATIONAL RAILWAY MUSEUM.**



5. THE AD60 CLASS OF THE NEW SOUTH WALES GOVERNMENT RAILWAYS. The photograph was taken at Gosford of No 6036, on 20 May 1968. The AD60 was truly the last word regarding steam locomotive design in Australia with 50 ordered from Beyer Peacock & Co. Their delivery was concurrent with the first diesel locomotives for New South Wales which resulted in the last 3 of the order being cancelled and 5 of the units that were delivered but not assembled. No. 6042 was ceremoniously steamed as the last of regular steam working of the NSWGR. 6029 is maintained by the Rail Transport Museum. **JLW.**

6. GARRATT No 406 OF THE SOUTH AUSTRALIAN RAILWAYS. It is doing the task for which it was purchased - the Broken Hill concentrates to the smelters at Port Pirie - but not for much longer. The new standard-gauge track is all packed down with ballast and ready for the first coast to coast freights in January 1970. There were two of these 400 class Garratts that survived and passed to rail heritage groups. 409 was the last of the class in steam and is in the National Railway Museum. No 402 went to the Zig Zag Railway. **JLW.**