

# Construction of the Fitzroy Dock, Cockatoo Island

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**SUMMARY** Fitzroy Dock was the first large-scale engineering project attempted in New South Wales. It was built entirely by prisoners detained on Cockatoo Island, to the design of Gother Kerr Mann, a 'military engineer', who also managed the construction and supervised the dock's operation.

## 1 HISTORICAL BACKGROUND

### 1.1 Political Climate in the 1840s

The devastating drought that lasted from 1837 till 1841 was one of the low points in the fortunes of the fledgling colony of New South Wales. By then, the harsh rule of early colonial governors was somewhat eased by the establishment of a Legislative Council. In 1823 the Council consisted of just five to seven members appointed by the Governor and that Council was not able to initiate or reject legislation.

With the years, the Council acquired popular representation and its power increased: by 1842 two-thirds of its 36 members were elected by admittedly a somewhat privileged electorate. The process of liberalisation was on its way, reinforced by the stand taken by free settlers such as William Charles Wentworth but it was also aided by the sympathetic attitude of two governors: Sir Richard Bourke (1831-38) and Sir George Gipps (1838-46). To the colonists' good fortune, these able and conscientious men were at the helm of government at the time of the drought crisis - probably Australia has had no abler governors than Bourke and Gipps.

### 1.2 The Engineer Establishment

The 1841 census showed a population, including the Port Phillip District, of 130,000 souls of whom some 25,000 were convicts. Only a few were engineers and this limited the construction of public works such as roads, bridges or water supplies. Governor Bourke, himself an engineer, requested for a competent civil engineer to be sent out from Britain and an officer of the Royal Engineer Corps was ordered to take up the post. Captain George Barney arrived in Sydney in 1835, took charge of the Engineer Department and took over as Commanding Royal Engineer.

The Department (previously headed by Ambrose Hallen, Surveyor General) was responsible for military and convict buildings, whilst the Colonial Architect was in charge of all Government (public) buildings (Barlow, 1971). Thomas Mitchell, the Surveyor General, with the reputable David Lennox, continued to build roads and bridges.

In 1836 Governor Bourke appointed Barney Colonial Engineer, a new title that was meant to lift him to a status equal to that of Colonial Architect. Alas, the title was short-lived: on Barney's departure at the end of 1843 Governor Gipps did not confer it on

Lieut. Col. James Gordon, Barney's successor as Commanding Royal Engineer. Thus the seat allocated to the Colonial Engineer in the re-constituted Legislative Council also remained vacant.

Worse still, in November 1843 the Council voted to cancel all engineering expenditure for the next year since the Colony was still suffering the aftermath of the drought. The Council also abolished the Engineer's Department and ordered that office, stores and books be handed over to the Colonial Architect's Department (Reynolds, 1972).

For the next twelve years, the Architect looked after construction and maintenance of roads, bridges and wharves in the colony whilst Col. Gordon retained command over military construction. An intriguing system of engineering tasks and responsibilities! The division between 'military' and 'civil' engineering remained well into the 1850s (see Table I)

### 1.3 Early History of Cockatoo Island

Barney had achieved much in his short term (1835-43) in Sydney with the building of wharves, fortifications, barracks and the completion of the city water supply. In 1839 prisoners, under his supervision, cut fifteen bottle-shaped grain receptacles ('silos') out of the rock on Cockatoo Island.

For 45 years after settlement, Cockatoo Island had remained dormant. In 1833, Governor Bourke caused the erection of the first permanent buildings for prisoners stationed there, ruins of some of which are still standing.

In 1841 a barracks building with berths for 344 was completed and the island was constituted as one of the colony's penal establishments, to hold prisoners under colonial sentence as well as transported convicts.

Such was the lead-up to the next move, ostensibly by the Legislative Council but possibly inspired by Governor Gipps. On 31st October, 1845, the Council adopted an Address to the Governor asking him 'to represent to Her Majesty's Government the advantages, which would accrue to this Colony and to the Empire at large, were a Dry Dock to be constructed at Sydney for Men of War.' When transmitting the address to the British Government, Gipps added: 'Cockatoo Island is the place in Sydney Harbour, which I consider best adapted for a Naval Establishment...' (HRA vol XXIV, p 611).\*

\* HRA stands for Historical Records of Australia.

