SCOTTS OF GREENOCK.

Shipbuilders and Engineers.

1820-1920.

A FAMILY ENTERPRISE.

Volume One - Text

Volume Two - Ship List

JOHNSTON FRASER ROBB.

"Whither, O splendid ship, thy white sails crowding,
Leaning across the bosom of the urgent West,
That fearest nor sea rising, nor sky clouding,
Whither away, fair rover, and what thy quest?"

Robert Bridges

Presented to the
University of Glasgow
for the degree of
Doctor of Philosophy

1993

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ABBREVIATIONS.

Classification Societies and other Regulatory Bodies.

A.B.S.	American Bureau of Shipping.
B.C.	British Corporation.
B.o.T.	Board of Trade.
B.V.	Bureau Veritas.
D.N.V.	Det Norske Veritas.
G.L.	Germanischer Lloyd.
L.R.	Lloyd's Register of Shipping.
M.o T.	Ministry of Transport.

Horsepowers.

N.H.P.	Nominal Horsepower.
I.H.P.	Indicated Horsepower.
B.H.P.	Brake Horsepower.
S.H.P.	Shaft Horsepower.
R.P.M.	Revolutions per Minute.

Technical Terms.

$C._b$	Block Coefficient.
K.W.	Kilowatt.
Satd.	Saturated.
Suphtr.	Superheater.
Recip.	Reciprocating.
Emer.	Emergency.
Hg.	Mercury.
Aux.	Auxiliary.
H.P.	High Pressure.
I.P.	Intermediate Pressure.
L.P.	Low Pressure.
Sq.ft.	Square Feet.
P.S.I.	Pounds per Square Inch.

The Imperial System of measurement has been used throughout this study (except for bore and stroke of certain oil engines).

For purposes of comparison it should be noted that:

1 ton	=	1.016 tonnes.
1 foot	=	0.3048 metres.
1 inch	=	25.4 millimetres.
1 lb	=	0.454 kilograms.
1 p.s.i.	=	6.89476 kilonewtons/square metre.
1 h.p.	=	0.746 kilowatt.

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ACKNOWLEDGEMENTS.

The original inspiration which led to this work being undertaken came from my first meetings with Dr. William Lind in 1986 when we worked together in rescuing the remaining Scotts' archive material before Scotts Cartsburn and Cartsdyke shipyards and Engine Works became but a memory.

The subsequent encouragement from my supervisor Professor A. Slaven of the Department of Economic History and Michael Moss, Archivist at Glasgow University and my good friend Dr. Willie Holmes together with the enthusiastic support of Michael A. Sinclair Scott C.B.E. led to my going ahead with the thesis and I offer my sincere thanks to all of these gentlemen.

During the long period of research I have been well served by many members of university staff, in particular Blythe O'Driscoll, Alma Topen and Vanna Skelley. Their courtesy and goodwill were greatly appreciated.

As an honorary member of the Ballast Trust I wish to thank George Gardner, Phil Thomas, Captain John Baird and Magdalene Colquoun for sharing with me their interest in shipbuilding and marine engineering history.

Finally, on the local scene I wish to record my appreciation of the sterling service provided by Mrs. I.L.E. Couperwhite of the Greenock Watt Library.

To all my former colleagues at Scotts' and Scott Lithgow who in so many ways assisted in the project I say thank you, in particular Jim Crawford, Tom Dunn, John Hawton, Willie Kane, Jim McMillan, Adam Mitchell, Jim Nicol, Andrew Paxton and Graham Strachan C.B.E.

From further afield I received great assistance in examining the Scott association with John Swire and Sons and Alfred Holt from Charlotte Havilland, Captain Graham Torrible O.B.E. the late Dr. Archie Blue, Fred Walker at the National Maritime Museum, Barbara Jones of Lloyds Register, London, Doris Callaghan of I.E.S.I.S., and my brother Robert M. Robb who assisted me in gathering data at the Public Record Office, Kew.

The Custom and Excise Ship Registration offices around the coast of the U.K. have also been helpful in providing information for the Ship List.

Finally, my thanks to my family for their support over the years, in particular my wife Christina, and my son Malcolm who took on board the word processing task.

ABSTRACT.

It would be an exaggeration to claim that the history of a great industry like shipbuilding in Britain, can be fully understood by concentrating on the history of only one of the many companies that contributed to the developments. However, Scotts of Greenock represent a case study that in many ways encapsulates the critical ingredients which came together to project British shipbuilding from purely local significance to world leadership between the late eighteenth century and the beginning of the twentieth century.

The roots of modern British shipbuilding lie in the craft industry based on wood and sail, one dominated by small scale family and partnership enterprises typical of the eighteenth and early nineteenth century. The Scotts grew out of this milieu, their family firm dating from 1711, and their survival from that date to the 1980s, marking them out as the longest surviving and oldest firm in British shipbuilding, probably the longest established shipbuilding enterprise in the world. Survival in the small scale world of local markets for wood and sail demanded ingenuity and flexibility, together with a willingness to tackle almost any type of related trade. The Scotts excelled in this unpredictable and opportunistic environment. In Chapter 1 which examines the characteristics of the family, their enterprise in the first century of activity between 1711 and 1820, the foundation of their success is set out.

The family foundations established in the first century of enterprise were not, in themselves, sufficient to guarantee success in the rapidly changing conditions of the 19th century which was dominated by the great transitions from

wood to iron and then steel, and from sail to steam. The challenges and problems confronted in these transitions are sharply focused through the Scotts experience. They were among the earliest builders in steam, and in the forefront of those risking the new investments in capital and skill required to build in iron. The four decades from 1820 to 1860 witnessed the emergence of the Clyde from obscurity to national and world leadership in shipbuilding by pioneering the new industry in steam and iron. The Scott family starkly portrays the prizes to be won, and the cost of failure to be borne, in facing these challenges as the family split over its commitment to sail and steam, one branch prospering and the other failing. Part One of the thesis focuses on the nature of the industry in this critical period, and captures the main elements of the transition as exemplified in the Scott activities.

One of the next notable features of 19th century shipbuilding was the dominance of important family firms whose reputations were built on qualities of hard work, resilience, and progressiveness, even in adversity. Part Two of the thesis clearly illustrates these features through examining three critical connections, in which the Scotts linked their business to dominant clients. The close builder-client link was a typical feature of the industry, and Scotts demonstrate both the advantages and perils of this type of relationship through their ventures with the French Compagnie Générale Transatlantique and with the Liverpool based shipping families of the Holts and the Swires.

Family enterprise, and close client connections, were essential ingredients in the success of many shipbuilding dynasties in Britain, and Scotts exemplify this admirably. But success demanded more than these elements in the rapidly changing technical environment in the age of steam and iron. The Scotts were early involved in these developments, but perhaps more than any other element, it was the family commitment to technical excellence and innovation that stamped their work with quality.

Chapter 3 establishes the early features of Scotts technical involvement, but their multiple contributions in construction, in boilers, in propulsion units, and in general design, accumulated in a drive for excellence from the 1860s onward. Chapter 6 identifies the Scott contribution in its notable diversity and significance. In addition, the Scott legacy in fine ships is set out in unprecedented detail in the technical appendix in Volume Two of the thesis.

The other dominant feature of British shipbuilding in its ascendancy, was its notable achievements in large passenger liners, and in naval construction. Scotts contributed significantly in both dimensions, and achieved this by recognising that scale and modernity, linked to good organisation, were necessary elements for success at the end of the nineteenth century. Scotts again exemplify the best type of innovation and response in the period from 1890s into the First World War, and Chapter 7 demonstrates how a leading family business could incorporate a new company form, infuse its family structure with new managerial talent, and restructure its traditional merchant activities to take in naval business with no loss in efficiency and effectiveness. Moreover the significance of penetrating the naval market for increasing profitability and providing financial strength to meet post-war problems is amply demonstrated in the Scotts case.

While the Scotts did not, and could not, build any kind of vessel representative of British shipbuilding in the C18 and C19 they did represent the classic features of the industry. They were a family firm that did not weaken as generations passed, but succeeded in making a transition to joint-stock status. The company demonstrates the transitions from sail to steam, wood to iron, merchant to naval building, and contributes significantly to major technical change, innovation and implementation. Moreover, in its changing organisation it reflects how firms change, and how their customer base was in itself one of the ingredients in long term success. In all of these ways, the Scotts of Greenock gave life and meaning to the nature of shipbuilding companies, and to the development of the industry on Clydeside. This case study is significant in general terms, as well as in the particular aspects of the family firm and in the development of the Greenock area.

CHAPTER 1.

INTRODUCTION.

THE EARLY YEARS : SCOTTS OF GREENOCK 1711-1820.

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Between the Union of the Parliaments in 1707 and the end of the Napoleonic Wars in 1815, Greenock grew to be the main port on the Clyde as Scotland's gateway to the Americas. At the same time the Scotts established themselves as shipbuilders there.

According to family tradition the Scotts came originally from Roxburghshire. Later they were settled in Arbroath and appear to have emigrated to Greenock some years before the Restoration, probably around 1655. At the beginning of the 18th century the family was headed by John Scott, referred to in the family as John Scott I. He was concerned with fishing vessels[1] as his father had been before him. He is mentioned in the "Papers relating to the ships and Voyages of the Company of Scotland Trading to Africa and the Indies (1696-1707)" as having provided goods and services in October 1699 to their ship 'Speedy Return' at Port Glasgow which at that time was involved in the Darien Expedition.[2] John Scott I appears to have trained as a carpenter and as a hammerman, and it was he who founded the family shipbuilding business in 1711. (See Fig. 1/1)

At that time the town and harbour of Greenock was expanding rapidly. As trade grew, the local landed superior, Sir John Schaw, and the townspeople acted to finance the building of a new West Harbour which was opened in 1710 at a cost of £5,500. Some £5,000 of this had been put up by Schaw and in return for receiving a levy of 1s 4d. on every sack of malt brewed into ale within the burgh the debt was cleared off in thirty years.[3]

As originally constructed the harbour was in the form of a semi-circle with East and West Quays, and a tongue called the Mid Quay, the ground being eight acres in extent. At high water there was a depth of eighteen feet, and at low water of eight feet. (See Fig. 1/2)

Hamilton of Wishaw wrote about Greenock at this time in the following terms:-

> *"The town hath ane great harbour for vessels, and is to become a place of considerable trade, and is like more and more to increase, especially if the herring fishing continue in the River Clyde which occasion confluence of many thousands of people to these pairts, which yearly continues a considerable space."*[4]

There can be little doubt that it was this civic optimism that lay behind John Scott I's decision to add the building of herring boats (or busses as they were then called) to his existing ship repairing and chandlery business.

As his business expanded, one of John Scott I's three sons, William, joined him in the yard, while another, James was also soon established in a complementary local business. He was a merchant with his office and works at the Bell Entry, a prime site at the front of the West Harbour. He was engaged in smithwork, specialising in anchors and chains. James also owned a number of coasting vessels which traded around the Irish Sea ports and beyond.

John Scott and his son William operated the shipyard together, mainly building and repairing herring busses until John Scott I died around 1745.

William was then joined by his brother James to form a new partnership as "James and William Scott," James bringing with him not only his smithwork but a small fleet of trading vessels. Under this new management, the yard which was located at the mouth of the West Burn was gradually developed.[5]

The land on which the yard was operated had been leased from the Schaw family, but in 1761, William, with considerable foresight, purchased another feu from J.E. Mason, enabling he and his brother to significantly enlarge the yard.[6] This move quickly followed Scotts first venture into building larger ships. In 1765 they had constructed a large square rigged ship for a Hull merchant, built with timber from the ducal woods at Hamilton and reportedly the first Clyde built vessel for non-Scottish owners.[7] The new enterprise however, quickly suffered a set back with William Scott's death in 1769, leaving his wife Martha, three sons and two daughters.

When William Scott died, his brother James continued to operate the business. William's sons were still young. John was seventeen, William and Christopher, thirteen and six years respectively. However, as soon as the young John Scott II had completed his education he joined his uncle James in the family firm in 1772. The next fifty years of the Scotts as shipbuilders was to be dominated by the leadership of this young man.

Around 1780, John Scott II (1752-1837) was joined in the business by his younger brother William Scott (1756-c.1840). By this time their uncle James had withdrawn from business and the firm was renamed as "John and William Scott." It continued as such until 1797, when William left to open a timber merchant's business in Barnstaple ultimately moving it to Bristol in 1810.

John Scott II led the business between 1773 and 1820. He is described in the family papers as being "clever, shrewd, and of a very cheerful temperament." He was also held to be a very punctual individual dedicated to the development of the yard. These qualities were very valuable in a time when local competition in shipbuilding was increasingly severe, as demonstrated by the growth of local yards.

It is clear that Greenock was a hive of shipbuilding activity at this time. In addition to the Scotts there was the Halliday yard opposite their premises, this yard passing to the control of the McKechnies. At the foot of Virginia Street was Love's yard, while nearer the Auld Kirk there were the yards operated by David Porter and Morgan and James Munn. In addition, at Rue End, there were the yards operated by Duncan Smith and John Wood. Consequently, in the 1770s there were at least eight yards in close proximity competing for business. A ninth yard, that of Steele and Carswell came into operation in 1786. However, most of these were of relatively short duration, and apart from the Scotts only Munn, Steele and Carswell and Wood continued in business for any length of time. The only other significant addition to Greenock shipbuilders at this time was the commencement of William Simons at the Rue End in 1810.[8]

It was in this intensely competitive environment that John Scott II gradually began to diversify his business away from its specialisation in herring busses and into the construction of larger craft. The ship registers in the Greenock Custom House clearly show Scotts making this transition. Between 1773 and 1822, John Scott built more than 100 ships at Greenock including gabbarts, wherries, sloops, schooners, brigs, barques and square rigged ships, with tonnages ranging from 33 to 647 tons. Only about 20 of these ships exceeded one hundred feet in length, and square rigged ships predominated in the later years.[9]

As the market demanded larger ships, Scott responded with two notable vessels, the 'Brunswick' of 600 tons in 1791 and the Caledonia of 650 tons in 1794. These were timber carriers for the local firm of Hunter and Robertson. The 'Brunswick' entered the Nova Scotia trade, while the 'Caledonia' carried timber for the Royal Dockyards. The ships were the largest built in Scotland in their respective years.[10] 1794 also saw the Scotts build their first ship for the Royal Navy - the 'Prince of Wales' - originally constructed for the Revenue Service and later converted to a sloop of war as H.M.S. 'Thrush'.

At the turn of the century he embarked on a major expansion at West Burn, building a large drydock and a fitting out basin there, (See Fig. 2/6), thus greatly enlarging the yard's capacity for repair work and allowing him to increase his labour force considerably.

As the trend to building larger wooden ships developed, there was a growing concern that the conventional method of construction, whereby the transverse ribs, connected together by the outside planking and the ceiling with no filling between the ribs, was vulnerable to the stresses encountered due to the hogging, sagging and racking motion of the ship in heavy weather. This in turn led to distortion of the frame planking assemblies resulting in leakage.

SEPPINGS NEW SYSTEM OF FRAMING.

At the beginning of the nineteenth century the Royal Navy was also keen to increase the size of its ships and Sir Robert Seppings at the Admiralty introduced and perfected a new system of framing which was a great stride forward and was immediately adopted by Scott & Sons.[11]

The system involved installing additional frames which were placed diagonally between the parallel frames, and also between the parallel deck beams which gave the whole structure much greater strength and rigidity. A trussed frame was laid on the inside of the transverse frame in the hold of the ship, and the decks were laid diagonally. The greatest benefit was that since hulls did not work so much in heavy weather, their planking did not open, and they remained much drier inside. The long term benefit was that hulls could be made much longer without hogging, and when the time came could bear the weight of boilers and machinery.

THE CANADIAN VENTURE.

As the Napoleonic conflict impacted on trade and shipping, it is clear that John Scott II perceived a number of opportunities. He pushed hard to meet local Greenock demands for larger vessels to cope with growing trade and simultaneously was taking steps to capitalise on the shortages and needs arising from the war with France, especially due to the losses of shipping to French privateers.

After five years of war, timber for shipbuilding which normally came from the Baltic countries was in short supply because of hostility to Britain from Russia, Denmark, and Sweden.[12] The price of ships rocketed, old worn out ships fetching up to three times what they had cost when new and Scotts had themselves sold a number of their own ships at inflated prices.[13]

Scotts considered a number of options to solve their timber problem, but when advised by a local merchant, Alan Ker, much experienced in trade with Canada, of the potential timber supply available there, and the presence of a number of shipyards at Saint John, New Brunswick, (at that time in decline due to increased competition from America in trade with the West Indies) John Scott II decided to send a team of skilled shipbuilding personnel, carpenters, blacksmiths, etc., led by his brother Christopher to set up a new Scott shipyard at Saint John, New Brunswick.

The idea of sending the skilled tradesmen was to provide training to ensure that the working practices and quality standards in use at Greenock would be established at an early stage in Saint John, New Brunswick.[14] Accordingly, two small ships set out for Canada crammed with shipbuilding materials and equipment not readily available there, e.g. copper nails, and sheathing. They arrived in March 1799 and Christopher immediately set about acquiring a site for a shipyard, and later began recruiting labour. He wrote to Greenock advising that he had engaged a Mr. Barlow whom he described as a "natural born exponent of our art, with an eye for the practical use of his native timbers which makes it imperative that we employ him." Scott advised Christopher to buy any new seaworthy ships he could, fill them and the new ships built by him with timber cargoes, and despatch them for resale on the Clyde. Not only oak and pine for shipbuilding were sent but also large quantities of black birch which were eagerly sought by the newly emerging furniture industries of Paisley and Beith.

At the same time John Scott II urged Christopher to lay down as many new ships as possible, with the warning that the New Brunswickers he employed should be strictly watched lest they used too many of the valuable copper spikes in fastening the bottom planks of the vessels - "a very bad colonial custom, and the sooner it's put a stop to the better!" he wrote. He also urged that the vessels should be rigged "neatly, and not after the manner and fashion of Saint John!"[15] The first of the new ships, the 'Carleton' was completed in October 1799 and reached the Clyde four weeks, later, where it was judged by John Scott II to be "tolerably well built!!" - praise indeed![16]

This profitable business continued for some years - in the first two years some nineteen new ships were built, and sent to the Clyde with timber. It was only made possible by the contacts made by Christopher Scott in the dominant Scottish mercantile community, and the cooperation of local builders, timber suppliers and workmen which this ensured, as well as the powerful backing of his brother back home in Greenock. It was an outstanding example of the projection of early industrial Scotland into the colonial scheme. An amazingly large scale operation for its day, involving the transfer of hundreds of workmen, hundreds of sailors for crews, and thousands of tons of cordage, copper sheathing and fittings, anchors and chains, sailcloth and rigging, tools and chandlery from the Clyde to service the new vessels.[17]

Great quantities of rum, whisky and gin were also exported. As in other British colonies, currency was scarce, and much of the trade was carried out by a system of barter, with liquor, especially rum, almost serving as a negotiable currency, always acceptable because the rate of local consumption was high, and spirits unlike so many other perishable commodities, kept indefinitely![18]

Christopher Scott developed a similar trade in new ships with the West Indies, ships and lumber cargoes being sold on arrival in Jamaica. The Scott built ships were reputedly "superior to most ships from that quarter (i.e. New Brunswick)" and Scotts were able to secure prices as high as £17 per register ton and make good profits on the sale.[19]

BRIEF RESPITE.

After the Peace of Amiens in 1802 between Britain, France, Spain and Holland brought a temporary reduction in shipbuilding activity, Christopher Scott returned to Greenock for a time, but with the resumption of war and a desperate shortage of shipbuilding timber, a fresh boom began in the Maritimes and Scotts opened up new contacts with shipbuilders at Pictou, supplying them with copper and iron items. They also engaged in the Highland emigrant trade, and continued their Saint John and other colonial connections. As evidence of the "Scottish connection" in the Atlantic area, Scotts imported seal oil for use in lighthouses from William Forsyth in Halifax, and despatched ship loads of rum to James Dunlop in Montreal, importing wheat from him, and offering him cut freight rates for Clyde bound cargoes.[20]

THE 'MARY' EPISODE.

Christopher Scott frequently took command of new ships built at Saint John, New Brunswick, for the delivery voyage to the Clyde. He built a small brig of excellent quality, the 'Mary' in 1803, and made two profitable voyages to the Clyde in her. However, in May 1805 he was returning in the 'Mary' to New

Brunswick, loaded with salt for the fisheries and manufactured goods and whisky for the timber trade when disaster struck.

It was the year of Trafalgar, and the French and Spanish privateers continued to threaten British merchant shipping in the Atlantic. Christopher Scott felt that by going north about outside the Hebrides he would avoid the enemy. Unfortunately, just off Barra, a fast barque began to overtake the 'Mary', flying the tricolour of France. Scott cracked on all sail, and hoisted up the flag of the United States, hoping to be taken for a neutral. However, after a warning shot from the French ship, Scott hove to, and a boarding party led by the captain came aboard.

Initially, Christopher Scott appeared to have persuaded the French captain that he was in fact a neutral. However, the captain became suspicious and suddenly ordered the ship's boy to be flogged. The boy, terrified, confessed that the 'Mary' was indeed a New Brunswick ship. The furious captain then ordered his men to plunder the vessel, removing the whisky and gunpowder and thereafter sank the 'Mary' with a broadside. Christopher, and his crew rowed ashore in the ship's boats and made their way back to Greenock. Fortunately, the 'Mary', was well insured, and Christopher purchased a new and larger ship, the 'Wilson' of Liverpool for which he took out "letters of marque" entitling him to attack enemy merchant ships, while engaged in normal trade as well. Unfortunately, for him, no great prizes came his way.[21]

TRADING ON THE LINE.

In 1810, Christopher Scott moved to the border town of St. Andrews, New Brunswick, where he erected a large warehouse for the storage of luxury goods, imported silks, muslins, fine linens and cottons, and elegant hand crafted furniture imported from Beith and Paisley in Scotland. His move was not altogether unconnected with a situation which had developed arising from the policies of the United States in cutting themselves off from all contact with Great Britain and its colonies.

However, in the United States there was a great need for manufactured goods from Britain and in Britain there was a ready market for American flour, cotton and tobacco. Understandably, smuggling on a grand scale developed from which huge profits were made. This activity was known as 'trading on the line', and in American eyes was illegal. The trade was clearly hazardous, but this did not deter Christopher Scott, who used small craft on the coast of Maine and the Bay of Passamaquoddy to dispose of his goods to American traders and to receive in turn American produce for re-export to Britain at a very handsome profit.[22]

BENEFACTIONS.

In 1812 Christopher Scott provided from his own resources, land and money, to build a blockhouse on the point of St. Andrews to defend the town, and which stands as a memento of the War of 1812. After that war he paid for the building of the Greenock Church in St. Andrews, designed by Scottish architects and built by Scottish craftsmen from the shipyards. It was modelled on the Mid

Kirk in Greenock and still stands, one of the finest 'colonial' churches in North America.

By 1820, Christopher Scott was recognised as one of the wealthiest men in the Maritime Provinces of Canada with considerable property in St. Andrews and St. John, New Brunswick, a shipyard, a country estate on the banks of the St. John River and two estates, Blackstone and Quarter in Ayrshire, Scotland - all achieved in twenty two years.

He took an active role in the foundation of the Bank of New Brunswick in April 1820 and also in setting up the Charlotte County Bank in his own headquarters in the town of St. Andrews, New Brunswick. In his later years he partnered his brother William in a number of ship owning ventures.[23]

He died in London in 1833, and was buried in All Hallows Church, Barking. He bequeathed his estate to his son, William Scott, of St. Andrews, New Brunswick, who having been killed in a shipyard accident (also in 1833) had in turn bequeathed his estate there for the endowment of a school for the maintenance and education of indigent children in Greenock.[24]

CORRESPONDENCE WITH ST.JOHN.N.B. (1799-1800) See Appendix 1/2.

The letters exchanged between the brothers John and Christopher Scott during 1799 and 1800, always at risk from the perils of the deep and the ravages of enemy privateers, give a most revealing commentary on the men concerned and on this remarkable episode in Scotts history. In spite of being three thousand miles away it is very clear that John Scott was in command and that Christopher was expected to do as he was told!

John's intense interest in all aspects of the project comes through in the range and nature of his detailed observations. In matters such as procurement of timber, he drew on his considerable experience to protect Christopher from exploitation. He was particularly critical of Christopher's failure to report progress regularly, and he was anxious also to be kept informed of the behaviour of the members of his staff. "How does Mr. Ewing and Mr. Taggart behave and the blacksmith? Write us particularly in your next (letter)."

THE UNFORTUNATE CAPTAIN PINCHER.

Scotts' outgoing letter books of the period embracing 1798-1817 provide further commentary on Scotts various business interests.[25] Ship owning and chandlery predominate with many references to their ships 'Fleece', 'Union', 'Nancy', 'Countess of Chatham' and 'Diamond', trading to Barnstaple and around the Irish Sea with occasional visits to the Baltic, mainly with timber cargoes. However, there are many references to other commodities, copper (sheeting and spikes), iron fittings, anchors, chains, pitch, varnish, resin, cod, seal and whale oil, turpentine and tar.

It was John Scott's habit to address a personal letter to the captains of his ships prior to their departure. The sample which follows is typical, and left Mr. Campbell of the 'Ruby' in no doubt as to his responsibilities.

Mr. John Campbell, *4th December, 1835.*
Schooner 'Ruby'

Sir,

Having entrusted you with the command of our vessel, the Ruby - let it be clearly understood that the conditions on which you have received that charge are:-

First - *Strict sobriety of conduct.*

Second- *Pushing to the uttermost of your power to make short passages and never on any account letting any opportunity escape to take advantage of favourable shifts of wind.*

Third - *Should you be obliged at any time to take shelter in intermediate ports.*

Fourth - *Avoid familiarity with your crew.*

Fifth - *The vessel must be kept constantly clean, and have the ropes about the decks always made up snug, and out the way of receiving injury when loading, or discharging cargo.*

Sixth - *The decks to be washed down every night after breaking off from working cargo.*

Seventh - *Strict economy with regard to your stores and the materials of the vessel to be carefully kept.*

Eighth - *Correct account to be taken by yourself or your mate of cargo taken aboard or discharged. You are wholly liable for all mistakes that may occur by negligence if you act otherwise.*

Ninth - *Be careful before proceeding to sea that your hatches are well caulked, and secured over with tarpaulins. Much damage frequently occurs at hatchways.*

Tenth - *Bear in remembrance that the disbursements of your vessel will undergo frequent comparisons, and on no account give money to any of your crew in Liverpool, or other ports as their wages are always settled up here.*

On arrival you will wait upon Messrs. Arthur Oughterson & Co. who will make arrangements for the discharge of the cargo, and providing freight in return.

Wishing you every success,

We are, etc.,

From the correspondence concerning the voyage of the Scott ship 'Fleece' to Bremen (October 1798 - August 1799) - (See Appendix 1/3), - it is clear that Captain Pincher of the 'Fleece' had ignored John Scott's instructions and paid the penalty!!

The 'Fleece' sailed (belatedly) from Leith with a cargo of tobacco for Bremen in late November 1798 and seemingly disappeared! In those days the only method of keeping track of ships at sea was by the use of flag signals exchanged by passing ships which were subsequently logged in port with the company agents.

Nothing was heard from Captain Pincher for two months when it was reported that he had been driven into Norway. A further three months later he was still in Tharsand, Norway, allegedly unable to leave because of the presence of privateers of the enemy. A further three months passed before he arrived at Leith and having passed through the Forth and Clyde Canal he arrived at Port Dundas on 3rd August 1799. Having long suspected Captain Pincher of trading on his own account, John Scott, with the assistance of his Glasgow agent, was able to thwart the Captain's attempt to abscond with the proceeds of the voyage. Captain Pincher was thereafter dismissed.

INDUSTRIAL RELATIONS.

Organised collective bargaining between masters and men was still decades away but tucked away in Scotts outgoing letter books amongst the correspondence in April 1799 with Christopher Scott there is an indication of Scott and Sons being in dispute with their workers. There were numerous trade guilds already established in Greenock including the Master Wrights (1731), Ship Carpenters

(1738) and Gardeners (1742) but it seems unlikely that they had any negotiating rights in respect of working conditions.

The letter which follows makes it clear that faced with a strike by some of his workers John Scott was unsure as to how to proceed.

It would seem that Peter Wilson of Leith, a timber merchant with whom John Scott had many dealings (he acted as Scott's agent on occasion) had successfully broken a strike by his workers by resort to the Courts and John Scott was contemplating similar action.

15th April 1799.

Sir,

We are duly favoured with yours of the 13th. As the carpenters have broke off here and we wish to take active steps to bring them to their duty again we will thank you to answer the following questions:

(1) What illegal steps were they guilty of or how was the combination proven?
(2) Were the Masters at the whole expense or were they assisted by the Merchants?
(3) Who were the prosecutors?
(4) How were the leaders of the combination discovered and were they taken up without having committed any assault on those who were willing to work or threatening them?
(5) In case of application to the Lord Advocate what is the method to be taken?
(6) Did your foremen and apprentices continue to work?
(7) Is your foremen agreed by the year, week or day?

Any other light you can throw upon it will be very kind, and we will thank you to write in due course.

Yours, etc.,

As will be recorded later, almost thirty years passed before any further reference appeared in correspondence to labour problems.

As by far the most important shipbuilding employer on the Clyde, John Scott was well placed to recruit local high quality tradesmen and apprentices.

His ability to switch labour between new construction, repair work and salvage operations allowed him to offer full employment which his competitors could not do, and his long established reputation for high quality workmanship must have attracted the best apprentices.

THE CHALLENGE OF STEAM.

Towards the end of the Napoleonic Wars the launch in 1812 of the steamship 'Comet' was an historic event marking the start of the long transition from sail to steam navigation on the world's oceans which will be addressed in the next section of this work. Predictably, within three years, John Scott II delivered two shallow draft steam paddle boats for Glasgow owners and in successive years the firm delivered the largest paddle steamers built in the United Kingdom in 1819, 1820, and 1821 - 'Waterloo' in 1819 inaugurated the regular steamship service between Belfast and Liverpool - 'Superb' in 1820 was built for the Naples-Palermo service - and 'Majestic' in 1821 was placed on the Clyde-Liverpool service. Because of her draught which in 1821 was too great for navigation of the upper reaches of the Clyde, passengers were conveyed to Greenock to join the steamer there by the small paddle steamer 'Post Boy'.[26]

This innovation came towards the end of over forty years of business leadership during which John Scott II had striven to mould and extend the firm he had inherited from his father. His record of achievement, sustained over such a long period was remarkable. Not only had he built over one hundred ships, he had made the transition from small boat builder to a leading shipbuilder of large square rigged vessels. Moreover at the age of sixty three, when many men would have been contemplating retirement, he launched his company into the risky waters of steam navigation. In construction of their large paddle steamers 'Waterloo', Superb', and 'Majestic' between 1819 and 1921, Scotts could justifiably claim to be the leading shipbuilders on the Clyde, a fitting testament to their first century in shipbuilding.

But while the Scotts could claim leadership in shipbuilding on the Clyde at this time, that position has to be seen in relation to shipbuilding in Scotland as a whole and also to Scotland's place in United Kingdom ship construction at the end of the second decade of the nineteenth century.

A register compiled in 1820 by the Association of Underwriters and Brokers in Glasgow of all Scottish owned ships at that date permits us to put the Scotts contribution in perspective.[27]

The ships recorded on the Register in 1820 totalled 2851 vessels of 273,453 tons. Their year of build ranged from 1765 to 1820. An analysis of the Register is presented in Tables 1/1 to 1/4.

Table 1/1

DISTRIBUTION OF FLEET IN RESPECT OF REGISTRATION.

1820

PORT	No. of Vessels.	Tonnage	Percentage of total tonnage
Glasgow	89	6,842	2.5
Port Glasgow	118	18,511	6.8
Greenock	338	44,107	16.1
Other Clyde Ports	320	22,224	8.1
Other Scottish Ports	1,986	181,769	66.5
Total	2,851	273,453	100

Table 1/1 analyses the port of registration and shows that 34 per cent of Scottish tonnage was registered on the Clyde, with Greenock as the leading port. However, the main port of registration was Aberdeen with Greenock in second place followed by Leith.

Table 1/2

ORIGIN OF SHIPS ON REGISTER.

1820.

Origins of Vessels	No. of vessels	Tonnage	% of total tonnage	Average Tons per vessel
Prizes	162	19,596	7.2	120.9
British built (not in Scotland)	407	57,516	21.0	141.3
Foreign built	48	11,947	4.4	248.9
Total	617	89,059	32.6	144.3
Built on the Clyde	468	42,213	15.4	90.2
Built on the Forth	611	46,704	17.1	76.4
Built elsewhere in Scotland	1,155	95,477	34.9	82.7
Total	2,234	184,394	67.4	82.5
Total built outside Scotland	617	89,059	32.6	144.3
Total built in Scotland	2,234	184,394	67.4	82.5
Total	2,851	273,453	100	95.9

Table 1/2 seeks to clarify the origin of these vessels. It is clear that Scotland imported one in twenty of her ships from outside the United Kingdom, one in fourteen was a prize and one in five was built in England, Ireland, Wales, the Channel Islands and the Isle of Man. In general one ship in three was built outside Scotland. It is also clear that at that time the River Forth was a more important centre of shipbuilding than the River Clyde.

However, it is apparent that the average tonnage per vessel launched on the Clyde was greater than the general average of those built in Scotland. This was due to the port of Greenock which was responsible for the majority of large vessels launched in Scotland as shown below:-

Table 1/3

ORIGIN OF ALL SHIPS OF OVER 400 TONS IN SCOTTISH REGISTER. 1820.

Origin of Vessels	No. of vessels	Tonnage	% of total tonnage	Average Tons per vessel
British built (not in Scotland)	4	1,802	18.1	450.5
Foreign built	6	2,857	28.7	476.2
Built in Scotland				
Built in Greenock	9	3,956	39.7	439.6
Built in Aberdeen	2	949	9.5	474.5
Built in Peterhead	1	400	4.0	400.0
Total	22	9964	100	452.9

Only ten vessels built in Glasgow appeared on the register, the largest built in 1807 was only of 96 tons. The minor role played by Glasgow at this time was, of course, due to the river being innavigable above Port Glasgow to any but the smallest ship until the 1830s.

Finally, an analysis of the birthplace of ships built in the West of Scotland produced the table shown below which confirms the leading role played by Greenock and Port Glasgow.

Table 1/4

PLACE OF BUILD OF WEST OF SCOTLAND BUILT SHIPS

IN SCOTTISH REGISTER

1820.

TOWN	TONNAGE	% of TOTAL TONNAGE
Greenock	19,483	48.7
Port Glasgow	6,510	16.3
Ayr	3,990	10.0
Irvine	3,142	7.8
Dumbarton	2,482	6.2
Saltcoats	2,356	5.9
Bowling	818	2.0
Troon	672	1.7
Other Clyde Ports	544	1.4
Total	39,997	100.0

It is clear from this analysis of the 1820 register of Scottish owned ships that, with the exception of Greenock and Port Glasgow, the River Clyde's contribution to Scotland's shipbuilding output was small, and the industry in the West of Scotland was of minor importance. In a United Kingdom setting, the role of Scottish shipbuilding was comparatively minor at this time when compared with the activity on the Thames and the South Coast of England.

The official returns indicate that Scotland built only 15 per cent of all U.K. tonnage in 1820.

LOOKING TO THE FUTURE.

In 1810, John Scott II, in anticipation of his ultimate retiral purchased the Hawkhill estate at Largs in Ayrshire from Sir Thomas Brisbane. In subsequent years whilst still directing affairs at the Westburn shipyard, he devoted much time and energy to developing the estate and laying out the plantations which involved planting fifty thousand trees.[28]

Fig. 1/3 shows Hawkhill (c.1870) which John Scott originally intended should house the estate offices and stables. However, during the long building period he grew attached to it, and gradually turned it into the fine dwelling house shown, and it became the family seat for the next one hundred and fifty years.

While no financial data of the period has survived John Scott was clearly a very wealthy man. Daniel Bishop Davy (1799-1874) from Devon visited Greenock on 28th September 1818, and toured the Scott, Steele, Simons and Carsewell shipyards. In his 'Memoranda Book' Davy remarks that "Mr. Scott is worth a great deal of money, reports say £150,000."[29] It is possible from Scott's correspondence to assess the relative contributions of the various sectors of the business. Ship repairing, ship owning, ship broking, and chandlery activities predominated with finely judged speculative ship building absorbing labour surplus to requirements when ship repair work was temporarily unavailable. There are also a number of references in Scott's letters at this time to ship salvage operations having been undertaken by him in areas ranging from the Clyde Estuary to as far away as Lochinver in north west Scotland.[30]

His sons, John Scott III and Charles Cunningham Scott I, took a great deal of responsibility off him as the nineteenth century got under way with many new challenges ahead, in particular the arrival on the scene of the iron ship, and the continuing development of the marine steam engine, topics which were to lead to serious disagreement between them in later years.

So in 1820, and in spite of significant deepening of the channel above Bowling, Greenock still remained the main Clyde port for the transatlantic and long distance trades. Scotts had completed their first century of shipbuilding on the Clyde, and as the firm passed to the hands of John Scott III and Charles Cunningham Scott I, the greatest achievements of the Scott family were still to come.

<u>CHAPTER ONE</u>.   <u>REFERENCES</u>.

<u>No</u>.

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   Port Glasgow - 20th October 1699.
   Account of prime cost and charges of outrick provisions and cargo on board the Indian and African Company's ship, the 'Speedy Return', Captain John Baillie, Commander for Caledonia, disbursed by William Arbuckle, Merchant in Glasgow.

   For account of said Company, viz:-

   November 9, Paid to John Scott, Carpenter p.acc. viz:-

5 bear pumpes at 2s. ster. per pss.	0 - 10 - 0
1 sheave to ye long boat mast	0 - 0 - 2
1 long boat's mast making	<u>0 - 2 - 0</u>
	0 - 12 - 2
Deduced of ye above account	<u>0 - 0 - 6</u>
	0 - 11 - 8
Paid p. receipt	0 - 11 - 8

   November 17 Paid to John Scott, Carpenter.

2 log realls p. his receipt	0 - 3 - 0

3. R.M. Smith. <u>The History of Greenock</u> (Greenock, 1921), p.17.

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(Chapter 1 References Continued).

No.

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No.

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33. Grahame Farr - letter to Rev. T. Willis, 8th May, 1970.

34. Ibid.

35. Grahame Farr - Records of Bristol Ships (1800-1838) p.3.

36. Ibid. p.4.

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SCOTTS' of GREENOCK

Family Involvement in Management. 1711 - 1978

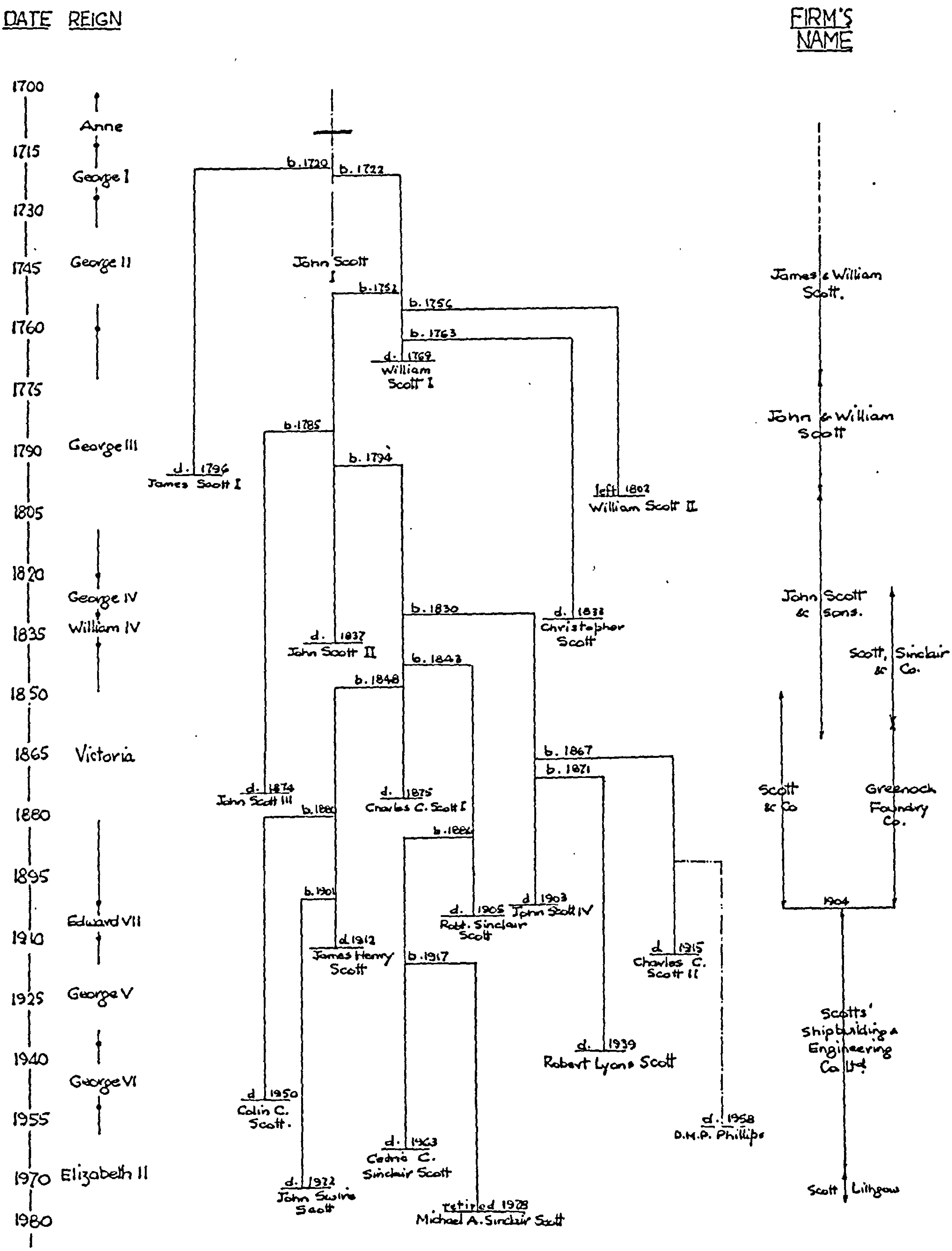
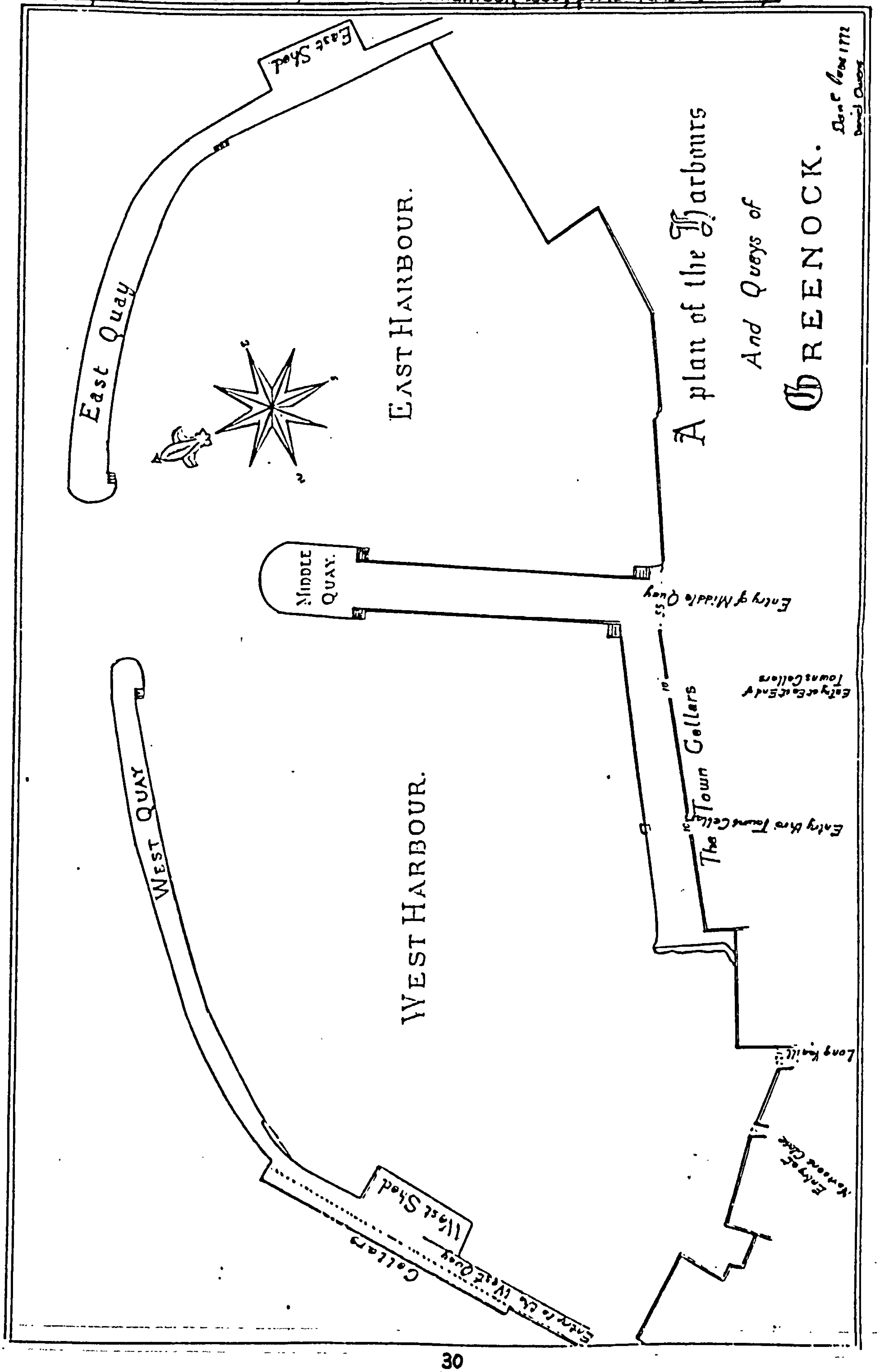


Fig. 1/2 - from 'Old Greenock' - Geo. Williamson 1886, pub. Gardner : Paisley.



Hawkhill c. 1890 —— Scott Family Photograph. Fig. 1/3

Fig 1/3

PART ONE.

1820 - 1860 - FROM SAIL TO STEAM.

CHAPTER 2.

THE LONG FAREWELL TO SAIL.

CHAPTER 2.

THE LONG FAREWELL TO SAIL.

John Scott II was joined in the business by his sons John and Charles who progessively took over the operation of the business from the end of the Napoleonic Wars. John Scott II however maintained an active role up to his death in 1837 and it was he who initially faced the challenge of the marine steam engine. As we have seen John Scott II quickly recognised the opportunities presented by this development and he was among the earliest steamboat builders on the Clyde.

In the early years of steamboats the installation of machinery in wooden hulls was a relatively simple matter. The engines were of low horsepower driving paddles and they required no concessions to ship design and posed no problems to progressive shipbuilders like the Scotts. John Scott II originally obtained most of his engines from David Napier of Glasgow, but quickly recognised the disadvantages of this arrangement. Consequently, in 1825, after ten years experience in building steamers, Scott decided to build his own propelling machinery and free himself from the constraints and risks on price and delivery posed by a reliance on sub-contractors.

In that year he formed a partnership with Robert Sinclair (his future son-in-law) and together they purchased a local brass and iron foundry which had been established in 1790 by Burrows and Lawson. They sold it in 1796 to William Brownlie, who in turn sold it for £5,000 to the new company known as Scott Sinclair & Co. (Robert Sinclair, managing partner).[1] On acquiring the works Scott Sinclair greatly enlarged the facilities with their new pattern, machine, boiler and fitting shops and smithy forge, together with offices and stores being added. (See Fig. 2/1).

The formation of Scott Sinclair & Co. enabled Scotts to build and instal their first set of steam propelling machinery in the paddle steamer 'Trinacria' (ancient name for Sicily) in 1825. The ship was destined for coastal work in the Mediterranean, plying between Naples and Palermo. She later became the 'Hylton Joliffe', one of the first ships employed by the General Steam Navigation Co. on their London-Hamburg service.[2]

It is interesting to note that Daniel Weir in his 'History of Greenock', published in 1829, noted that in their first four years:-

> *"they have manufactured some splendid engines and - what is more to be looked for than the appearance - they have wrought well!!*
> *They have in hand the largest engine ever made which is of a size of horsepower, and is intended for a vessel building at Bristol.*
> *The number of men employed amounts to about 220 and the weekly distribution of wages is £180."*[3]

In the period 1825-30, when the whole of the shipbuilding industry in Britain was in deep depression and the annual average output declined by almost half, John Scott & Sons built thirty two ships. These comprised twenty five sailing vessels and seven steamers, a ratio of one steamer to 3.6 sailing vessels compared with one steamer to thirty sailing vessels in the U.K. as a whole.[4] In the period 1831-37, years of modest recovery, Scott and Sons built a further twenty six ships, fourteen sailing vessels and twelve steamers, one steamer to 1.17 sailing vessels, compared with one steamer to 16.4 sailing vessels in the U.K. as a whole. Indeed in the entire period 1825-37, Scott Sinclair and Co. built twenty nine sets of machinery including ten sets for other shipyards located in Leith, London, Waterford and Australia, indicating an active pursuit of steamship orders.

This period of intense activity in exploiting the new steam engine culminated in John Scott's death in 1837. At this juncture the terms of his will proved to be a source of dissension between his sons. Four months before his death Scott had decided to let his family see his will, since he hoped by doing so he could demonstrate, as he said, "that you may see it is right, as I wish to please you all." (Fig. 2/2)

The will made some provision for all four children, William Scott III, John Scott III, Charles C. Scott I and Margaret Scott, married to Robert Sinclair, managing partner of Scott, Sinclair. Of these four only John III and Charles I were active in the business at the time of their father's death.

In his will John Scott II 'devised' his estate Hawkhill to his son John, the building yard and its adjacent properties to his son Charles, and part of further properties at the Mid Quay to his daughter Margaret and her husband Robert Sinclair at that time manager of Scott, Sinclair & Co. Provision was also made for his son William, who had been forced to retire from the business by ill health. In addition to these settlements, Scott had already disposed of much of his moveable property through earlier arrangements. In 1832 he had purchased the Garvel Park estate, east Cartsdyke and installed his daughter and son-in-law, Mr. and Mrs Robert Sinclair there. Moreover he had transferred his capital in the John Scott & Sons business to his sons, so much of his money in the bank to his sons, and all of his stock and profits in Scott, Sinclair & Co. to his sons and to his daughter and son-in-law.

His attempt at even handed treatment did not please everyone. John was far from happy with his father's will and felt that as the elder brother he should have had both the building yard and the family estate, Hawkhill. Understandably Charles was unimpressed by this argument and bearing in mind that both men were middle aged and had spent their entire working lives in the business one must feel some sympathy for Charles.

All of this information and reaction to it was recorded in memoranda at the time by Mr. Scott's son-in-law, Robert Sinclair, who was highly regarded and trusted by both brothers. (See Fig. 2/2). John Scott III wrote to his father indicating that he and brother Charles would prefer that the West Burn yard and its appurtenances should go to him and that Hawkhill should go to Charles. (See Fig. 2/3). John Scott II agreed to this but as will emerge later, his son John Scott III was in fact very unhappy about his father's will and his obsession in this regard alienated his brother and sister and tested the patience of his brother-in-law.

Subsequent developments tend to support the notion that perhaps John Scott II saw his son Charles as better equipped to cope with the challenges which lay ahead than his son John.

UNEASY PEACE.

After their father's death in March 1837 the brothers continued to run the business, primarily the shipbuilding, repair, ship trading and chandlery activities, while their brother-in-law ran the engineering company, Scott Sinclair & Co. Within Scott & Sons, John Scott III undertook the technical, commercial and administration aspects of the business, whilst Charles C. Scott handled all production and ship repair activities at West Burn. However, on 16th April, 1841, Robert Sinclair died and as a consequence, Charles C. Scott took over as manager of Scott, Sinclair & Co. He and his brother John, together with their sister Margaret, widow of Robert Sinclair were, of course, the principal shareholders in that company.

The period 1837-1851, during which the brothers continued to manage the business, was one which had far reaching consequences both for the Scotts and the people of Greenock. Two of John Scott III's shipyard diaries covering the years 1837-41 and 1847-51 have survived, and this had made it possible to examine the events in considerable detail.[5]

THE SCOTTS PRODUCTION PROGRAMME 1837-51.

The diaries have permitted the reconstruction of Scotts production between 1837-51 (See Fig 2/4). The period was one of alternating expansion and contraction. Output was rising from 1837 to 1840, followed by a sharp contraction between 1841 and 1843, this in turn giving way to a recovery of output between 1844-1851.

Over the entire period forty four ships were built by Scotts, thirty six sailing vessels and eight steamers, one steamer to 4.5 sailing vessels compared with one steamer to 9.2 sailing vessels in the U.K. as a whole.[6] It is interesting to note that when compared with the figures already quoted for the periods 1825-30 and 1831-37, the penetration of the shipbuilding market by steamers in the U.K. had continued to improve although not as much as at Scotts.

However, during 1838-51, with John Scott III in sole charge at Westburn, Scotts performance in this regard had fallen off badly. In the light of subsequent events, it would seem that Charles Scott felt that brother John was somewhat unenthusiastic about steamships. In fairness, however, it must be recorded that in times of depression, shippers were looking for cheapness rather than speed, whereas during a trade boom speed became an important factor.[7]

The majority of ships built between 1837 and 1851 were for local shipowners, ranging in size and type from small cutters and sloops to large ships and barques. The trend towards larger ships continued and the earlier emphasis on the West Indies and Canadian trades was broadened to include many ships for the Far East trades to India, Singapore, China and also to South Africa and Australia. Early connections were established with the liner companies, P. & O, and Royal Mail.[8]

TRADE DEPRESSION - 1843-1844.

Reference was made above to a depression which was country wide, starting in 1842 but affecting the shipbuilding industry in Greenock mainly in 1843-4.

In order to assess the impact of this deep depression on the area it was decided to make an exhaustive search of the Ship Registration books held in the Greenock Custom House embracing the period 1786-1864. The plan was based on the fair assumption that since almost the entire output of the Greenock shipyards was for local owners, then, over the period the search should produce a list of all shipbuilders active in Greenock and Port Glasgow during that time.

The resulting list, Fig. 2/5, includes the names of nearly seventy shipbuilders who were building in Greenock and Port Glasgow during the period 1740-1853, many of whom should perhaps be described as boatbuilders, and many of whom were only active for one or two years. Immediately prior to the 1842-4 depression the following firms had an established presence in Greenock and Port Glasgow:-

John Scott & Sons,	Greenock.
Robert Steele & Sons	"
William Simons & Co	"
James McMillan	"
William Johnston	"
Thomson & Spiers	"
Mories & Clark	"
Robert Duncan	"
John Wood	Port Glasgow
Peter Murchie	"
Ken Mathieson	"

The depression was not confined to the shipyards and engineering works and affected all aspects of trade. The consequent unemployment caused great distress in the area. Some 1960 men out of a total of 3,287 engaged in industry had been discharged and the total might have been higher, but for feelings of humanity on the part of the local employers.[9]

Scotts fared better than most shipyards in the town and it was not until 1843 that they were short of new work. By the second half of that year there were signs of improvement. However, whereas in 1841 there had been several thousand carpenters employed in eight building yards, by 1842 journeymen carpenters who had been earning twenty one shillings per week were employed breaking stones for the roads at one shilling per day. To keep their families as well as other local inhabitants alive, seven soup kitchens were opened throughout the town.

The Greenock Advertiser recorded on 25th January, 1842 that:-

> *"demand at the soup kitchens has continued to increase. 700 quarts of soup and sometimes a greater number of halfpenny scones are issued each day."*

Sadly, of the eleven shipbuilders listed above, only Scotts, Simons, Steele and Wood survived the impact of this disastrous period.

Scotts survived these difficult years not only through their efficiency in building ships, but from their involvement in ship repairing. The diaries give an insight to this side of the business.

Table 2/1.

Year.	No. of Repair Contracts.
1837	76
1838	48
1839	51
1840	68
1847	87
1848	69
1849	65
1850	64
1851	62

Information derived from Diaries See GD319/26/1/1 & 2.

Scotts investment in their dockyard and basin, together with the development of Greenock as an international port, attracted ships from all over the world, and delivered Scotts a very wide clientele.

Ship repairing operated as a different regime from ship construction. Time was of the essence and work went on round the clock at all times at the mercy of tides and weather. It was more likely to be profitable than new building work, because shipowners, desperate to get their ships back into service were less disposed to argue about repair bills! In the period under discussion repair work was also a more stressful occupation requiring quick decisions and much ingenuity in solving difficult problems.

From the diaries it is clear that both John and Charles Scott had to turn out at any hour of the day or night and make quick judgements based on their collective expertise, on the nature and extent of repair work required by a damaged vessel after it had been docked, the dock pumped out and the damage exposed.

In some cases, the damage could be so severe as to require that the ship be virtually rebuilt. However, the diaries show that the great majority of their repair contracts involved re-caulking and re-sheathing work stemming from wracking of the ships in heavy seas. Others related to specific heavy weather damage, masts and rigging carried away, twisted rudders, and of course collisions and strandings. Nevertheless, this work was a major complement to ship construction and was a vital part of the Scott business in the 1830s and 1840s.

The relative importance of the ship repairing activities in the Scott business can in fact be gauged from the surviving yard layout plan (Fig. 2/6). It is clear from this that the prime concern of the business was ship repairing in which Scotts already had one hundred and twenty years experience. This experience clearly influenced their design of new ships, and how they operated their own ships.

It can be seen from the plan that the shipbuilding berths were located on the beach in the north east corner of the yard. On the eastern boundary of the site were large workshops embracing the moulding loft, joiner shop, mast and spar house, machine shop and boat shed. The drydock and basin occupied the western half of the centre ground, the eastern half containing three sawpit areas serving a number of work stations and also a store house alongside the sawpit area which dealt with ships planking.

On the western boundary of the site backing on to the West Burn there was located a large workshop for the manufacture of chain cables, an activity in which Scotts had specialised for over a century. In the same area were located a large smithy and the general stores. A number of boiler/engine units served various work stations, the largest for the drydock pumping plant. Work in progress is not shown but separate work stations catered for the major sub-assemblies - keel, keelson, stem, sternpost, frames, beam shelves, hull and deck planking - whether required for repair or new work.

A detailed description of the construction in the West Burn shipyard in 1839 of the barque 'Culdee' has been derived from the shipyard diaries referred to earlier and is included as Appendix 2/1.

There was clearly considerable movement of timber around the yard to the drydock and building berths. Horse transport was mainly used for dragging logs around. For the erection of large heavy units on the berth, pulley blocks, sheer legs, and the simple inclined plane were used, supplemented by the collective muscle power of the work force.

A full list of the plant and equipment in use in the West Burn shipyard at that time is shown in Fig. 2/12. The entire site occupied six acres. One of the major elements of the business was its provision for timber storage. The Scotts timber ponds were located to the west of the shipyard near the Bay of Quick. Logs were penned in the timber ponds but frequently stormy weather would breach the ponds causing many logs to escape and urgent recovery action had to be taken.[10]

Over their long history Scotts held large quantities of seasoned timber for their own ships and for sale to other shipbuilders on the river. It was a significant part of their business, and their correspondence in the first half of the nineteenth century was dominated by their trading in timber. They were experts in this field and they travelled extensively in the south of England in collaboration with brother William at Barnstaple and Bristol, purchasing timber. They also used their own ships to bring timber to Greenock from locations as far afield as the Baltic, Africa and Canada.[11] For example, their ship 'Essequibo' made many voyages to Africa to bring back teak cargoes.

COMPANY ORGANISATION.

The shipyard plan also enables us to reconstruct how the company was organised at this period.

A shipyard, engineering works or any workplace for that matter is brought to life through the activity of those who earn their living there, and the effectiveness of any such establishment is a function of the organisation and training of its workforce in all aspects of the business, the quality of the design and manufacture of its products, and the reputation derived therefrom in the market place. These comments applied as much in 1840 as they do today, but the means of achieving these aims differed markedly!!

In a modern shipyard the chief executive presides over a series of divisions of his company embracing technical, production, planning, financial, marketing research and development, and personnel functions, each headed by a director, all of whom report to a general manager who in turn reports to the chief executive. Increasingly major contracts are being run by project management teams, each team including representation from each of the divisions listed above.

For the greater part of the nineteenth century all of these functions were performed by the Scotts, with delegation only at foreman level. The long history and collective experience of the Scotts and their workforce helped to make this possible. The Scotts recognised the high level of skill exercised by their men in meeting their quality standards as their greatest asset and treated them accordingly. In a workforce totalling only four hundred and eighty (shipyard and engine works) with a wage bill of £400 per week they knew all their employees personally.[12] Many of their key personnel lived in Scott owned houses within walking distance of the yard.

However, in the 1830s and the 1840s the activities of the Society of Shipwrights were becoming an embarrassment to the shipbuilders on the Lower Clyde and the flavour of their unhappiness can best be gauged from studying correspondence between John Scott and his fellow shipbuilders, samples of which are shown in Appendix 2/2.

RULES AND REGULATIONS.

Fig. 2/7 is illustrative of the Rules and Regulations which applied to the employees in Scott Sinclair & Co's engine works in 1852 and which no doubt also applied in the Westburn shipyard.

The notice whilst couched in easy going terms does not err on the side of leniency.

The working week consisted of six week days each of twelve hours 6 a.m. to 6 p.m. with one hour breaks for breakfast from 9 to 10 a.m. and dinner from 2 to 3 p.m. Each alternate Saturday afternoon only was free, and that only from 3 o'clock, while on the - 'Blind Saturday' - work was carried on until 6 o'clock - an average nett working week of fifty nine hours. During the three winter months outside work commenced at daylight and finished at dusk, a provision, which with the inefficient outdoor gas lighting then available must have been very necessary.

Timekeeping and costing were carried on conjointly, each man having been provided with a slate time board and wages were paid fortnightly. Overtime was paid at the rate of time and quarter but was not paid for until the full normal fortnight's time had been made up.

It is interesting to note that the fines imposed for offences - petty or otherwise - were donated to the Greenock Infirmary.

The justice of the sentence of instant dismissal for being 'under the influence of intoxicating drink' will not be disputed, but the accompanying 'forfeiture of his whole wages due' must have caused the thirsty workman to watch his step - especially towards the end of the fortnight!

APPRENTICESHIPS.

The Scotts offered apprenticeships in the following trades:-

Carpenter (shipwright), blacksmith, rigger, joiner and caulker.

On 17th April, 1799, John Scott II wrote to a Mr. McIver of Campbeltown as follows[13]:-

Dear Sir,

We received yours of 2nd April respecting your son - we will take him on as an apprentice for five years and we will pay him 4/6d. per week the lst year and 5/- the remaining time. We will find him a set of tools if he behaves himself properly. He may enter about 1st May and he must have a cautioner to sign the indentures under the penalty of twenty pounds.

Yours, etc.,

Almost forty years later in August 1838 Mr. John Scott wrote to an enquirer describing the system in the following terms[14]:-

"Lads from 15 to 16 years we bind 7 years, paying a rate of board wages of:-

3/6d.	*per*	*week -*	*1st year*
4/-	*"*	*"*	*2nd year*
5/-	*"*	*"*	*3rd year*
6/-	*"*	*"*	*4th year*
7/-	*"*	*"*	*remainder"*

The weekly wage for a time served tradesman was 21 shillings.

"Lads from 17 to 20 years we bind 6 years, paying a rate of board wages of:-

5/-	*per*	*week -*	*1st year*
6/-	*"*	*"*	*2nd year*
7/-	*"*	*"*	*remainder*

All the apprentices find their own tools of all description."

The earliest indenture agreement which has survived is shown as Fig. 2/8 and was signed by William Smith, riveter who undertook to serve a five year apprenticeship 1861-6 with Scott & Co.

The weekly rates of pay had improved since 1838 to 7, 8, 9, 10, and 11 shillings per week but the terms of the Agreement are by today's standards very onerous and the penalties for absence, legitimate or otherwise, very severe.

SHIP DESIGN.

In tendering to potential customers for new tonnage the Scotts' had the advantage of being able to draw on their extensive portfolio of designs built up over decades, all of which had benefited from Scotts experience as shipowners and ship repairers.

For the larger sailing ships in demand in the 1840s and for the new and larger steamers they were able to extrapolate from their data bank of earlier designs.

There was little or no collaboration between shipbuilders in technical matters, quite the reverse, and so the reputation of each shipbuilding company was determined by the quality of its domestically produced designs.

The Scotts required all their employees, per the Company Rules, not to reveal the company's secrets.

A typical preliminary tender by Scotts in 1840 to the Hayle and Bristol Steam Packet Co. Cornwall is set out in Appendix 2/3 and details the remarkable range of woods employed in high class tonnage at that time.

RESEARCH AND DEVELOPMENT.

In the 1830s and 1840s Scotts put their private drydock to good use in investigating the factors which improved the design of their ships by reducing hull resistance and increasing their carrying capacity per register ton. In this latter respect they were more successful than the designers of the East Indiamen, in spite of the bluff form of the latter. They also carried out extensive experiments on the influence on ship's speed of response to changes in helm whilst tacking. These latter experiments were carried out using full rigged models about 5 feet long, to test ship form and rudder performance.[15] The location for the tests was Loch Thom, a large reservoir located on the hillside behind Greenock.

The diaries and yard plans give a detailed insight into the nature of shipbuilding and the organisation and function of a major shipyard in the middle of the nineteenth century. They also detail the scale of the company just before John and Charles dissolved their partnership and went their separate ways.

THE PARTING OF THE WAYS.

The uneasy peace in relations between John and Charles Scott became increasingly fragile through the 1840s. Two years after his father's death John was still complaining to his brother in law Robert Sinclair about the terms of his father's will and in a manner which suggested he strongly resented the Hawkhill estate going to brother Charles (see Fig. 2/9).

There were other factors emerging which exacerbated the already strained relations. Charles recognised that brother John saw himself as his father's successor at West Burn, head of a famous shipyard which had gained great prestige from the quality of its wooden sailing ships, with substantial business interests in the area, and approaching retirement, with little enthusiasm for confronting the challenges already beginning to appear. John could probably tolerate the steamboats which in his day were sailing vessels with auxiliary drive, but iron shipbuilding was an entirely different matter with new techniques, manufacturing methods and requiring considerable investment in new workshop equipment.

Shipowners, also, were wary of the new developments and John Scott III with the knowledge that orders for wooden sailing vessels still predominated on the market was content to continue as before. The prospect of having to adopt new production methods and to train his workforce in these methods did not appeal to him. In this attitude he was aided and abetted by his shipwrights who bitterly opposed any changeover to iron shipbuilding as a threat to their trade as indeed it was. In the years which followed few shipwrights chose to retrain as iron shipbuilders and many left the industry.[16]

Charles, however was an ambitious and far sighted man, and had an entirely different view.

In the 1840s he was entirely dependent on the success of Scott, Sinclair & Co. for his income. However, as will be seen from Fig. 2/10 the penetration of the U.K. shipbuilding market by steamers in the first twenty five years of Scott, Sinclair & Co. was very slow. Charles Scott diversified into the manufacture of railway engines for I.K. Brunel and a wide range of machine tools, lathes, drills, shapers, punching and shearing machines.[17] He also undertook the manufacture of a number of sets of machinery for naval vessels built in the Royal Dockyards at home and abroad.[18] However, in spite of the company's quality products, it was not very profitable. This was partly due to an agreement Scott, Sinclair & Co. had with the Shaws Water Co. for the supply of hydraulic power to drive the workshop machinery, which was described as 'onerous'.[19]

So with little prospect of assistance from brother John, Charles Scott had to look elsewhere. He recollected Scott, Sinclair and Co. building the first two iron ships built by the Scotts in 1839.[20] These were the paddle steamers Don Pedro and Infante Don Henrique for Portuguese owners to carry passengers on the Tagus and Sado rivers. They were fabricated entirely in the Scott, Sinclair boiler shop and erected and launched in the West Burn yard. So in 1844 he tendered for the construction of the first iron hulled steam frigate built on the Clyde for the Royal Navy, H.M.S. 'Greenock' and Scott Sinclair and Co. were awarded the order on 11th January 1845. H.M.S. 'Greenock' was erected on the ground to the west of the wood shipyard at West Burn on land accumulated by Scott & Sons over the years in preparation for the development of iron shipbuilding, anticipated the building of John Scott III's iron shipyard by three years. The entire hull was fabricated by Charles Scott's boilermakers at Scott Sinclair & Co.[21] Moreover the propelling machinery for 'Greenock' was also manufactured by Scott Sinclair & Co.

H.M.S. 'Greenock' was launched on 30th April 1849 and by the end of that year with over ten years experience of iron shipbuilding, Charles Scott must have felt somewhat persuaded that he would fare better by setting up in business to build iron steamships on his own account. To obtain the capital for such a course he would have had to dispose of his interest in Scott, Sinclair and Co. Unfortunately, in this respect he was thwarted by his brother, John Scott III who, on 31st

December 1849, gave notice to brother Charles of his intention to withdraw from Scott, Sinclair and Co. on that date.[22]

Charles responded by pointing out that John could not withdraw from the partnership until 31st May 1850, the date of the Balance. The ensuing and lengthy correspondence is contained in Appendix 2/4 and supports the view that both brothers wanted out of Scott, Sinclair & Co. for different reasons but could not agree on terms for the disposal of their separate interests.

Charles complained in December 1850 about delay in settling matters and pointed out to John that he (Charles) did not have a large remunerative business to support him and that if there was no settlement soon he would not remain as manager at Scott, Sinclair & Co. as he regarded it as imperative that he take up another business to support his large family.[23] Finally, in March 1851, Charles sold out to John for the sum of £14,000 sterling.[24]

So, after a lifetime of partnership in the various family concerns, the two brothers went their separate ways. At this time John Scott III was sixty six years of age and Charles C. Scott I was fifty seven years of age.

ANOTHER GENERATION.

At this critical point in the Scott family history, it is appropriate that two new players in the drama come on stage.

The eldest sons of both John Scott III and Charles C. Scott I were both called John Scott, identified by the family as John Scott, jr. and John Scott yst. (later John Scott IV) respectively. John Scott, jr. was latterly in partnership with his father in John Scott and Sons and Scott, Sinclair and Co. but subsequently played no significant part in the family history. John Scott IV on the other hand became probably the most outstanding member of the family throughout its entire history.

A NEW BEGINNING.

Remarkably, John Scott III did not after all dispose of the Scott, Sinclair business in 1851. Instead, in partnership with his son John Scott, jr. he embarked on a massive investment programme. At Scott, Sinclair and Co. he installed new power plant and added a large new turning shop containing twenty new lathes and six planing machines. He also, at last, built a new iron shipyard and equipped it with powerful metal working machinery - plate and angle iron furnaces, punches, shears, drills, and rivetting machines.[25] - all of which suggests that his principal motive in the earlier confrontation with Charles had been to sever all connection with him.

Meanwhile, within weeks of leaving Scott, Sinclair and Co. Charles had formed a new company, Scott & Co. shipbuilders, in partnership with his son, John Scott IV, (who had just come of age) to build iron vessels, steamers where possible.

In the light of John Scott IV's subsequent career and notwithstanding his youth at the time, it seems likely that this brave decision by his father Charles, was enthusiastically supported by if not prompted by him. Charles C. Scott's new shipyard at Cartsdyke was located on a green field site on the Garvel Park estate owned by his sister Mrs. Robert Sinclair and it was from that yard that Scott and Co's first iron steamer, P.S. 'Gourock' was launched on 18th February, 1852.[26]

A FATEFUL DECADE. (1852-1862).

The decade which followed saw remarkable changes in the fortunes of John Scott III and Charles C. Scott I. In spite of his investment programme John Scott had lost his shipyards and his engine works. In contrast, Charles Scott and Co. had been extremely successful and had acquired an international clientele for their iron steamships.

The eclipse of John Scott and Sons culminated in the sequestration of their estates in November 1861. At the bankruptcy hearing in the Sheriff Court House, Greenock on 30th November, 1861 John Scott, jr. attributed their downfall to the accumulation of debt owing by the concern during a period of dull trade.[27] The iron shipyard opened in 1852 was sold by the Clydesdale Bank in June 1862 to McNab and Co. for £15,000[28] and the West Burn wood shipyard and drydock in December 1862 to Caird and Co. for £30,000.[29] In February 1859, Scott. Sinclair and Co. which had been offered for sale in 1858, was purchased by Charles C. Scott's son, John Scott IV and his partners. (See Fig. 2/14)

In the absence of family correspondence for the period 1852-1857 (destroyed during German air raids on Greenock in May 1941) it is not possible to say with certainty what went wrong at the West Burn during that critical period. John Scott jr. who had been left to run both yards and the engine works may not have been up to the task. The absence of Charles Scott from the scene must have been a major factor. It is also very probable that some key personnel from West Burn and the Scott, Sinclair engine works joined Charles Scott at Cartsdyke.

COMPARISON OF PERFORMANCE.

To assist in further analysis of the failure of John Scott and Sons Table 2/2 has been prepared contrasting the performance of the two companies, John Scott and Sons and Scott and Co. during the decade. Scott and Co. largely achieved their objective of building only iron steamships. However, they also built a number of iron sailing ships, including in 1853 the record breaking tea clipper 'Lord of the Isles' which made the voyage from China to Britain in ninety seven days in 1856, and reduced the time to eighty seven days in 1859.[30] Other important landmarks during the decade included Scott and Co's first three steamships for Alfred Holt of Liverpool 'Plantagenet', 'Talisman' and 'Askalon' - built in 1859, 1860, and 1861 - the start of a long association with Holt. (discussed in detail in Ch.5. See also Volume Two) In contrast, John Scott and Sons, after a brief initial surge of building iron ships in 1853-4, appear to have reverted to building wooden sailing ships during which time they only built twenty three ships in contrast to Scott and Co's., total of sixty two ships. A further and significant contrast also emerges from a study of the performance of the two companies in the marketing field. John Scott and Sons built exclusively for local owners, whereas 46 per cent of the output of Scott and Co. was for foreign owners.

This withdrawal from iron construction took place as demand for ship tonnage in the United Kingdom was increasing between 1852-7. But in August 1855 John Scott and Sons offered to sell ground comprising their iron shipyard and another area further west embracing their timber pond to Greenock Harbour Trust which was keen to provide further harbour, graving dock and slip facilities at the west end of the town. See Fig. 2/11. A price of £30,000 was provisionally agreed but the deal was much delayed due to doubts regarding some of the title deeds. The Greenock Harbour Trust plan was effectively abandoned in 1859. Only the ground around Scotts timber pond was sold. However, the incident does indicate that at a time when iron steamers were at last penetrating the market (See Fig. 2/10) John Scott and Sons were for whatever reason seeking to withdraw from it. One theory which does not support John Scott, jr's earlier comments as to the cause of the failure is that the company had lost heavily in building iron ships in 1853-4-5. Certainly in the years which followed 1856-61 they only built four iron steamers of modest size. The insertion in January 1856 of the advertisement included as Fig. 2/12 was probably prompted by Charles Scott, anxious to establish that he was no longer associated with John Scott and Sons. The dissolution of the brothers' partnership in 1851 had received no publicity.

SALE OF SCOTT, SINCLAIR & CO.

On May 4th 1858 an advertisement in the Greenock Advertiser (See Fig. 2/13) offered for sale by private bargain:-

> 'Those extensive premises in Greenock known as the Greenock Foundry belonging to and occupied by Scott, Sinclair and Co., with the machinery and plant and goodwill of their long established business'.

and on February 15th 1859 a further advertisement (See Fig. 2/14) announced the purchase of the business (to be known in the future as Greenock Foundry Company) by John Scott IV and his partners, Richard Ovington and J. Ramsay Hill.

At the age of twenty nine, John Scott IV was effectively chief executive of Scott and Co. and the Greenock Foundry Co. He had been educated at Edinburgh Academy and Glasgow University and served an apprenticeship with his father before becoming a partner in Scott and Co. at the age of twenty one years.

The sale of the Greenock Foundry was soon followed by the bankruptcy of Scott and Sons on 1861. This brought to an end some one hundred and fifty years of shipbuilding and ship repairing at West Burn by the Scott family. During their operations there the Scotts launched over two hundred and fifty ships, including fifty steamers, all with main or auxiliary sails. Only eighteen iron hulled ships were built by them, the remainder being of wooden construction. The number of ship repair contracts executed was of the order of 5,000.[31]

In 1860, John Scott III and his son John Scott jr. moved out of the family home, Finnart House, which had been left to him in 1833 by his uncle, Christopher Scott and they moved into Finnart Cottage, elsewhere on the Finnart estate in the west end of Greenock. John Scott III died in 1874 at the age of eighty nine years. Somewhat ironically, his son, John Scott jr. began a new career as an iron merchant in Glasgow.

However, the Scott house flag still flew over the Cartsdyke shipyard and the Greenock Foundry Co. Scott & Co. was firmly established as a modern shipyard specialising in iron steamers (81 per cent of output) compared with a national percentage over the same decade of 28.5 per cent. Sailing ships were still in demand nationally but the demand was cyclical being greatest at times of trade depression. So Scott and Co. were happy to build iron sailing ships in such circumstances. They built twenty large iron sailing ships, some in fact for their own account, the last in 1905, and reference will be made to them later. However, the magnificent procession of wooden sloops, brigs, schooners, barques and ships from West Burn had come to an end in 1860.

CHAPTER TWO. REFERENCES.

No.

1. Scotts Two Centuries of Shipbuilding (London 1906) p.22.

2. Ibid. - p.21.

3. Ibid. - p.22.

4. W.S. Cormack. - An Economic History of Shipbuilding and Marine Engineering - Unpublished Ph.D. thesis, University of Glasgow (1930) Table C3.

5. Scotts Archives - Glasgow University - ref. GD 319/26/1/1 & 2

6. W.S. Cormack. Ibid. - Table C.3.

7. Ibid. - pp.139-140.

8. Scotts Ibid. - pp. 26.

9. R.M. Smith - The History of Greenock (Greenock 1921) p.321.

10. Scott Archives - Glasgow University - ref. GD 319/11/1/7 Letter from Scotts 13th December 1838 to James Morrison, Scoulog, Bute requesting his help in recovering some of their logs which had escaped from their timber pond during a gale and had been washed up on Bute some time later.

11. Ibid. - ref. GD 319/11/1-8.

12. Scotts' Two Centuries of Shipbuilding (London 1906) p.22.

13. Scotts Archives - Glasgow University - ref. GD 319/11/1/1.

14. Ibid. - ref. GD 319/11/1/7-Aug. 1838.

15. Scotts Two Centuries of Shipbuilding (London 1906) p.12.

16. S. Pollard and P. Robertson. - The British Shipbuilding Industry 1870-1914 (Cambridge, Mass. and London, 1979) pp.152-4.

17. His involvement with railway engine production is discussed in more detail in Chapter 3. The machine tools were displayed in the Practical Mechanic and Engineer's Magazine, Vol. 2. 1842.

(Chapter 2 References continued).

No.

18. See Scott Ship List, Volume Two. pp. 833-840.

19. See Appendix 2/4, letter Charles C. Scott to John Scott III, dated 16th January, 1851.

20. Scotts Archives - Glasgow University - ref. GD319/26/1/1 & 2. Shipyard Diaries.

21. Scotts' - Two Centuries of Shipbuilding (London 1906) pp. 44-8.

22. See Appendix 2/4, letter John Scott III to Charles C. Scott I dated 13th December 1849.

23. Ibid. letter Charles C. Scott I to John Scott III dated 30th December 1850.

24. Ibid. letter Charles C. Scott I to John Scott III dated 21st March 1851.

25. Greenock Advertiser. 24th December, 1852.

26. Scotts. Ibid. - Personalia. p.xii.

27. Dumbarton Herald - 7th November 1861.

28. Ibid. - 5th June 1862.

29. Ibid. 4th December, 1862.

30. Scotts. Two Hundred and Fifty Years of Shipbuilding (Glasgow 1961) p.1.

31. This information complied from the Scott Ship List, Volume Two of this thesis and from Scotts Archives - ref.GD319/26/1/1 & 2. shipyard diaries.

Table 2/2.

SHIP PRODUCTION - 1852-1861.

YEAR	John Scott and Sons.						Scott and Co.					
	No. of Ships				Total		No. of Ships				Total	
	Iron		Wood		No.	Nett. Tonnage	Iron		Wood		No.	Nett. Tonnage
	Sail	Steam	Sail	Steam			Sail	Steam	Sail	Steam		
1852	-	1	2	-	3	168	4	2	-	-	6	535
1853	2	4	2	-	8	3868	1	6	-	-	7	1791
1854	2	4	2	-	8	2225	4	6	-	-	10	3087
1855	-	1	3	-	4	3253	1	7	-	-	8	1917
1856	-	3	8	1	12	1598	1	7	-	-	8	1611
1857	-	1	2	1	4	1117	-	11	-	-	11	3060
1858	-	-	3	-	3	311	1	8	-	-	9	2000
1859	-	-	1	-	1	15	1	7	-	-	8	1945
1860	-	-	1	-	1	120	2	7	-	-	9	3673
1861	-	-	-	-	-	-	1	8	-	-	9	3819
	4	14	24	2	44	12675	16	69	-	-	85	23438

Table 2/2 was compiled from particulars of the output of both yards given in Scotts Ship List - Volume Two of this thesis.

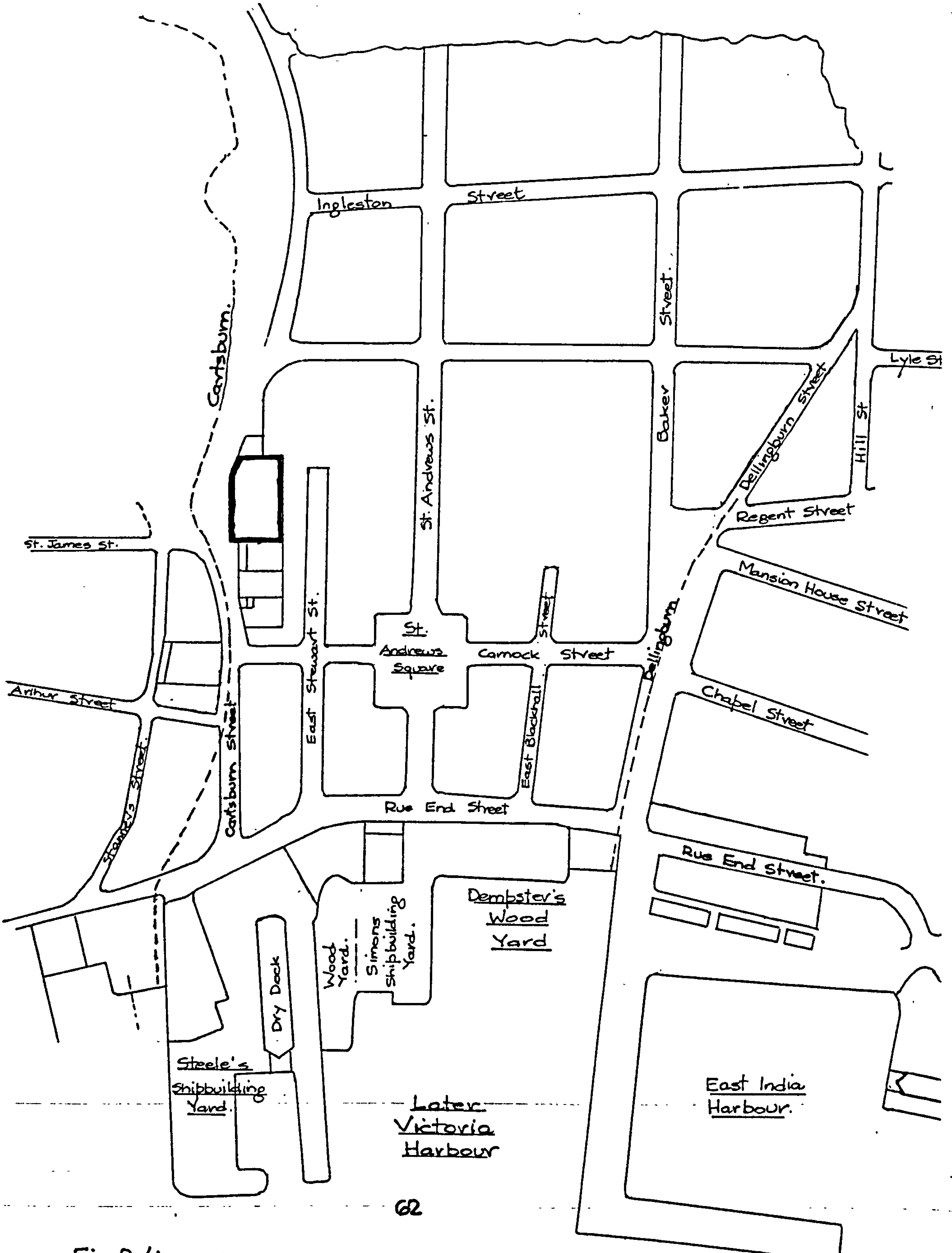


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Fig 2/1 SCOTTS ENGINE WORKS.
as purchased - 1825.
See also Figs. 42 & 43, Chapter 6.

Fig. 2/2

Memorandum by Robert Sinclair, son-in-law of John Scott II (married to Margaret Scott) Scotts Private Papers.

February 1837.

From the whole of Mr. Scott's observations (John Scott II) in my hearing - and he has all along spoken quite openly to us all.

It appears that after having made a settlement some years ago at Hawkhill of which I believe he and his man of business alone knew the contents, he began to think it would be better that his children knew the particulars. - as he said -"that you may see it is right as I wish to please and satisfy you all."

He opened this Settlement at Hawkhill in November last, but his sons declined reading it. Having brought it up to Greenock with him - a few days ago - he again opened it and it was read by John and us all. He devised Hawkhill to John - the building yard and its houses to Charles, and his part of the Mid Quay houses to Margaret - that was all the heritage mentioned. Provision was made for William £5,000 and another £5,000 in the event of his recovery and thereafter appropriation - and £5,000 to his daughter - without any further note of by much the greater part of his moveable property - and which in some measure has disposed of otherwise than by Will and or by Donations. - thus transferring his Capital in the John Scott & Sons business to his sons - so much of his money in the Bank to his sons and all of his Stock and Profits in Scott, Sinclair & Co., to his sons and to his daughter and me, leaving still considerable moveable subjects to be disposed of. In consequence of his transfer to his daughter as above the clause of the donation of £5,000 in his settlement is to be done away with.

Mr. Scott's sons think that the Heritable bequest should be exchanged - the Building Yard and its appurtances should be John's and Hawkhill should be Charles's - to this their father agrees.

The Heritable Property undevised by the Settlement is:-

Mill and Mill Lands - Gogo Water - and Distillery
Parish of Largs.
Timber pond near the yard.
Houses at Bell Entry.
Martha Brae Cottage and the (Garvel) Park.

Exchange Building and Ayrshire Vote Feus.

The Moveable in Phoenix Fire Office Stock.
in Bank of England Stock.
in Greenock Bank.

Mr. Scott too wishes the stronger Trustees to be put out - and if he leaves his sons - John and Charles - residuary legatees - then his affairs would be all wound up in course of business and matters kept as they assuredly ought - all within themselves.

John Scott II died on 15th March 1837.

Fig. 2/3

Fig. 2/3 - Scotts' private letters.

Greenock, 18 January 1837.

My dear Father,

After quietly and maturely considering all the matters which you were anxious your children should do from a feeling so truly parental, I am now of opinion that it will be for the good of all our families -

That the yard and its appurtenances should descend to me, and the Ayrshire property of Hawkhill to Charles, - whatever way you please to fix all other matters I am certain will be satisfactory to us all.

I am truly,

My dear father,
Yours affectionate son,

J.SCOTT.

John Scott Esq., of Hawkhill.

Fig 2/4 (1) JOHN SCOTT & SONS —— PRODUCTION PROGRAMME – 1837-51.

Figs. 2/4 (1) & (2) derived from Shipyard Diaries, Archive ref. GD319/26/1&2, also Scott's Ship Registers, Contemporary Newspapers, etc.

Fig 2/4 (2) JOHN SCOTT & SONS PRODUCTION PROGRAMME 1837-51.

SHIP	TYPE	TONS NET
Erromanga	B	395
Mountaineer	Smack	31
Opal	Sch.	189
Somnauth	S	672
Cambria	S	399
Sapphire	Sch.	193
Onyx	Sch.	232
Investigator	S	422
Lord F. Somerset	Tug	216
Moncrieff	Cutter	21
Trelawny	B	316
Wizard	Tug	21
Seringapatam	S	587
HMS Greenock	Frigate	1413
Taymouth Castle	S	604
America	S	486
St. James	S	413
Alexander	Gabbart	38
Tartar	S	668

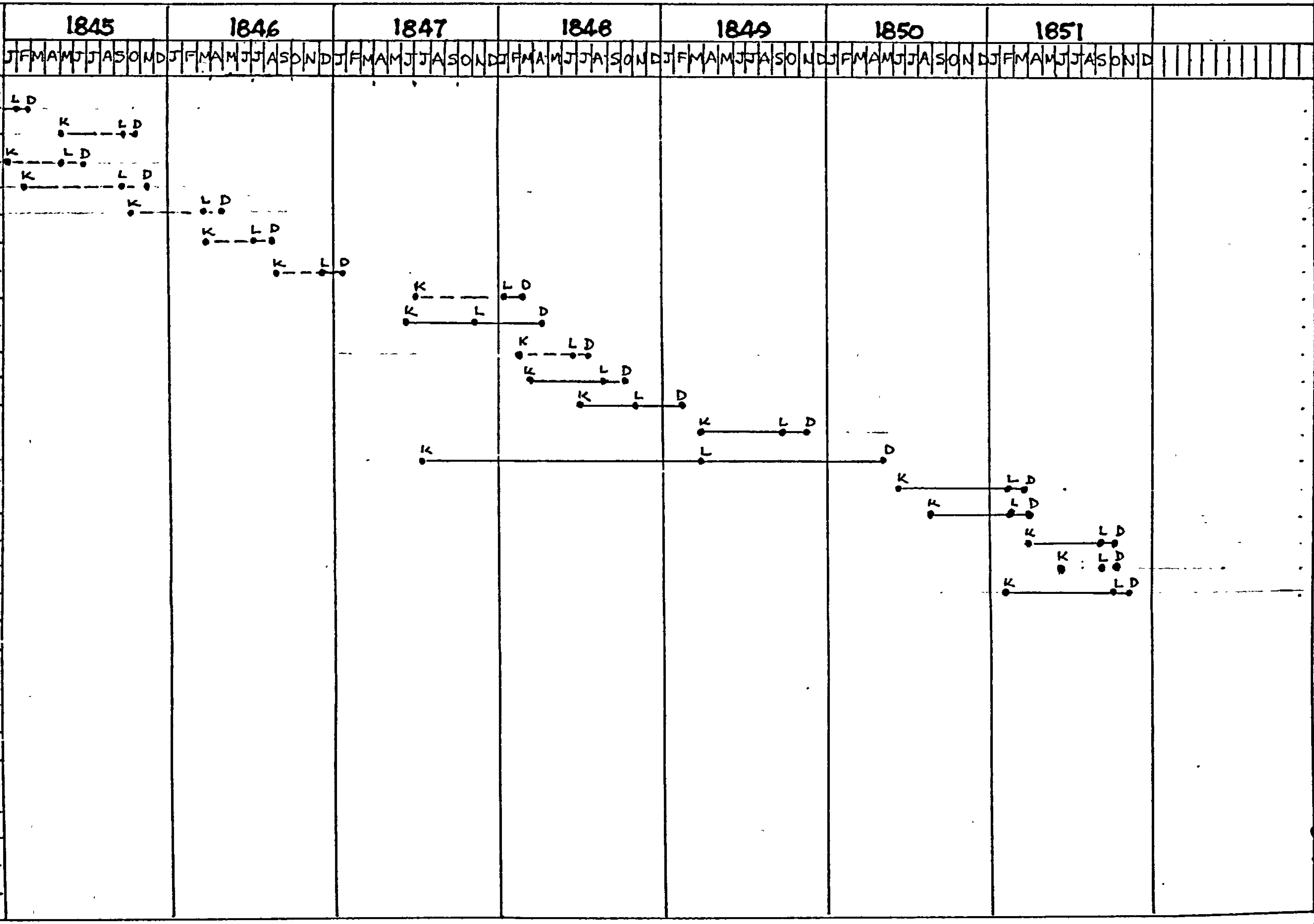


Fig 2/4(2)

Fig. 2/5. SHIPBUILDERS.