TABLE I  
ENGINEERING RESPONSIBILITIES IN NEW SOUTH WALES 1835-57

YEAR	1830	35	1840	45	1850	55	1860
Colonial Governor	Sir Richard Bourke —1831-38—		Sir George Gipps —1838-46—		Sir Charles Fitzroy —1846-55—		Sir William Denison —1855-61—
Colonial Architect responsible for	Mortimer Lewis —1835-49— —public buildings—				E T Blacket —1849-54— —public buildings, roads & bridges—		
Engineer Département responsible for	George Barney —1836-43— military & convict bldgs, roads and bridges				abolished in 1844		Dept of Lands & Works *—1857—
Colonial Engineer	George Barney —1836-43—				title abandoned in 1843		
Commanding Royal Engineer responsible for	George Barney —1835-43— as for Engineer Dept				James Gordon —1844-56— military construction		

\* The first 'responsible government' was formed in New South Wales in June, 1856

It could well be that in his choice of the island, the Governor considered the useful employment of hundreds of prisoners held there. Other factors in its favour were that the island was a mere 2¼ miles (3.6 km) from Sydney wharves and that it was surrounded by deep water with plenty of room off its shores to manoeuvre boats into a dock. See Figures 1 and 2.

## 2 PLANNING FOR THE DOCK

### 2.1 Government Actions

Whilst Governors were virtual rulers of the colonial administration, they had little discretion in fiscal matters. The reply to Governor Gipps' letter by the

then Home Secretary, William Gladstone (future Liberal Prime Minister of Britain) in June, 1846 was based on advice from the Admiralty: 'while their Lordships approved of the work itself as well as the locality...they were not prepared to recommend that the expense...should be borne by the British Treasury'. (HRA vol XXVI, p 50)

Another two years had to pass before the Admiralty relented. In a despatch dated June 1848 it was stated that 'in the event of the Local Government consenting to the construction of the Dock in the form and according to the dimensions pointed out in the accompanying sketch, and provided the work can be executed at a reasonable cost, their Lordships will be prepared...for a fair contribution' (HRA vol XXVI, p 458).

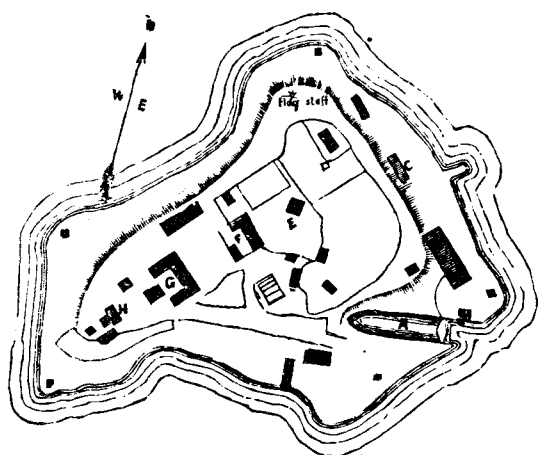


Figure 1 1854 map of Cockatoo Island drawn by Jas Wm Thomas Esq, Resident Engineer

- A Fitzroy Dock
- B Pumping Station
- G Barracks of 1841
- H Kitchen & Guard House of 1833

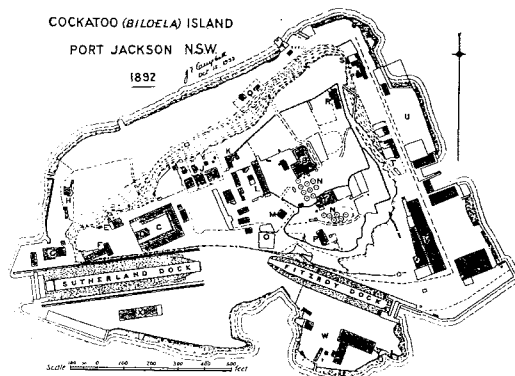


Figure 2 1892 map of the Island drawn by J F Campbell in 1932

- C & D Barracks of 1841
- F Ruins of kitchen etc of 1833
- G Power House
- N Silos of 1839 (Barney)
- V Workshops

But during those two years Gother Kerr Mann had prepared a design and estimate for the Dock. In June, 1847, Governor Fitzroy transmitted these plans to the Legislative Council, asking it 'to report upon the expediency of undertaking the execution of this work upon the scale proposed'. A Select Committee of Council recommended within three months in favour of construction on Cockatoo Island, with an extension of the water-line breadth and the depth of water at the sill (Votes & Procs of LC 1847 vol 2, pp 393-414).\*

Subsequently, in November, 1847 the Governor ordered Col. Gordon to commence work on the Dock. A month later the Legislative Council voted £ 500 for each of the next two years to finance construction. The Admiralty's plans had not reached Sydney until July, 1848 - by this time surveys and investigations had been completed! Now it was up to Mann to comply with the Admiralty's design standards and it appears that he managed to conform.