IN

GREENOCK AND PORT GLASGOW.

1711-1853.

Shipyard (Greenock)	Dates	Location etc.,
John Scott I		
James & William (I) Scott	1711-1802	Dalrymple St.,
John (II) & William Scott (II)		
John Scott & Sons	1802-1863	Dalrymple St.,
Peter Love	1740-1760	Virginia St.,
Simon Halliday	1740-1760	West of West Burn.
David Porter & Morgan	1740-1760	West of West Burn
Duncan Robertson	1762-	
Duncan Nicol	1766-	
Robert Colquoun	1767-1785	
Thomas Edwards	1771-	
Alex. & Arch. McArthur	1771-1816	Bay of Quick
Archd. Turner	1772-	
John Weir	1772-1786	
Duncan Smith	1773-1794	Rue End St.,
Alex. Crawford	1774-	
Chas. Telfair	1774-	
Pat. McPherson	1781-1787	
Hugh McConochy	1783-	
Wm. Hyndman	1784-	
Archd. McPherson	1784-1793	
John McKechany	1785-1793	
John McCunn	1785-	
John McGilp	1785=	
John McConachy	1786-	
John Thomson	1787-	
Wm. McKechany	1787-1793	
Alex. McKechany	1788-1813	West of West Burn
McPherson & McLachlan	1788-	Bay of Quick
Archd. McMillan	1788-	Bay of Quick
Scott & Thomson	1788-1789	
Wm. McGill	1789-	
John Cameron	1790-	
Thomas Scott	1791-1793	
A. McDonald	1792-	
Chas. McKechany	1793-1802	

Fig. 2/5 continued.

Shipyard	Dates	Location etc.,
Steele & Carswell	1798-1818	Bay of Quick
Campbell & McNicol	1802-	
F. Morgan	1802-	
T. Nicol	1803-1825	Rue End St.,
James Munn	1809-1819	West of West Burn
Duncan McNicol	1813-1820	Rue End St.,
Robert Steele	1816-1883	Rue End St.,
John Murray	1816-	
James Nicol	1816-	
Robert Carsewell	1817-1819	West Blackhall St.,
William Simons	1818-1852	Rue End St.,
John Denny & Robt. Miller	1818-	
Walter McKirdy	1820-	
Cornwallis	1820-1821	
Hunter & McMillan	1826-1829	Rue End St.,
Colin McKenzie	1827-	
Humphrey McLaurin	1828-	West Quay
John McLean	1830-	
W. Cockburn	1831-	
McMillan & Duncan	1831-	Rue End St.,
Muress & Clark	1832-1843	Ropework St.,
Robert Duncan	1834-1843	Rue End St., Crawfordsdyke.
James McMillan	1835-1851	Rue End St., Crawfordsdyke & Bay of Quick.
W. Johnston	1835-1842	Ropework St.
Thomson & Spiers	1840-1844	Brougham St.,
Robert Sharp	1841-	Dellingburn St.,
James Murray	1841-	Clyde Crescent
John McDonald	1844-	Virginia St.,
James Duncan	1845-1851	Rue End St.,
John Barnhill	1844-1847	Bay of Quick
Caird & Co.,	1848-1863	Cartsdyke Mid.
Laurence Hill,	1853-1869	Inch Yard.

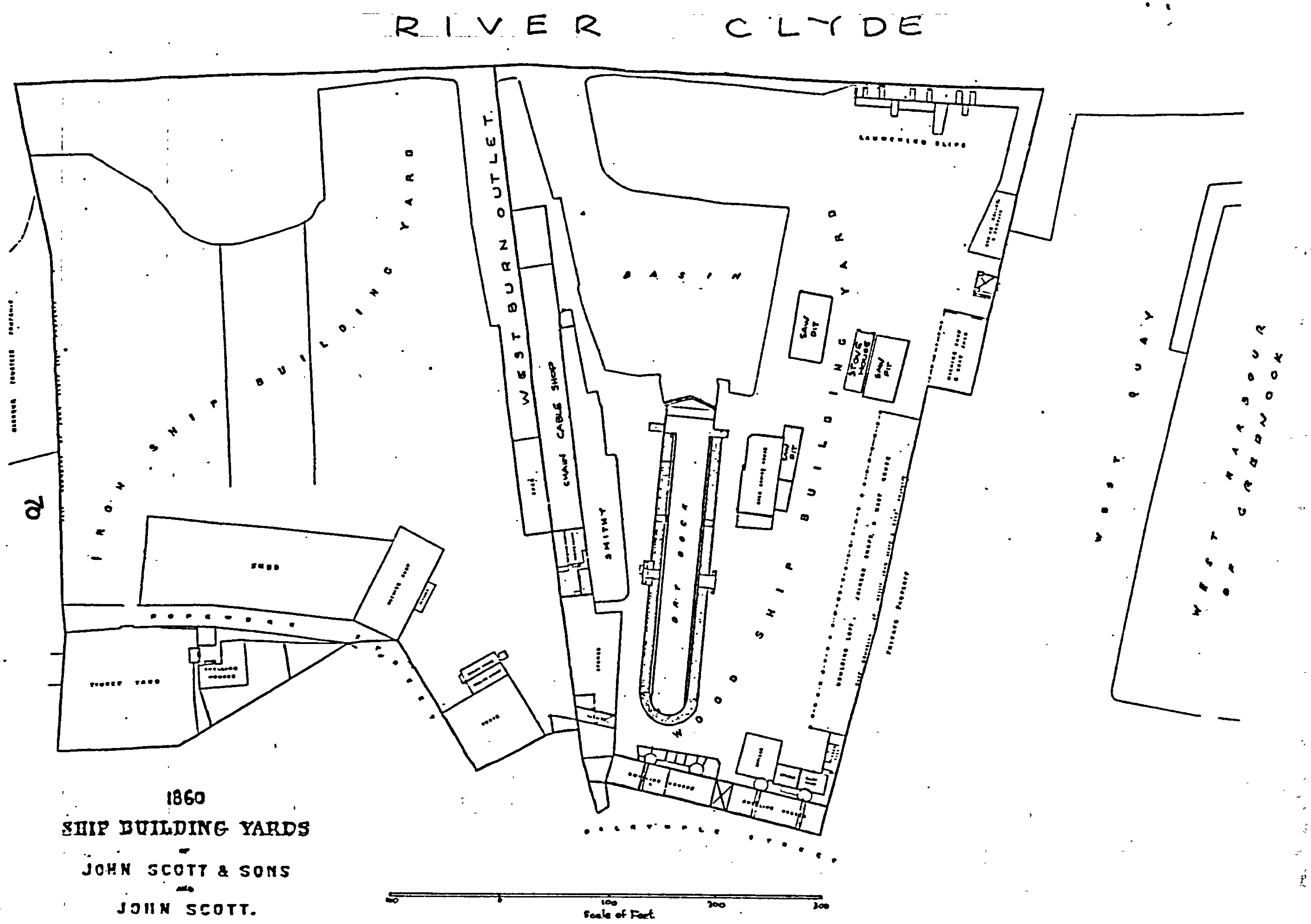
Fig. 2/5 continued.

PORT GLASGOW.

Shipyard (Port Glasgow)	Dates	Location etc.,
Thomas McGill	1783-1792	Newark.
John McKechany	1783-1806	
Thos. Gordon	1784-1793	
John Wood	1786-1851	East Yard.
Steele & Carswell	1786-1816	Glen.
Thomas McColl	1792-	
John Martin	1803-1813	Glen
Thomas Crawford	1803-	
Alex. Martin	1815-1818	Newark
John & Chas. Wood & Jas Barclay	1815-1826	
John Hunter	1821-1826	
J.& G. McDonald	1831-1834	Newark
Peter Murchie	1836-1844	Bay
Ken Mathieson	1838-1842	Newark
J. & M. McIntyre	1842-	
John Reid	1849-1851	

The foregoing lists were compiled from a search of the Ship Registers held in the Custom House, Greenock which cover the period 1711-1853.

Fig. 2/6



Original Drawing in Scotts Archives, ref. GD 319/3/3a.

Fig. 2/7.

RULES & REGULATIONS

TO BE OBSERVED BY THE

WORKMEN

IN THE EMPLOYMENT OF

SCOTT, SINCLAIR & CO.

I.—Working Hours.

From 6 o'Clock Morning, till 6 o'Clock Evening,—being a day's work throughout the year, except on Pay Saturdays, when the day's work will end at 3 o'Clock. In the Morning, the Bell will be rung for 15 minutes before 6, and in the Evening at 6.

II.—Attendance.

The Gate will be shut at 5 minutes past 6 Morning, for 10 minutes. Any Workman admitted thereafter, and before 20 minutes to 7 o'Clock, shall forfeit one hour's Wages. No Workman to commence later than 20 minutes to 7, without the consent of his Foreman.

III.—Meal Hours.

From 9 to 10 o'clock morning for Breakfast, and from 2 to 3 o'clock for Dinner—at each of which hours the Bell will be rung, and the Gate kept shut during the intervals.

IV.—Time.

Each Workman shall write daily on his Time Board (1) the Time, and (2) the Job at which he has been working throughout the day; and he shall hand in his Time Board every night when done Work, and finally make up his full time the evening previous to the Pay day.

V.—Overtime and Allowances.

Eight hours of Overtime, whether in or out of the Works, to be reckoned a day, and payment made in proportion. To be allowed in addition when working till 10 o'clock, 6d. and if longer, 1d. per hour—payable in cash with his Wages. No refreshments to be brought into Works, but 20 minutes to be given for obtaining same out of Shop. Neither Overtime nor Allowance Money to be reckoned or paid for, till the regular time of 10 hours for each day (Pay day excepted) during the Fortnight has been made up. Apprentices to receive half the Allowance of Journeymen.

VI.—Working Hours out of Shop.

1st, At Steam Boats in the Harbour or Building Yards, and generally at all Jobbings in progress in-doors, to commence at the same time as if in the Shop. 2d, Workmen employed at out-door work during the months of November, December, and January, to commence at day light, and knock at Dusk, allowing one hour, from 10 till 11, for Breakfast. 3d, When employed within 3 miles of the Shop, to go to work on the Employer's time, and return from it on their own time. 4th, Workmen sent to a distance of 3 miles or upwards from the Shop, will be paid in addition to their regular Wages, 1s. per day as Boarding, and should they require to travel by public conveyance, the travelling expense to be paid by their Employers.

VII.—Tools.

Each Workman shall be accountable for his Tools as well when returning from out-door work as when leaving the employ; and in case of Loss the value to be deducted from his Wages.

VIII.—Warning.

Any Workman intending to leave the Employment shall give 14 days previous notice on Pay-day, at receiving his wages, and his engagement shall continue till the expiry of the notice. The Employers shall be bound to give the like notice before discharging a Workman, with the option to them in place thereof, of paying him a fortnight's wages.

IX.—Fines.

1. TIME BOARDS.—Any Workman, for neglecting to return his Time Board at night when done work, to be fined 1s
2. For neglecting to return his full time prior to Pay day, ... 1s
3. For putting in or taking out any other Time Board than his own, ... 1s
4. For putting Slate in the wrong Slip. 6d
5. For losing or damaging Slate, ... 6d
6. NEGLECT OF WORK.—Any Workman, for continued want of punctuality in attendance at hours, to be fined . . . 1s
7. For leaving his work without liberty from his Foreman, ... 1s
8. For being in any part of the Works where he has no business, either in working or meal hours, ... 1s
9. For putting on his Coat, or making other preparations for leaving Work before the Bell rings, ... 1s
10. TOOLS.—Any Workman taking the Tools of another without leave, to be fined 6d
11. For neglecting to return Taps or Dies or any other general Tool to the person in charge of them as soon as he has done with the same, to be fined 1s
12. For interfering with, altering, deranging, or injuring any Machinery or Tool, (besides paying the cost of Repairs) .. 1s
13. OFFENCES.—Any Workman bringing in, or found with intoxicating Drink, or Smoking within the Gates, or any place where engaged on his Employer's Work, or having loose or using Lucifer or other Matches, whether during the working or meal hours. 5s.
14. For playing at Cards or other Games within the Works or other places where employed, ... 5s
15. For creating tumult or quarrelling within the Works, ... 5s
16. For taking Strangers into the Work without leave, ... 2s 6d
17. For removing Forged Work from the Smiths' Shop without its being previously weighed, ... 2s 6d
18. For using Waste for any improper purpose, or Oil to clean his hands, ... 1s
19. For leaving his Candle burning, or neglecting to turn off his Gas Light, or for enlarging or damaging the Gas Burner. . . 1s

X.—Grounds for immediate Dismissal.

1. Any Workman giving in more time than he wrought for,
2. Any Workman taking Drawings or Dimensions without leave from his Employers, or
3. Any Workman in the Works under the influence of intoxicating Drink will be dismissed with the forfeiture of his whole wages then due.

XI.—Apprentices.

The foregoing Rules to apply not only to Mechanics and Labourers, but also to Apprentices.

The Employers to be the sole Judges in the exaction of Fines and Forfeitures, which will be paid over to the Greenock Infirmary.

GREENOCK, 1st JANUARY, 1852.

from The Channel'. Trans. Greenock Assocn. of Engrs & Shipbuilders, 1917/8.

Fig. 2/8

MESSRS SCOTT & CO. *Boilermakers and Iron Shipbuilders, Greenock.*

GENTLEMEN I William Smith. GD 319/3/4/22

hereby offer and agree and bind and oblige myself to work and serve you in your employment as a Rivetter regularly, and for the period of Five years, commencing on and from the Twenty second day of February Eighteen Hundred and ~~fifty~~ Sixty-two years; and I further agree and hereby promise to conduct myself in a steady and sober manner, and that I shall civilly, discreetly, and with promptitude and alacrity, obey all lawful commands of you my said Masters, or others set over me, and that I shall not reveal your secrets, nor conceal anything to your loss or damage, but shall acquaint you therewith, and prevent the same to the utmost of my power; that I shall not purloin or embezzle your goods or gear, nor know of nor be accessory thereto, or to your hurt or prejudice, without timeously revealing and preventing the same to the utmost of my power; and, in case of the contrary, that I shall pay double the value of the loss which you may sustain thereby, or through my fault or negligence; and I promise to observe and conform to all the published Rules and Regulations at present existing and in force in your Works, a printed copy of which posted up at the Entrance Gate of your Works I have read, and I also agree and engage to observe and conform to such other or additional Rules and Regulations in said Works as you may find it necessary to promulgate and put in force therein from time to time; and in particular I hereby agree not to absent myself from your said employment, without liberty asked and obtained, except in case of sickness instructed by the certificate of a Surgeon upon soul and conscience; failing the production of which, I agree to be held and considered as absent without liberty: And, at the expiry of the foresaid period of this my engagement, I agree and bind myself to serve two days for each day's absence without liberty as aforesaid, and day for day for whatever time I may be absent on liberty, or owing to sickness; and so in proportion, in case of absence, for any part of a day; or in your option, I agree that you shall be entitled to deduct two days' wages (at the rate then hereby payable) for every day or part of a day that I may be so absent without liberty, and one day's wages for every day or part of a day that I may be absent on liberty or owing to sickness,—the number of which days shall be sufficiently ascertained and proven by the Pay-book, or writ or oath of either of the Partners of your said Firm, or of that of your Clerk, in lieu of all other probation; and I promise to the utmost of my power to further your interests at all times, by a good and steady attendance at my work, and by doing as much work at any job I may be sent to as I may be capable of, according to my ability, without passing any of my time away in careless indolence, or in any other trifling way prejudicial to your interests; on the other hand you the said SCOTT & CO. agree, as by acceptance and subscription hereof, ~~you agree and become bound to~~ pay me every Fortnight, for the foresaid period, Wages, at the rate of Seven Shillings per Week, for the First Year; at the rate of Eight Shillings per Week for the Second Year; at the rate of Nine Shillings per week for the Third Year at the rate of Ten Shillings per week for the Fourth Year and at the rate of Eleven Shillings per week for the Fifth and last Year of this my engagement with you the said SCOTT & COMPANY, under this agreement. IN WITNESS WHEREOF, these presents, in so far as not printed, written on ~~un~~stamped paper by Hugh Maclean Clerk to the said Scott & Co are subscribed as follows:—By the said SCOTT & COMPANY, and by the said William Smith both at Greenock, the Fourth day of March Eighteen hundred and ~~fifty~~ Sixty-two years, before these Witnesses the said Hugh Maclean and John Donaldson Scott also Clerk to the said Scott & Co with the understanding of two printed words being delete before subscription.

Hugh Maclean Witness

Jn Donaldson Scott Witness

Scott & Co

William Smith

Greenock 30th March 1839

My dear Robert

In reply to your letter of yesterday. I have to state that my only object in mentioning my Fathers. Will and settlement to you in the Yard on Tuesday. was for the alone cause of getting my house at Finnart valued or adjusted agreeably to the spirit and intention of said deed — that I was to receive it free. Now as you and Margaret were present when Mr Turner was instructed by my Father to draw up the Will. — I call upon you to know what was his meaning in stating there the house to be given free. — Was it not in some measure to compensate for my brothers getting two houses. And the sooner this matter is decided the better. — after this is done. I shall be glad to look over the Foundery matters with you and trust that you and I can settle our affairs to each others entire satisfaction. which surely ever will be amicable. —

I would be possessed of little spirit or feeling indeed. — If after what did occur on opening the Will. — My Father would only transpose the Yard for Hawkhill to me refusing to name the value for the latter if I inclined to retain it — when this plain request would not be conceded or complied with. —— Can you think it strange or unreasonable that I. or one of my decendants. should ever wish to look upon. or tread the threshold. or put footstep on the ground of that domain. —

Believe me ever affectionately and sincerely.

Yours

J. Scott

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Fig. 2/9

Fig. 2/10.

Percentage of Total Tonnage built in the United Kingdom annually equipped with steam propulsion :- 1825 -1865.

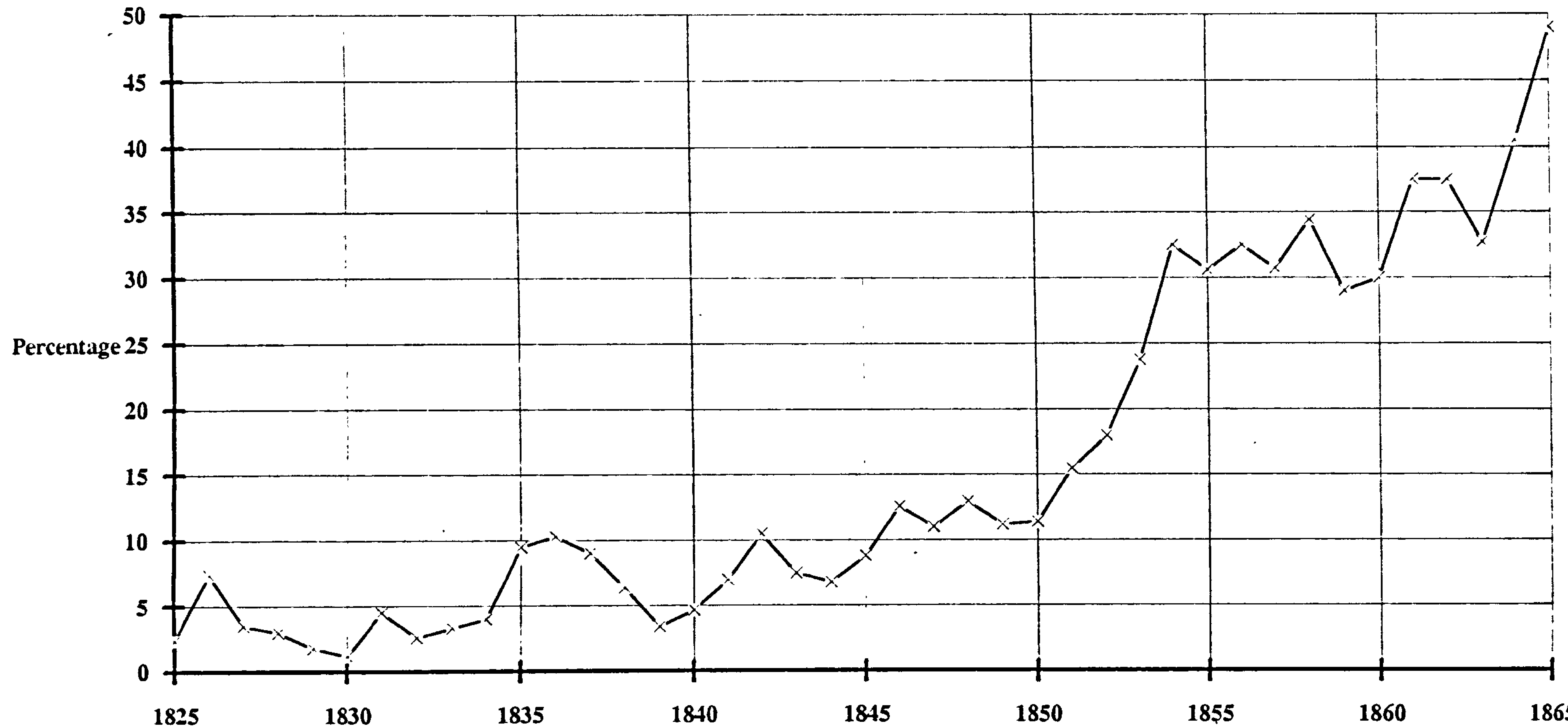

Fig. No. 2/10 - from W.S. Cormack - Unpublished Thesis - Univ. of Glasgow - 1930.
(Economic History of Shipbuilding and Marine Engineering - Table C1.)

AT MESSRS JOHN SCOTT & SONS' SHIPBUILDING YARD, GREENOCK, ON TUESDAY, 27TH MAY, AT 11 O'CLOCK. & 1856

High Pressure Steam Engines, Cylindrical Egg-Ended and other Engine Boilers, Steam Pipes and Mounting, Forge and Tilt Hammers, Forge Furnaces, Large Angle Iron and Plate Heating Furnaces; Yuill and Wilkie's Patent Angle Iron Cutting and Punching and Riveting Machine, capable of Cutting 8-inch Angle Iron, and several other Powerful Cutting and Punching Machines; Vertical Drilling Machines and Screwing Machines, and Quantity of Heavy and Light Wrought Iron, Shafting, Pulleys and Hangers, Leather Belting for Driving Machines, Square Setting Tables, Fish Press, Two Powerful Cranes, Double and Single-Powered Ship and Crab Winches; Large Building Shed, recently erected, 200 Feet by 70 Feet, and 30 Feet High, made of Corrugated Iron, on Iron Columns, with Fluted Plate-Glass Lights; the Building Materials of Machine Shop, Forge House (both with very massive Roofs, nearly new); Engine Houses, Engine, Chimney Stalks, Large Wooden Sheds, and a large Quantity of Fire Bricks; Smiths' Treble, Double, and Single Hearths, Fire Irons and Water Boxes, 50 Patent Portable and Common Rivet Hearths; Large Foundry Fanners, 6 Ft. Dia.; and several Sets Smiths' Fanners, Iron Bogies, Tressles, Grindstones, &c., and about 3500 Feet of Iron Rails.

HUTCHISON & DIXON, Auctioneers, Glasgow, are favoured with instructions from Messrs John Scott & Sons to Sell the above Valuable PLANT, which is situated in that portion of Ground recently Sold by them to the Town of Greenock.

Detailed Catalogues are now ready for delivery. They can be had at the Works; and will be forwarded on application to the Auctioneers, 8 Virginia Street, Glasgow.

Fig 2/11

Advertisements in Greenock Advertiser.

NOTICE.

Greenock, 14th January, 1856.

THE deceased JOHN SCOTT of Hawkhill, Shipbuilder in Greenock, on 24th January, 1837, the deceased ROBERT SINCLAIR, Engineer in Greenock, on 15th April, 1841, and the Subscriber, CHARLES CUNINGHAM SCOTT, Shipbuilder in Greenock, on 1st March, 1851, respectively Ceased to be Partners of the Firm of SCOTT, SINCLAIR & CO., Engineers and Founders in Greenock. The said deceased JOHN SCOTT of Hawkhill, in March, 1837, also Ceased to be a Partner of the Firm of JOHN SCOTT & SONS, Shipbuilders in Greenock, as then carried on.

JOHN SCOTT, CHARLES C. SCOTT, } Executors of John Scott of Hawkhill.
CHARLES C. SCOTT,
Surviving Executor of Robert Sinclair.
CHARLES C. SCOTT.

JAMES SINCLAIR, Witness.
HUGH M'LEAN, Witness.

BOTH of said Firms of JOHN SCOTT & SONS, and SCOTT, SINCLAIR & CO., are now carried on by the Subscribers, JOHN SCOTT and JOHN SCOTT, Junior, as Sole Partners thereof.

JOHN SCOTT.
JOHN SCOTT, Jr

Fig 2/12

Fig 2/13

EXTENSIVE ENGINE MANUFACTORY AND FOUNDRY,

WITH GOOD WILL OF GOING BUSINESS,
FOR SALE BY PRIVATE BARGAIN.

THOSE EXTENSIVE PREMISES IN GREENOCK, known as THE GREENOCK FOUNDRY, belonging to and occupied by SCOTT, SINCLAIR & CO., with the MACHINERY and PLANT and GOOD WILL of their long established Business.

The Premises comprehend 5 Acres of Land, and adjoin the Greenock Railway, with which a communication might be opened, besides being within 200 yards of the Victoria Harbour in a straight line, along which permission has been obtained to lay Rails, and the same are put down in part.

The following are the principal Work Shops:—

Erecting Shop with powerful Cranes; Turning and large Machine Shops, containing new and powerful Planing Machines, Slotting Machines, Boring Machines, and Lathes of all kinds; Pattern Shop and Iron Foundry, both recently erected at great expense, having Cranes therein to lift from 10 to 25 Tons, with Stoves, Cupolas, &c. &c. to correspond; Brass Foundry, Boiler Sheds, and Smith Shop containing a patent Steam Hammer.

The Machinery is driven by a water wheel of 77 horse power, the Fall acquired from the Shaws Water Co. The Works also contain a supplemental Condensing Steam Engine of 50 horses power (nominal).

An Inventory will be shown at the Works, and all further particulars communicated on application personally or by letter, to

SCOTT, SINCLAIR & CO.

Greenock Foundry, 1st May, 1858.

Fig 2/14

NOTICE.

Greenock, 15th February, 1859.

THE SUBSCRIBERS, Sole PARTNERS of the Firm of Scott, Sinclair & Co., Engineers and Founders in Greenock, have Sold the Works hitherto occupied by them, in East Stewart Street, Greenock, with the Machinery, Utensils, and Stock in Trade therein, and Good Will of their Business, to the Greenock Foundry Company. All ACCOUNTS due to them will be Received, and all ACCOUNTS owing by them will be Paid, at the Office of John Scott & Sons, Greenock.

(Signed) JOHN SCOTT.
JOHN SCOTT, Jr.

(Signed) JAMES SINCLAIR, Witness.
JOHN CRAWFORD, Witness.

WITH reference to the foregoing Notice, the Subscribers beg to intimate their Purchase of the Works for many years in the occupancy of Messrs Scott, Sinclair & Co., and that they now carry on the same Business therein, under the Firm of the GREENOCK FOUNDRY COMPANY, of which they are Sole Partners.

(Signed) RICHARD OVINGTON.
JOHN SCOTT, Yrt.
J. RAMSAY HILL.

Advertisements in Greenock Advertiser.

CHAPTER 3.

SCOTTS AND THE DEVELOPMENT OF THE MARINE STEAM ENGINE.

1788-1865.

CHAPTER 3.

SCOTTS AND THE DEVELOPMENT OF THE MARINE STEAM ENGINE. 1788 - 1865.

John Scott IV, from his days as an apprentice in the family business, through his long working life in the company, firstly assisting his father Charles C. Scott I, and later running Scott and Co. shipbuilders, and the Greenock Foundry Company, marine engineers, never lost his enthusiasm for steam navigation. He was a disciple of Professor Macquorn Rankine and a close friend of William Froude whose classic experiments on skin resistance were so influential on the history of naval architecture. During the second half of the nineteenth century he was greatly concerned that the previous muddled thinking on the design of the steam engine should be discarded and replaced by ideas emerging from the new Laws of Thermodynamics. His vision of large and powerful steam ships taking over the long haul ocean trade routes was totally dependent on significantly reducing the bunker/cargo space ratio on steamers. He realised that the required increase in engine efficiency resulting in a reduction in fuel consumption could only be obtained by utilising the expansive properties of steam, and that to do this to advantage would require a much higher steam pressure than had been used heretofore.

EARLY DEVELOPMENTS.

However, before discussing John Scott IV's contribution to the development of the steam engine, it will perhaps be useful to touch briefly on the early experimental work on steam navigation in Scotland, and to refer to some of the early and historic steam ships built by the Scotts which have their place in the history of the development of the marine steam engine.

THE 'CHARLOTTE DUNDAS'.

William Symington (1764-1831) an engineer much involved with steam pumping plant in the coal mines is generally credited with much of the early experimental work on steam propulsion. Firstly, in partnership with Patrick Miller, gentleman of Dalswinton, umfries he steamed a small vessel (25ft x 8ft) with two centre line paddles on Dalswinton Loch at 5 miles per hour![1] Later they experimented further with a steam boat on the Forth and Clyde Canal. Eleven years later Mr. Symington was approached by Lord Dundas to build a steam propelled vessel for service as a tug on the Forth and Clyde Canal as a tug to replace the traction horses. In March 1802 the now famous 'Charlotte Dundas' gave a successful demonstration by towing two loaded vessels each of seventy tons burden through the summit level of the canal to Port Dundas some nineteen miles in six hours against a strong head wind.[2] Sadly, the canal proprietors claimed that the wash from the paddles would cause crumbling of the canal banks and refused to support the substitution of the 'Charlotte Dundas' for the drag horses. The 'Charlotte Dundas' was eventually laid up in a creek of the canal and whilst there was visited on many occasions by Mr. Henry Bell.

THE 'COMET'.

Henry Bell (1767-1830), was a time-served millwright, who had worked for some years in a Bo'ness shipyard. He had long been convinced that steam propulsion of ships was a practical proposition and pressed his ideas on the Admiralty with no response from their Lordships. It is also known that James Watt regarded the propulsion of ships by steam power as impracticable and he wrote to Henry Bell saying so.[3] Despite such discouragement, in October 1811 he placed an order with John and Charles Wood of Port Glasgow for the construction of the 'Comet'. The 'grasshopper' type engine (see Fig. 3/2) was a variant of the side lever type and was built by John Robertson of Glasgow and the boiler was built by David Napier of Glasgow. The 'Comet' was launched on 24th July 1812 and began service as Europe's first commercial steamship carrying passengers and cargo between Glasgow, Greenock and Helensburgh.

The success of Bell's 'Comet' resulted in a flood of orders for steam boats - forty two were built on the Clyde between 1812 and 1820, eight of them by Scott and Sons.[4] Their first steamers were the 'Active ' and 'Despatch' built in 1815 followed by a river boat 'Lady of Shannon' which plied between Limerick and Kilrush on the River Shannon.[5] Other steamship builders at that time included McLachlan and Denny, both of Dumbarton, James Munn of Greenock, J.W. Fife of Fairlie and Hunter of Port Glasgow. However, with a long tradition of building sailing ships for the Clyde and Belfast trades, for the Glasgow and Liverpool service and for the Liverpool and Drogheda and other coastal routes, Scott and Sons quickly moved into the building of larger and more powerful steamers for these routes and further afield. Table 3/1 lists some of the more notable steamers produced. Almost all of the engines installed in their early steamers were provided by David Napier of Glasgow.[6] The choice by Scotts of David Napier to build the engines for their steamers was significant. He had chosen to specialise in building engines designed for marine service, whereas his competitors were primarily concerned with providing and servicing equipment for the cotton mills and coal mines of the area.

THE ESTABLISHMENT OF SCOTT, SINCLAIR & COMPANY.

The Scotts, recognising that a market for steam ships had been firmly established, decided that it would be in their best interests if they were to manufacture their own propelling machinery. This would give them control over delivery of their ships and machinery and allow them to retain the profit on the machinery. So they purchased a local foundry in 1825 which they greatly extended into an engineering works equipped with the best available machine tools for the manufacture of marine steam engines and boilers. The new business was called Scott, Sinclair and Company, with Robert Sinclair, John Scott's son-in-law as managing partner.[7]

As mentioned in Chapter 2 the expected surge of orders for steamers did not materialise and during its first twenty years of operation the Scott, Sinclair factory produced only thirty sets of propelling machinery for paddle steamers of significant size for deep sea service, for owners including the Peninsular and Oriental Company, the Royal West India Mail Company and the India Steam Ship Company.[8] They also pursued and obtained orders for machinery for other shipyards at home, including the machinery for the naval ships H.M.S. 'Hecla' and

'Hecate', building at Chatham Dockyard, and abroad, including Australia, India and Ireland.

In these difficult years Scott, Sinclair & Co. also turned their skills to railway engine production. The opportunity arose when the Glasgow, Paisley and Greenock Railway (G.P. & G.) was inaugurated on March 1841 and in 1844 Robert Sinclair, nephew of Robert Sinclair of Scott, Sinclair & Co. who had served his apprenticeship with that company, returned to Greenock as general manager of the railway company with special responsibility for locomotive manufacture.[9] Inside four years Sinclair had built thirty 2-2-2 locomotives for the Caledonian Railway which had taken control of the G.P. & G. Railway and he had ordered three engines from Scott, Sinclair & Co.[10] About the same time Scott, Sinclair received an order for three further locomotives for the South Devon Railway from Mr. I. K. Brunel. A copy of the order dated 13th January 1845 is included as Fig. 3/3.[11]

In the early 1840s with shipbuilding in deep depression the prospects of a growing locomotive industry coming to Greenock caused great jubilation. Alas, in due course, the Caledonian Railway Company decided that Greenock was a bad geographical location for the workshops of a national railway, closed the Greenock works and opened spacious new workshops in Springburn, Glasgow and the Greenock dream faded.[12]

During the 1850s Scott, Sinclair built a variety of other types of engine to their own distinctive designs including the oscillating, steeple, trunk and double cylinder engines. In later years John Scott IV concentrated on direct acting inverted two cylinder designs. The first Scott compound engine of this type was built in 1856. The company specialised in geared (speed increasing) installations for steamers. All of these types played their part in the development of the marine steam engine, some possessing advantages in paddle applications and others in screw propeller applications. However, almost the entire machinery output from 1825 to 1852 was for the propulsion of wooden paddle steamers, and the engines, all of the side lever type, were of modest horsepower. One exception was the frigate H.M.S. 'Greenock' delivered to the Royal Navy in 1850. Particulars of her unusual machinery are given below.

The challenge confronting Scott, Sinclair & Co. in these years can be better understood in relation to the complex nature of the marine steam power plant. It is important to recognise that the marine steam power plant of today (as in the 1850's) involves a number of interdependent elements and that the overall efficiency of the plant is the product of the individual efficiencies of the various elements.[13]

These elements are:-

(1) <u>BOILER</u>.

The efficiency of the boiler is that fraction of the energy emerging from combustion of the fuel which is transferred to the water in the boiler. Energy is lost in the boiler through incomplete combustion, conduction, radiation, and to the flue gases.

(2) <u>ENGINE</u>.

(a) The steam efficiency of the engine is that fraction of the heat supplied to convert the water in the boiler into steam which is converted into work by the steam driving the piston.

(b) The mechanical efficiency of the engine is that fraction of the energy exerted by the steam in driving the piston which is applied to the power transmission, either paddle or screw propeller.

(3) PROPELLER.

The efficiency of the propeller, screw or paddle, is that fraction of the energy supplied to it, which is usefully expended in overcoming the resistance of the vessel and driving her ahead, the remainder being wasted in agitating the water in which the propeller works.

Clearly as the overall efficiency of the plant is the product of the individual efficiencies of the elements listed above, then any improvement in any element efficiency will enhance the overall efficiency.

SPECIAL MARINE ASPECTS.

The task, therefore, of the early steam engine designers was to seek to improve the various elements of the plant, due regard being paid to the costs involved. At this time the prime concern of power plant manufacturers was the building of engines and boilers for industrial applications. The engine fitted in the 'Comet' was originally intended for industrial use.[14] When they turned to marine applications they were immediately confronted with a number of constraints not present in their industrial work.

The weight of the machinery and the space occupied by it were obviously important. In particular the large bunker capacity required, stemming from the poor overall efficiency of the plant, effectively barred the steamer from the ocean trade routes and confined the early Clyde built steamers to river, estuary and cross channel applications and limited the payload to passengers and mail. The machinery had to withstand the effects of heavy weather, e.g. when the ship was rolling, one paddle could be fully immersed and the other running free. Similarly, with a propeller driven ship, when pitching, the propeller could be completely out of the water and racing. Such situations, not met with in land installations, required that safety margins be provided in the detailed design of working parts to prevent catastrophic failure. Another major constraint not encountered on ashore was the use of salt water feed in the boilers which led to operational and maintenance problems.

The paramount requirement - that the machinery be reliable - (i.e. that it kept going day and night perhaps for weeks on end) was best achieved when the engine had few working parts which also made for easy access for maintenance purposes.

Given these constraints it will readily be understood that for a comparable horsepower a marine engine, properly designed to take account of the points mentioned above, was more expensive than its industrial counterpart.

The safety margins built into Scott, Sinclair engines were generous and ensured that the engines would develop their designed horsepower comfortably.

In 1852, for example Scott, Sinclair built and installed the propelling machinery in the sloop H.M.S. 'Brisk' which was brought to Greenock from Devonport Dockyard for this purpose. After arrival at Devonport Dockyard on the delivery voyage, Scott's chief engineer, Mr. McAulay, wrote to John Scott on June 25th, 1852. He commented -"I will never again complain of the weight of our engines when I see some of the rattletraps fitted in other ships! The engines of the

'Sans Pareil' which I have seen here are 30 to 40 tons lighter than ours but they would be much better if heavier. I know they will be troublesome!" [15]

Scotts summary records allow us to make an assessment of the state of the art of designing marine power plants in the period 1820-1865 touching on the main elements namely, boiler, engine, (with condenser), transmission, and finally propeller. (screw or paddle)

BOILERS.

A number of drawings have survived of boilers manufactured and installed by Scott, Sinclair and Co. during the years 1830-1850 and these are included as Figs. 3/4a and 4b and are generally typical of the current practice during those years. They were known as 'box' boilers, being of rectangular shape with rounded or wagon tops with small radii at other corners. They were constructed from wrought iron plate or copper sheeting, riveted together. The furnaces, usually three or four in number, were connected to large flues which conveyed the products of combustion in a somewhat tortuous path through the boiler and into the base of the funnel. All flat surfaces were stayed internally. Typical examples were the boilers fitted on the 'Tagus' and 'Phoenix' which incorporated two tiers of furnaces, presumably to reduce the overall length of the boilers, and in 'Tagus' smoke tubes were introduced to increase the heating surface, a feature copied from locomotive practice.

These early boilers were very heavy and space consuming. They operated at a very low steam pressure in the early years (around 3 p.s.i.) and were fitted with two sets of safety valves - those opening outwards to permit the release of excess steam pressure and those that opened inwards to break any vacuum that might form during cooling down of the boiler after withdrawal of the fires. Their relatively flimsy construction resulted in leaks stemming from unequal expansion in operation, so a variety of materials, sawdust, dung and oatmeal were regularly fed into the boilers to plug them.[16]

Standing orders on H.M.S.'Hecla', engined by Scott, Sinclair and Co. in 1839 contained the following instruction:-[17]

> 'Two sacks of oatmeal to be scattered uniformly through the water spaces before the water is put in'.

THE SCALING PROBLEM.

The early boilers had a major problem stemming from the use of salt water as feed. This resulted in the gradual formation of scale on the interior surfaces of the boiler, particularly calcium sulphate which adversely affected heat transfer from the combustion gases to the boiler water. In order to deal with this problem the density of the boiler water had to be controlled by regularly blowing down a proportion of the denser boiler water to the sea and making up the loss by admitting a larger quantity of sea water feed. In spite of this process which represented a serious heat loss, it became necessary to empty the boiler regularly and descale the internal surfaces. Failure to do this caused corrosion and overheating of the flue casings leading to weakening of the material and subsequent collapse.

Over the years, as improvement in boiler plate material made it possible to raise the boiler pressure, so the scale problem intensified. This ultimately led to the abandonment of salt water fed boilers and the adoption of fresh water boiler feed and surface condensers as discussed later.

The 'box' boilers had a relatively short life of from three to seven years, corrosion being the principal cause of failure, and re-boilering was frequently necessary. Scott, Sinclair records show that in 1836 boiler pressure was of the order of 7 p.s.i. and by 1854 it had reached 15 p.s.i. In later years the working pressure of 'box' boilers was limited to 30 p.s.i. The 'box' design ultimately gave way to the oval and cylindrical designs.

PROPELLING ENGINES.

SIDE LEVER TYPE.

During the period 1825-1850 almost all steam engines built by Scott, Sinclair & Co. were of the side lever type, and all were installed in paddle steamers of wooden construction. Some drawings have survived of side lever engines built by Scott, Sinclair in 1831-2-8-9 and are included as Fig. 3/5,/6 and /7. The 1831 engine was fitted in the paddle steamer 'Herald' built for Bristol owners and the 1832 engine was fitted in the 'Cornubia' built initially for the Plymouth-Channel Islands service. The 1838 engine was fitted in the 'Hope' built for the Cape of Good Hope Steam Ship Company. Finally the 1839 engines were installed in H.M. Sloops 'Hecla' and 'Hecate' built at Chatham Dockyard and which were brought to Greenock to have their engines installed, the first naval vessels to make such a journey.

The side lever engine was derived from the industrial beam engine, the flywheel being omitted and the overhead beam replaced by two side levers at lower level straddling the steam cylinder and pivoted on substantial fulcrum bearings secured to the large cast iron box section bedplate. The function of the flywheel was taken over by the paddles. The steam cylinder and the substantial structure carrying the overhead crankshaft were also secured to the bedplate. The jet condenser was mounted above the side lever fulcrum bearings.

The side lever engines were popular for a variety of reasons - they were simple and therefore cheap. They required little maintenance and could operate satisfactorily when in a bad state of repair, but they were very heavy and occupied much space. Operating at low steam pressures and requiring full stroke admission of steam, they were slow and inefficient. In a seaway they transmitted longitudinal twisting forces to the keel and framing of wooden ships which effectively limited their use at higher powers on such craft.

Scotts built their last side lever engine in 1848 - or so it seemed!!. Later in this work reference is made to Scotts engine works, the Greenock Foundry Co. building side lever machinery for three mail and passenger liners delivered in 1864-5 for the French Line. This remarkable situation arose because the French Government, which was subsidising the new transatlantic routes, insisted on the new ships being virtual copies of the Cunard ships then operating on the Atlantic. So paddle side lever machinery was specified and fitted. Before the first new French ship was in service, the Admiralty allowed Cunard to use propeller drive in their new ships and the French ships were out of date before they entered service. Scotts had originally recommended propeller drive but were overruled for the reasons stated.

OSCILLATING ENGINES.

During the 1850-60 decade, both Scott, Sinclair and Co. and its successor the Greenock Foundry Co. built a variety of engine types of which the oscillating engine was the most popular. Operating at low pressures, driving paddles and on river, esturial and cross channel services it performed extremely well, and Scotts' only used it for such applications.

The idea was first suggested by Trevithick and the design developed and perfected by Maudslay and later by Penn. From Fig 3/8 it will be seen that the connecting rod was dispensed with, the end of the piston rod being connected directly to the crank pin. The cylinder was located below the crankshaft and was supported on two substantial trunnion bearings which allowed the cylinder to oscillate about the trunnions and let the piston and rod follow the rotation of the crank. Steam was admitted to the cylinder via one of the trunnion bearings and exhausted from the other.

The oscillating engine was simple with few working parts and lighter and more compact than other types of engine. However, it did not readily adapt to compounding when that development came along, nor was it easy to fit expansion gear. Many of its advantages were somewhat nullified when higher steam pressures were introduced and as the screw propeller gained popularity so demand for the oscillating engine waned.

DOUBLE CYLINDER ENGINE.

Another popular engine built and installed by Scott, Sinclair was the double cylinder engine shown in Fig. 3/9. In researching the various types of engine in use at this time, a general concern emerged that the connecting rod length relative to the crank radius should be as large as possible.

The double cylinder engine is a good example of how this was achieved in situation where head room was restricted. The cylinders were used, side by side, disposed symmetrically about the vertical centre line of the overhead crankshaft. The ends of the piston rods were connected to a T-shaped crosshead and the lower end of the connecting rod was connected to the lower end of the crosshead.

This, as can be seen, allowed for a longer connecting rod.

Over the years the ratio $\dfrac{\text{length of connecting rod}}{\text{crank radius}}$ settled down at 4:1. Anything significantly smaller resulted in overheating and heavy wear on the crank pin and crosshead brasses (due to the obliquity of the connecting rod).

STEEPLE ENGINE.

The steeple engine was invented by David Napier c.1842 and is illustrated in Fig. 3/10. It was very popular for tug boat and river steamer applications, was relatively cheap and was economical in space. It had a similarity to the double cylinder engine in that it contrived to provide for a long connecting rod. However, the overhead guides gave rise to vibration which could not readily be overcome. Scott, Sinclair did not favour this engine and built only four of them (at customers request).

NAVAL DEVELOPMENTS.

Before proceeding further with this discourse on the development of the steam engine at Greenock, it will be helpful if reference is made here to the building of the iron steam powered frigate H.M.S. 'Greenock' over the period 1845-50 by the Scotts.

In the 1840s the Royal Navy lagged behind the merchant Service in the adoption of steam propulsion and of iron ships. They particularly disliked paddle drive, complaining that the paddle boxes were vulnerable, being located above the water line, and their presence limited the number of guns which could be used for broadside fire.[18] However, the classic tug of war in 1843 between the two naval sloops, the propeller driven ' Rattler' and the paddle driven 'Alecto' was decisively won by the 'Rattler', and by 1845 the Admiralty had adopted the screw propeller.[19]

In the same year and primarily because of a fear that some foreign power might gain a decisive advantage by building iron warships, the Admiralty, with great reluctance, ordered five experimental iron frigates. The order for H.M.S. 'Pegasus' (later renamed 'Greenock') the largest iron warship of her day, was placed with Scott Sinclair & Co. She was 213 ft. in overall length, the beam was 37 ft. 4 in. and the depth of hold 23 ft. She was of 1413 tons burden, and carried ten 32-pounder smooth bore muzzle loading guns. She was launched on 30th April, 1849 from Scott and Sons, West Burn yard and the figure head on her bow was a bust of John Scott II in honour of his contribution to the development of naval architecture.

The machinery installed in H.M.S. 'Greenock' is illustrated in Fig. 3/11 and was one of the earliest attempts to increase the revolutions per minute of the propeller by fitting gearing between the engine and the propeller. As shown, the gearing took the form of four sets of massive spur wheels and pinions which raised the 42 r.p.m. of the engine to 98.7 r.p.m. of the propeller thus considerably increasing the propeller efficiency. It will also be noted that the machinery was located very low in the hull to be safe from enemy gunfire. The engine, which was direct acting, had two cylinders 71 inches in diameter and of 4 ft. stroke. There were four rectangular brass tube boilers installed as shown, each with four wet bottomed furnaces and all the internal flues united in a single funnel.[20]

On the first trial the engines developed 719 indicated horse power and drove the ship at 9.6 knots. On a later trial she averaged over 12 knots between the Cloch Light and the Cumbrae Light and sailed from the Clyde on her delivery voyage on May 17, 1850. The following comment which appeared in the 'Greenock Advertiser' of 27th August 1849 confirmed the writer's experience and opinion that nothing ever really changes!!

> 'H.M. 'Vesuvius' arrived on Monday and brought spars, anchors and chains for the new frigate 'Greenock' and also a band of 70 riggers from the Admiralty Dockyards who are now employed in fitting out the vessel with these items.
> Whether it arises from the want of tools to which they are accustomed or from the Scotch air having some peculiar effect on them we know not but it must be a treat to a lazy man to see the very cool way in which they go about their work"
> Government employment must be very pleasant!!'

At a later date experiments showed that the 32 pounder gun at short range could penetrate the side of an iron ship and cause as much damage as to a wooden ship. This gave the anti-iron ship lobby at the Admiralty their opportunity and all of the iron ships then in service with the Royal Navy were condemned, including the 'Simoon' built a little later than 'Greenock' by Robert Napier. The result of this decision was that the use of iron on the main structure of naval vessels was delayed by nearly ten years. The 'Greenock' was subsequently sold and become a sailing ship renamed 'Melbourne' and she had a long and profitable career trading to the Far East. Her engines and boilers were subsequently installed in H.M.S. ' Hannibal' in 1854.

The split between the Scott brothers in 1850-1 which followed the delivery of H.M.S. 'Greenock' was discussed in the previous chapter. There can be little doubt that Charles Scott I and his son John Scott IV were persuaded by their experience on that contract that the future of shipbuilding and marine engineering lay with iron ships and steam engines. As pointed out earlier, John Scott III and his son John Scott, jr. did not agree.

However, when they went their separate ways the steamships built by both companies in the period 1852-8 became increasingly propeller driven. The use of better materials, increased scantlings and stiffening of the box type boilers made it possible to raise boiler pressure to between 20 and 30 p.s.i. Similarly on engines, better materials, workmanship, and design details allowed of higher piston speeds and revolutions per minute resulting in higher propeller efficiency.

DOUBLE GEARED ENGINES.

However, before moving on to the new types of engine stemming from propeller drive, reference should be made to Scott, Sinclair and Co. having patented a new geared double engine described at the time as "the most compact specimen of its type then in existence." "Every weight was well balanced, the working parts were clear and open, and the combined whole was stable, firm and bound well together." (See Fig. 3/12) The great virtue of this configuration was that in a ship 249 ft. in length, the fore and aft length taken up by the machinery was only 12 ft. 6 in.[21]

The engine shown was installed in the 'Clyde', an early Atlantic liner delivered in 1854 and developed 250 nominal horsepower. The cylinders were disposed at 105 degrees to each other and were 52 in. in diameter and had a stroke of 3 ft. 9 in. They were direct acting, each had two piston rods with a common broad crosshead from which long return connecting rods, the top ends of which were fitted to crank pins fixed in opposite arms of a pair of large spur wheels, meshed with a pair of corresponding pinions bolted to the propeller shaft which rotated at 2.1/2 times the speed of the engine.

Similar installations but of 120 nominal horsepower were installed in 1853 and 1855 in the ships 'Ebro' and 'Scindian' for Spanish owners and the Bombay Steam Navigation Co. respectively. All of these installations were for propeller driven ships.

Scott, Sinclair and Co. also patented a similar arrangement specifically designed for paddle drive for which gearing was unnecessary. This installation of 90 nominal horsepower shown on Fig. 3/13 was installed on the paddle steamer 'Duncan Hoyle' in 1853 and as in the 'Clyde' arrangement, was extremely economical in the space occupied. In this case the engine assembly occupied a space of 15 feet fore and aft and 5 feet 6 inches transversely.

The rigidity of both designs was favourably commented upon and contrasted with the loose working, jingling action which afflicted oscillating engines after a few years service.[22] Both designs are extensively covered in Volume VI of the Practical Mechanic's Journal (1853).

TRUNK TYPE ENGINES.

Finally, Scott, Sinclair built a few 'trunk' engines in the late 1850s. This novel type of engine (See Fig. 3/14) was invented by John Penn and Sons and was particularly well suited for the steamers of the Royal Navy, being horizontal, below the water line, and having a low centre of gravity. It operated with a higher piston speed than was usual at the time thus obviating the use of gearing. However, it had a number of drawbacks, particularly a high heat loss by radiation from the trunks. The large diameter stuffing boxes also gave trouble and barrelling of the top and bottom surfaces of the horizontal cylinder was also a problem.

CONDENSERS.

(a) Jet Condenser.

The entire range of engines described so far had one common factor - they were all equipped with jet condensers. This type of condenser can be observed on Figs. 3/5 and 3/6 and consisted of an air-tight chamber attached to the exhaust outlet of the engine. Cold water was sprayed into the exhaust steam flow and the resultant mixture of condensate and air was pumped out by the air pump. The ratio of cooling water/steam was of the order of 20/1 and of course make up feed and the spray cooling water came from the sea which was necessarily at a temperature below that of the exhaust steam. The problems of scale accumulation in such circumstances have already been discussed.

(b) Surface Condensers.

As will emerge later, John Scott recognised the necessity of replacing jet condensers by surface condensers in machinery installations designed for service on long haul ocean trade routes and operating at boiler pressures in excess of 40 p.s.i. In surface condensers the exhaust steam and condensate from the engine were initially passed through tube nests, isolated from the circulating cooling water outside the tubes with consequent poor control of velocity and distribution. The early development of surface condensers of this type was carried out by Samuel Hall of Darlington in the 1830s and Scotts fitted a Hall designed surface condenser in 1839 in the steamship 'India' which operated successfully for many years.[23] (See Fig. 3/15)

However, practical difficulties were encountered. The copper tubes frequently split at their brazed joints. Another serious problem arose from the tallow, used for cylinder lubrication, being carried over in the steam and clogging up the tubes. It also coated internal surfaces of the boilers and initiated corrosion and reduced heat transfer. So whilst real fuel savings stemmed from the elimination of boiler blow down, the boiler cleaning problem remained.

These difficulties together with the extra weight and cost of surface condensers led to a slowing down in their adoption and they became unpopular. However, the cost of boiler maintenance (and in many instances replacement) where sea water feed was used, and the gradual rise in boiler working pressure gave fresh impetus to efforts to overcome the problems described above.

These efforts were led by J.F. Spencer of Newcastle upon Tyne who made a number of fundamental changes of design. (See Fig. 3/16) He introduced the 'outside' condensing system with the cooling water passing through the tubes and the steam circulating outside the tubes. He also introduced a contraflow system of steam entering at the top and condensate leaving at the bottom, with the cooling water entering the multipass system of tube nests at the bottom and the hot water leaving at the top giving improved heat transfer performance. The condensate at a temperature slightly below that of the exhaust steam could now be used as boiler feed.

Spencer countered the complaint of extra cost and space occupied by pointing out the considerable reduction in bunker space arising from the fuel savings due to the elimination of 'blow down'.

New corrosion problems appeared however in iron boilers working with surface condensers having brass or copper tubes. A combination of measures ultimately cured the problem over a number of years. These included the use of mineral lubricating oil, distilled boiler feed water and the use of zinc inserts for anodic protection.

STEAM EFFICIENCY.

Another common factor shared by the variety of types of engine available was their extremely low 'steam efficiency'. John Scott was concerned at the slow growth in boiler pressure (during the first 30 years of Scott, Sinclair), which he considered was the key to improved performance of the engine. It was equally clear that the breakthrough of the steam engine into the international longhaul trades would remain a pipe dream until the overall efficiency of the steam power plant was significantly improved with a consequential reduction in the space required on steam ships for the carriage of bunkers.

During the period 1852-1859, before he purchased the Scott, Sinclair engine works, John Scott IV obtained the engines for the ships built by him at Cartsdyke from various suppliers on the Clyde, Caird, Blackwood and Gordon, Neilson, Scott Sinclair, McNab and Clark, and Rowan. He was aware that the use of boiler pressures in excess of 37 p.s.i. implied the use of fresh water boiler feed and the consequent use of surface condensers. (where the cooling water was drawn from the sea and the condensate was kept separate). It would also involve re-designing the engine and boiler to withstand the increased pressure.

A further benefit arising from the use of high pressure steam would be the ability to employ compound expansion of the steam. The full expansion of high pressure steam from boiler pressure down to vacuum in one cylinder becomes increasingly impractical as the pressure and the potential expansion ratio increase due to very early cut off. Such a cylinder would require to be large enough to allow of the expansion and at the same time strong enough to withstand the maximum pressures involved. The working parts would similarly require to be sufficiently large and strong to carry the maximum loads involved. This would result in a heavy and expensive engine.

Because of the wide range in temperature of the cylinder walls in such an engine, there would be significant initial condensation of the steam at entry to the cylinder, and with the wide variation in pressure on the piston there would be excessive variation in turning moment on the crankshaft. All of these deficiencies would be greatly reduced in a compound engine where the range of expansion would be split between two cylinders, known as the h.p. (high pressure) and 1.p. (low pressure) cylinders.[24]

THE 'THETIS' EXPERIMENT.

John Scott IV found a kindred spirit in J.M.Rowan whose firm manufactured steam engines and boilers at the Atlas Foundry, Glasgow and in 1856 he embarked on the construction of the historic vessel, the S.S. 'Thetis', which he built at his own expense and which was fitted with prototype machinery comprising watertube boilers and compound expansion steam engines with surface condensers, the boiler working pressure being 115 p.s.i.[25] The engine was of somewhat unusual configuration having two cranks, each crank driven by a group of three cylinders, the h.p. cylinder being on the engine vertical centre line, flanked on each side outboard by an 1.p. cylinder. The diameters were h.p. - 21 in and l.p. - 42 in. and the engine stroke was 30 in. (See Fig. 3/17)

Extensive sea trials of 'Thetis' were carried out on the Clyde and 226 indicated horsepower was developed at 51 revs. per minute with a piston speed of 255 ft per minute. Professor Macquorn Rankine of the University of Glasgow supervised the fuel consumption trials and the remarkable figure of 1.018 lb of coal per indicated horse power hour was certified by him. After extended service experience a figure of 1.86 lb per indicated horsepower hour emerged. At that time the average figure nationally was assessed at 3.4 lb per indicated horsepower hour.[26]

The watertube boiler contributed mainly to this remarkable performance with an evaporation rate of 11 lb of water per lb of coal, 30 per cent higher than the best performance at the time. (See Fig. 3/18) In the course of time the tubes of the Rowan boiler suffered from severe pitting corrosion, identified later as electrolytic corrosion which it is now known cannot be prevented, but the effect can be reduced by keeping control of the boiler water alkinity and eliminating dissolved oxygen from the boiler water. Although for this reason the early watertube boilers did not succeed, there is no doubt that their performance led to improvements which resulted in their complete acceptance particularly for ships of large horsepower.

FURTHER SCOTT/ROWAN DEVELOPMENT WORK.

John Scott was a founder member of the Institute of Naval Architects in 1860 and through that body he met with M.Dupuy de Lome, then head of warship design at the French Ministry of Marine. In that year John Scott had laid before the Admiralty a machinery design for a new class of sloop incorporating watertube boilers and a compound expansion engine.[27] He in fact received an order for six sets of machinery for sloops, subsequently built at the Deptford and Devonport Dockyards, and it was intended that one set should comprise watertube boilers and a compound engine. However, because it was impossible to ensure that the top of the boilers would be at least one foot below the load line - a condition then enforced in naval steam vessels for tactical reasons, the ships were all provided with conventional machinery working at a steam pressure of 25 p.s.i. instead of 125 p.s.i. proposed for the experimental vessel.

M. Dupuy de Lome was nevertheless attracted by Scotts proposal and ordered a small auxiliary vessel, 'Actif' from Scotts with the new design machinery for the French Navy.[28] Fig. 3/19 shows the machinery arrangements for 'Actif' as built, the first compound expansion engines in the French Navy. In addition to 'Actif', John Scott built a number of other steamships with advanced machinery at this time including the paddle steamers, 'Guajara' and 'Bengal' for service in Brazil and India and two screw steamers, 'Italia' and 'Haco'. The average trial fuel consumption of the five ships mentioned was of the order of 1.6 lb. per i.h.p. per hour.[29]

By embarking on this extensive programme of research largely financed by himself, and in spite of subsequent difficulties in service of the Rowan design watertube boilers (not built by Scotts), John Scott had secured wider acceptance of the economy resulting from the use of higher boiler pressures which the 'Thetis' experiment had clearly established.

TRANSMISSION.

Having discussed the boiler and engine elements of the marine steam power plant, consideration must now be given to the efficiency of transmission of power generated in the engine cylinders to the propulsion device, paddle or screw propeller.

In all reciprocating engines the principal power loss in transmission is due to friction. In the early steam engines (1820-1860) the friction loss was particularly high due to a variety of causes including poor lubrication arrangements, vegetable gland packings, and manufacturing limitations including, for example, lack of accuracy and circularity, as well as poor quality of surface finish. The main sources of friction loss were the piston, guides and slides, shaft journal and stern tube bearings (with brass bushes), valve guides, valve gear, and gland stuffing boxes. It was possible by over tightening the glands on a trunk engine to generate sufficient resistance to stop the engine!!

In diagonal and horizontal engines, piston friction tended to make the cylinders oval, and on vertical engines pitching or rolling of the ship also caused cylinder wear. On the early engines tallow was injected into the engine cylinders and valve chests for lubrication purposes, but later, with the introduction of surface condensers, this led to fouling of the condenser tubes. Tallow was then replaced by mineral oil. Shaft bearings and guides were lubricated by capillary attraction conveying oil from adjacent oil boxes by means of worsted syphons. Replenishment of the oil boxes was extremely hazardous on these old engines.

A further transmission power loss was incurred in overcoming the inertia forces generated by the engine reciprocating masses - pistons, rods, and an equivalence of the rotating masses. Finally, transmission losses occurred when speed increasing or decreasing gearing was employed.

METHOD OF PROPULSION.

The final element of the early marine power plant to be discussed is the propelling device.

Up to the late 1840s paddle propulsion was the only method available and it possessed a number of advantages. It was well suited to the slow running engines of the day and the installation of the engines into wooden hulls was straightforward. The hull penetrations for the paddle wheel shafts were above the water line and the additional timber strengthening to take the thrust which was transmitted through the walls of the ship was easily accommodated. However, there were also disadvantages, a number of which, concerning fighting ships, were discussed earlier. Paddle machinery occupied the most valuable part of the ship, and the greatly increased beam in way of the paddle boxes resulted in large areas being exposed to the forces of wind and waves.

The slow running engines occupied much space and were very heavy. Their high fuel consumption effectively confined paddle steamers to coastal and esturial services because on transocean voyages the space absorbed by the very large quantity of bunkers made regular ocean voyages uneconomic. At modest powers, and particularly with the adoption of the feathering paddle wheel in 1835, paddle drive was reasonably competitive with the screw propeller. However, as the demand for higher engine powers increased so the limitations of paddle drive were exposed.[30] The concept of screw propulsion was introduced as far back as 1770 by James Watt. In 1867, John Bourne in his work "Treatise on the Screw Propeller" listed some 470 names associated with the development of the invention.[31]

However, the adoption of the screw propeller was primarily due to the endeavours of Francis Pettit Smith in England and John Ericsson in Sweden, both of whom took out patents in 1836.

The Navy finally adopted the screw propeller in 1845 and thereby eliminated most of the problems associated with paddle propulsion.

Scotts first propeller driven ship was the frigate H.M.S. 'Greenock' (1850) which was fitted with a propeller of F.P.Smith design.

In the commercial field the screw propeller removed one of the major barriers to the introduction of steam navigation on the long haul ocean routes, namely the adverse effect on the propulsive efficiency of paddle steamers caused by the variation in paddle immersion as bunkers were consumed en voyage. A further benefit to propeller driven ships was that the performance of the machinery was hardly affected by rolling.[32] On the other hand propellers were prone to racing when the ship's stern came out of the water in heavy weather.

There were other problems, mainly related to the much higher engine revolutions required to obtain a good propeller efficiency, and these problems were so serious as to threaten the future of screw propulsion. These higher speeds resulted in out of balance forces stemming from the unbalanced propeller blades. The subsequent heavy wear and much enlarged clearance in the stern tube bearing gave rise to a great thumping effect which set the entire aft end of the ship vibrating and caused considerable damage to structure, especially on wooden ships. In a number of instances the heavy stern tube itself split, putting the ship in danger of sinking.[33] It was only when static balancing of propellers and (in

1854) the lignum vitae water lubricated stern tube bearing were introduced that these problems came under control.[34]

It must be appreciated that in the 1850s, and in spite of a great deal of investigatory work done at that time, the efficiency of the screw propeller was extremely low. The interrelationships between propeller diameter, pitch, number of blades, blade area and thickness and their influence on producing a satisfactory design were still something of a mystery!! This situation did not prevent a virtual plethora of patents being lodged concerning propellers and Fig. 3/20 shows the Scotts versions embracing two, three and four blade designs.

Finally, the axial thrust from the propeller was transmitted through the propeller shafting inboard and to prevent problems with the engine therefrom, a thrust block was introduced immediately aft of the engine. The propeller shaft in this area was fitted with a series of integral collars, which transmitted the thrust through pads in the thrust block to the ship's structure thus isolating the engine from the thrust forces.

SOME PIONEERING SHIPS.

Scotts contribution to these technical developments is in part signposted by their construction of a number of what can be regarded as pioneering ships. Such for example was the steamship 'India' delivered in 1839 by Scott and Sons.

'India' was originally intended for the service to India via Cape of Good Hope, and the chairman of the sponsoring company, Sir John Ross, the noted Arctic explorer, carried out a feasibility study on the reboilered 'City of Glasgow' another Scott built ship, to establish fuel consumption rates for the projected service. When built, the 'India' was the largest steamer built on the Clyde up to that date and she was unique for two reasons. She was fitted with iron bulkheads at the end of the machinery spaces to prevent the accidental outbreak of fire and also for damage control - this over forty years ahead of Lloyd's rule insisting that they be fitted (1882). She was also notable for having her machinery of 320 N.H.P. being equipped with one of the earliest of Hall's patent surface condensers.[35]

The prospective owners ran into financial difficulties and withdrew from the contract and she was ultimately purchased by the Eastern Steam Navigation Co. who employed her on the Calcutta - Suez service.

Because of a condition of subsidy for the mail contract on this run that the engine horsepower should be not less than 400 N.H.P. and in spite of the 'India's' superior performance over her P. & O. company rivals on the run, the subsidy went to P. & O. Subsequently, the 'India' was sold to P. & O. and put back on the run, despite the conditions acting against the Eastern Steam Navigation Co.

We have already noted Scott's experiment with S.S. 'Thetis', and the early use of compound engines and water tube boilers in 1856, but even more significant was Scott's construction of three great vessels for Alfred Holt, the 'Agamemnon', 'Ajax' and 'Achilles'. These vessels are arguably John Scott IV's greatest contribution to the development of the steamship. They were built for Holt between 1865-1866, and were ordered to inaugurate the first regular steamship service to the Far East using compound expansion engines.

The engines were designed and manfactured by John Scott's Greenock Foundry Co. around Alfred Holt's unusual tandem concept, with the 62 in.

diameter low pressure cylinder located vertically above the 30 in. diameter high pressure cylinder and having a stroke of 52 in. Mounted on the common piston rod was a broad crosshead from which two connecting rods, passing the lower (h.p.) cylinder, were connected to a single crankpin. A heavy flywheel, 12 ft. in diameter and weighing 5 tons was fitted and catered for the torque variation on the single crank. It was fitted with inching gear to move the engine off dead centre when necessary.

Another unusual feature was that the propeller was located aft of the rudder, the reverse of normal practice, an innovation which did not last long.

The propeller was 17 ft. in diameter, 26 ft 6 in pitch and had three blades. The engine rotated at 46 r.p.m. giving a piston speed of 390 ft. per minute.

Trading on his previous experience, Alfred Holt had specified that two locomotive type boilers, working pressure 60 p.s.i. be fitted.

The machinery arrangement of the early Holt China steamers is shown on Fig. 3/21. Alfred Holt persisted for many years with single crank engines. In the 1870's the engine was simplified by reversing the positions of the cylinders, the h.p. going on top and fitting the crosshead below the cylinders with a single connecting rod on to the crank pin. This alternative design is shown on Fig. 3/22.

The trip to China started from Liverpool and proceeded non stop via the Cape of Good Hope to Mauritius, under steam all the way. From there the ships proceeded to Penang, Singapore, Hong Kong and Shanghai. This long voyage was performed with great regularity with no financial assistance from the Government. On one voyage the 'Achilles' came home from China in 57 days 18 hours net steaming time having travelled 12,352 miles on a consumption of coal which did not exceed 20 tons per day for all purposes equal to 2.1/4 lb. per unit of power per hour. Each of the three pioneer ships cost £52,000.[36]

Until Alfred Holt ordered his famous trio of ships for service to the Far East and confronted directly the question of fuel economy on steamships the general attitude of most shipowners was one of disinterest in the subject.[37] They saw no advantage in raising boiler pressures and many thought high pressure steam positively dangerous and were encouraged in their view by a series of boiler explosions in the U.S.A. and also at home. Such slow progress as had been achieved in getting higher pressures was due more to the availability at better materials than any belief in the economic value!! There was also at this time great reluctance to approach a pressure of 40 p.s.i. with its implications of switching to surface condensation.

It is in this context that Scotts forward vision is made clear. This review of fifty years of progress in the design and construction of marine steam power plant clearly established the contribution of the Scotts in the adoption of many improvements in the efficiency and reliability of the marine engine and associated plant. The subsequent design of Holts three great ships and the far reaching consequences of their technical and commercial success, is a further tribute to, and an indication of, Scotts significant role on the development of the shipbuilding and the marine engineering industry during the first main period of its growth in the nineteenth century on Clydeside.

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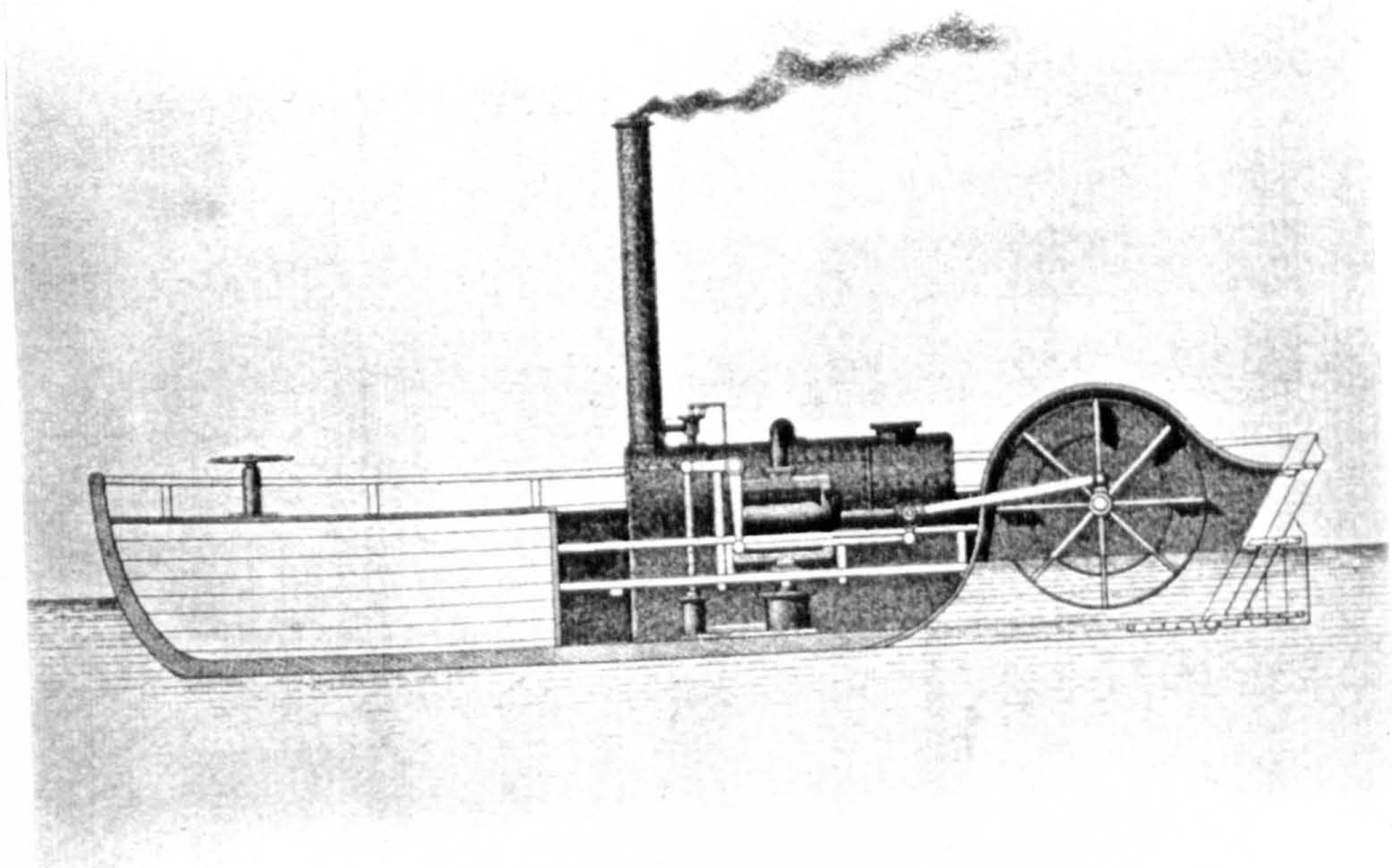
TABLE 3/1 - NOTABLE PADDLE STEAMERS BUILT BY JOHN SCOTT & SONS, 1819-1822.

Year of Build.	Ship's Name	Tons Nett	Dimensions L × B × D. ft.	N.H.P.	Speed m.p.h.	Engine Builder	Cost £	Service built for.	Remarks.
1819	Waterloo	133	106·3 × 21·3 × 9·6	60	8/9	Jas. Cook	-	Belfast Liverpool	Inaugurated Service. Largest Steamer built in U.K - 1819 Spur gearing between crankshaft & paddles.
1819	Sir William Wallace	110	80 × 16·0 × 8·9	60	10	Jas. Cook	-	Clyde Liverpool	-
1819	Robert Bruce	91	94 × 18·6 × 11·0	60	9	David Napier	-	Clyde Liverpool	Inaugurated Service.
1820	Ivanhoe	90	97·3 × 19·0 × 14·5	60	8	David Napier	-	Holyhead Dublin.	-
1820	Superb	240	113·5 × 21·4 × 11·1	72	9	David Napier	8900	Naples Palermo	Largest Steamer built in U.K. - 1820
1821	Majestic	345	134·9 × 22·7 × 14·4	100	10	David Napier	13800	Clyde Liverpool	Largest Steamer built in U.K. - 1821
1822	City of Glasgow	191	110·3 × 22·3 × 13·0	100	11	David Napier.	15000	Clyde Liverpool	Consort to Majestic

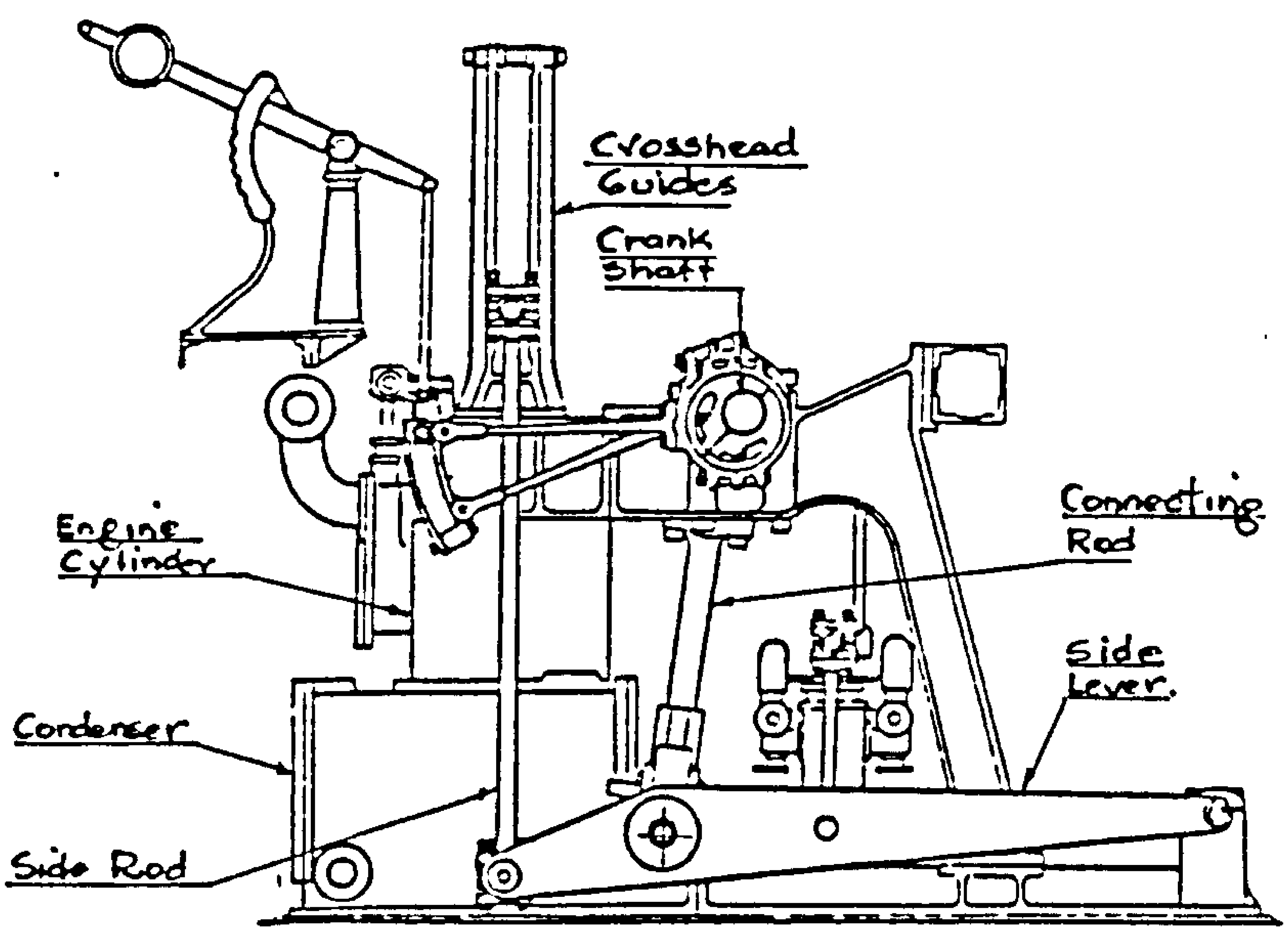
Compiled from Data in Scotts Ship List, Vol. 2 of this thesis



"CHARLOTTE DUNDAS."

From Woodcroft's "Origin and Progress of Steam Navigation."

From 'David Napier' - Engineer 1790-1869 - Glasgow 1912.



GRASSHOPPER ENGINE — Fig.3/2
(A History of Marine Engineering - Guthrie)
(London 1971)

Fig. 3/3. *SOUTH DEVON RAILWAY*

EXETER.

13th January, 1845.

Messrs. Scott Sinclair & Co.,

Greenock.

Dear Sirs,

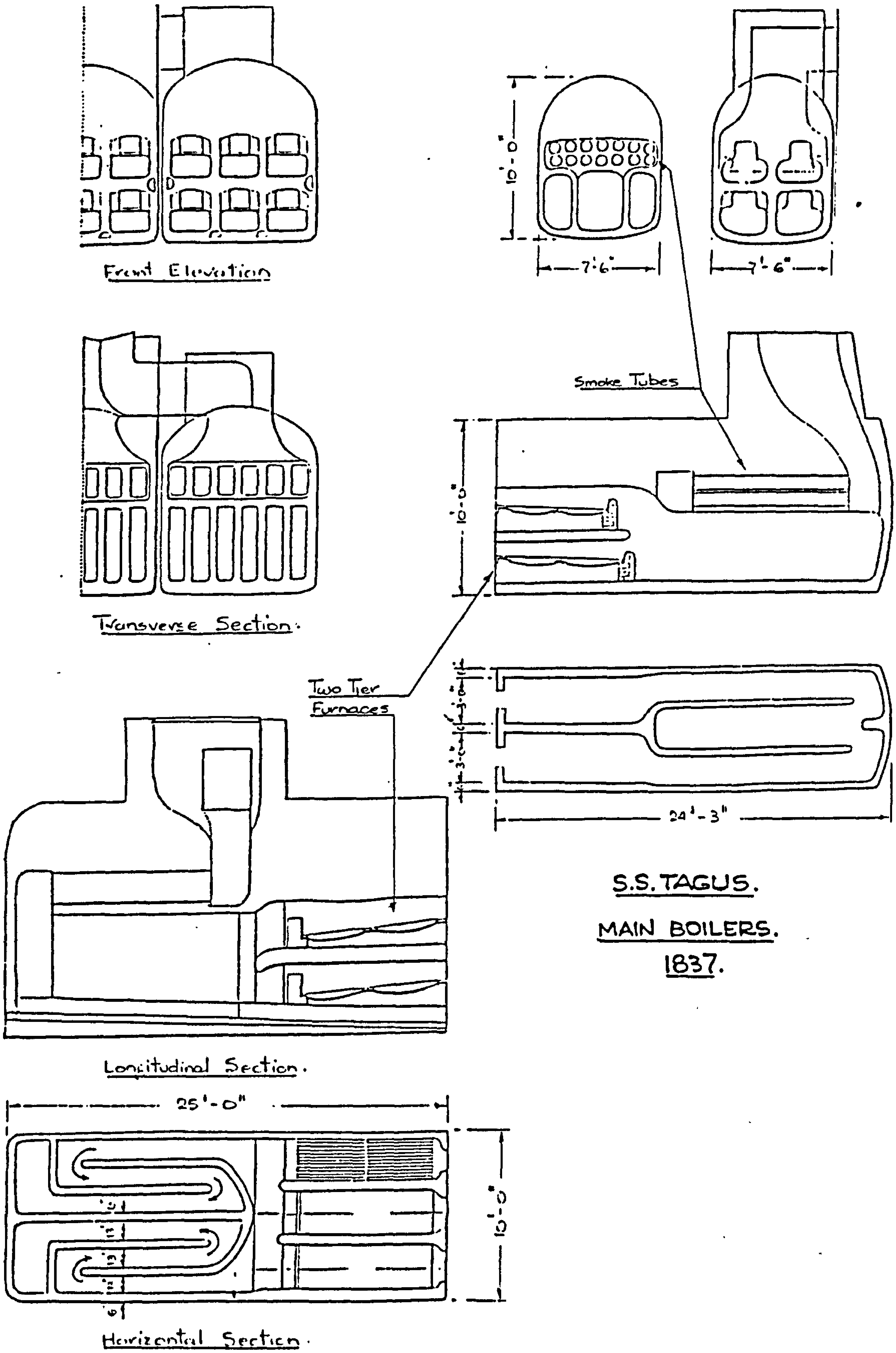
I have the pleasure of conveying to you in a more formal manner than the communication already made to you by Mr. Brunel the Resolution of the Board of the South Devon Co., to accept your Tender opened on the 7th instant for three pairs of Direct Action Engines according to your plan and specifications and also if made in accordance with the specification of our Engineer who will communicate with you more particularly regarding a small alteration that maybe required by him at a cost that may be added to your Tender. He will also furnish you with all further particulars and prepare the contract for delivery to this company but as punctuality of delivery is of the greatest importance there must be a condition of penalty of twenty five pounds per day for every day beyond the first of July 1845 until the Engines are set to work and approved by our Engineer.

I remain, Dear Sir,

Yours very faithfully,

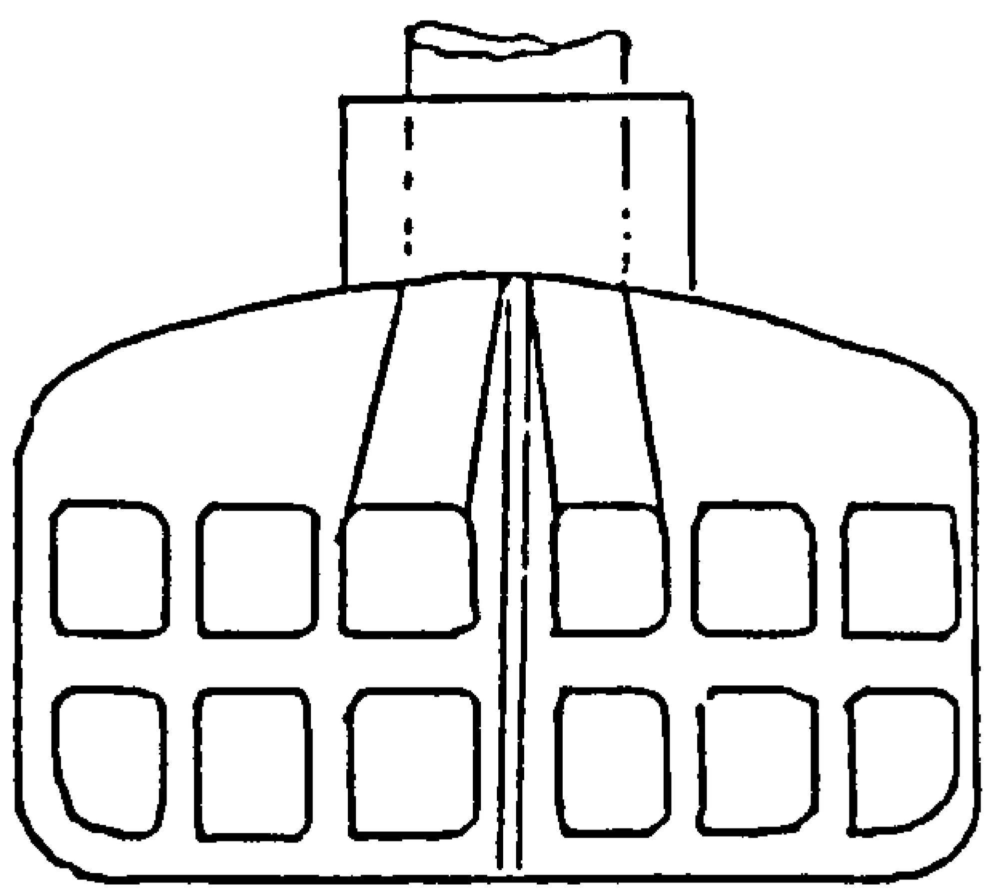
WM. PRINSEP. Secretary.

From: Scotts Archives, Glasgow University, ref. GD.319/12/10/50.

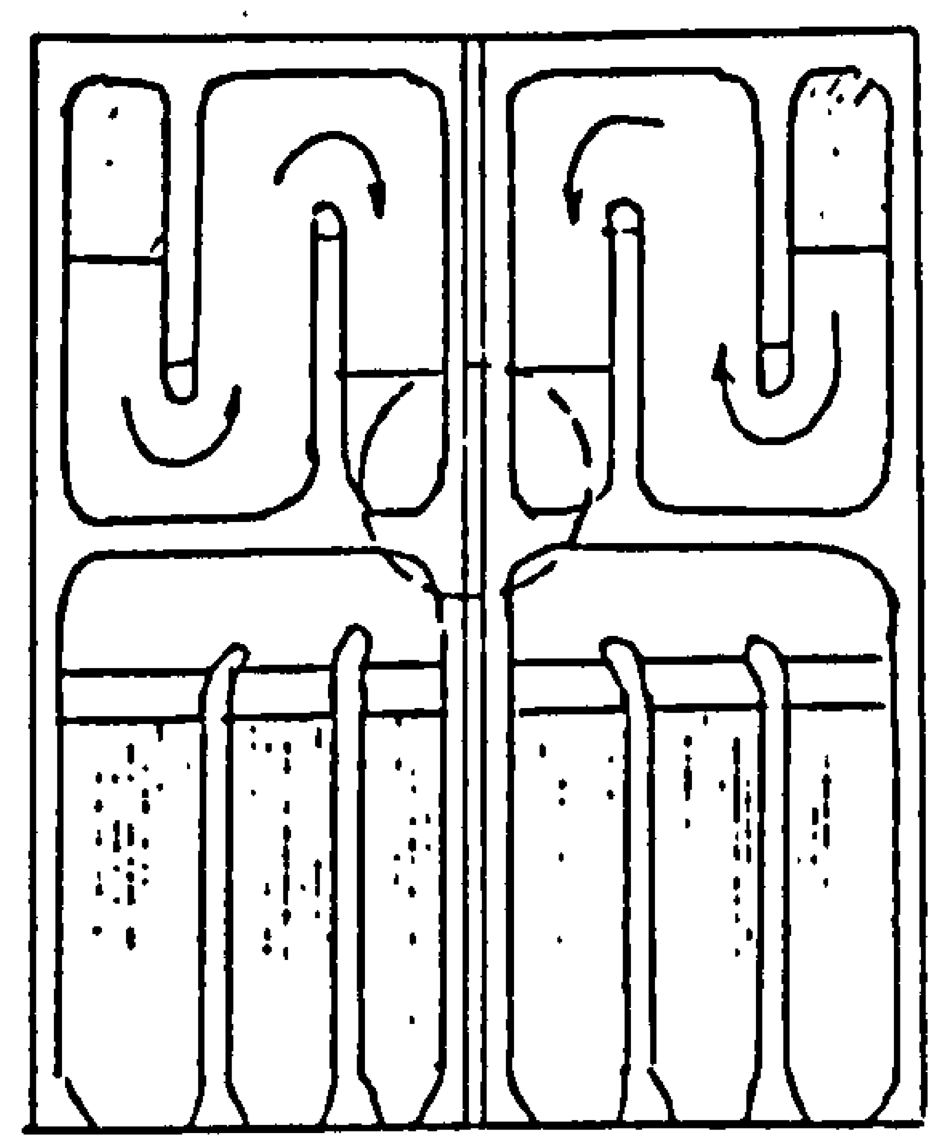


S.S. DEE & SOLWAY.
MAIN BOILERS.
1841.