At the time when the Select Committee was formed in June, 1847, the Council received a petition 'from certain inhabitants of Sydney against the employment of Convict Labour in the construction of a Dry Dock on Cockatoo Island'. This could have been a reaction to the inhuman treatment of the prisoners on the Island.

## 2.2 Planning: Feasibility

The moment of conception for the project lingered on for two years: from October, 1845 when the Legislative Council adopted an address to Governor Gipps, to the order to commence work by Governor Fitzroy, in October, 1847. The time was spent on enquiries of maritime and engineering nature.

\* LC denotes the Legislative Council of New South Wales.

Ships had hitherto been serviced by Captain Mosman's shipyard in Mosman Bay and by slipways in Careening Cove (off Kirribilli) and Darling Harbour. 'Careening' meant to give the floating vessel a list to each side in succession, to obtain access to the bottom for scraping. This was considered a dangerous practice because of a risk of capsize. 'Heaving down' involved a similar operation on land - here, supports were provided to avoid damage to the hull.

Dry docks could be operated efficiently at places of large rise and fall in the tide, enabling boats to enter at high tide. The falling tide then drained the dock without need for pumping. This is the case on the Merseyside: the Liverpool docks operate practically without pumping. At Cockatoo Island, rise and fall of tides is only 1.2m to 1.8m, and it was realised that pumping machinery will be required.

In order to establish feasibility of the project, the 1847 Select Committee took evidence on maritime and technical questions. The shoals of the Sow and Pigs inside the Heads appeared to limit the size of vessel that could navigate up the Harbour and reach the proposed dock. A witness expressed preference for using a dock, compared to delays and expenses involved in heaving down a ship. Economic advantages that could accrue to Sydney were pointed out by others: 'French vessels of war, as well as commercial vessels, would come here'.

Gordon and Mann were examined on the nature of the rock on site (with a view to selling the excavated material), on the type of buildings and the water supply on the island, and on the supply of labour. To the question: Do you think convicts would do as much work as free men?, Mann replied: No; but I think, even with the additional expense of