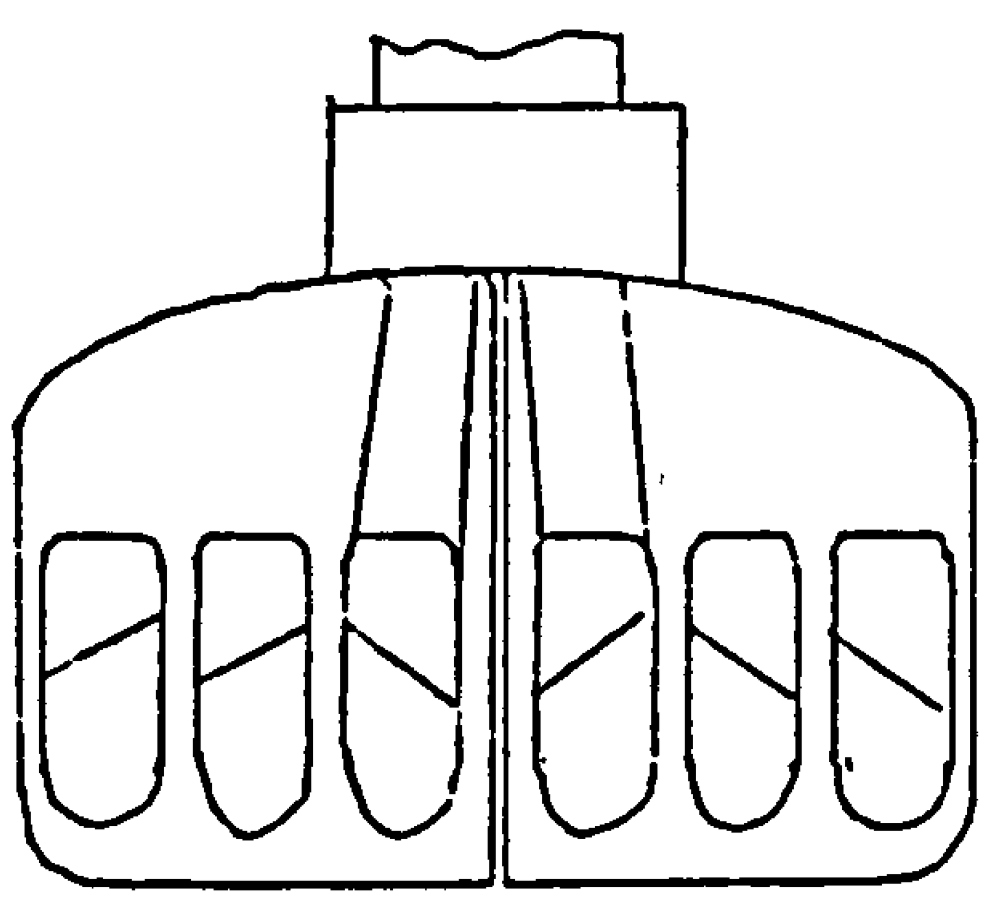
Sketches on Figs. 3/4 a & b.
derived from J. Bourne's
'A Treatise on the Steam Engine' pub. by
Longman, Brown, Green & Longman, London.
1st edition, 1846 pp. 56-7, 61-2, 66



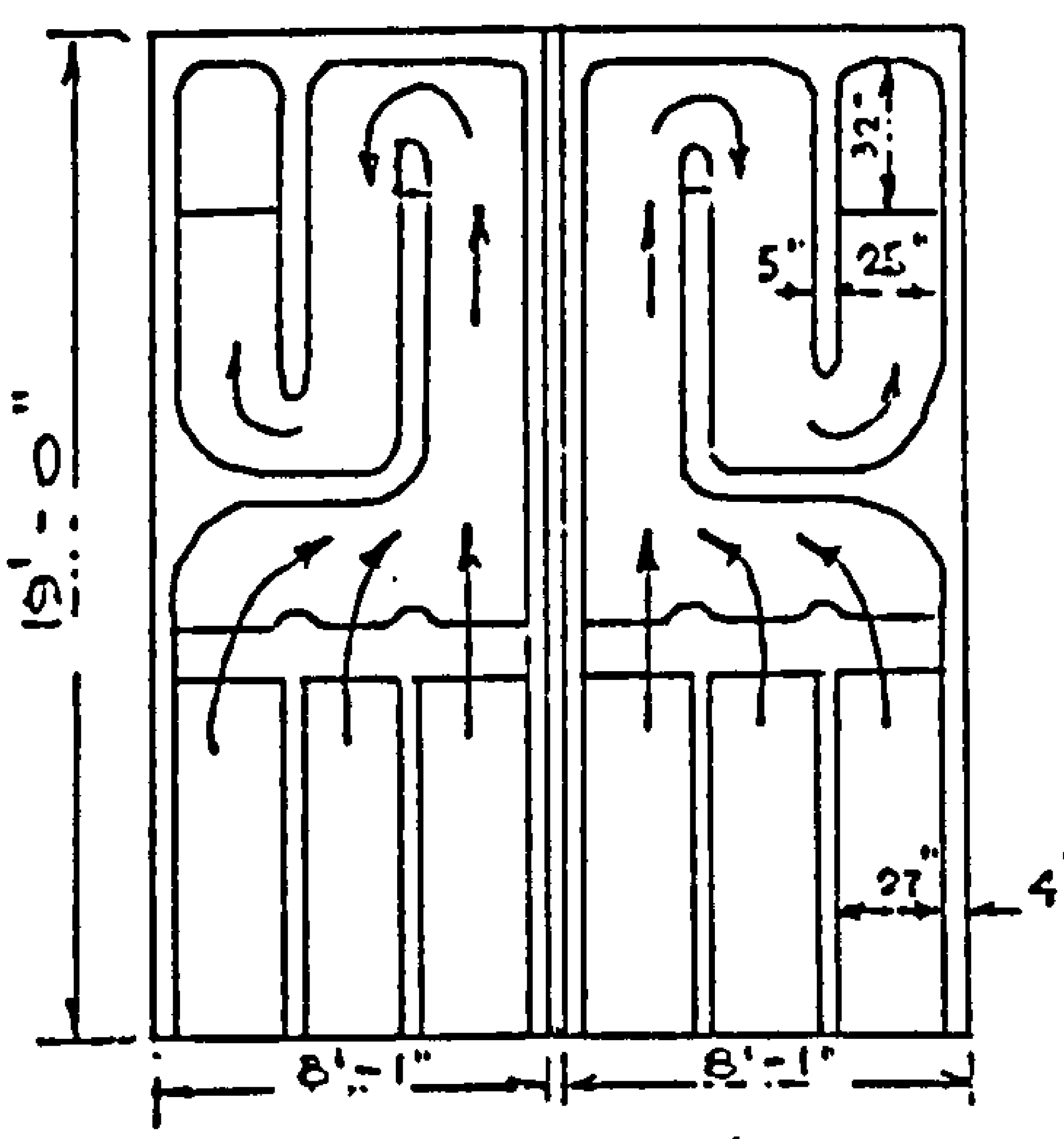
Transverse Section KL



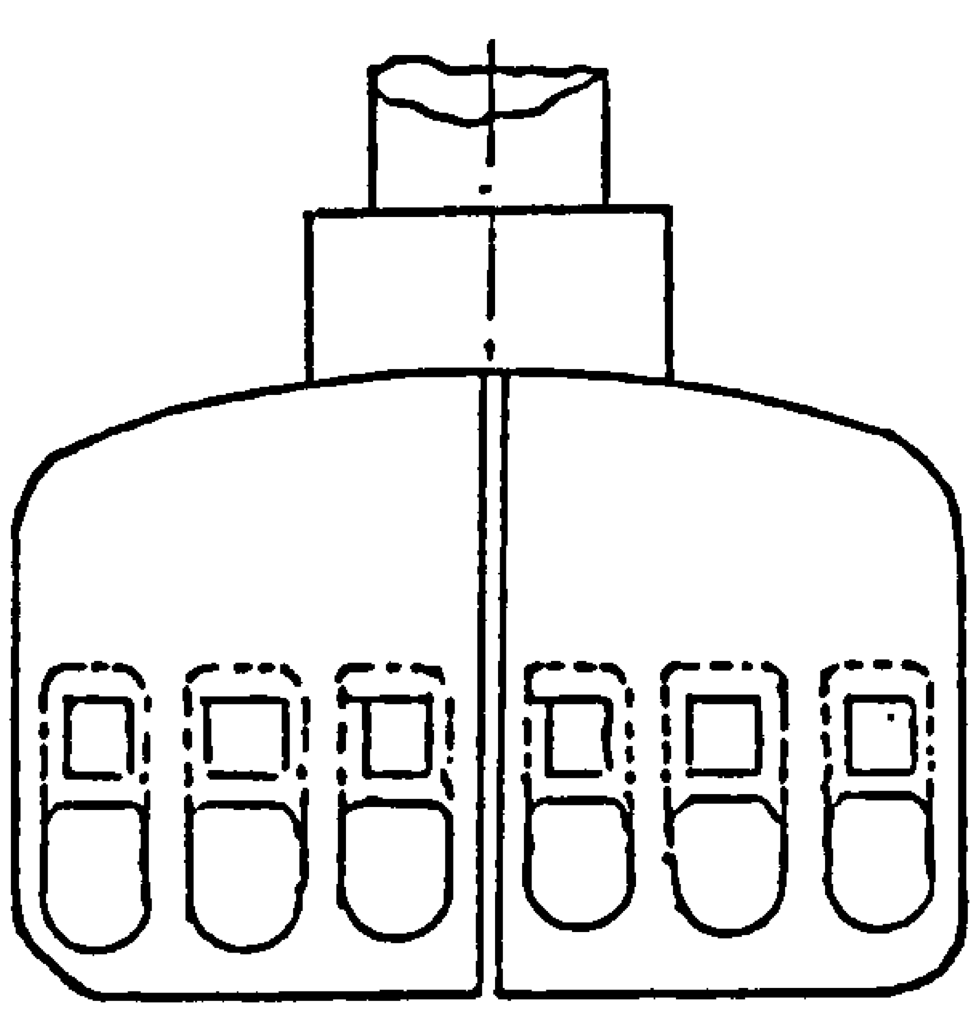
Horizontal Section AB



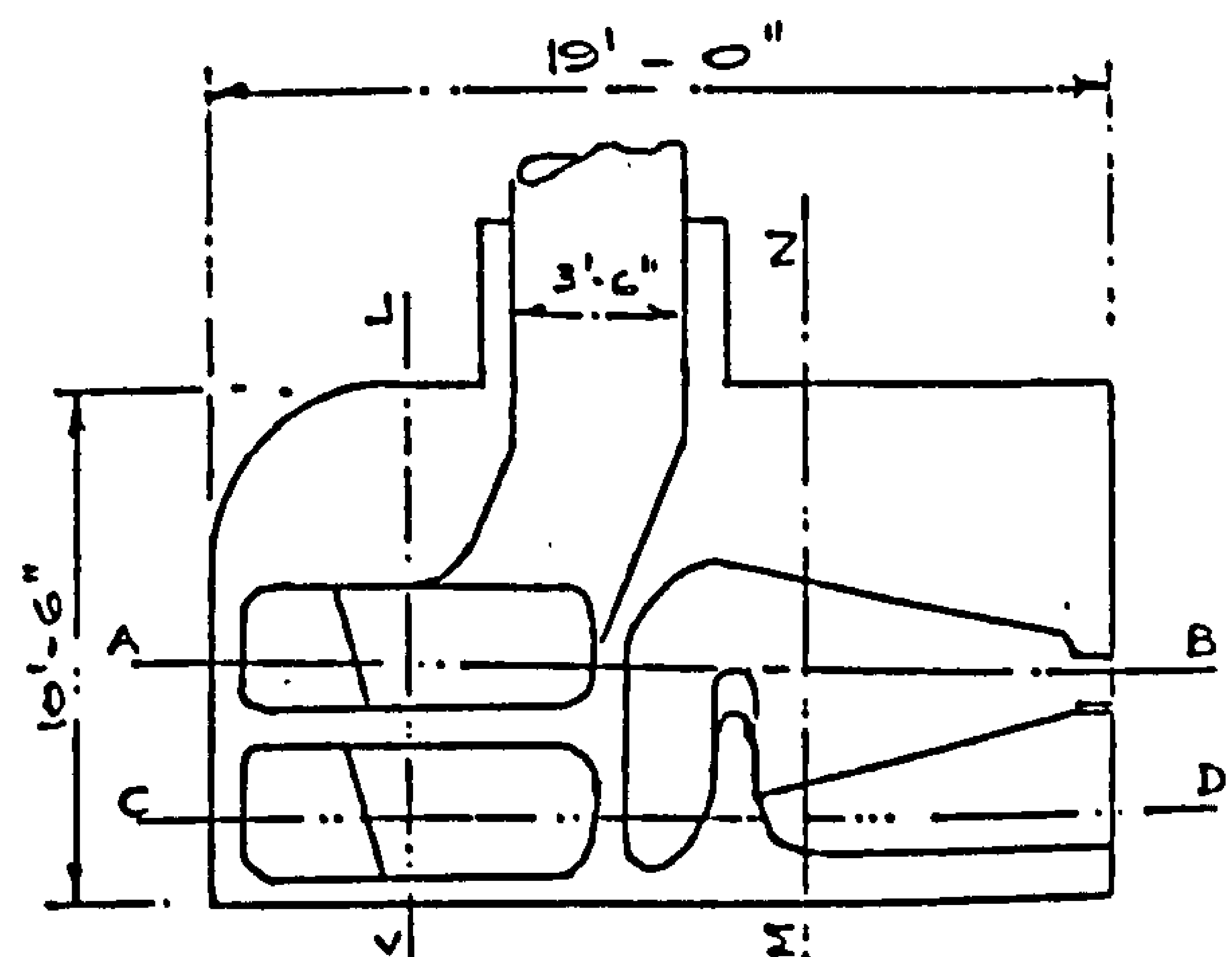
Transverse Section MN



Horizontal Section CD



Front Elevation



Longitudinal Section

S.S. PHOENIX.

MAIN BOILERS.

1842

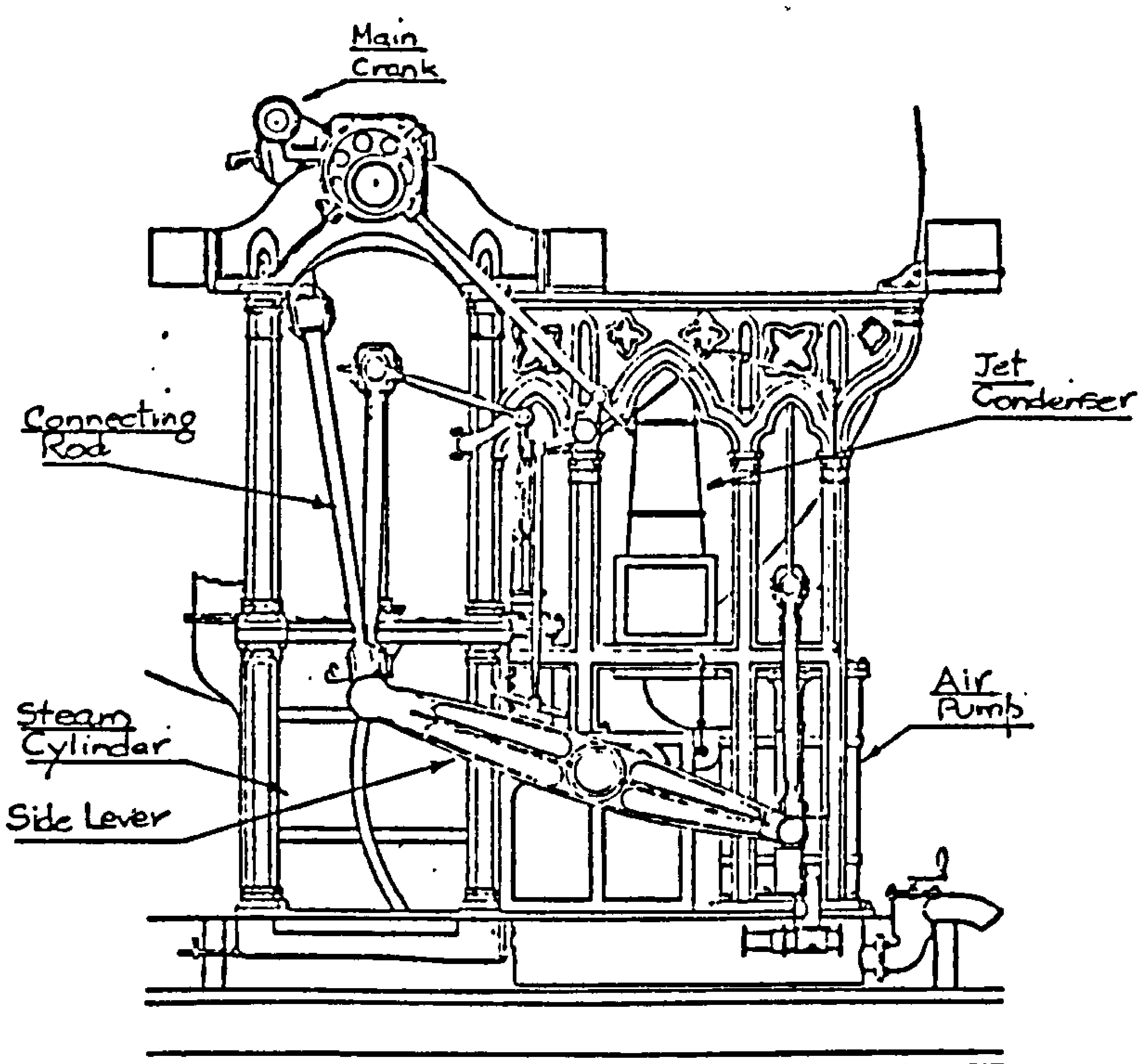
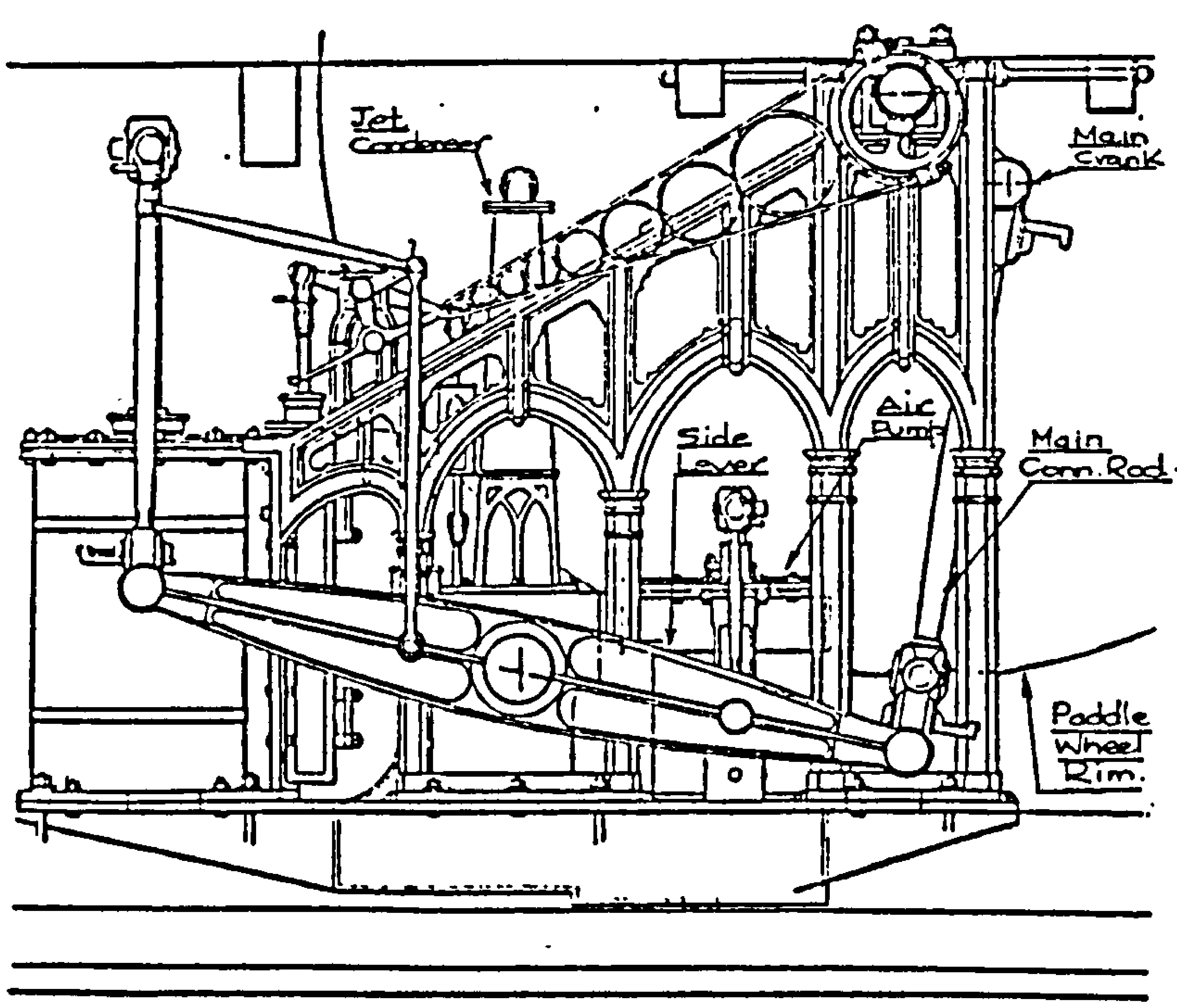


Fig. 3/5a A SIDE-LEVER ENGINE OF 1831



AN ENGINE OF 1832

Fig. 3/5b Sketches from Scotts' 'Two Centuries of Shipbuilding 1961

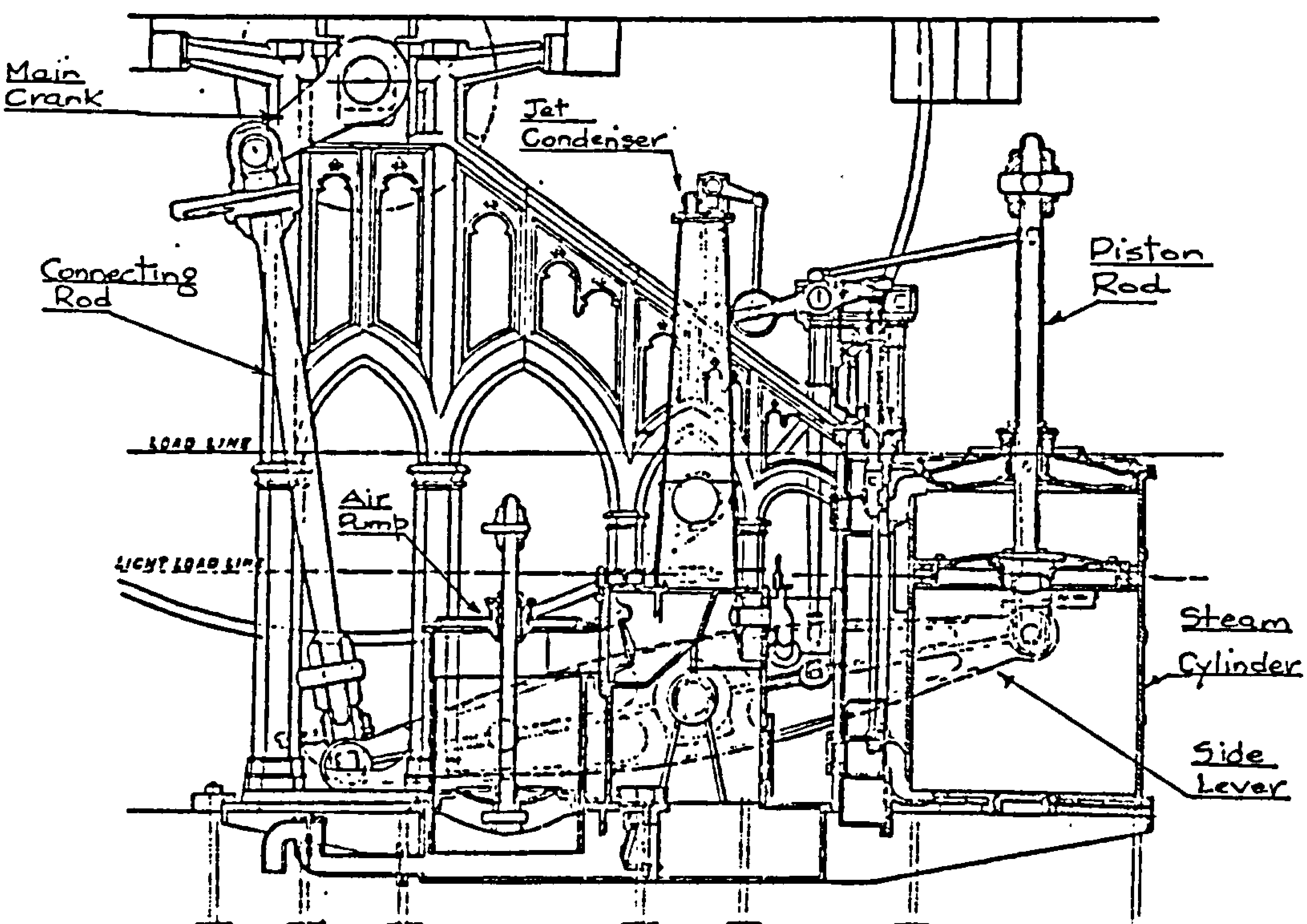
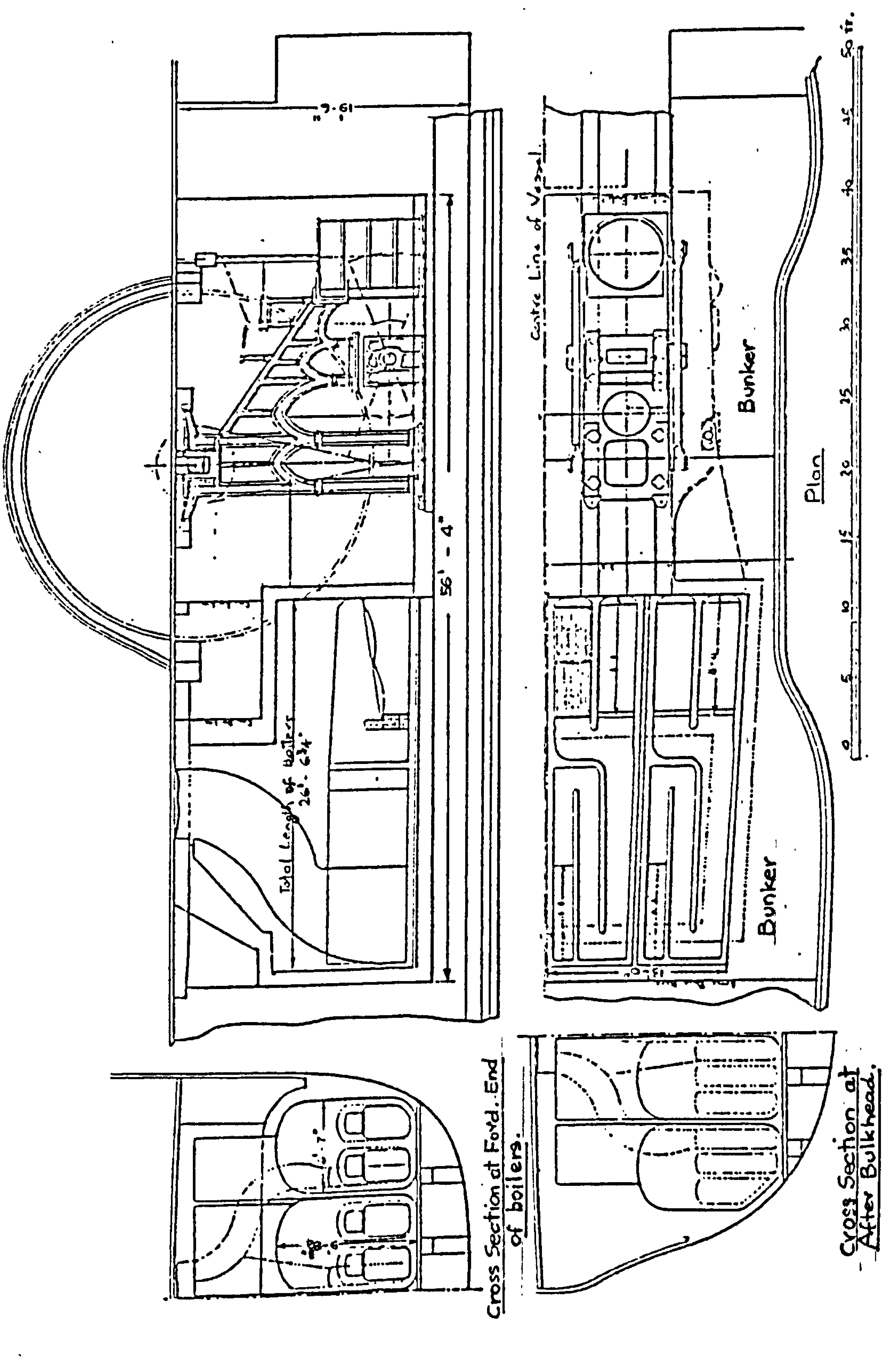
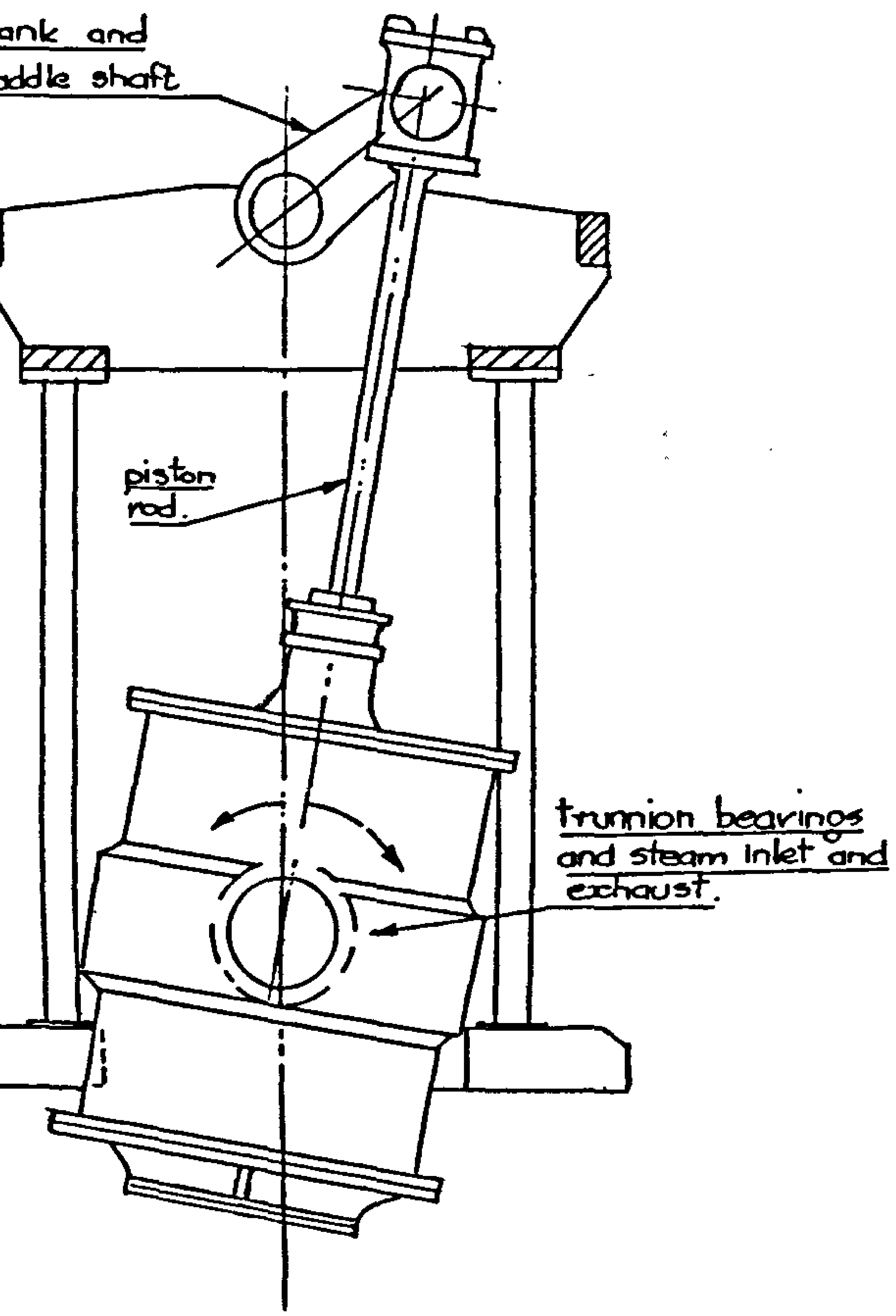


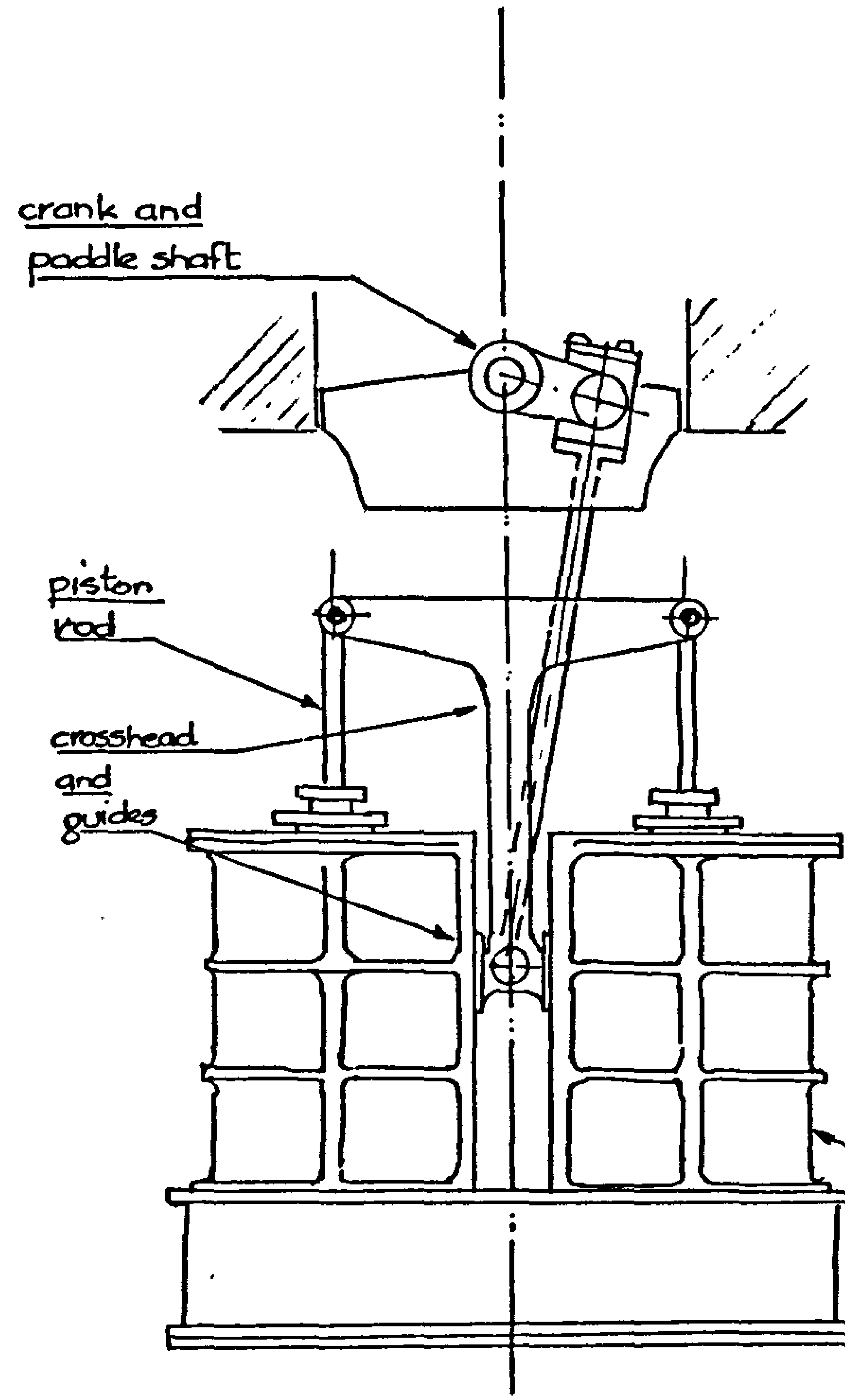
Fig.3/6. TYPE OF SIDE-LEVER ENGINE OF 1838
Scotts' 'Two Centuries of Shipbuilding, 1961.



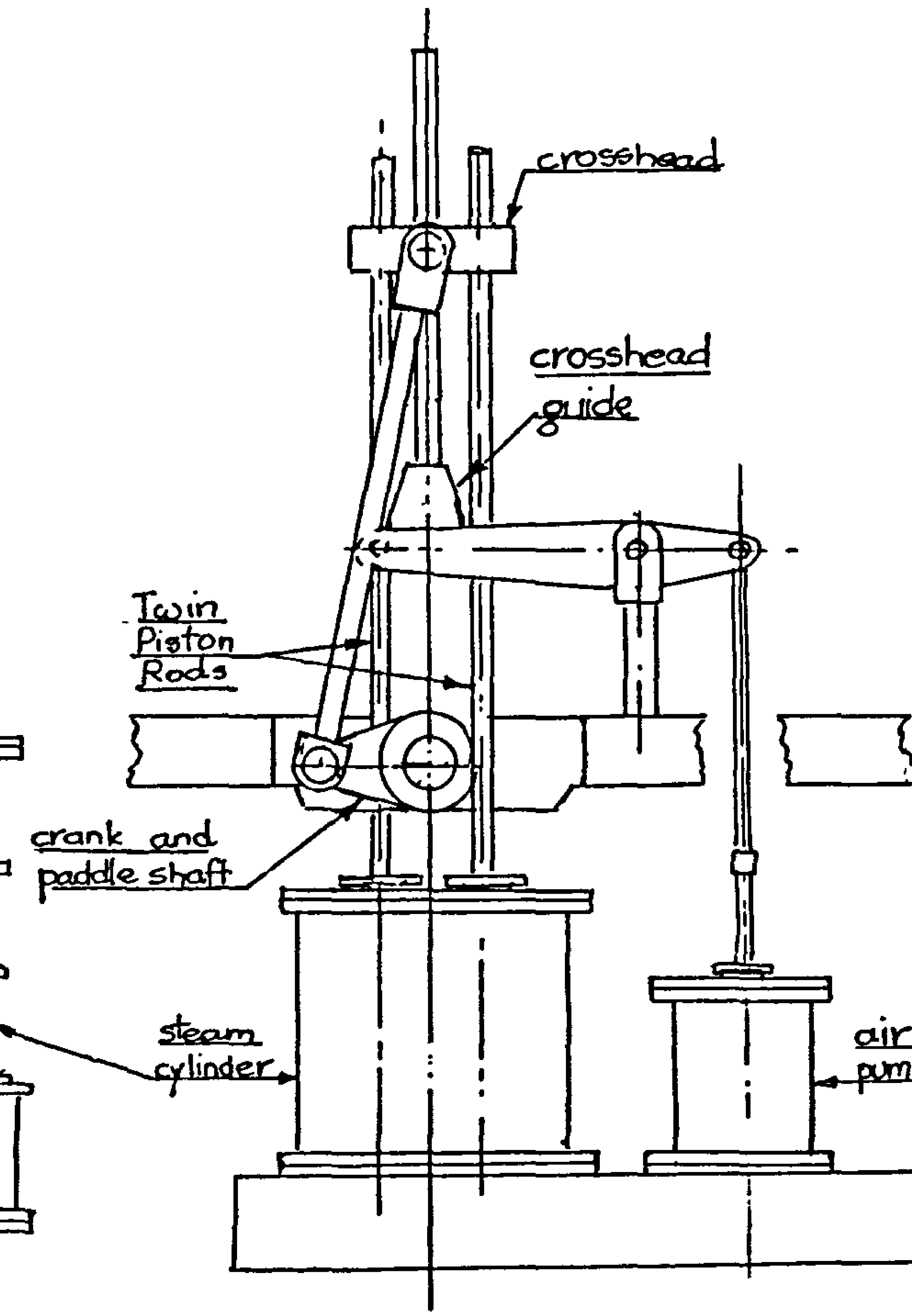
MACHINERY OF H.M. SS. "HECLA" AND "HECATE", 1839
Scotts 'Two Centuries of Shipbuilding' 1961



OSCILLATING ENGINE
Fig. 3/8



DOUBLE CYLINDER ENGINE
Fig. 3/9



STEEPLE ENGINE
Fig. 3/10

J Y Robb
1992

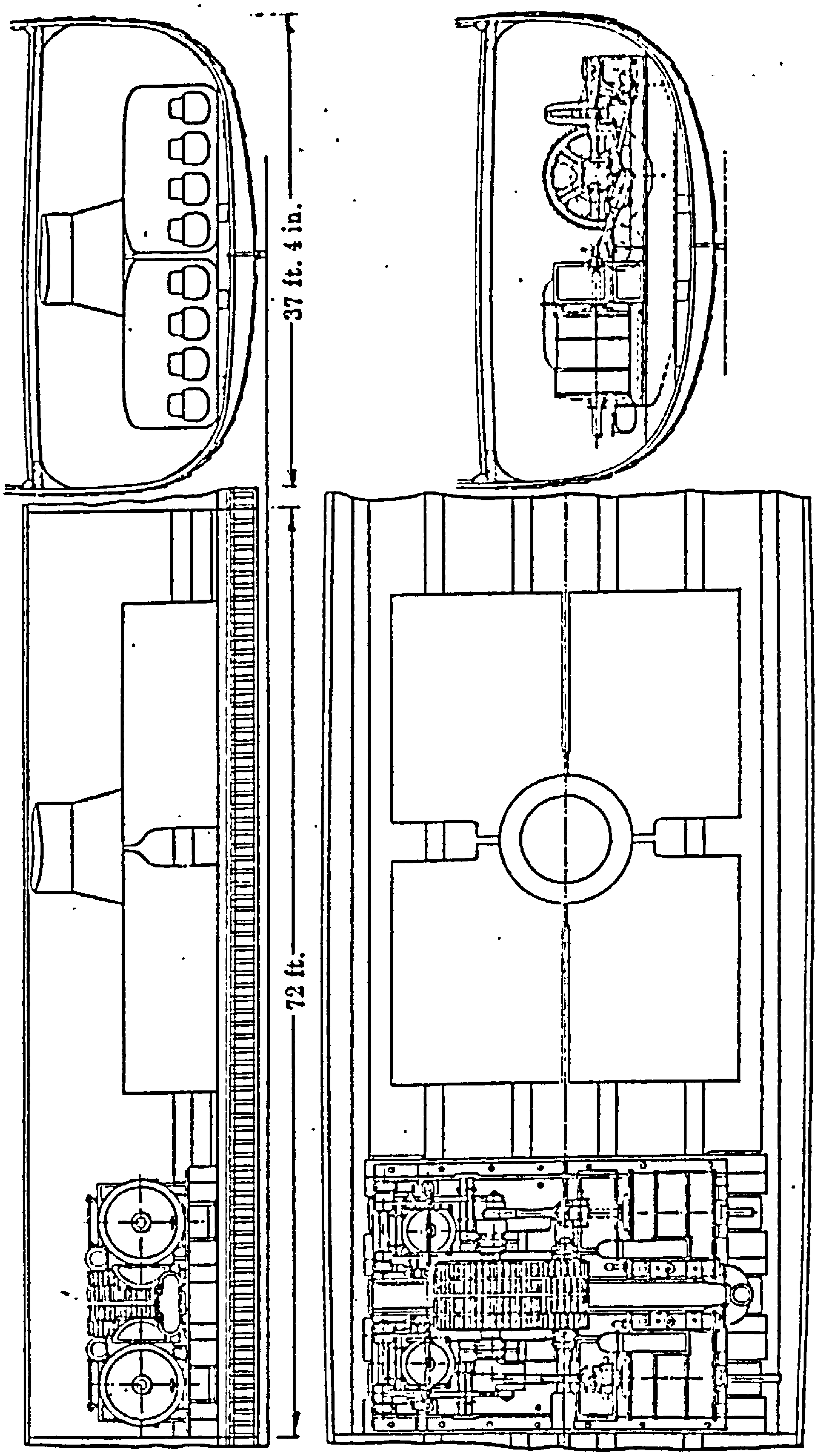
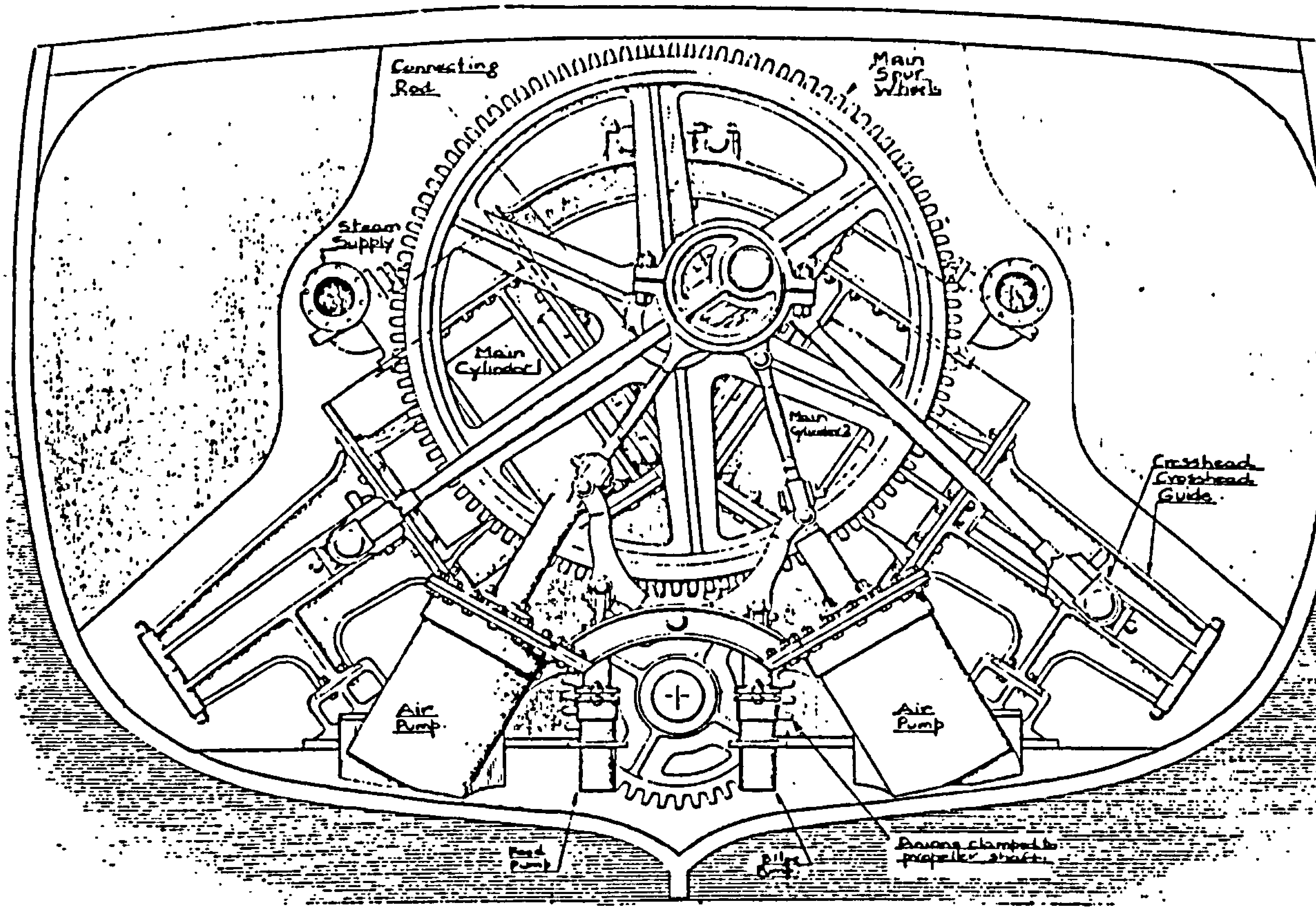


Fig. 3/11 - MACHINERY OF THE FRIGATE "GREENOCK", 1849,—719 I.H.P.