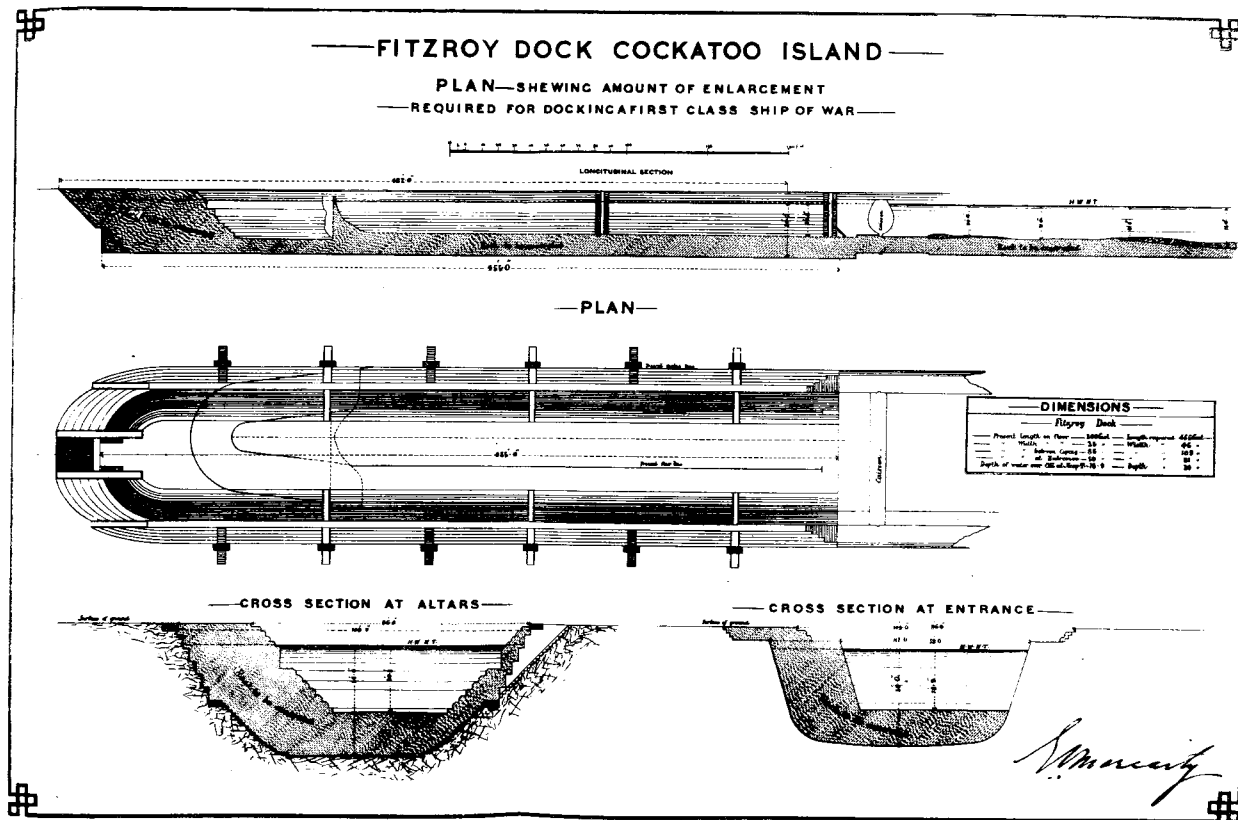


Figure 3 Fitzroy Dock after 1870 extensions and showing planned further enlargement  
From L C Journal 1873-74 vol 23 Pt 1, p 738

indulgences (small extra rations of tea and sugar), a considerable saving would be effected.

In the years to come, he had reason to regret that statement.

Mann's cost estimate was £ 4,626 with convict labour, or £ 10,377 with free labour. It covered the cost of labour, tools and machinery but did not include rations and clothing for the convicts since they had to be maintained in any case at the cost of the Colony. A superintending engineer and assistants were required and it was anticipated that their salaries would be covered by the sale of rock, valued at £ 1,000.

Strangely, members of the Select Committee omitted to ask how long construction will take? Six years later, Mann had to face another searching enquiry by a Committee of the Legislative Council, with members pressing him 'to state anything like an approximate period when this Dock will be ready to receive a vessel' (Votes & Procs, L C 1853).

### 2.3 Design

From Mann's replies to questions by members of the 1847 Select Committee it transpires that he was educated as a Civil Engineer (passed an examination) and that he was employed by Gordon in preparing the estimate for the Dock. He had consulted various works on the subject, he said, and, considering the capabilities of the harbour, came to the conclusion that the best or most profitable size for the Dock was as he has drawn it - Figure 3.

Indications are that he conceived the design on his own, possibly with some assistance from Gordon. His later mentor and adviser, Sir William Denison, designer of Woolwich Dock in England, did not arrive in Hobart as Lieut. Governor of Tasmania until January, 1848, and it is unlikely that he had seen Mann's design until late in 1849.

It is probable that Mann arrived at the shape of the Dock by analysing the form of contemporary vessels. A major parameter was the depth of water over the sill of the Dock and Mann based this dimension on the depth of passage at the Sow & Pigs: 24 ft (7.3m). The original 17 ft (5.2m) design depth over the sill at high water allowed for the passage of a

ship of 1,800 tons, the prototype being a paddle-wheeler steam frigate.

The Dock had been enlarged several times: plans were modified before construction started and then during construction, and twice later when extensions were carried out. Table II lists these dimensions; for comparison, some of the Waterview Dock (Balmain, NSW) and Alfred Dock (Williamstown, Vic) dimensions are also listed.

Mann perceived the difference between tidal conditions here and at Home and altered the cross section shown on Admiralty plans by narrowing it below low water line. This reduced the quantity of water remaining to be pumped out when a vessel was docked. Another concern was the level of keel blocks: the floor level was dropped 2 ft (.6m) below the entrance sill to allow placing of keel blocks. This facilitated work on the bottom of ships.

The design concept involved excavating the Dock out of the rock. Denison wrote that 'to cut the Dock out of the solid sandstone seems...to be very feasible' (G K Mann Papers vol 1, p 313). A major concern was, however, stone quality. Mann allowed for blasting away a considerable volume of the cliff occupying the site but the permeability of the rock in situ and its suitability for lining had not been tested. On the surface the sandstone was mixed with a layer of clay and when that was removed to some .5m above high water line, a close-grained sandstone rock was encountered. Denison was led to believe that a stratum of shale occupied the bottom level of the Dock and that both bottom and sides of the Dock would require to be lined with stone.

For the floor, Denison suggested that the stones should be cut to a mould with a thickness of 3 ft (.91m) and laid in an inverted arch of a radius (in a vertical plane) of some 70 ft (21m). His sketch showed how the shale behind the altars (series of steps running along the side of the Dock) should be replaced by rubble masonry and the stones for the altars laid against this backing. The stone floor was to be carried under the altar stones and to extend back to the depth of the rubble backing; the lowest altar stone to be let into the stones of the floor and each successive upper altar stone to be rebated into the stone below. The sill courses had

TABLE II

DIMENSIONS OF FITZROY DOCK AND OTHER CONTEMPORARY DOCKS IN AUSTRALIA

Dock	Year	Length along top altar in m	Length along keel floor in m	Breadth in middle in m	Entrance width (mean) in m	Depth over sill OHW in m
Fitzroy Dock original plans	1846	81	69	23	16.5	5.2
Fitzroy Dock as built	1857	86	79	26	17.7	6.2
Fitzroy Dock first extension	1870	122	116	26	17.7	6.2
Fitzroy Dock second extension (present dimensions)	1880	146	142	26	17.7	6.2
Alfred Dock Williamstown, Vic	1864	142	137	30	25	8.2
Waterview Dock Balmain, NSW	1854		105	23		5.8

to be deep, also laid as an inverted arch and carried under the floor lining.

It is essential, Denison wrote, that all the masonry work be well jointed with a watertight mortar. Cement sets too rapidly and once the joint is broken, it is of no further use. He recommended a mortar composed of good hydraulic lime and pozzolana, or common lime mixed with clay and 'rebounded'.

Design of the caisson or floating gate caused a problem for Mann who stated at the 1847 Select Committee hearing that he had not seen a detailed plan of an iron plate caisson. The shape of the caisson was determined for conditions of stability when floating free, and for sufficient buoyancy to rise for undocking a vessel.

In housing the caisson, Mann initially allowed for a groove. 'In order to make the entrance suitable for a caisson, it is necessary to deviate from the form shown in the (admiralty's) sketch' wrote Mann to the Colonial Secretary. 'By it, the piers are represented as perpendicular'. Mann has insisted on a batter of 4 ft (1.22m) in the height of the piers; thus the caisson would float free after rising 10 ft (3.05m) and leave a draft of about 11 ft (3.25m), twice the draft required for safe free floating (G K Mann Papers, 14th July, 1849).

Instead of a groove in the sill and piers, Denison proposed a step (rebate) all around. This way the caisson would float if it was drained of a small amount of water.

According to Denison, structural design conditions were: when water pressure is on one side only, it is resisted by the sheathing and framing, and transmitted through the keel and stem of the caisson to the dock itself. Also, the water contained in the caisson for buoyancy and manoeuvring exerts internal pressure and this must be met by cross ties and braces (G K Mann Papers 1845-69, Vol 1).

Mann designed the contours of the caisson and indicated valves, sluices and pumps. The detail design, all in galvanised wrought iron, was carried out by fabricating contractors Rennie & Waterman, of Blackwall, London - see Figure 4.