Scotts 'Two Centuries of Shipbuilding.' 1961.



DOUBLE-GEARED MARINE ENGINES.

MESSRS SCOTT, SINCLAIR & Co GREENOCK

S.S. CLYDE —— 1854
S.S. EBRO —— 1853
S.S. SCINDIAN —— 1855

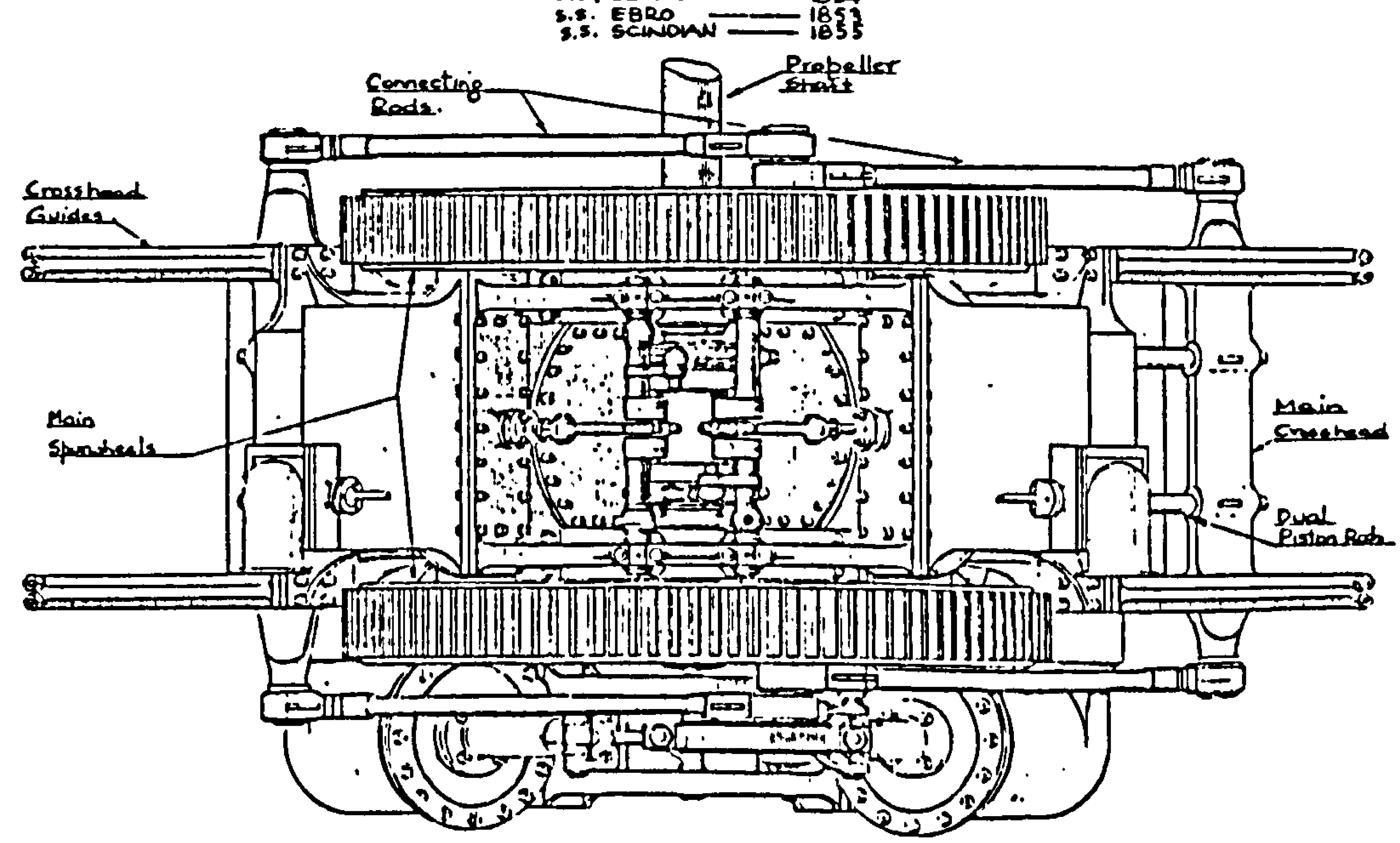


Fig 3/12 - from Scotts' Two Hundred and Fifty Years of Shipbuilding - 1961.

ENGINES OF THE 'DUNCAN HOYLE' STEAMER.

MESSRS SCOTT, SINCLAIR & CO

GREENOCK.

1853

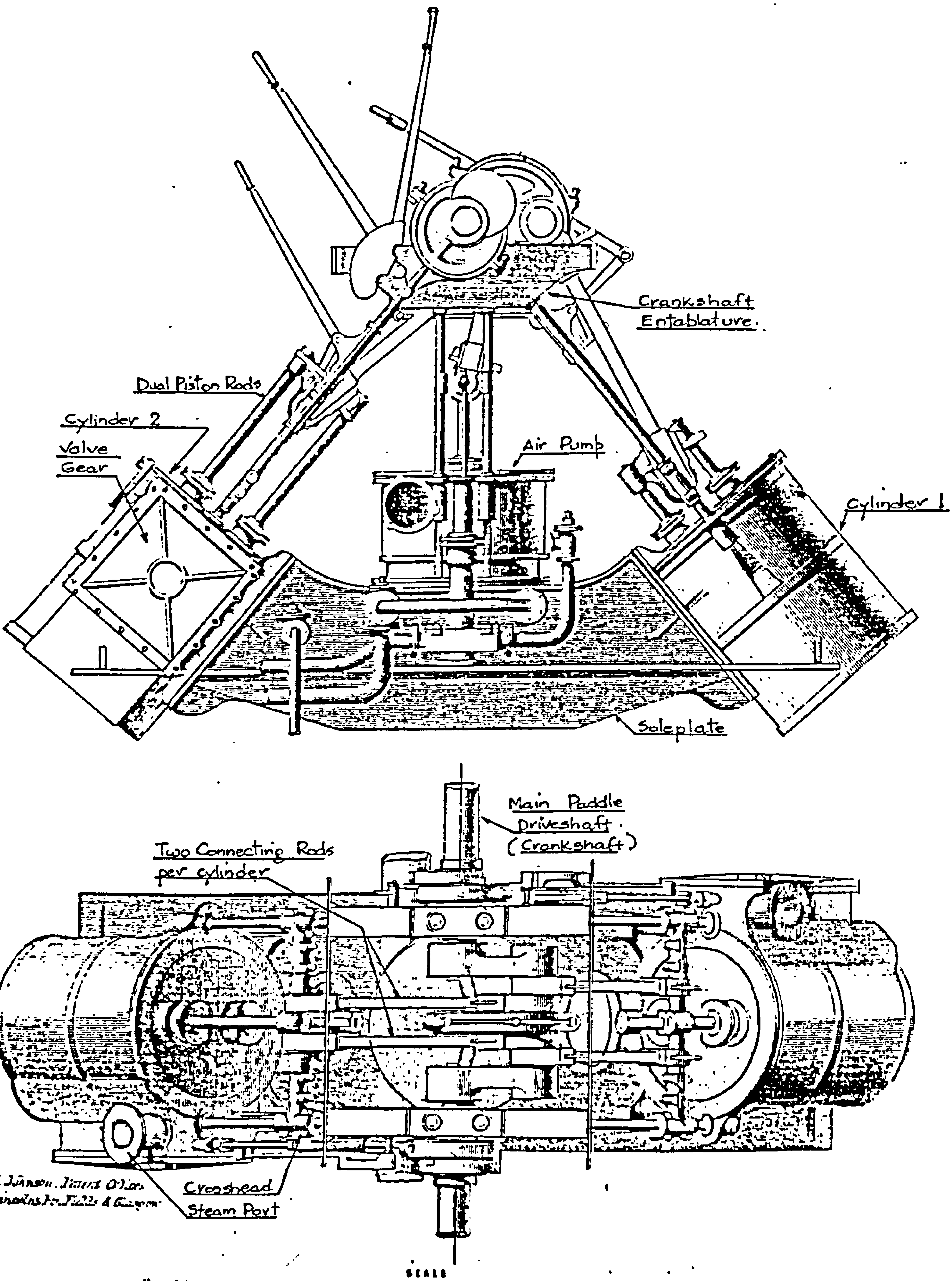


Fig 3/13. The Practical Mechanics Journal-1853.

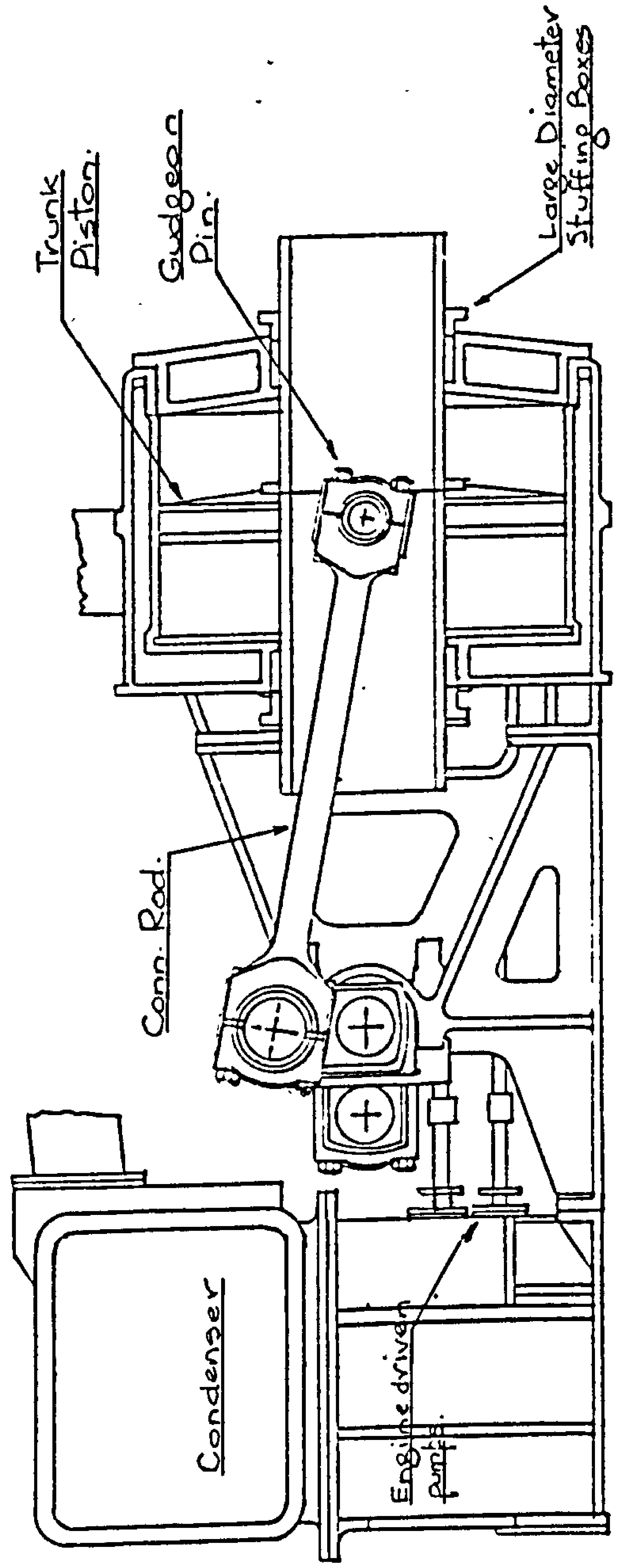


Fig.3/14 TRUNK ENGINE. A Manual of Marine Engineering. Seaton - 1899.

From the Practical Mechanic & Engineers Magazine, 1842, pp. 224-5.

Fig. 3/15

SAMUEL HALL'S
PATENT IMPROVEMENTS ON STEAM ENGINES,
BASFORD *NEAR* NOTTINGHAM.

Fig 1.

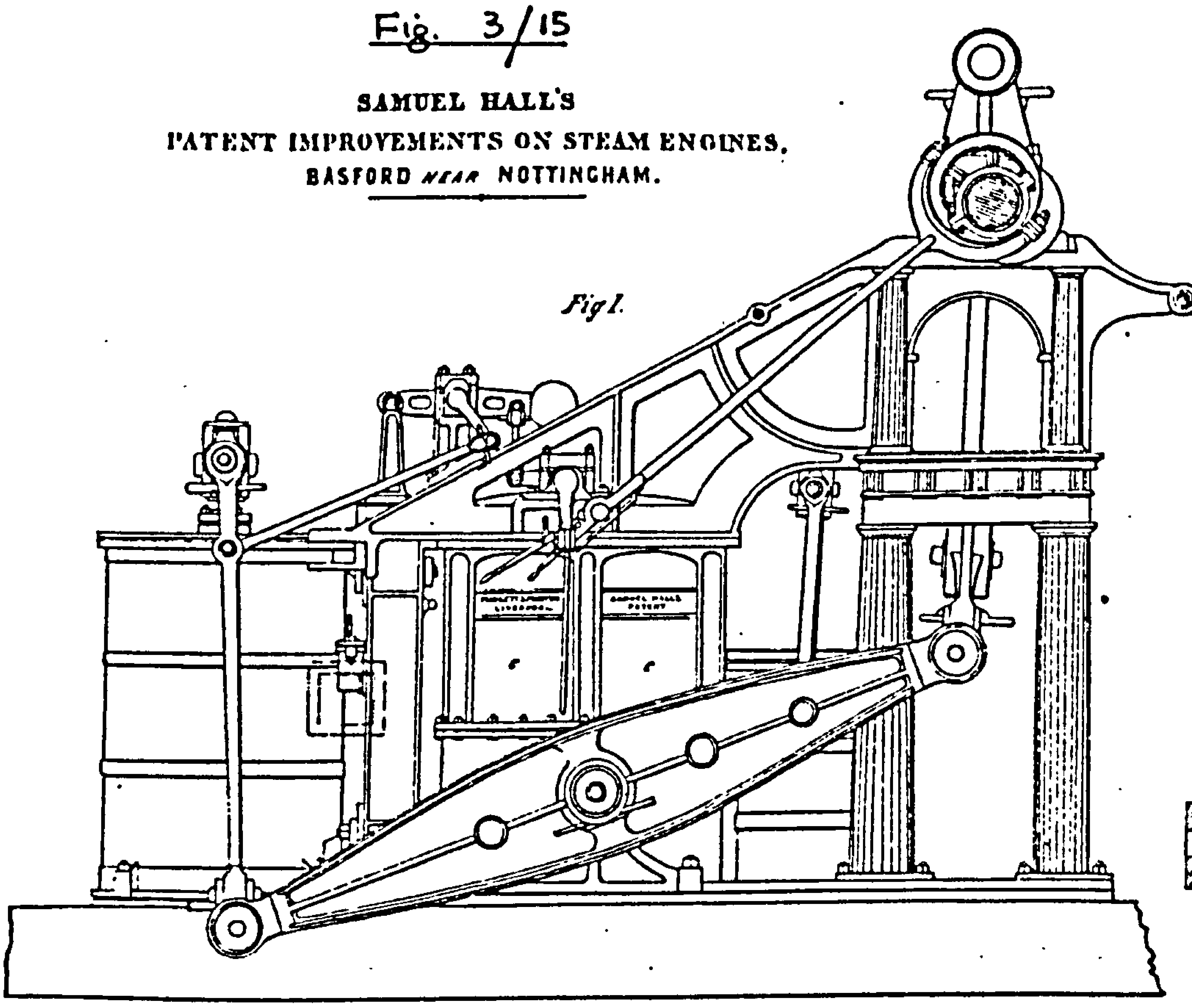


Fig 2.

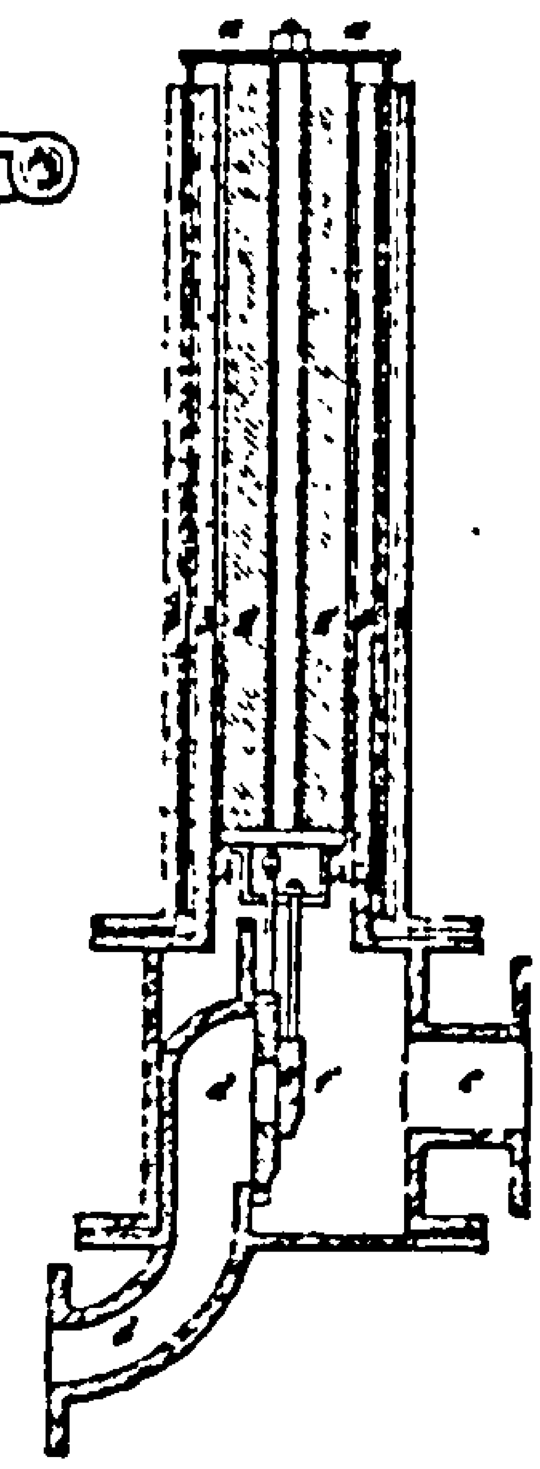


Fig 3.

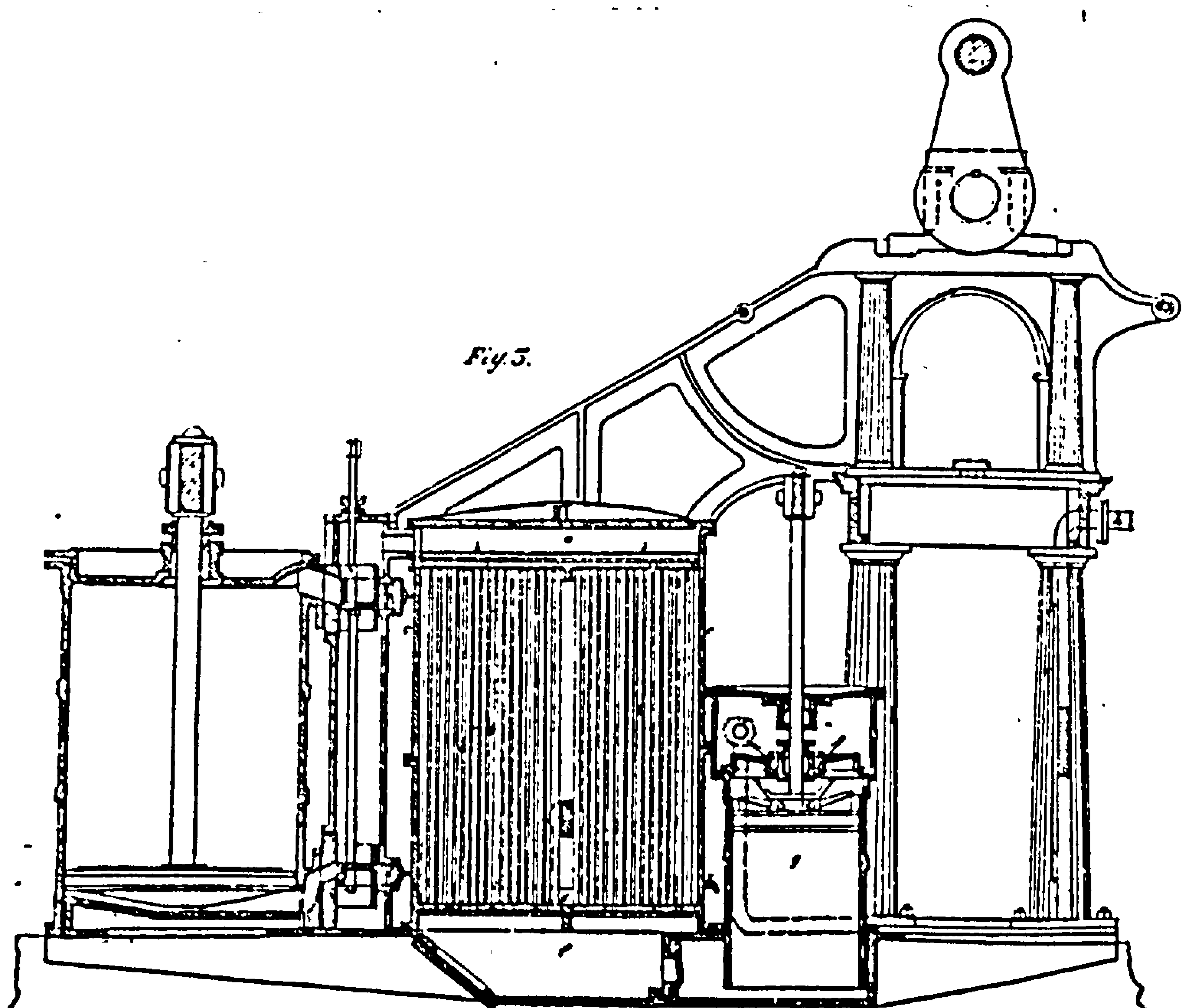
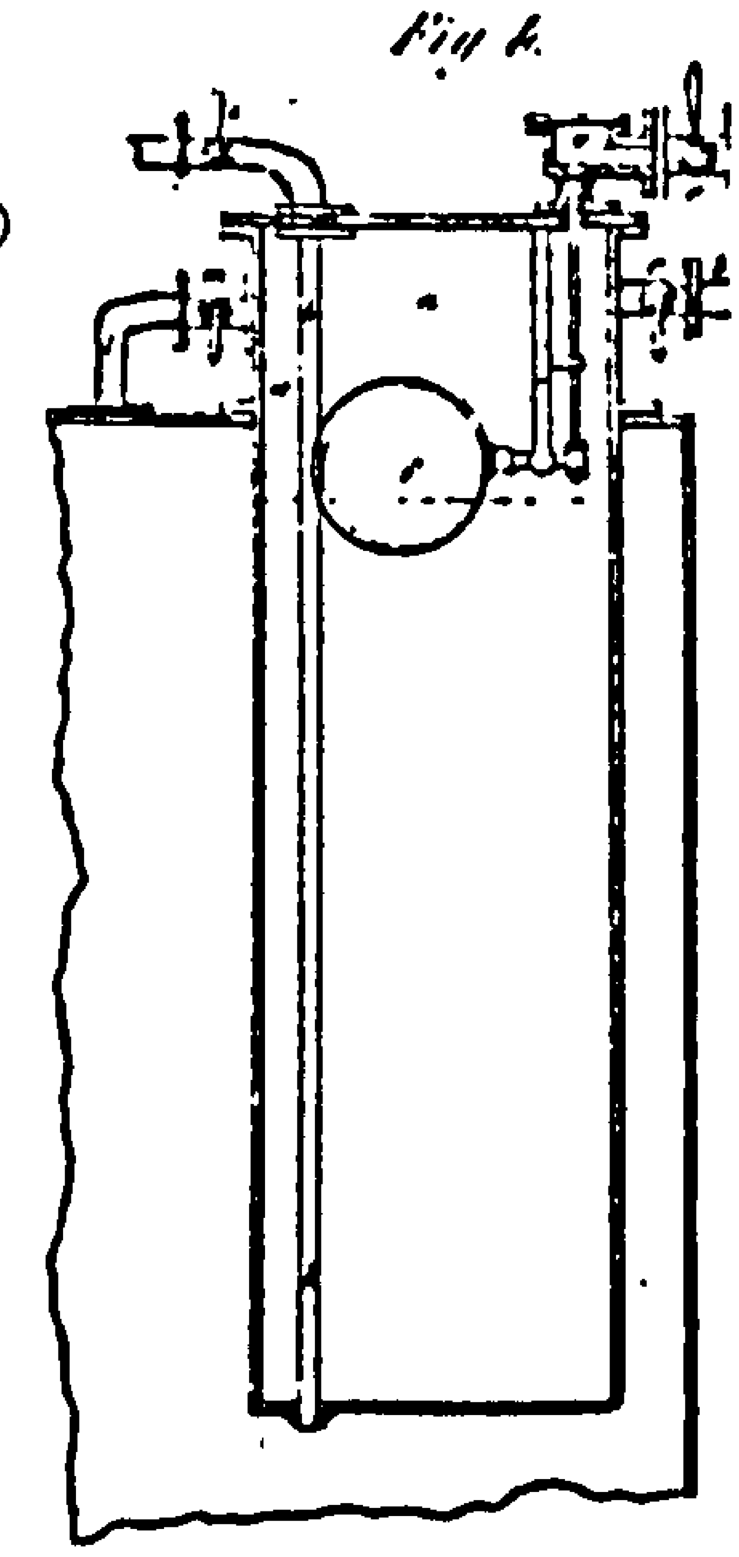


Fig 4.



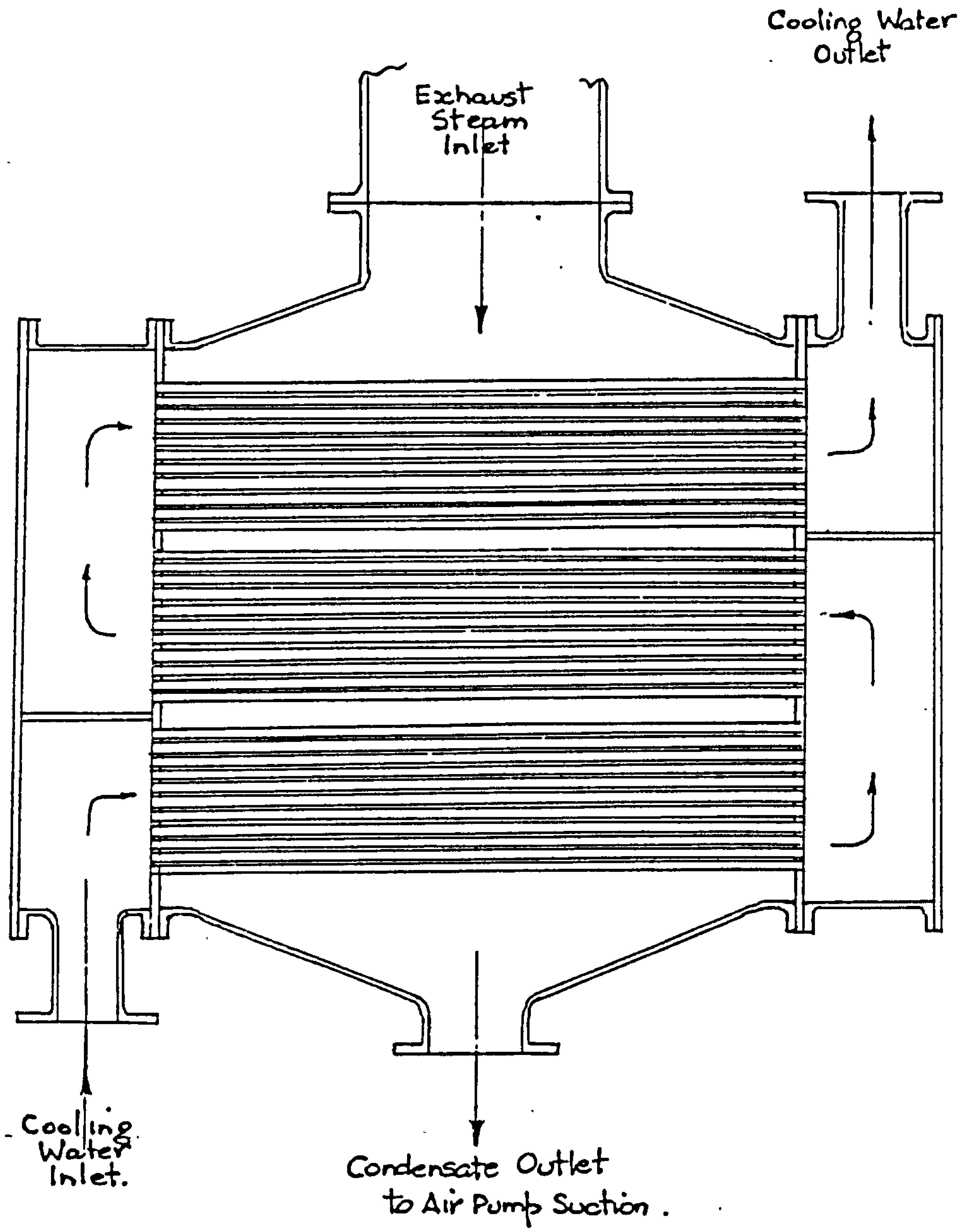


Fig. 3/16 SURFACE CONDENSER
(after J.F. Spencer)

Spencer solved a number of surface condenser problems at a stroke by reversing the Hall practice and passing the cooling water through the tubes and having the steam circulate around the tubes.
He also introduced a contraflow with the cooling water rising through the condenser against the downward flow of the steam, giving improved heat transfer.

J.F. Robb.

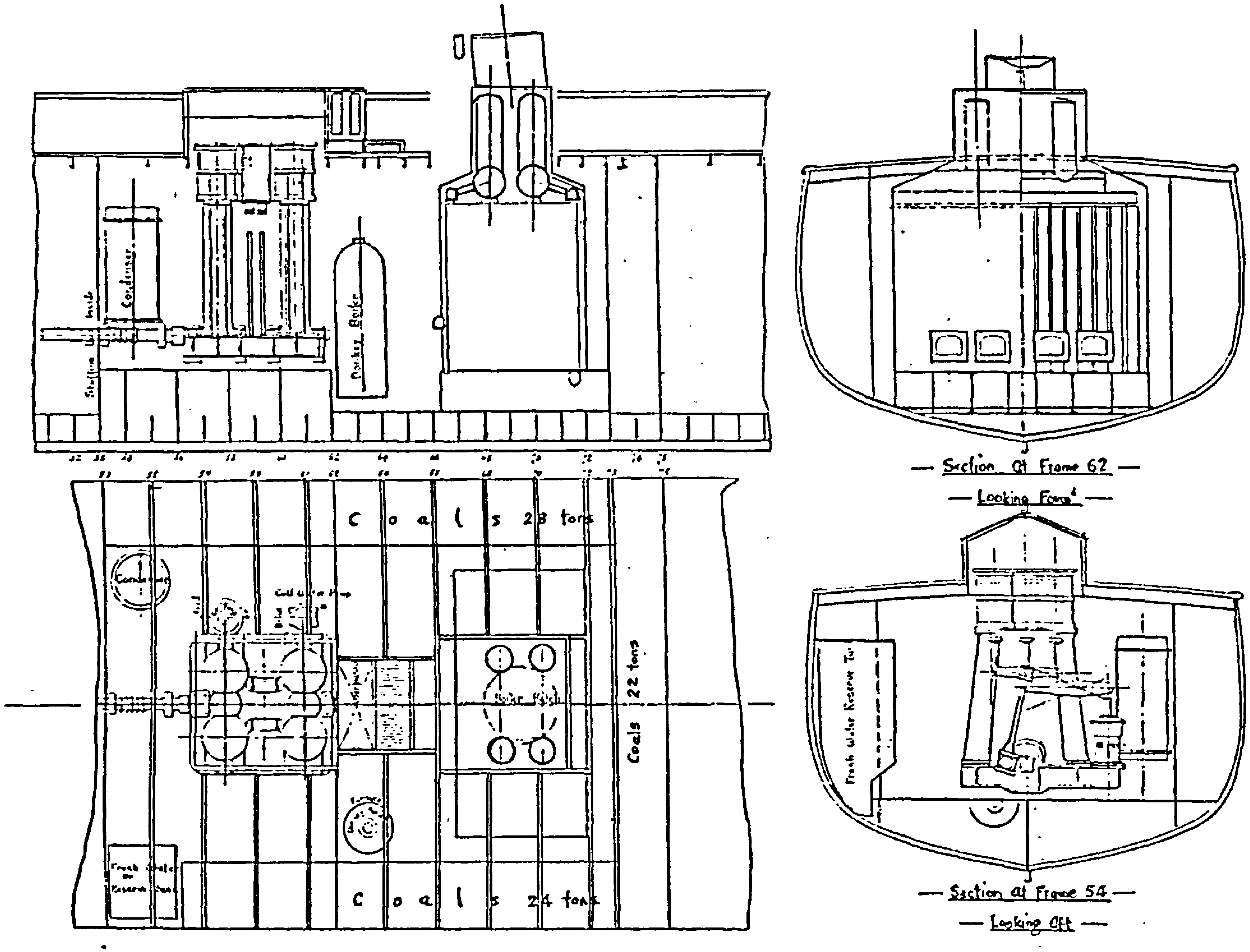


FIG. 3/17 - HIGH-PRESSURE MACHINERY IN THE "THETIS." — 1857
Scotts - 'Two Centuries of Shipbuilding' - 1961

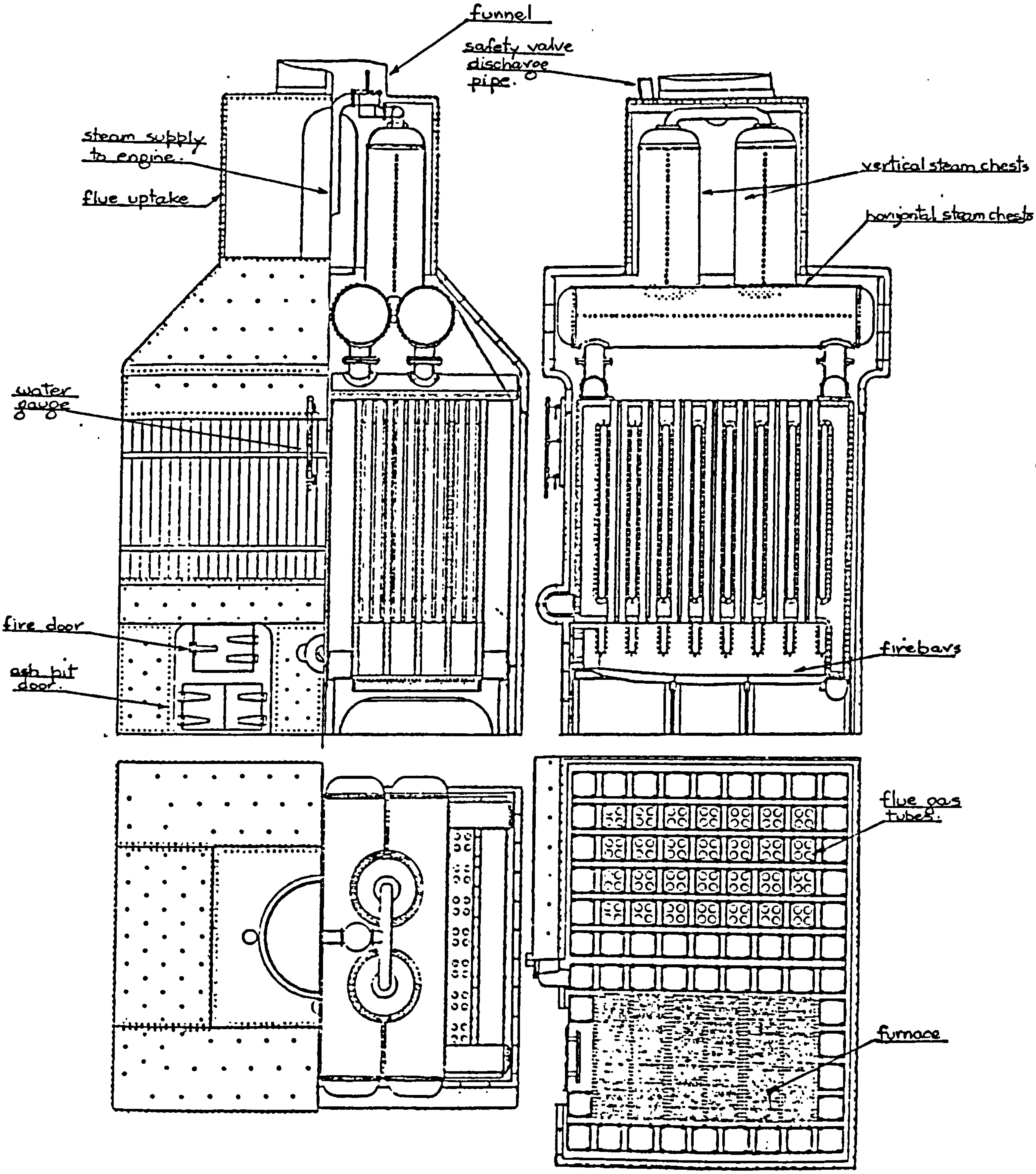


Fig. 3/18 - A PIONEER IN WATER-TUBE BOILERS. (Rowan type).
as installed on Scotts S.S. Thetis, Guajava, Italia, Burmah, Haco, Actif.
See Rowan & Horton Patent No 856 - 1858
Improvements in Steam Engines & Boilers.

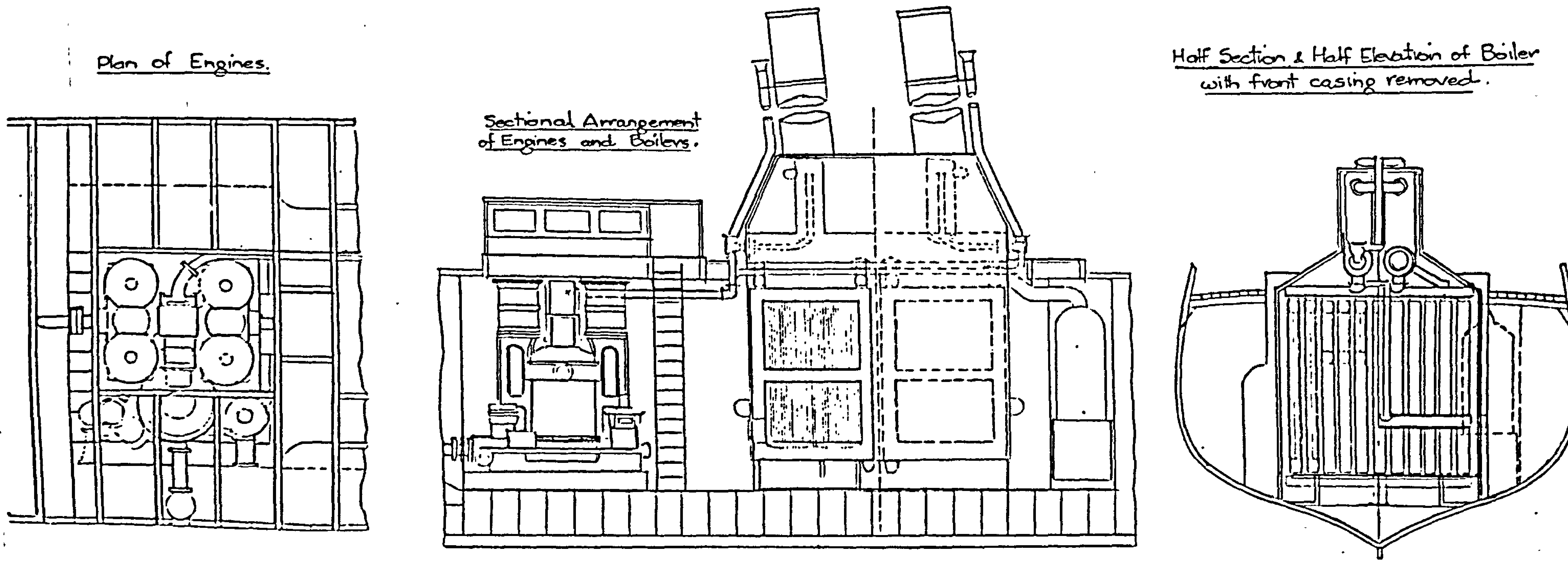


Fig. 3/19 Arrangement of Machinery - S.S. Actif - 1861.
Trans. Instn. of Engrs. & Shipbuilders in Scotland.
November - 1879.

Fig 3/20 IMPROVED SCREWS FOR MARINE PROPULSION from The Practical Mechanics Journal Vol. 7. - 1854.

BY SCOTT SINCLAIR & Co GREENOCK

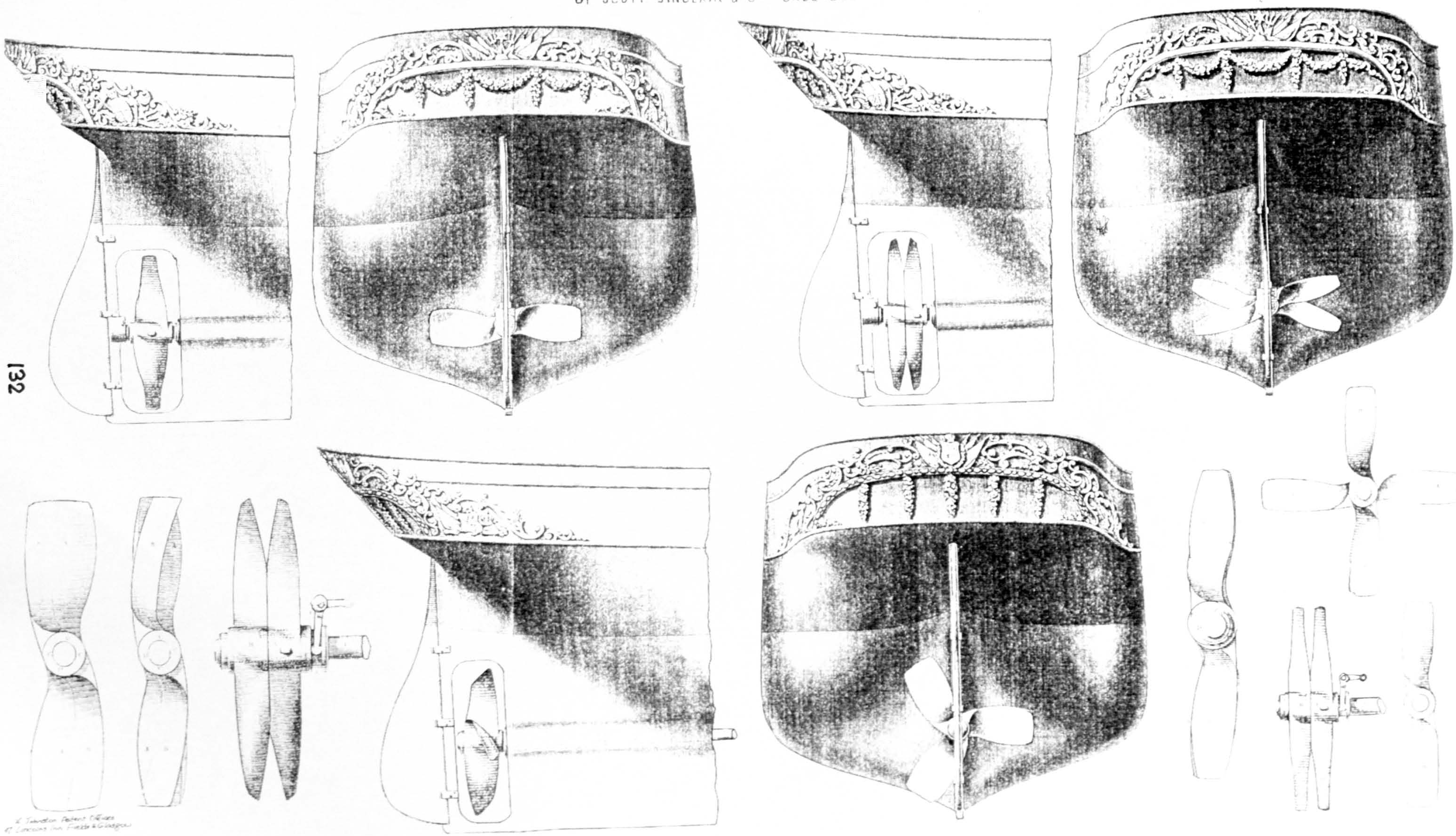


Fig. 3/20

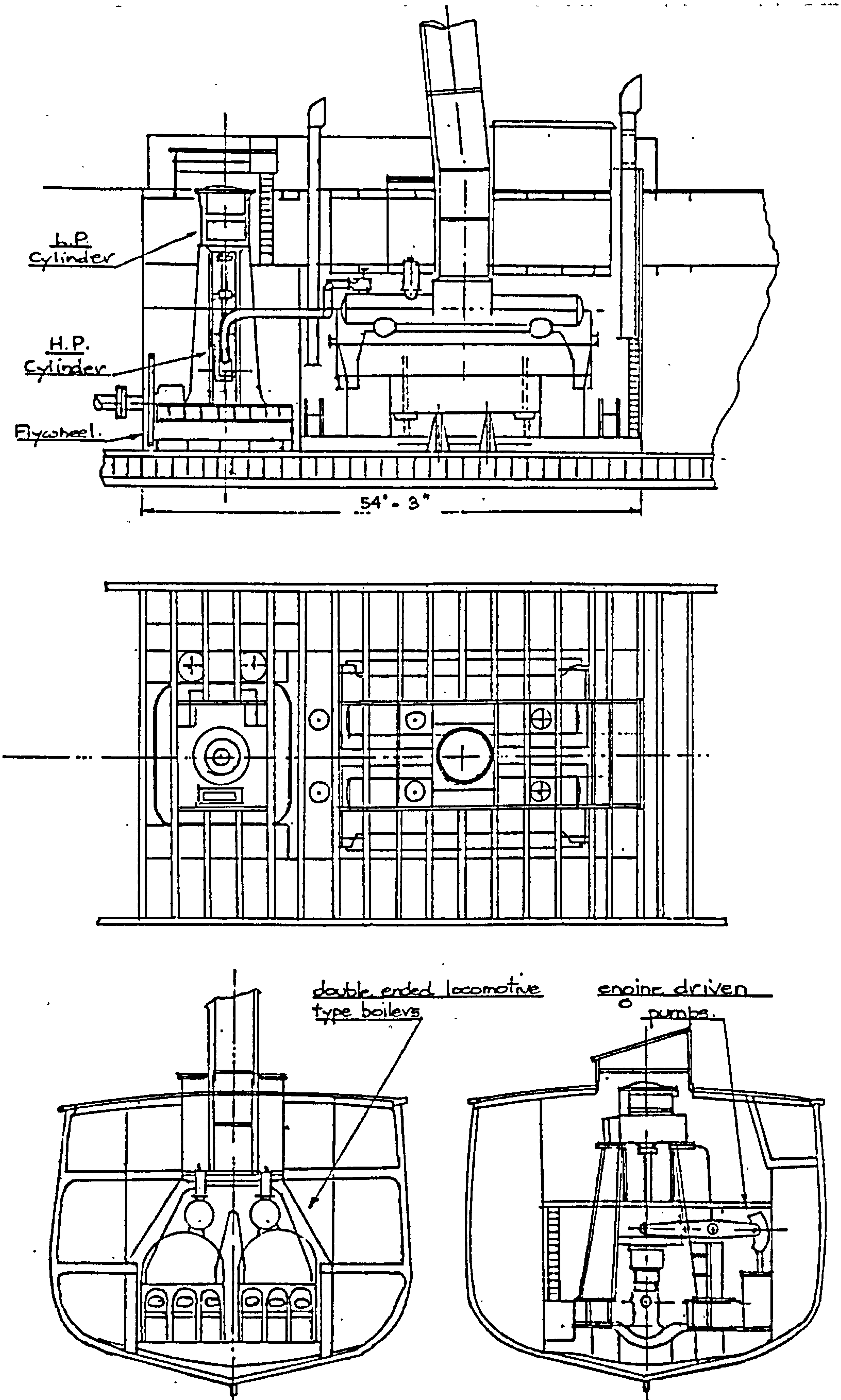
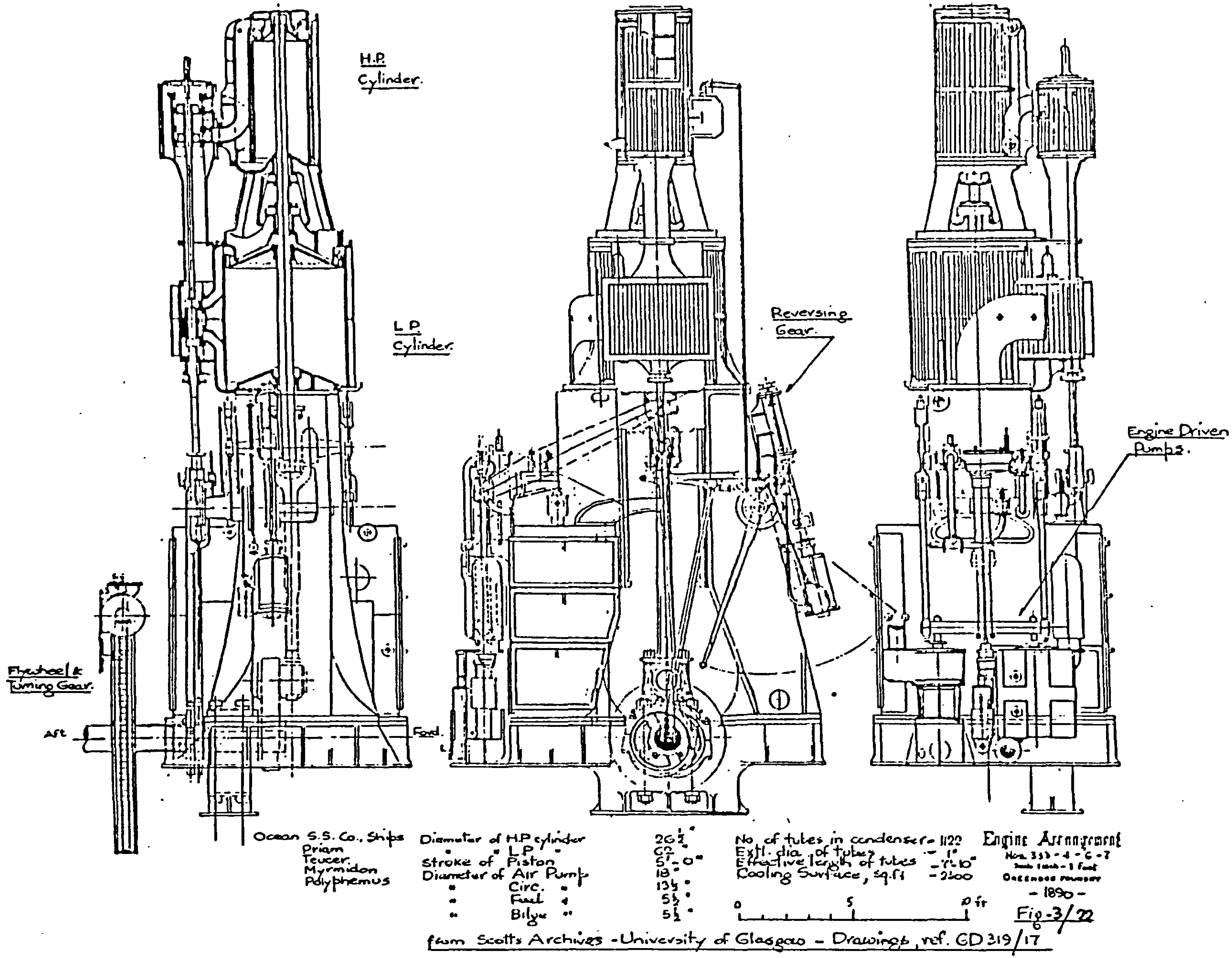


Fig. 3/21 – Typical Arrangement of Holt/Scott design of Single Crank Compound Machinery. S.S. Achilles – 1866

Scotts' - Two Centuries of Shipbuilding - 1906 - pp. 38-9


H.P. Cylinder.
L.P. Cylinder.
Reversing Gear.
Engine Driven Pumps.
Flywheel & Turning Gear.
Aft
Ford.
Ocean S.S. Co., Ships
Priam
Teucer.
Myrmidon
Polyphemus
Diameter of H.P. cylinder 26½"
" " L.P. " 62"
Stroke of Piston 5'-0"
Diameter of Air Pump 18"
" Circ. " 13½"
" Feed " 5½"
" Bilge " 5½"
No of tubes in condenser - 1122
Extl. dia. of tubes - 1"
Effective length of tubes - 7'-10"
Cooling Surface, sq.ft - 2200
0 5 10 ft
Engine Arrangement
- 1890 -
Fig. 3/22
from Scotts Archives - University of Glasgow - Drawings, ref. GD 319/17

PART TWO.

CRITICAL CLIENTS-SCOTTS MERCHANT MARKET.

1860-1914.

CHAPTER 4.

THE FRENCH CONNECTION.

CHAPTER 4.

THE FRENCH CONNECTION.

From the opening of the Scott and Co. Cartsdyke shipyard in 1851 the order book contained a high proportion of orders from foreign owners. Their principal foreign customers operated coastal steamers in the Baltic Sea and the Gulf of Finland, connecting St. Petersburg, Riga and Lubeck. Others based at Marseille ran services to Corsica and the North African coast.[1] The latter services were operated by Valery Frères et Fils carrying passengers, mail and cargo to these areas. Relations with Count Valery and the Scotts were close and the Count placed many orders for new steamers and for the re-engining of his older steamers with Scotts who in later years had a share holding in the Valery concern. The French Navy thought highly of the Valery steamers and later this led to Scotts obtaining an order from the French Navy for propelling machinery for a naval auxiliary ship.[2]

M. Dupuy de Lome, head of the French Navy Constructive Dept. was close to M. Forquenot, an eminent consulting engineer, who was Engineer-in-Chief of the Compagnie Générale Maritime and it is likely that this relationship had some influence in the choice of Scotts in 1862 to build a fleet of transatlantic liners to inaugurate the prestigious French passenger and mail services to the U.S.A. and Caribbean which is the main subject of this chapter. Before proceeding to discuss these contracts which earned Scotts many plaudits, but also resulted in a cash flow crisis which fortunately they ultimately overcame, it is necessary to review early developments in transatlantic steamship services from which France was conspicuously absent.

EARLY TRANSATLANTIC STEAMSHIP DEVELOPMENT.

The great boom in the early 1830s in transatlantic trade, with U.S.A.-Europe trade doubling between 1830 and 1835 and emigrants flooding into the U.S.A. led to great dissatisfaction with the unreliability of sailing vessels which at that time carried all the trade, and a demand for a punctual transatlantic steamship service carrying passengers, mail and cargo.[3] The experts on both sides of the ocean were not hopeful of solving the technical problems involved in adapting steamships for long ocean voyages.[4] However on 22nd and 23rd April 1838 two British steamers, 'Sirius' and 'Great Western' arrived in New York having made the transatlantic crossing under steam, albeit with their cargo spaces used as coal bunkers.[5]

By 1840 'Great Western' had made thirty four crossings[6] and in July of that year Samuel Cunard had inaugurated a subsidised mail boat service from the United Kingdom and Canada using Liverpool, Halifax, and Boston.[7]

The introduction of iron steamships in 1843 further stimulated intense competition between rival shipping lines. A number of heavily subsidised American shipping companies entered the fray rivalling each other in speed, comfort and luxury. These mailboats travelled to Bremen and Hamburg to embark high calibre emigrants, businessmen and adventurers attracted by the New World and trade between Germany and the U.S.A. tripled immediately.[8]

There was great concern in France at these developments. Their largest export market was with the U.S.A., Franco-American trade being worth in excess of 300 million francs. Sustained agitation for French intervention in transatlantic trade in the chamber of Deputies and in the press produced over the years a series of public enquiries in 1840, 1845 and 1847 by the Minister of Marine with no practical results.[9] In 1854 the agitation was revived when it emerged that French troops going to the Crimea had been transported by chartered British merchant ships. (including the Scott-built 'Amalfi', 'Clyde', 'European' and 'Oneida').[10] However, despite the clamour, it was recognised that the resources required to set up transatlantic steamer services in competition with long established foreign shipping companies were not available to the French shipowners of the time who were mainly involved in coastal trade - enormous capital would be involved - state aid would be essential.[11]

The debate on the need for subsidies for trans-ocean services continued, it being recognised that mail steamers at that time could only carry passengers, mail and expensive or precious articles if income was to balance operating costs, fuel, wages and depreciation.[12]

French shipowners pointed out that the British Admiralty supported companies with which it had mail contracts and also argued that as the cost of building iron ships and of coal were both higher in France than in Britain there was further justification for a French subsidy.[13]

ENTER THE PÉREIRES.

The brothers, Emil and Isaac Péreire, somewhat controversial figures in French financial circles, who had been much involved in developing the French national railway system saw its logical expansion as being towards connecting the French Atlantic ports, European rail termini and the American railheads then being built and they saw France becoming the emigration port of Europe and the emporium of American produce.[14] (See also Appendix 4/1). They acquired a Norman shipping company in 1855 which they renamed the Compagnie Générale Maritime (C.G.M.) with the long term aim of entering the transatlantic trade.[15] Thus it was in 1857 when the French Marine Minister announced a subsidy to compensate French shipowners for the cost of ships and fuel on transatlantic services of 52.16 francs per league.[16] As no company could take on the whole development it was divided into three portions.[17]

(1) New York line based at New York.

(2) Central America and West Indies line based at St. Nazaire.

(3) Brazil line based at Bordeaux and Marseille.

The Brazilian mail contract was awarded to Messageries Maritimes and the other two lines were initially awarded to Rothschilds, the Péreires great rival, but they had to withdraw owing to their inability to raise the necessary finance.[18]

The Péreires, who had been very unhappy about the initial financial arrangements offered then moved in, renegotiated the agreement and the specification and were awarded the New York and the Central America and West Indies lines.[19] They were given three years to build the new fleet. The company name was changed to Compagnie Générale Transatlantique.[20]

SPECIFICATION OF THE MAIL STEAMERS.

During the discussions on the specification for the new steamers, Emil Péreire, conscious of Cunard emphasis on increasing speed got agreement to standardising all engines at 850 N.H.P: six ships would serve on the Central American run, with two in reserve for the New York winter service. Three mail steamers, 354 feet long, and of 1,000 N.H.P. would operate the New York summer service - March to October. After long discussions it was decided to adopt paddle propulsion, a decision probably influenced by Cunard practice at that time. Unfortunately for C.G.T.; Cunard later changed to screw propulsion, a change which Scotts, at that time not involved, would have heartily endorsed. It was unanimously agreed that the new ships should follow the latest and best British practice, with a few differences of detail in the accommodation.[21]

CHOICE OF BUILDER.

M. Péreire agreed to a request of the Finance Minister that half of the new ships should be built in France. He brushed aside requests that all the ships should be built in France, pointing out that to build such a fleet in France in the time specified was impossible. A number of Scottish, English, Belgian and Dutch shipbuilders were invited to quote price and delivery for the 850 N.H.P. steamers.

Scott and Co. of Greenock, Scotland was chosen by C.G.T. as being of the highest reputation and amongst the best equipped. Their price for the hull was 1.976 million francs and 0.89 million francs for the machinery, built at Greenock. After payment of customs duty, a mail steamer delivered in France would cost about 3.2 million francs.[22]

CONTRACTS.

Two main contracts were drawn up, negotiated and signed on 24th October 1861 in Paris. (See Appendices 4/2 and 4/3) The first contract was for three ships to be built in Greenock and delivered to Cherbourg, while the second contract was for five ships to be built at Penhoët, St-Nazaire with different prices and with engines supplied by the owners, C.G.T. In both contracts there was provision for C.G.T. to make part payment in preference shares (obligations) - a condition accepted by Scotts which they later bitterly regretted. In the Greenock ship contract it was stipulated that a guarantee mortgage on the Scotts engine works, Greenock Foundry, would be granted to C.G.T. In the Penhoët ships contract C.G.T. reserved the right to enter into partnership with Scott and Co. to develop the Penhoët yard, in a fashion and to an extent mutually agreed. A third agreement was signed on 18th January 1862, (See Appendix 4/4), in which the Penhoët shipyard was leased to Scotts who were to provide the workshops, machine tools, plant and equipment to build the five ships with C.G.T. the sole landlord of the ground, and C.G.T. having an option to buy all the above tools, equipment, etc., at the end of the construction of the five ships.

PERSONALITIES CONCERNED.

Before moving on to discuss the construction of the ships it is necessary to set the scene.

In order to avoid confusion it should be noted that all eight ships were renamed at an early stage in the contract. The original and final names were as follows:-

Location	Original	Final
Greenock	Napoléon	Washington
	Bretagne	Lafayette
	Normandie	Europe
St-Nazaire	Nouveau Monde	L'Imperatrice Eugenie
	St. Laurent	France
	Panama	Nouveau Monde
	Péreire	Panama
	Ville de Paris	St. Laurent

The senior C.G.T. representatives involved were the Président, M. Emil Péreire and the Director General, M. Leonce Goyetche. On technical matters their chief Engineer, M. Forquenot was well respected by the Scotts and in the difficult days ahead was to prove extremely helpful. His surveyor at Greenock, M. Guède got on well with the Scotts production staff.

At Penhoët, the yard manager employed by Scotts was M. Audenet, lately with the French Department of Marine. John Scott IV's senior representative at Penhoët, St-Nazaire was a Mr. William Shand, related by marriage to the Scotts'. Thomas S. Begbie who in the 1850s and 1860s acted as London agent to Scott, Denny and Hawthorn, Leslie was involved in securing the contracts. (See Appendix 4/5)

John Scott IV was of course the central figure in this story of what deserved to be a great success and became a glorious failure. His father was to all intents and purposes retired and his younger brothers who were to play a significant role in the fortunes of Scott and Co. later, were still at school.

CONSTRUCTION.

1862.

During the first six months of the Greenock contract, all three ships got off to a good start but there were clear indications that Scotts suppliers of iron plates and sections, primarily Blochairn, were having difficulty in meeting the quality requirements of the specification and deliveries were beginning to fall behind. Meanwhile at the Penhoët site, near St-Nazaire, the civil engineering work to create the new building berths and to flatten the 'green field' site to allow the new workshops to be built and the production equipment to be installed also fell badly behind. This in turn led to the keel laying dates for the Penhoët ships being pushed back, and to the first coolness in relations between Scotts and C.G.T.[23]

Mr. Scott in a letter dated 9th October 1862 to M. Goyetche complained at length not only about the poor consolidation of the building berths but about the unfinished state of much of the ground of which less than half had been made over to Scott et Cie. Meanwhile, the entire outfit of machine tools, almost all of which had been manufactured in Johnstone, Scotland by famous firms such as Shanks, Clifton and Baird and McDowall, lay in crates on the quayside.[24]

The workforce was drawn from the surrounding agricultural areas and John Scott brought over a number of his foremen to train them in the various skills involved, a remarkably successful operation considering the primitive conditions obtaining at the time.

John Scott was undaunted by the magnitude of the task he had taken on. Building large ships for a foreign owner in a foreign land was one thing; building and equipping a new shipyard and training the workforce from scratch before building the ships was surely something else! In order to prevent the exploitation of his workpeople by the local lodging house keepers and restaurateurs, John Scott bought eight acres of adjacent land and built thereon houses, canteens and refectories for his workers.[25] (See also Fig. 4/1)

1863.

Delays in the building of the C.G.T. ships at Greenock due to late delivery of iron plates and sections were compounded by a shortage of iron workers. This shortage was due to an unexpected boom in shipbuilding on the Clyde and elsewhere. The Table 4.1 below shows the percentage increase in United Kingdom tonnage built during the years of the C.G.T. contracts at Greenock in comparison with the tonnage built in 1861 when the contract was awarded.

TABLE 4/1. PERCENTAGE INCREASE IN U.K. NETT TONNAGE BUILT DURING 1862-6 OVER 1861 PRODUCTION.

Year	Percentage Increase in U.K Tonnage Built.
1862	26
1863	82
1864	121
1865	115
1866	82

Data from W.S. Cormack - Economic History of shipbuilding and Marine Engineering. with special reference to the West of Scotland Ph.D. Dissertation, University of Glasgow, 1930. Table C.1.

These delays in turn created cash flow problems for Scotts, as progress payments were linked to the achievement of production targets.

In a letter to M. Goyetche dated 9th May 1863, John Scott addressed these various problems. He firstly refuted allegations that, at Greenock, Scotts had given preference to 'boom' contracts by taking workmen from the C.G.T. ships and using them on other ships. He pointed out that out of 1650 workmen employed in the yard some 1500 were employed on the C.G.T. contracts. He also recorded that Scotts had sent agents all over the country to recruit more labour and in spite of offering higher wage rates the search had been largely unsuccessful. However, he had resolved, notwithstanding the enormous sacrifice involved, to make a further increase of 20 per cent in wage rates, trusting that this would have the effect of inducing a large number of men to flock to Scotts yard.[26]

Later on 29th May, 1863 he asked C.G.T. to anticipate the completion of certain work and pay the appropriate instalments in order to allow Scotts to meet material costs and wage bills. C.G.T. agreed to the request, the first of many of a similar nature. However, yet another problem arose when Scotts tried to convert the preference shares they had received in part payment for the ships into cash, only to find that C.G.T. had not yet valued them on the Bourse.[27] John Scott also had to fight off an attempt by C.G.T. to transfer the fifth Penhoët ship to another French yard in order to expedite completion of the order. He correctly pointed out on 6th June, 1863 that such action would increase the chance of delay on the Penhoët ships rather than diminish it.[28]

The first Greenock ship 'Washington' was launched on 17th June 1863 and was followed on 15th October, 1863 by the launch of the 'Lafayette', some three months behind schedule. (See Fig. 4/2 - illustration of Washington as originally built)

In France, at Penhoët, by the end of 1863, all five C.G.T. ships were being erected on the berths. During the period from March to September the workforce had risen from 500 to 1,500, but there was a serious shortage of riveters.

See Fig. 4/3 showing numbers employed at Penhoët and wage rates paid in 1863-4-5.

1864.

By the end of 1864 by which time all eight ships should have been delivered, only 'Washington' and 'Lafayette' were in service and C.G.T. were claiming penalties for late delivery of 'Washington'. However, as the centre of gravity moved to St-Nazaire, Scotts were pointing out that the Penhoët ships were currently held up by the late delivery of the owner-supplied propelling machinery.

The mortgage on the Greenock Foundry was lifted and replaced by another on the Penhoët shipyard plant and equipment. In spite of the deteriorating relations between Scotts and C.G.T. M. Goyetche had no scruples about using John Scott as an unpaid consultant, commenting on the latest Cunard designs.[29]

1865.

This year saw delivery of the last Greenock ship and the first three Penhoët ships, all late; during which time the monthly struggle to get money from C.G.T. to pay the wages continued.

To add to Scotts difficulties, C.G.T. suspended work on the last two Penhoët ships, whilst they contemplated design changes.[30] Finally, a decision was arrived at, namely the last ship, 'St. Laurent', was to be converted to screw propulsion, resulting in further delay.

Much of the C.G.T. archive material relating to this period was lost in air raids during the Second World War. However, from the Scotts correspondence with C.G.T. over the period it is clear that other contracts were executed at Penhoët in parallel with the mail steamers. For example, a very comprehensive specification for an iron sailing ship of 825 tons was supplied to C.G.T. in 1865 and such a ship was built at Penhoët in 1866.

She was a three masted barque, the 'Mentana' for M.L. Leveque, of Nantes.[31]

1866.

The last two mail steamers, 'Panama' and 'St. Laurent', the latter fitted with a screw propeller, were delivered in that year together with 'Mentana', referred to above, and three coastal steamers, 'Oncle Joseph', 'Vannina' and 'Colomba', for Valery Frères, the engines being supplied from Greenock. One further contract in progress that year was the conversion of the Steamship 'Darien' built in 1863 by Spencer, Pile and Co. of Hartlepool, for the West Indies and Panama Steamship Co. and purchased by C.G.T. from them in November 1865. Scott et Cie were awarded the contract to fit her out for the St-Nazaire - New Orleans service.[32]

APPROACHING DISASTER.

It will be evident from the foregoing summary of the construction programme for the C.G.T. mail steamers that from an early date the entire project began to go badly wrong. Fig. 4/4 indicates the extent of slippage of the planned delivery dates. Stage payments were linked to progress achieved and whilst C.G.T. co-operated in overcoming the problems initially, relations between Scotts and C.G.T. deteriorated and the correspondence over the years 1863-4-5-6 became dominated by the unending struggle to get money to pay the wages at Penhoët. In April 1864, C.G.T. threatened to apply the contractual penalties for late delivery of the ships built at Greenock.[33] Scotts financial position was of course not only affected by their considerable capital investment in building the magnificent Penhoët shipyard and improving the Cartsburn yard at Greenock (See a contemporary report in the Daily Telegraph in 1865 - Appendix 4/6) but also by their inability to convert into cash their shares in C.G.T.

At the end of 1864 the guarantee mortgage on the Greenock Foundry Co. was cancelled (the Greenock contract being virtually complete) and replaced by a similar mortgage on the Penhoët shipyard.[34] John Scott in 1864 set out in a draft letter (See Appendix 4/7) to M.

Goyetche of C.G.T. some of the factors which had contributed to his difficulties at Greenock. The other contracts undertaken by Scotts at Greenock during the period of the C.G.T. order are shown on Fig. 4/5. Since most of the ships shown were relatively small and many were sister vessels it seems unlikely that Scotts undertook too many contracts during the period. A seven month gap was created by Scotts in their small ship production in mid 1863 to help reduce delays in the French contracts. The delays were due to combination of late delivery of hull plating of the requisite quality and shortage of labour caused by high wages being offered elsewhere.

It is also important to note that Scotts problems have to be viewed against the world wide economic crisis which had already resulted in significant numbers of company failures.

On 8th June 1866 T.S. Begbie wrote to John Scott describing the situation in London:- [35]

'Agra's failure here is a very terrible affair and fairly has unhinged matters again: who to trust or what is now wired and a rattle at two banks to-day: very probably we shall have another crash or two or three or several mercantile houses, but the terrible consequences of Agra's failure is the involvement of hundreds of families, officers, widows, East Indians,retired on their savings of 15 to 20 years in the East, utterly and entirely ruined, many of them.
It is the worst failure, will be the heaviest felt of any of them yet. Affairs you see published, look shockingly bad to me'.

As the year neared its end, John Scott was being assailed in Scotland by the Royal Bank of Scotland and in France by C.G.T. who were reluctant to advance further money to him, believing that his creditors would in some way or other be able to claim it.

Disaster was never far away and because many of the machinations going on behind the scenes were only hinted at in the correspondence of the time it is very difficult to establish what led finally to financial failure both at Penhoët and Greenock. The sailing ship 'Mentana' was central to John Scott's survival as the Royal Bank was prepared to accept her as security for a large loan which he had applied for, and which would have solved his problems in Greenock.[36]

Unfortunately, in France, C.G.T. were prepared to provide further help provided they got the sailing ship!! John Scott seemed to favour getting rid of his immediate problem at Penhoët (wages), to allow the Penhoët plant to be sold either to the harbour authorities or the railways. His friends including many in C.G.T. and in France more generally, including Count Valery, M. Forquenot and M. Audenet together with his agent T.S. Begbie considered setting up a new Penhoët company but all the scheming came to naught as his major French creditor and supplier of iron plates and sections forced Scott et Cie into bankruptcy on 25th November 1866.[37]

It is clear from the final exchange of letters between John Scott and M.L. Goyetche of C.G.T., enclosed as Figs. 4/6 and 4/7, that John Scott felt extremely bitter over the affair and believed that the Penhoët shipyard could have survived, had certain parties within C.G.T. had the will for it to do so. In the event, as a consequence of the failure at Penhoët the estates of Scott and Co. and the Greenock Foundry Co. in Scotland were sequestered at their own request on 5th December, 1866 by Sheriff Substitute Tennent at Greenock Sheriff Court.[38]

So the great adventure at Penhoët, Saint-Nazaire which owed so much to the flair, imagination and courage of John Scott was over so far as he was concerned. However, he was not to be aware of the significance of two other events which took place in 1866.

In June 1866 John Scott delivered the last of the famous trio for Alfred Holt, the steamships 'Agamemnon', 'Ajax' and 'Achilles' which established the role of the steamship on the long haul ocean routes. On Christmas Eve, 1866, James Henry Scott, younger brother of John Scott, on the strength of a free passage provided by Alfred Holt arrived in Shanghai, where he joined the staff of John S. Swire, who was at that time establishing an organisation destined to become one of the most prestigious trading concerns in the Far East. Through these two events, the destiny of Scott and Co. was to be determined for the next hundred years, during which time Scotts built in excess of two hundred ships for the Holt and Swire shipping concerns, as described in the following chapters.

THE AFTERMATH.

In France, C.G.T. made a concordat with Scotts creditors buying them out with a 25 per cent cash payment. They repossessed the Penhoët shipyard and for a time converted some of their smaller ships there from paddle to screw propulsion.

Thereafter Penhoët was briefly leased to Ocean Shipbuilders of Bordeaux and one further new ship, Ville de Brest, was built there for C.G.T. in 1869. However, by that time the Crédit Mobilier had been wound up and the Péreire brothers were gone from the C.G.T. After the Franco-German War the Penhoët shipyard was closed. For more than ten years thereafter the once lively, noisy shipyard was silent - the only sound - the wind blowing across the weed infested berths.[39]

Following the Greenock sequestration on 5th December 1866 a meeting of Scotts' creditors took place in the Tontine Hotel, Greenock on 14th December 1866 to elect trustees and commissioners. (The claims of their unsecured creditors amounted to upwards of £45,000) On 17th January 1867 in Glasgow John Scott met with Messrs. Jas. Galbraith, Peter Denny and T.S. Begbie and they offered to find friends to pay three shillings in the pound.[40]

FURTHER PROBLEMS.

Whilst endeavours were being made to find guarantors for both the Scott and Co. and Greenock Foundry Co. compositions, another problem emerged which made that task more difficult.

At the time of the bankruptcy Scott and Co. were building the iron screw steamer called 'Galvanic' for the Belfast Steamship Co. Ordered in June 1866, 'Galvanic' was to be paid for in four cash instalments totalling £15,000 together with a balance of £4,000 in the form of the paddle steamer 'Enniskillen'. The Belfast Steamship Co. agreed on 24th November 1866 to hand over 'Enniskillen' early to Scott and Co. who had a potential buyer, provided Scott and Co. paid interest on her value of £4,000 up to the time of delivery of 'Galvanic'.

Unfortunately, it was on that very date that Scott et Cie in France was declared bankrupt and the Belfast Steamship Co. immediately demanded the return of Enniskillen which was refused. However, in February 1867 Scott and Co. were ordered to return 'Enniskillen' to the Belfast steamship Co. (Court of Session, Edinburgh, Lord Kinloch)[41]

In parallel, at Greenock Sheriff Court, the Belfast Steamship Co. pursued the Greenock Foundry Co. for the release of the 'Galvanic's' engines. They lost this case and were ordered to pay £2,840 to the Greenock Foundry Co. for completion and delivery of the engines.[42]

Mr. James Welsh had been appointed interim manager of Scott and Co's affairs and he placed an order with local shipbuilders, McNab and Co. to complete and deliver 'Galvanic' to her owners. She was delivered on 14th June, 1867.[43] Meanwhile 'Enniskillen' had been converted to a twin screw steamship with Greenock Foundry engines. She became the property of Greenock Foundry Co. due to the default of the Belfast Steamship Co. and was sold by them to Robertson Bros., of Grangemouth in July 1868 and was re-registered there on 8th August 1868.[44]

END OF SEQUESTRATION.

Reverting to the Scott and Co. sequestration of 5th December 1866 there was frenzied activity by Messrs. Galbraith, Denny and Begbie during December, January and February resulting in eighty out of ninety seven creditors signing the Deed of Arrangement which was passed by the Sheriff at Greenock Sheriff Court on Tuesday 19th February 1867.[45] Work was resumed immediately at the

Greenock Foundry on the engines for 'Galvanic' and on the final pre-sequestration contract - the installation of new machinery in 'Columbian' - a contract they had received in part payment for the new Mongolia for the P. & O. company. 'Columbian' was delivered in May 1867.[46]

THE NEW BEGINNING.

The day after the sequestration on Scotts' was lifted, John Scott wrote to the local Superior, Sir Michael R. Shaw Stewart, Bt. asking for his support in securing orders for the Greenock Foundry Co. to supply propelling machinery for naval vessels building in the Royal Dockyards. In his letter to Sir Michael he made the point that at that time, with the shipbuilding and marine engineering industries being in deep depression, he would not only be helping Scotts' but also the town of Greenock which had so many people unemployed.[47] The following morning he was in London off the night train to have a meeting at the Admiralty.

The depression, now nation wide, had not arrived suddenly but had been steadily getting worse from the heady days of the blockade runners in 1864 coupled with the depredations of the Confederate cruisers which had driven the greater part of Federal shipping from the ocean and forced most of the transatlantic merchandise into British bottoms.

So 1864 was a great year, but by the spring of 1865 it was clear that the Confederacy could not sustain the unequal struggle any longer and the surrender of General Lee ended the war, and 1865 saw a significant drop in Clyde built tonnage from 178,000 tons in 1864 to 153,000 tons in 1865. The early prospects for 1866 were not encouraging but unfortunately the workforce chose to ignore the signs and began agitation for shorter hours and higher pay. On 16th April 1866 a general demand was made on the Clyde for sixty hours pay for fifty seven hours work together with a variety of other demands from individual unions, all of which were refused by the employers. A partial strike was followed by a lockout which ended with the workforce totalling some twenty thousand returning to work.[48]

These difficulties had led Clyde shipbuilders to turn away work and to decline to tender, resulting in work being placed elsewhere, and by the middle of 1866 hundreds of skilled shipbuilding and engineering tradesmen were out of work.[49] Scott and Co. had fared better than most firms during 1866 mainly due to Alfred Holt's policy of ordering tonnage during periods of depression. However, things continued to be difficult through 1867 and in spite of submitting a host of tenders no orders were received. In August 1867 John Scott wrote to Begbie - 'could you not make up an order for us for the Albion Co. or some other of your friends, or give us a hand somehow to put a vessel on on chance? A sailing ship could not go wrong I think by next spring after the usual winter losses'.[50]

A TIMELY DIVERSION.

At this time John Scott's struggle to re-establish the position of Scott and Co. received a fillip from an unexpected quarter. Hardly had the Victoria Harbour been opened in 1850 when demands were once again heard for more dock facilities. The local authorities, concerned at the growing threat to their prosperity from the increasing trade and traffic sailing up river to Glasgow, investigated a number of improvement schemes. It was decided to create the Albert Harbour by enclosing the existing Albert Quay and extending the waterfront of the new Albert Harbour westward thus forming what became Princes Pier. Work began in 1862 and the new Albert Harbour was opened in 1867, the new Princes Pier following in 1869.[51]

These developments were not universally popular. Many detected pressure from the railway lobby in the decision and felt the site should have been used for the provision of docks and a large graving dock, still badly needed.[52] Attention was then focussed on the Garvel Park estate in the east end of the town, on the western end of which the Scott and Co. Cartsdyke shipyard was located. The estate was owned by John Scott's father, Charles Cunningham Scott I, who had inherited it from his sister, Mrs. Margaret Sinclair following her death in 1859 and was occupied thereafter by John Scott IV until 1865. In 1867 a substantial part of the estate was sold by Charles C. Scott to Greenock Harbour Trust for £80,000.[53]

Subsequently, the Garvel Graving Dock was built there, beginning in 1870 and completed in 1874 at a cost of £89,000.[54] After some years it was agreed that the James Watt Dock should be built at Garvel Park. The first sod was cut by Provost Lyle on August 1, 1878, the foundation stone laid on August 6, 1881 and the dock opened in August 1886 by Provost Edward Wilson.[55] The first estimate of cost of the James Watt Dock was £208,000. The actual outlay amounted to £634,000. In the event this final attempt to capture Glasgow bound traffic ended in failure and led to the financial collapse of the Greenock Harbour Trust.

In a letter to T.S. Begbie John Scott wrote:-

> *'The sale of the largest part of the Garvel Park property has been completed for the sum of £80,000 of which sum £60,000 went to my father and the remainder went to the Royal Bank of Scotland. We still have the building yard left and with the splendid new dock we shall shortly have alongside it, I think we have a nest egg of £30,000 still there when we choose to realise it'.*[56]

These events greatly eased John Scott's financial problems but he was still without an order.

SIGNS OF REVIVAL.

Very early in 1868 there were the first signs of activity in the shipping market. Begbie sent two liners, 'Carolina' and 'Gambia', to Scotts for overhaul including the supply and installation of new boilers.[57] Morris, Munro of Glasgow in which James Galbraith had a significant interest, ordered a steamer, 'Hispania', for their Mediterranean trade in February, 1868. At the same time a large iron sailing ship was ordered for local owners. In March the French connection was re-established when a steamer was ordered for Marseille owners, and in May, Count Valery ordered three steamers for his Mediterranean coastal trade.[58]

In parallel with the receipt of these orders John Scott drew up a new partnership agreement, (See Fig. 4/8) and made his younger brother a partner of Scott and Co. an association which lasted thirty five years. Robert Sinclair Scott, at that time was twenty five years of age. The revival was sustained and for the next seven years the tonnage built in the United Kingdom increased year by year. The decades of co-operation with Alfred Holt and John Swire lay ahead.

CHAPTER FOUR. REFERENCES

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58. See Volume 2 Scotts Ship List for ship orders received in 1868.

Fig. 4/1

Workers Houses built by Scotts at Penhoet - St-Nazaire - 1862
from Saint Nazaire et La Construction Navale (Nantes 1991)

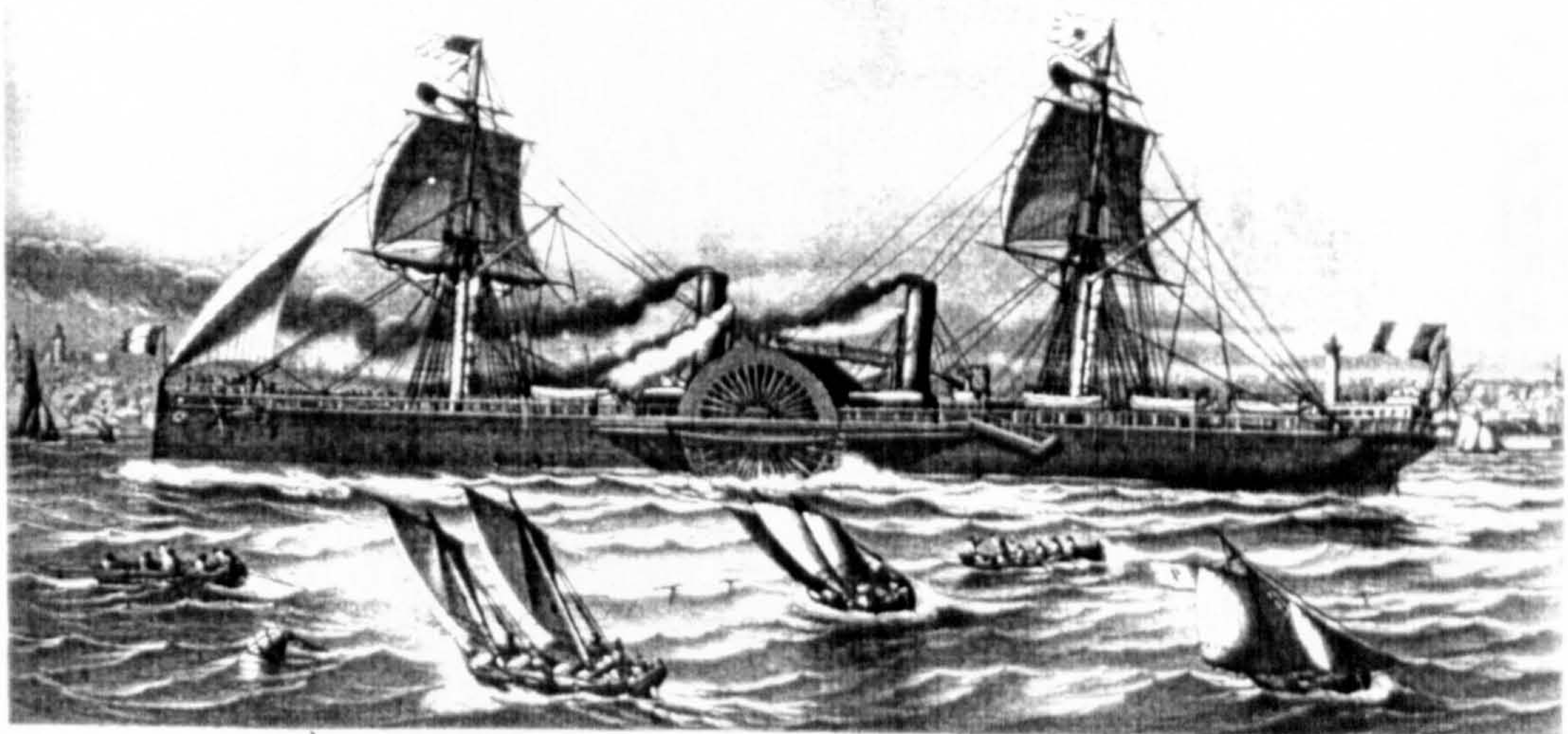
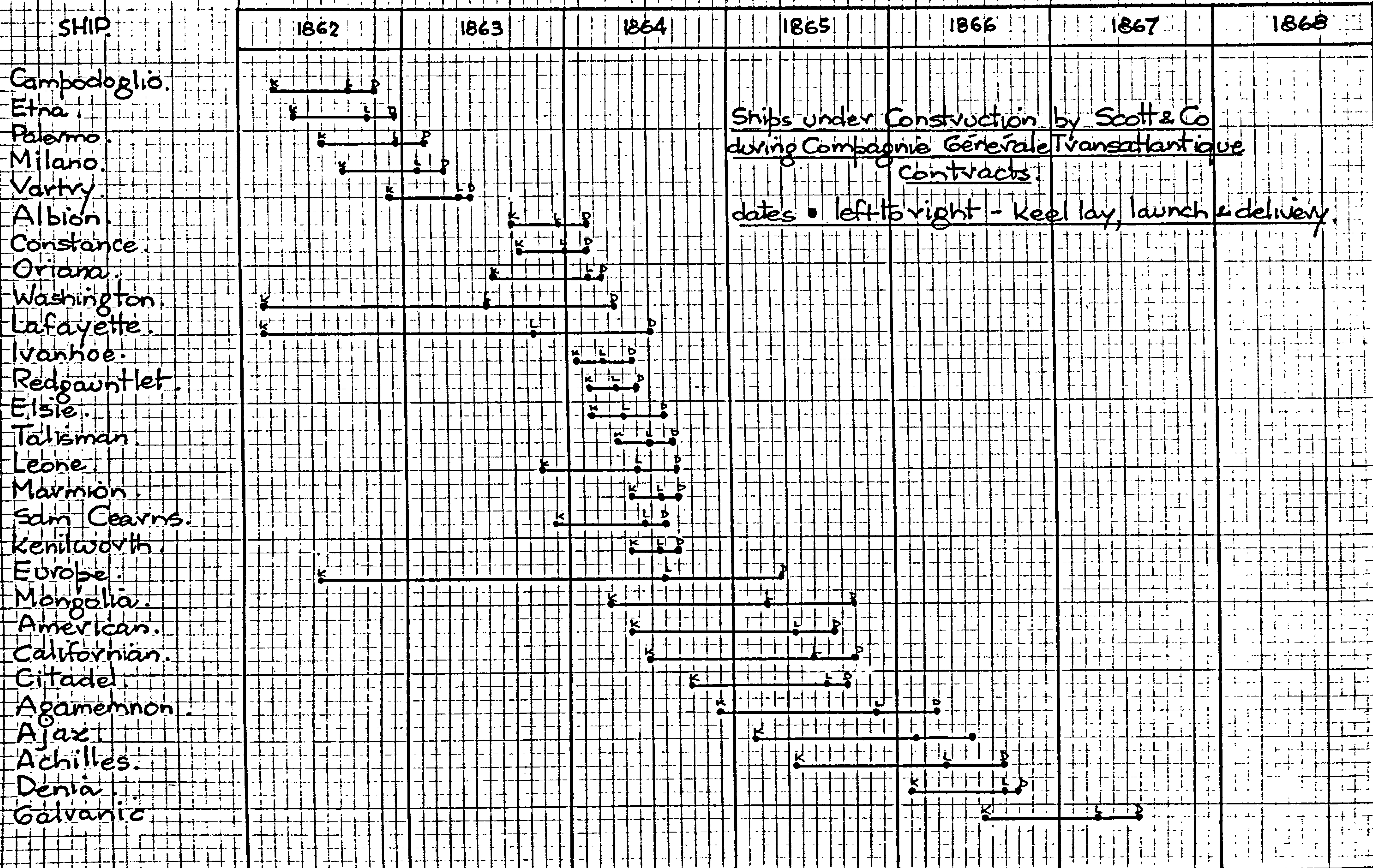


Fig 4/2 - P.S. Washington - as delivered 1864.
from Histoire de la Compagnie Générale Transatlantique
Paris 1955.

SCOTT et CIE.
Penhoet Shipyard
St. Nazaire.
No. of Employees
2500
2000
1500
1000
500
Labour Rate Francs/day.
4
2
Number of Employees
Labour Rate
Data derived from surviving progress reports.
See GD 319/26/1/5.
(Exchange rate c. 25.5 f. per pound)
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1863
1864
1865

Fig. 4/3

Compiled from contract documents and the Scott Ship List.



Compiled from data available in the Scott Ship List - Volume Two of this thesis

Fig. 4/5.

Fig. 4/6

Fig. 4/6.

Cartsdyke,
Greenock.

8th December, 1866.

Monsieur Goyetche,
Compagnie Générale Transatlantique,
Paris.