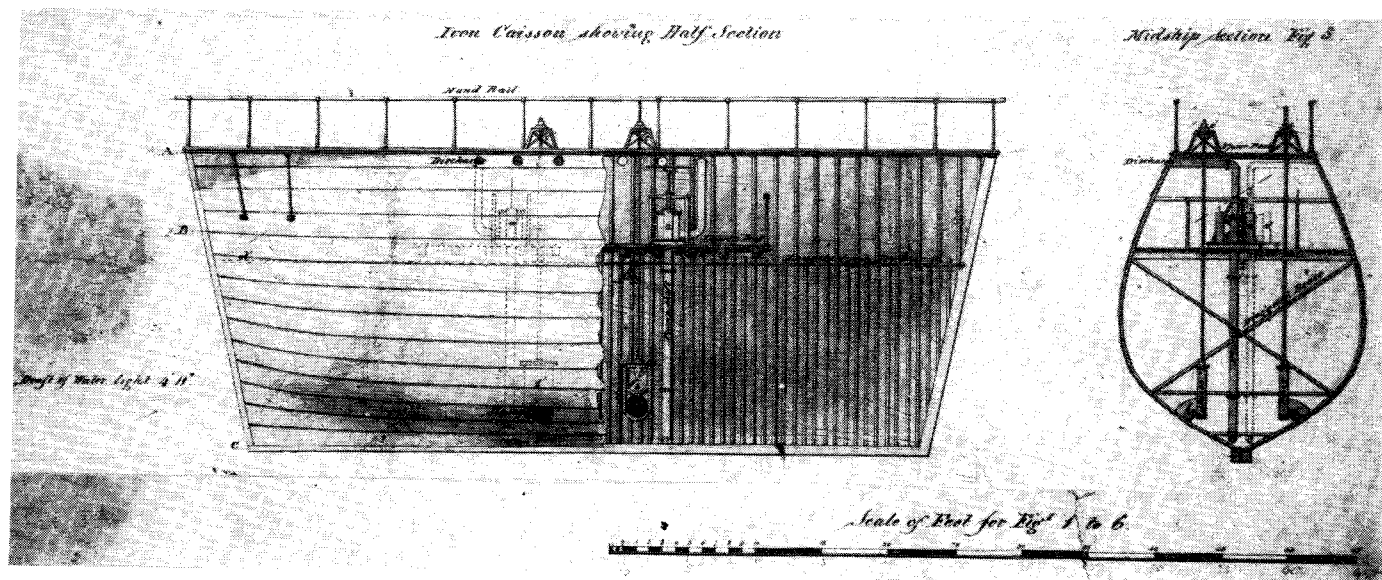


Figure 4 Mann's design for the Caisson

### 3 CONSTRUCTION

In 1848, Mann was delegated to the Dock project but he was unhappy with his position. Denison wrote: 'I am glad to see that the authorities in N S Wales propose to put you on a more respectable footing than heretofore' (G K Mann Correspondence 1845-69). By 1853 the matter was resolved: a Parliamentary Committee addressed him as 'Civil Engineer of the Dry Dock at Cockatoo Island'.

By then he was well known in the Colony through the spectacular blasting of the high cliffs overlying the Dock site. Mann used the technique known as mine firing: a gallery was cut into the cliff and charges were placed in two places, with the entrance and the connecting galleries well tamped - see Figure 5. The gunpowder charges (in pounds) were calculated by Mann to be  $(LLR)^3/30$ , where (LLR), the least line of resistance, was 34 ft (10.4m) and 25 ft (7.6m) for the two charges respectively.

Mann constructed an electric firing machine, geared to attain simultaneous firing of the two charges - see Figure 5.

By July, 1853 1½ million cu ft (42,600 m<sup>3</sup>) of rock had been excavated, including 580,000 cu ft (16,200 m<sup>3</sup>) to form the Dock itself. Removal of 80,000 cu ft (2,200 m<sup>3</sup>) still remained but this could have been difficult since it included the underwater work at the entrance to the Dock. Mann used a quantity of Bickford's fuse for blasting under water and a diving bell to remove the stone.

In the meantime stones for the inverted arch lining were being prepared and Mann built a traversing crane to lay them speedily. Mann now admitted that progress would be faster if free stonemasons and quarrymen were employed - but these would not work on the Island because of an antipathy to working by the side of prisoners!

Mann also had his hands full with receiving and assembling the prefabricated caisson; with the erection of a boiler and pump house, and installation of workshop equipment.

In 1855, William Denison was appointed Governor of New South Wales. Together with Mann, he had been a

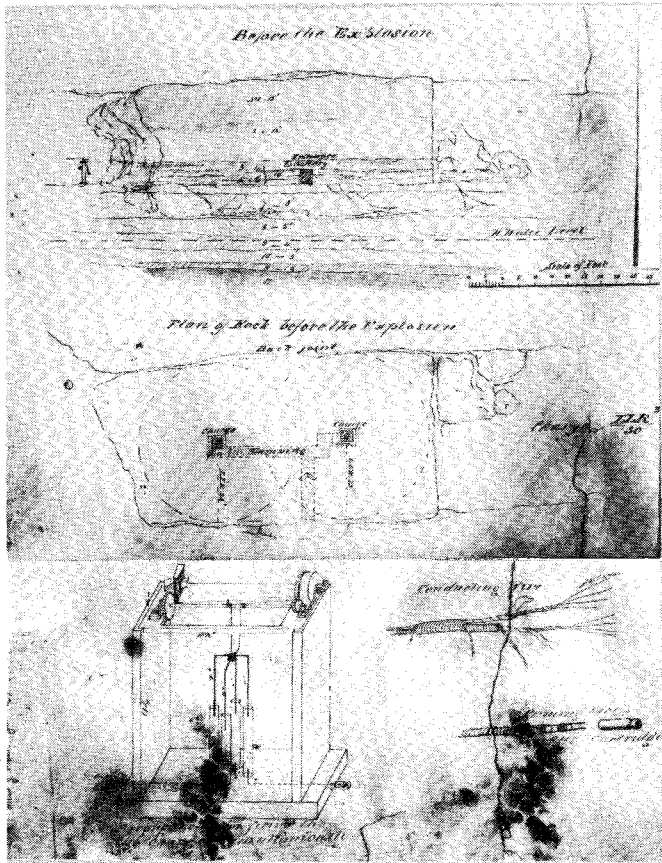


Figure 5 Mann's sketch of the arrangement for the great blast

Top: elevation of cliff  
 Centre: plan of gallery & charges  
 Bottom: the firing mechanism

driving force behind the establishment of railways in the Colony. The private railways company was taken over by the Colony in 1855 and Mann served as Commissioner of Railways for the next two years.

Responsible government came in June 1856 and in October 1857 a new Department of Land and Public Works was established. In the Public Works Branch, one of the Departments was Civil Engineering, Dry Docks and Cockatoo Island, with G K Mann as Engineer-in-Chief. Fittingly, the first vessel docked weeks after in the new Fitzroy Dock - see Figure 6.

The project was far from finished and in the coming years, work continued on several extensions, followed by increasing the scope and capacity of the equipment.

As early as 1865 Mann was advocating 'the construction of an additional dock of sufficient capacity for any future requirements' (Journal of L C, 1865-6). This came to be realised twenty years later in the building of Sutherland Dock on the Island - see Figure 2.

Mann retired in 1870 at the age of 62, when the Penal Establishment on the Island was abolished. A few months later he offered to undertake the management of Fitzroy Dock but was curtly informed that his 'proposition cannot be entertained' (G K Mann Papers).

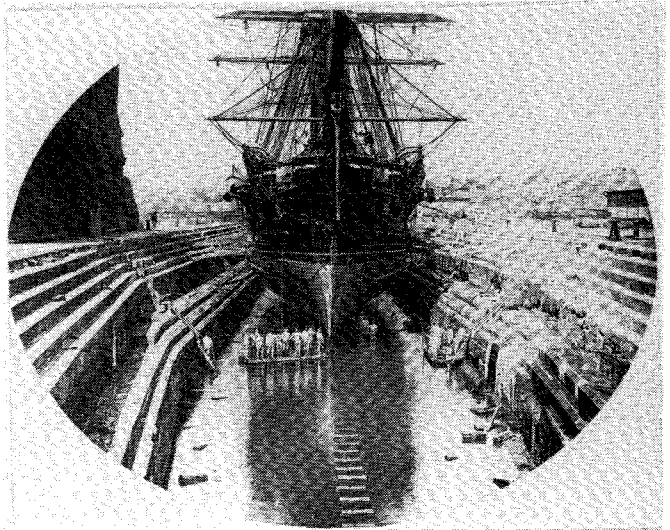


Figure 6 Royal Navy ship in Fitzroy Dock, c1866.

#### 4 CONCLUSION

Fitzroy Dock is now a working unit of the Cockatoo Dockyard Pty Ltd. The Island is a veritable treasury of engineering heritage and much of it is worthy of recording and preservation. Over the years there have been changes: the old boiler and pump house is now part of the workshop complex and the original caisson has been replaced by a steel structure that uses compressed air to speed up the discharge of water.

Since the last war, a few docks were closed down and operators and workers have dispersed. It would be an urgent task to track down documents and to record traditions of Australian dock building and operation.

#### 5 ACKNOWLEDGEMENTS

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