Sir,

It is with feelings of great sorrow that I have to enclose to you the accompanying circular of Messrs. Scott & Co., announcing their inability to meet their debts. In doing so I can state that this result has been brought about entirely by the enormous losses which have been sustained through the contacts entered into with your Company and latterly through the action which you have deemed it necessary to assume in relation to my business at St-Nazaire. Trusting too implicitly to the representations made me when I undertook your work I soon found myself in a position of great difficulty and although you assisted me with advances of money before it was strictly due and you no doubt thus materially aided me I certainly never expected to have received at your hands the treatment I have met with during the last few weeks. You have thereby obtained the unenviable notoriety at least in all circles in this country of having caused my ruin and that of my family and of having made me the scapegoat ofthe errors committed by the officials of your Company in the designs of your steamers.

I trusted that the million and a half francs which I have lost in this country in the service of your Company might have induced them to render me the paltry assistance I asked a few days since and which I certainly should have received from any Company of the same nominal standing as yours.

I can only now regret that I had not better appreciated the character of the parties with whom I had to deal which I certainly ought to have done had I taken the advice of many of my best friends in France and Britain.

Personally from yourself I have always received great kindness and I thank you for it in now closing our correspondence.

I am,
Yours obediently,

JOHN SCOTT.

From: Scotts private letters.

Fig. 4/7

Fig. 4/7.

Paris,
16th November, 1866.

Mr. John Scott,
4 Mansion House Place,
London.

Sir,

We reply to your letter of the 15th November. Certainly we regret the deplorable state to which your business affairs at St-Nazaire have been reduced, but it is not up to us in any way to remedy the situation.

Our company has conducted itself towards you with great loyalty and great benevolence.

It has constantly put faith in statements which were not quite exact and has received in exchange for its correct conduct nothing but all kinds of annoyance.

Today we are obliged to complete from our own funds, the construction of the 'Darien' - the cost of which had been completely paid into your account - and thus your debt towards us is increased.

It is quite wrong to say that your duties at St-Nazaire were onerous. On the contrary we know that you gained considerable benefits from it by the construction of our five ships.

The sacrifices were made rather on the part of our company which has suffered considerable damage because of the inexplicable delays which you imposed on it in the delivery of its ships.

Thus our intention is to uphold in their entirety the legal rights which we maintain on our past contracts with you and to assert them in the most precise manner.

Yours sincerely,
for C.G.T.

L. GOYETCHE.

From: Scotts private letters.

Greenock 27th Feb 1868

It is this day agreed that the new firm of Scott & Co. shall consist of the following Partners, holding the following shares.

John Scott Jnt 7 Shares

Robert Sinclair Scott 1 Share;

said arrangement to subsist for three years when the ~~share~~ proportions shall be altered as follows:-

John Scott Jnt 3 Shares

Robert Sinclair Scott 1 Shares

which arrangement shall subsist for four years thereafter

Contract of copartnery to be drawn up & signed by the Partners containing the usual clauses

Partners to be allowed five per cent interest on the amount at the credit of their account before division of profits.

John Scott Jnt

R. Sinclair Scott

Fig. 4/8 from the Scott family private archives

CHAPTER 5.

THE SCOTT, HOLT AND SWIRE CONNECTION.

CHAPTER 5.

THE SCOTT, HOLT AND SWIRE CONNECTION.

This chapter sets out how events in Greenock, Liverpool and Shanghai, c. 1870, together with an element of chance, set in train the coming together of three remarkable men whose collaboration in business was to create two personal shipping empires in the cases of John Swire and Alfred Holt, and in the case of John Scott was to confirm his reputation as a shipbuilder and marine engineer of world renown.

The connection begins in 1858 when Alfred Holt visited the Clyde in his search for new tonnage for his fledgling shipping company. He arrived in Greenock armed with a letter of introduction to John Scott from W.S. Lindsay, a Liverpool shipowner and ship historian.[1] In the event only John Scott could offer Holt prompt delivery of a suitable ship and a deal was quickly struck.

The 'Plantagenet' (695 gross tons) was delivered in 1859 and was placed on the West Indies trade. A recently discovered drawing of her is included as Fig. 5/1. She was followed by other similar Scott built ships, 'Talisman', 'Askalon' and 'Crusader' in 1860-1-2. What had begun as a chance business contact developed into a close personal friendship. Alfred Holt had trained originally as a railway engineer and had moved via consulting work into shipping.[2] He shared with John Scott a great enthusiasm for steam navigation. The subsequent rapport between Alfred Holt and the Scott family is very clearly demonstrated in Fig. 5/2 which includes extracts from his correspondence, a fragment from his autobiography and an extract from a letter to John Scott. The business relationship between their two firms endured for over one hundred years.

John Scott as we have already seen had some years earlier built the 'Thetis' at his own expense and equipped her with a steam plant using steam at a pressure of 115 pounds per square inch, which on sea trials produced an extremely low fuel consumption of 1.018 lb per i.h.p. hr. certified by no less a person than Professor Macquorn Rankine of the University of Glasgow. Subsequent service experience produced an all purposes figure of 1.86 lb per i.h.p. hour, almost half of the going rate at that time of 3.4 lb per i.h.p. hour.[3] The clear message had not been lost on Alfred Holt that lower fuel consumption would result in a reduction in space required for bunkers thus leaving more space for cargo.

Holt's shipping service to the West Indies, initially very successful, came under pressure from intense competition, cargo volumes declined and profits fell. So he sold off all his ships except for the 'Cleator', which he re-equipped as an experiment with a two cylinder tandem compound engine using 60 lb per square inch steam. He sent 'Cleator' on a wide ranging series of coastal voyages to France, the Baltic and to Brazil and was well pleased with the results obtained, namely, a 40 per cent reduction in fuel over that obtained with the earlier machinery.[4]

Having withdrawn from their West Indies venture in 1864, Alfred Holt with his brother Philip, having considerable capital to invest and after long deliberation, decided to enter the China tea trade, at that time in the hands of the tea clippers.[5] It was at that point he turned to his friend John Scott (he had that year been best man at John Scott's wedding) and after many discussions a design and technical specification was evolved for tender purposes and in 1865 three ships, 'Agamemnon', 'Ajax' and 'Achilles' for the newly founded Ocean Steam Ship Co. were ordered from Scotts at a total cost of £156,000.[6] Design and construction of the engines and boilers was placed with the Greenock Foundry Co. Scotts engine works. Thus the Ocean Steam Ship Company was born and on the 19th April, 1866 the 'Agamemnon' sailed for China after successful sea trials which produced a fuel consumption rate described by Alfred Holt as 'better than that of any ship afloat'. (See Fig. 5/3) 'Ajax and 'Achilles' were delivered in June and September 1866 respectively. The great adventure had begun.[7]

ENTER JOHN SWIRE.

We now introduce the third member of the triumvirate, John S. Swire of Liverpool, who had with his brother William, inherited the family import and export business on the death of their father in 1847.[8] Both brothers in the mid 1850s had travelled abroad seeking to improve the prospects for their business, William for a short period in America and John for five years in Australia where he tried his hand at sheep farming and gold prospecting. He returned to Liverpool in 1859 and at the end of that year he married Helen Fairrie, daughter of Adam Fairrie, a member of the Creenock sugar refining family and the second link with Greenock.[9]

In the early 1860s John Swire and Sons main trade was the import of American cotton, which was dislocated by the American Civil War. So the Swires began to ship cotton, woollen and worsted goods to China and Japan for various clients including R.S. Butterfield. By 1866-7 they were starting to import teas and silks. They also shared the distinction with John Scott as being among the original shareholders in Holt's Ocean Steam Ship Co.[10]

In 1866 the brothers became concerned about the financial affairs of their agent in Shanghai, Preston, Bruell & Co. and John Swire decided to go there personally and open a business house there. Within five weeks of his arrival there he had taken over Preston, Bruell, secured the agency for Holt's Ocean Steam Ship Co. and formed a new company, Butterfield and Swire, in partnership with R.S. Butterfield and opened for business in Shanghai on January 1,1867.[11]

It is at this point that the basic elements of our Scott-Holt-Swire story come together. When John Swire's Butterfield and Swire opened for business that New Year's Day, one James Henry Scott took post as bookkeeper, general and shipping clerk. Young Scott, younger brother of John Scott, trained in banking, had been offered a free passage to Shanghai on the maiden voyage of the 'Achilles' by Alfred Holt together with a letter of introduction to John Swire at Shanghai.[12] His appointment and subsequent life time of service with John Swire and Sons are part of our story.[13]

On that New Year's Day in 1867 our three principal characters were encountering widely different emotions. For John Swire and Alfred Holt the future was one of hope but John Scott was having to plot a new course following the disastrous outcome of his brave adventure in Saint-Nazaire. However, the ability of his father Charles C. Scott to dispose of his local Garvel Park estate to the Greenock Harbour Trust for a substantial sum made it possible for Scott & Co. and the Greenock Foundry Co. to continue in business. His difficulties at this time, described in the previous chapter, were associated with a deep trade depression in the mid 1860s which had taken its toll of many shipbuilders on the river and elsewhere and many firms, whose mushroom growth had led to Scotts labour shortage in 1862-3, did not survive. Fig. 5/4 lists the more significant firms which did survive with indications as to their subsequent fate. However, in the seven years which followed the period of depression, John Scott was able to rely on influential friends like Peter Denny, James Galbraith and Thomas S. Begbie, the latter pair ship brokers, and past clients like Count Valery of Marseille. In that period some forty ships were built, thirty five steamers and five sailing ships, including eighteen for foreign owners. During 1870 and 1871 a veritable flood of orders from abroad prevented Scott from undertaking follow on orders from Holt, although Scott did deliver 'Priam' to the Ocean Steamship Co. in 1870.[14] After a three year gap, Holt ordered three ships, 'Stentor', 'Anchises' and 'Orestes' in 1874. The same year there occurred another of the chance events in our story which is related below and led to a business relationship between Scotts and Swires which was also to last over one hundred years. From this point in our story the interrelation between the fortunes of Scott, Swire and Holt is very complex and for the sake of clarity the Scott involvement in the development of the Swire and Holt enterprises over periods of time will be discussed separately.

SCOTT-SWIRE (1874-1883).

During his first visit to China in 1866-7, John Swire foresaw great opportunities for a considerable expansion of steamship services on the rivers and coasts of China, particularly on the Yangtse river.

Some local steamship services were already being run on Chinese waters by such British and U.S. firms as Jardine, Matheson, Russells, Heards and Dents, all long established in the area, but John Swire believed there was room for more, especially on the Yangtse.

It was clear to him that the prospects for an entrepreneur with the necessary capital, energy and foresight were excellent. He subsequently tried to persuade Alfred Holt that there was scope for a mutually beneficial service to complement and to act as a feeder service to Holt's Europe-Far East operations, but without success.[15] He eventually set up the China Navigation Co. in 1872 in London with a capital of £360,000 and John Scott IV among the shareholders. Butterfield and Swire were appointed managers.[16]

The company began by purchasing the Union Steam Navigation Co. which had two ships already plying on the Yangtse and provided a shore base in Shanghai. They also ordered three light draught paddle steamers from Inglis of Glasgow which were delivered in 1874.[17] Swire's subsequent battles with the incumbents on the Yangtse, whilst ultimately successful, were very difficult and will be discussed later.

COAST BOATS OWNERY.

John Swire was also keen to enter China's coastal trade. Consequently when he heard during a visit to Liverpool in 1874, accompanied by James Henry Scott, now a partner in Swires, that John Scott had three new steamers left on his hands and available for sale cheaply, he expressed interest. He agreed to purchase two of the ships for £32,000 if John Scott would take a half share in them. The ships were satisfactorily surveyed, the bargain struck, and the 'Foochow' and 'Swatow' sailed for China in 1874. Thus began the coastal fleet of the company which became known as the Coast Boats Ownery.[18] It was an immediate success, the profits exceeding even the expectations of John Swire and John Scott. By 1879 the fleet had grown to six ships acquired at a cost of £120,000, and registered a profit for that year of £38,500.[19] Thus encouraged, John Swire and John Scott continued to invest in more new ships, all built by Scotts at Greenock, and in land and other properties.

Between 1874 and 1882 a further sixteen ships had been ordered, fourteen of which were committed to the development of a new trade, previously junk borne, for steamers which was to become of vital importance to the Ownery, later the China Navigation Co. and of course to Scotts, namely the carriage of soya beans and beancake from Newchwang in Manchuria to Swatow and Amoy in south China where the beancake was used as fertiliser and where return cargoes of sugar were often available. (See Appendix 5/1). By November 1882 the fleet of coasters had averaged a return of 20 per cent during eight years of operation.[20]

STRUGGLE ON THE YANGTSE.

On the lower Yangtse, progress was clearly much more difficult. Immediately the China Navigation Co. appeared on the Yangtse there was a freight war with Russell's Shanghai Steam Navigation Co. which lasted for six months before China Navigation Co. was accepted. Immediately another new company appeared on the Yangtse, the China Merchants Steam Navigation Co. a Chinese company, part owned and controlled by the Chinese government, which gave trouble from the start. In 1877 they purchased Russell's Shanghai Steam Navigation Co.[21]

John Swire, already locked in battle with Jardine, Matheson elsewhere in China, decided to visit China and reached agreement with the China Merchants sharing the Yangtse trade, 55 per cent to China Merchants and 45 per cent to Swires.[22]

Thereafter in 1878, following the Chefoo Agreement which opened up 340 miles of the Middle Yangtse for foreign trade and shipping, China Merchants and Swires jointly operated a service there. However, the bitter struggle with Jardine, Matheson continued unabated. When, in John Swire's view, Jardine, Matheson broke a longstanding agreement to keep out of the Yangtse, he was furious.[23]

He threatened to challenge Jardines interests in the sugar and insurance markets having already built the Taikoo sugar refinery with this in mind. During these 'hostilities', Jardine, Matheson consolidated all their shipping interests to form the Indo-China Steam Navigation Co.[24] John Swire who, in any event, had been concerned about a possible conflict of interest between the Coast Boats Ownery and the China Navigation Co. as they continued to extend their spheres of interest, suggested to John Scott that Coast Boats Ownery should be absorbed into the China Navigation Co. Fig. 5/5 lists the fleets of the Ownery and China Navigation Co. at that time. John Scott who had a significant financial interest in the Ownery agreed and the merger took place in 1883.[25]

John Swire, who recognised that agreement on sharing the Yangtse trade was inevitable, produced a series of pooling arrangements which he submitted to Jardines and the China Merchants. After much haggling in 1882 a pooling agreement for the Yangtse was signed by all parties which gave 42 per cent to the China Merchants, 38 per cent to the China Navigation Co. and 20 per cent to Jardine Matheson.[26] A similar agreement was reached covering the Shanghai to Tientsin route. John Swire regarded the agreements as a great victory and felt that at last, China Navigation would be treated as an equal by Jardine, Matheson. In December, 1881, at the height of the struggle, John Swire wrote to John Scott stressing his determination to maintain China Navigation Co.'s position vis a vis Jardine, Matheson & Co. saying "this greatly hinges on the brains of builder v builder. Do give your (personal) attention to (the design of) our coasters. I don't intend to play second fiddle to J. M. & Co. and I don't intend to go to any other builder. When you can't compete, I'll retire!!"[27] (Appendix 5/2 discusses a number of factors affecting ship operation on the China Coast)

SCOTT-HOLT (1867-1888).

The first four years of Ocean Steam Ship Co. trading were undertaken in a period of general trade depression. Nevertheless by 1869 the firm was regarded as being securely established.[28] Alfred Holt strongly backed the Suez Canal which opened in 1869 and from March 1870 all Blue Funnel ships used the Canal.[29] The period 1869-1875 was a period of considerable prosperity and was noteworthy also for Holt's decision in 1874 to move to self insurance.[30] Such a policy required the accumulation of large reserves to underwrite the fleet. It also required that all new construction be placed with shipbuilders of the highest repute and built to standards in excess of those of Lloyds A1 class. This requirement was largely met by Scotts. From 1875 to 1900, 33 out of 44 ships delivered to Holt came from Scotts and the remainder from Leslie and Workman, Clark. Scotts were invariably the lead yard and other yards used their drawings and worked to Scotts 'Holt' standards.

However, even though trade was brisk in the early 1870s, clouds were appearing on the horizon. John Swire in his capacity as agent for the Ocean Steam Ship Co. a responsibility which he took very seriously, had his finger on the pulse of the China trade. So as the decade progressed, he repeatedly drew to Alfred Holt's attention three major problems which required to be dealt with.[31] Firstly, competition on the run was intensifying for both outward and homeward freight and as result freight rates were being forced down and ships were sailing with part cargoes.[32] Secondly, Holt ships were becoming increasingly uncompetitive with those of their rivals, such as the Glen, Shire, Castle and (from 1882) China Mutual lines. The Holt ships which only ten years before had been hailed as years ahead of the opposition were now, in Swires view, small, underpowered, and by neglecting such innovations as steel hulls and the triple expansion engine, were becoming out of date.[33] Thirdly, cargo patterns were changing. Outward cargoes had formerly been mainly textiles, but were becoming a miscellaneous variety including machinery, boilers, bricks, fertilisers and scrap iron. The old homeward cargoes of tea were becoming less in demand and alternatives such as sugar, rice, sago, timber and wood had to be sought, cargoes for which the old ships were ill suited.[34] John Swire, after many years of urgently pressing the Holt brothers to improve their fleet with no success whatever, used his expertise in negotiating pooling agreements on the Yangtse to organise the first China Conference in 1879 with the aim of overcoming the difficulties encountered by shipowners trading to the Far East and, in the going, to protect Holt from the consequences of what

Swire perceived as their unprogressive attitude to the trade.[35] Swire believed that conference organisation would replace cut throat competition by regulated competition and cooperation between the liner companies.[36] However, even here, Holts were uncooperative and at times a source of embarrassment to John Swire. He was particularly critical of Philip Holt, who in his view, hated the conference because 'he was a disbeliever in its results'.[37]

In seeking to discover the reasons for the Holts apparent lack of response to Swire's efforts on their behalf, one has to look at a number of factors. Firstly, both Alfred and Philip Holt were strong believers in competition. Their business had been established through the competitiveness of their fleet in the outward carriage of Lancashire and Yorkshire textiles to the Far East. If their slower ships were less competitive than those of their rivals on the homeward carriage of tea to London, they could still make profitable round voyages. The Holts wanted to be able to undercut their high (fuel) cost, faster, competitors in order to maintain homeward cargoes and they felt that the rate fixing element in the conference arrangements could compromise their room for manoeuvre in this respect.[38] Their conversion lay some years ahead and as will emerge coincided in 1889 with the recruitment of three young members of the Holt family into the Company.

From the technical aspect, Alfred Holt had over a period of twenty five years installed the single crank compound tandem engine in all Ocean Steam Ship Co. vessels with only modest increases in boiler pressure and horsepower linked to a similarly modest increase in gross tonnage.

John Scott in 1888 managed to persuade him to instal a triple expansion engine in 'Ulysses' which unfortunately had a very short working life, being wrecked early in 1890 off Japan. However, by that time Alfred Holt must have recognised that the limitations of the single crank compound engine would be exposed if the larger and more powerful ships which John Swire was advocating were to be built. Consequently, as will emerge in the next section of the Scott-Holt story, all new tonnage for the next thirty years was equipped with triple expansion machinery.

SCOTT-SWIRE (1883-1914).

For six years following the 1882 pooling agreements, Swire, Jardines and China Merchants lived in peaceful co-existence, all three companies expanding their trades.[39] The profit figures for the years 1883 to 1889 for the China Navigation Co. (Table 5/2) were very creditable but of course the capital of C.N.Co. was increased to £500,000 in 1883 and the earnings included both those of the Coast Boats Ownery and the China Navigation Co. However, notwithstanding that Swires and Jardines had the same nominal capital, Swires nett earnings for the period were nearly three and a half times that of Jardines.[40]

John Swire and the China Navigation Co. were in a strong position to negotiate the new pooling agreements now due and accordingly took a strong line in the tripartite discussions. Agreement was not reached and a long period of squabbling followed. It was not in fact until 1893 that a new agreement was reached which worked well and was renewed for a further five years.[41] The outcomes for the periods 1890-3 and subsequently 1894-1900 show the influence of the breakdown in the pooling agreements (See Table 5/2).

Scotts had a considerable vested interest in these matters both as shipbuilder and shareholders and it is interesting to note how the China Navigation Co. developed during this period.

In 1883 China Navigation Co's main interest was still in the Newchwang/Swatow chartering (beancake) trade with some Shanghai/Tientsin berth trade. A China/Australia service had just been started and soundings were being taken on a Amoy/Hong Kong/Manila run when Tientsin was closed in winter. However, by the early 1900s the four largest ships owned by the company were employed carrying passengers and cargo on the China/Australia run: the Tientsin/Canton and Shanghai/Canton trades were being developed in addition to Newchwang/Swatow, Newchwang/Canton, Wuhu/Swatow and Hankow/Swatow charter trades which were being catered for: while ports in Borneo, Japan and Siberia were 'of frequent call'.[42] It was recognised that to retain their lead in developing these new trades many new ships would be required.[43] The new building programme during the period 1883-1914 provided Scotts with orders for sixty three vessels. The orders came in groups of two, four and six at a time. The informality of a typical order for two ships (See Fig. 5/6) contrasts strongly with present day purchasing practice!!

THE C.N. AUSTRALIAN PASSENGER VESSELS.

The most prestigious ships built by Scotts during the period were the four passenger cargo liners built for the Swire Australia service and their story deserves to be recorded. Sometime after 1881 an exploratory service was started by the China Navigation Co. to Australia with the coasters 'Changchow', 'Keelung', and

'Taiwan'. They were routed southward via Singapore and Java, and called at Port Darwin, Thursday Island and Cooktown en route to Brisbane, Sydney and Melbourne. Southward earnings were mainly derived from Foochow tea, Chinese passengers, Chinese food for the emigrants in Australia and sugar 'raws' from the Philippines and 'refineds' from Hong Kong.

Northwards the staple cargo was coal from Newcastle N.S.W. or from New Zealand ports either by call or by trans-shipment in Sydney.[44] Butterfield and Swire were enthusiastic but unusually John Swire could not make up his mind about the new trade. Typically he set out his reservations as follows:-

(1) Competition from chartered tramps.
(2) Doubt at the time as to the vulnerability to immigration restrictions of the Chinese passenger trade.
(3) Changing fashion for Indian and Ceylon tea in preference to China tea.
(4) Threat of Australian tariff protection against Taikoo sugar.
(5) Hostility of Australian labour to Chinese crews.[45]

In 1884 'Keelung' and 'Changchow' were lost and 'Taiwan' wrecked but not lost and there was therefore a debate on whether to replace them by ships specially designed for the service or build more coasters and secondly, whether to abandon the service or charter for it. Somewhat surprisingly in view of John Swire's reservations and his known reluctance to investing heavily so far from base, the decision was made to build four passenger/cargo steamers, 'Changsha', 'Chingtu', 'Taiyuan' and 'Tsinan', each 40 feet longer than any other C.N. Co. ship. Scotts tender of around £184,000 for the four ships was accepted.[46]

The ships which were all delivered in 1886, were extremely handsome, yacht like in appearance, with luxurious accommodation. (See Fig. 6/21)

John Swire was delighted with them and wrote:-

"Our ships are splendid. Their passenger accommodation will tempt Australia and China people to travel to avoid their respective summers." In 1890, his Melbourne agent commented that, in season, their passenger accommodation could be filled twice over.[47]

In time, some of John Swire's fears were justified and he at times contemplated abandoning the Australian service. However, when a large refrigerated store was opened in Manila, he converted two holds in both 'Changsha' and 'Taiyuan' to refrigerated spaces for the carriage of frozen meat to the Philippines.[48] The service was in fact maintained until 1909 when 'Chingtu' and 'Tsinan' were sold to Shanghai owners and then in 1912 'Changsha' and 'Taiyuan' were transferred to G.S. Yuill who had been Swire's agent in Australia since 1900. All four ships continued to give good service to their owners and all four had service lives in excess of forty years.

DEATH OF JOHN S. SWIRE.

John S. Swire died on 1st December 1898 aged seventy one years.

This remarkable man, strong, loyal, in modern terms a workaholic, of total integrity and universally respected, not least by his competitors, chose his staff well and drove them hard.[49] He was imaginative, restless, forever analysing the performance of his competitors and learning from their mistakes. He will however, be best remembered for his role in the creation and operation of the ocean liner conferences, the adoption of which was largely due to his initiative, perspicacity and determination and to his influence with Alfred Holt referred to later in the text. Personal feelings were never allowed to cloud his business judgement and it is therefore a tribute in a sense to his allies, Alfred Holt and John Scott, that his friendship with these equally strong characters was so enduring. On occasion all three went on yachting holidays together. Probably the last occasion when John Swire, Alfred Holt and John Scott met together was at the launch of 'Menelaus' at Greenock on 5th June 1895. (See Fig. 5/7)

Of John Swire's original team, W. Lang, his senior Eastern partner retired in 1888 and F.R. Gamwell, his London office partner retired in 1895. James Henry Scott, who had joined the company in 1867 as a young bookkeeper, had become a partner in Butterfield and Swire in 1874 and was in Singapore on a Far Eastern tour when he received a telegram from Edwin Mackintosh in the London office advising him of Mr. Swire's death and appealing to him to return to London immediately. He arrived home on Hogmanay 1898 and became senior partner, the other partners being Edwin Mackintosh and John Swire, jr. G.W.Swire, John Swire's younger son did not become a partner until 1905. J.H. Scott's elder son, Colin C. Scott became a partner in 1910 two years before his father's death. He became a director of Scotts' Shipbuilding and Engineering Co. Ltd., in 1916 and later was Chairman of that company from 1939 to 1950.[50]

The foresight and organisational genius of John S. Swire left its mark for many years after his death and the company continued to operate on the basis of the body of rules and principles for the correct conduct of the business bequeathed by him, as managing agents for the China Navigation Co., Ltd., and the Taikoo Sugar Refinery, and as agents for the Ocean Steam Ship Co. and various insurance companies.[51]

MIXED FORTUNES.

During the years before John Swire died two new ventures had on occasion received consideration only to be subsequently shelved - firstly, the building of the Taikoo Dockyard, Hong Kong for shipbuilding, engineering and ship repairing activities, and secondly, the Tientsin Lighter Co. However, in 1899 it was decided to proceed with both projects, the latter in partnership with Holts.[52] In the period which followed, up to the start of the First World War, all of the Swire enterprises had very mixed fortunes. The Tientsin Lighter Co. was set up to counter the monopoly of a local company over tugs and services and was an immediate success.

The China Navigation Co. had a massive new building programme between 1901 and 1905 with some twenty ships being ordered from Scotts. However, as can be seen from Table 5/2 the China Navigation Co. had a rough time between 1906 and 1910. The poor performance at this time arose from a series of crop failures which resulted in low freight rates due to intense competition from German and Japanese shippers. This resulted in losses in the years 1907 to 1910 with no dividend being paid in 1907, 1908 and 1909. The shareholders became unhappy but the more far sighted of them, backed by Holt, prevailed and in the event profits recovered sharply in 1912 and 1913. Taikoo Sugar Refinery also had problems but it fared better than China Navigation Co. Their export markets had all but gone by this time and 80 per cent of the Refinery's output was for Chinese consumption and demand was increasing rapidly so in general they did well.[53]

THE BUILDING OF TAIKOO DOCKYARD AND THEREAFTER.

John Swire and Sons entrusted John Scott IV with the role of technical adviser in the design and construction of the Taikoo Dockyard project which comprised a large graving dock, slipways, building berths and an engine works all of which became Taikoo Dockyard and Engineering Co., Ltd., of Hong Kong. On John Scott's death in 1903, his brother Robert Sinclair Scott took over the role, and in turn following his death in 1905, Charles Cuningham Scott II, John Scott's son, completed the work. Thereafter Scotts' Shipbuilding and Engineering Co. Ltd., were appointed technical advisers to Messrs. John Swire and Sons, and the China Navigation Co.[54]

Due to initial problems with a very difficult site which delayed its opening until 1909, and cut throat competition from its local rival, the Hong Kong and Whampoa Dock Company, it was not until 1915 that the Taikoo working account showed a profit and not until 1919 that a dividend was declared.[55] With the advent of Taikoo Dockyard, Scotts' role in the Swire China coast operations changed. They continued to build ships for

China Navigation Co. but less frequently than in the past. They designed all China Navigation Co. Taikoo built ships and in many instances supplied the propelling machinery. In addition to their role as technical advisers they were appointed purchasing agents for the Dockyard.

During this period James Henry Scott died. He had been Senior Partner from 1899 to 1912 and during his term of office the firm's holdings and turnover doubled. During his forty eight years with the company he did much to develop Swires' areas of interest throughout the East. On his death, G.W.Swire took over control of the China Navigation Co.[56]

As technical advisers Scotts made recommendations on the appointment of key management and other staff for the Taikoo Dockyard. The Scott-Swire link was further strengthened with the arrival in Hong Kong from Scotts' of many engineering and shipbuilding craftsmen and technical staff for service in the Dockyard and on China Navigation Co. steamers, a practice which continued for decades.

The Scott-Swire relationship during the First World War and its aftermath will be addressed in Chapter 7 of the work.

SCOTT-HOLT 1889-1914.

The year 1889 began in familiar fashion with John Swire stepping up pressure on Alfred and Philip Holt and trying to convince them that their survival was dependent on the modernisation of their fleet.[57] There were however two significant developments that year. Firstly, three young members of the Holt family joined the Company, a very clear indication of future changes.[58] Secondly, Scotts received an order to build four steel hulled ships for Ocean Steam Ship Co. with a 40 per cent increase in gross tonnage and a 65 per cent increase in power, but still retaining the old familiar tandem engine. There was further progress made when in 1891 Scotts were asked to build a further four ships to a new design of the three island type incorporating a poop, centre castle and forecastle. Derrick posts were added to speed up cargo handling. They were much larger than the earlier Ocean steamers, being of 3572 gross tons and having tripe expansion machinery of 2286 i.h.p. two and half times that of the original 'Agamemnon' class.[59]

So, here at last was a clear indication of a new policy and it was no coincidence that in 1895 the three recruits of 1889, Richard Durning Holt, Maurice L. Davies and George Holt, jr. were appointed Managers of the Company joining Alfred Holt, Philip Holt and Albert Crompton, the last having been the most resistant to John Swire's appeals for change during the 1880s.[60] These events coincided with a marked revival in the fortunes of Holts which was sustained up to and through the First World War. Gradually the younger men, led by Richard Holt took over the running of the Company. Philip Holt retired in 1897 and Alfred Holt took little part in company affairs after 1898, formally resigning in 1904. Crompton retired in 1901.[61] Notwithstanding these developments, and the death in 1898 of John Swire referred to elsewhere, Scotts continued to obtain the lion's share of orders for Holt ships up to 1900 and were responsible for the detailed design of all the Holt ships which by the end of the period were in excess of 7,000 gross tons. The remarkable new building programme undertaken by Scotts during the period 1892-1900, largely financed from reserves and which cost in excess of £1,500,000, is illustrated in Table 5/3.

The growth in gross tonnage and ships speed during the period is also shown. By 1900 half the fleet was less than eight years old. Table 5/4 shows the dramatic increase in earnings per voyage, due principally to their modern and better designed ships being able to take advantage of a world wide boom in trade.

In 1902 the Company was registered as a private company with limited liability, it being considered that the remarkable growth of the company required a new structure.[62]

Another important event in 1902 was the purchase of a controlling interest in the China Mutual Steam Navigation Co. which was also largely financed by the sale of reserve investments. This purchase added to the fleet thirteen new ships all under ten years old, and extended the Blue Funnel trading area to include trans-Pacific sailings to the west coast ports of Canada and the U.S.A.[63] The acquisition of these ships had an impact on Scotts' work for Ocean Steam Ship Co. and in the remaining years up to the outbreak of the First World War, i.e. from 1901 to 1914 only ten Blue Funnel ships were built by them. Table 5/5 gives particular of these ships and it will be noted the trend to larger and faster ships was maintained. During these latter years the Company experienced unprecedented prosperity, and the outbreak of war found the Ocean Steam Ship Co. in a strong financial position.

THE SCOTT-HOLT-SWIRE CONNECTION. AN ASSESSMENT.

Shipping and shipbuilding bound these three influential families together for over a century. The key to the initial contact was Scotts reputation and capability as a builder of superior merchants ships and a willingness to involve the Scott family in joint ventures with client shipowners. The Holt connection was the starting point, founded in 1858 on common technical interest in steam power, and quickly secured on deep personal friendships. In contrast, the Swire connection began in 1866 as a direct family involvement when James Henry Scott was taken on in Shanghai as a clerk by John Swire, a connection that led to John Scott IV taking an investor's interest in Swire's China Navigation Co. From that point the connection linking Scotts to Holt and Swire took on a growing importance and one in which the benefits to Scotts, in commercial terms, were highly unequal. Table 5/6 shows the number of merchant ship contracts won by Scotts in five year periods from 1871. In the 1870s, Holt and Swire placed a similar number of ships with Scott, 10 and 11 respectively, contributing 31 per cent of the merchant order book. Thereafter the Swire connection became much more significant, representing over one quarter of all contracts in the 1880s and nearly one third in the 1890s. Over the period 1871 to 1910, the Swire connection produced orders for 77 ships, 25.8 per cent against 45 for Holt, 15 per cent. Together they contributed over 40 per cent of all Scotts merchant contracts. During the 1890s the two firms contributed over half of all Scotts merchant contracts.

The significance of this remarkable flow of orders and the relative importance of Holt and Swire to Scotts can be illustrated in a number of ways.

Over the period 1868 to 1920 the Swire and Holt orders represented 44.4 per cent of the total contract value of merchant tonnage delivered by Scotts. In comparative terms the Holt connection appears to have been more important, their 57 ships representing no less than 28 per cent of the value of the order book, while Swire's 81 vessels contributed only 16 per cent. In tonnage terms also, Holts were more significant than Swires, Holt's ships represented about 30 per cent of tonnage built as against 20 per cent for Swires. The Holt vessels were also larger, averaging over 4,000 tons against 1,700 for the Swire vessels.

On all these counts the Holt contribution appears to be more important to Scotts that of Swire, but appearances can be deceptive. The returns Scotts made in profit on these ventures show a very different relationship. While Holt contributed 28 per cent of contract value, Scotts, earned only 15.9 per cent of their net profit from these vessels. In contrast, while the value of the Swire contracts represented only 16 per cent of all merchant orders in the period under review, (See Tables 5/7 and 5/8) these orders earned nearly 40 per cent of all net profits for Scotts. No other connection remotely approached the importance of the Swire relationship for Scotts. The Swire connection indeed delivered an average net profit of 11.4 per cent on contracts, while the much larger Holt tonnage returned only a very modest 2.6 per cent, by far the poorest return on contracts of all Scotts merchant work, other than their residual sailing ship construction. Swire's rate of return to Scotts was indeed greater than the profit earned on naval construction, even in wartime.

In total, however, the naval work at the end of the century and into the First World War, only 35 naval vessels from 375 in total built by Scotts from 1868 contributed 54 per cent of all net profits in the period. However, leaving aside the distortion of the war period, merchant work provided 85.6 per cent of contract work and 79.5 per cent of net profit. Swire delivered 31.5 per cent of total net profit and Holt only 12.6 per cent. It is clear therefore that while Holt tonnage dominated the building berths, Swire ships were the key element in Scotts profitability in the years between 1870 and the First World War.

One factor shared by Holt and Swire in their relationship with Scotts was the superior quality of their ships. Appendices 5/3 and 5/4 clearly illustrate the extent of the programmes which provided a base load for the Scotts at Greenock for almost a century. The average service life of the fleets (excluding casualties) of forty years shows that they built well.

Further developments in the Scott-Holt relationship during the First World War and in the immediate post war period are dealt with in the next chapter.

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34. Ibid. - p.110.

35. Marriner and Hyde pp.137-140.

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37. Ibid. - p.145.

38. M. Falkus p.124-5.

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39. Marriner and Hyde p.38.

40. Ibid. - p.85.

41. Ibid. - p.88.

42. A.V.T. Dean Part II p.2.

43. Ibid. - p.3.

44. A.V.T. Dean Part II, p.5.

45. Ibid. - p.5.

46. Ibid. - p.6.

47. Ibid. - p.4.

48. Marriner and Hyde p.95.

49. A.T.V. Dean Part II p.28. in his 'Random Notes on the Period' remarked: J.S.S. was continually emphasising to his Eastern partners the vital need to choose good men, to see that the Company's regulations were carried out, and to know the men personally. The shadow of the bottle lurked in the background of not infrequent casualties and to illustrate a London technique J.S.S. wrote in 1884:-
'Here either Gammell or myself interviews every man as he arrives and gets to leeward of him to ascertain if there be not a glass of spirit behind a peppermint drop!

50. J.H. Scott. pp.30-1.

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APPENDIX 5/2.

64. Lt. Cdr. B.L. Butcher Ibid. p.13.

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Table. 5/1. COAST BOATS OWNERY RESULTS.

1875-1882.

Period.	Eastern Profit Taels	No. of Ships	Rates of Exchange L.s.d. L.s.d.
Apr.1875-June 1876	49,259	2	5.3 to 5.5
July/December 1876	34.947	4	5.4.1/4 to 5.9.1/2
January/June 1877	65,465	4	5.4.1/2 to 5.8.1/4
July/December 1877	54.767	4	5.4 to 5.6.7/8
January/June 1878	77,791	6	5.4.1/8 to 5.6
July/December 1878	34,072	6	5.0.7/8 to 5.2.1/4
January/June 1879	75,717	6	4.10 to 5.3
July/December 1879	106,368	6	5.0.1/4 to 5/4
January/June 1880	(70,959)	4	5.1.1/4 to 5/3
July/December 1880	(54,097)	4	5.0.1/2 to 5.3.1/8
January/June 1881	96,168	8	5.0.1/4 to 5.1.5/8
July/December 1881	90,451	8	5.1.3/8 to 5.1.5/8
January/June 1882	100,003	7	5.0.1/2 to 5.2.7/8
July/December 1882	41,814	7	5.0.1/2 to 5.2

From : Marriner & Hyde : The Senior - John Samuel Swire 1825-1898 (Liverpool 1967) pp.84 and 199.

CHINA NAVIGATION COMPANY'S PROFITS.

1873-1882.

Year	Balance after all expenses £ including insurance.	Amount of Dividend Distributed £	Amount transferred to Reserve and Depreciation. £
1873-4	47,348	23,250	24,098
1875	55,082	14,750	40,332
1876	44,832	15,000	29,832
1877	3,002	15,000	3,002
1878	69,560	30,000	39,560
1879	86,958	30,000	56,958
1880	91,847	45,000	46,847
1881	71,962	45,000	26,962
1882	71,958	45,000	26,958

From : Marriner & Hyde : The Senior - John Samuel Swire 1825-1898 (Liverpool 1967) pp.84 and 199.

Table. 5/2. THE CHINA NAVIGATION COMPANY PROFITS. 1883-1913.

Year.	Balance after all expenses including insurance.	Amount of Dividend Distributed.	Amount Transferred to Reserve and Depreciation.
1883	89,619	50,000	39,619
1884	74,536	25,000	49,536
1885	110,690	62,500	48,190
1886	119,991	62,500	57,491
1887	102,264	50,000	52,264
1888	157,422	75,000	82,422
1889	158,030	75,000	83,030
1890	74,942	50,000	24,942
1891	98,100	50,000	48,100
1892	87,029	50,000	37,029
1893	98,023	60,000	38,023
1894	219,647	75,000	144,647
1895	230,942	80,000	150,942
1896	98,140	50,000	48,140
1897	115,666	60,000	55,666
1898	186,016	80,000	106,016
1899	167,925	100,000	67,925
1900	306,221	100,000	206,221

Year	Profit after depcn. £	Loss after depcn. £	Dividend %
1901	163,273		20 (£60,725 from reserve)
1902	15,891		10 (£19,579 from reserve)
1903	30,672		15
1904	151,199		15
1905	117,390		15
1906	10,206		5
1907		90,390	nil
1908		51,279	nil
1909		24,137	nil
1910		3,327	2.1/2(£13,769 from underwriting account)
1911	69,295		6
1912	155,579		10
1913	123,907		10

From : Marriner & Hyde : The Senior - John Samuel Swire 1825-1898 (Liverpool 1967) pp.84 and 199.

Table. 5/3.
HOLT'S NEWBUILDING PROGRAMME AT SCOTTS' 1892-1900.

Date	Name	Tons Gross	Dimensions - feet		Service Speed Knots	I.H.P.
			length b.p.	beam		
1892	Ixion	3572	352	42.5	11	2000
1892	Tantalus	3572	352	42.5	11	2000
1892	Ulysses	3572	352	42.5	11	2000
1892	Pyrrhus	3572	352	42.5	11	2000
1894	Orestes	4348	390	47.0	11.5	2500
1894	Dardanus	4348	390	47.0	11.5	2500
1895	Diomed	4279	390	47.0	11.5	2500
1895	Menelaus	4258	390	47.0	11.5	2500
1896	Prometheus	5204	420	49.0	12.5	3500
1896	Glaucus	5295	420	49.0	12.5	3500
1899	Idomeneus	6763	441	52.5	12.5	4000
1899	Calchas	6763	441	52.5	12.5	4000
1899	Machaon	6763	441	52.5	12.5	4000
1900	Alcinous	6743	441	52.5	12.5	4000
1900	Agamemnon	7011	441	52.5	12.5	4000
1900	Ajax	7011	441	52.5	12.5	4000
1900	Achilles	7043	441	52.5	12.5	4000
1900	Deucalion	7030	441	52.5	12.5	4000

from: Volume Two : Scott Ship List.

Table. 5/4.
BLUE FUNNEL FLEET AND FINANCIAL RESULTS 1881-1900.

Year	Number of Ships	Gross Tonnage (000)	Average Tonnage	Net Profit £(000)	Number of Voyages	Profits per Voyage
1881	23	48.4	2104	238.9	50	4778
1882	-	-	-	-	-	-
1883	-	-	-	-	-	-
1884	25	53.3	2132	-	-	-
1885	28	58.4	2086	-	-	-
1886	31	66.6	2148	-	-	-
1887	30	64.7	2157	49.3	55	890
1888	31	66.8	2155	66.6	65	1025
1889	30	64.6	2135	95.4	66	1445
1890	34	78.2	2300	65.6	89	737
1891	33	76.1	2301	45.0	72	625
1892	37	90.3	2440	27.5	74	372
1893	35	86.2	2463	50.5	71	711
1894	34	86.6	2547	114.7	70	1629
1895	36	100.5	2792	123.6	-	-
1896	38	117.6	3095	59.1	-	-
1897	36	118.0	3278	106.1	67	1582
1898	35	115.8	3309	179.9	-	-
1899	38	140.0	3684	274.5	-	-
1900	41	165.6	4039	302.8	79	3832

The Blue Funnel Legend by Malcolm Falkus (1990) p.110.

Table. 5/5.
HOLT'S NEWBUILDING PROGRAMME AT SCOTTS 1906-1914.

Date	Name	Tons Gross	Dimensions - feet		Service Speed Knots	I.H.P.
			length b.p.	beam		
1906	Astyanax	4872	390	49.0	11	2000
1906	Memnon	4870	390	49.0	11	2000
1908	Gorgon	2885	300	42.0	10.5	1300
1911	Atreus	6699	441	52.5	14	4500
1911	Rhesus	6704	441	52.5	14	4500
1912	Talthybius	10224	506	60.0	13	5000
1912	Ixion	10221	506	60.0	13	5000
1913	Helenus	7555	452	56.0	14	4750
1914	Agapenor	7565	452	56.0	14	4750
1914	Mentor	7585	452	56.0	14	4750

from: Volume Two : Scott Ship List.

TABLE 5/6 PROPORTION OF SCOTTS SHIP OUTPUT BY 5 YEAR PERIODS. CONTRIBUTED BY ORDERS FROM SWIRE & HOLT.

Compiled from data in Volume II - Scotts Ship List.

CATEGORY	FIVE YEAR PERIODS																					
	1871 1875	1876 1880	1881 1885	1886 1890	1891 1895	1896 1900	1901 1905	1906 1910	1911 1915	1916 1920	1921 1925	1926 1930	1931 1935	1936 1940	1941 1945	1946 1950	1951 1955	1956 1960	1961 1965	1966 1970	1971 1975	1976 1980
HOLT SHIPS.	4	6	5	7	8	10	-	5	8	3	11	6	1	5	-	6	3	3	3	-	-	3
SWIRE SHIPS.	2	9	9	13	19	6	19	-	3	1	6	1	5	-	-	6	1	-	-	1	-	-
TOTAL SHIPS	35	32	44	41	48	31	39	28	35	29	21	24	10	24	35	21	14	16	15	23	16	12
Percentage - Holt	11·4	18·8	11·4	17·1	16·7	32·3	-	17·9	22·9	10·3	52·4	25·0	10·0	25·0	-	28·6	21·4	18·1	20·0	-	-	25
Percentage - Swire	5·7	28·1	20·5	31·7	39·6	19·4	48·7	-	8·6	11·1	28·6	4·2	50·0	-	-	28·6	7·1	-	-	4·3	-	-
Percentage - Total	17·1	46·9	31·9	48·8	56·3	51·7	48·7	17·9	31·5	21·4	81·0	29·2	60·0	25·0	-	57·2	28·5	18·1	20·0	4·3	-	25

PERIOD 1871 1980

TOTAL HOLT SHIPS 97 - AVERAGE per cent 16·35
TOTAL SWIRE SHIPS 101 - " - 17·03
TOTAL ALL SHIPS 593

33·38 per cent over 100 years

PERIOD 1871 1921

do 56
81
362

do 15·5
22·4

37·9 per cent over 50 years

SCOTT & CO/SCOTTS' S & E CO. LTD.

MAIN CONTRACT OUTCOMES 1868-1920

MERCHANT CONTRACTS.

SHIP CATEGORY	No. of Ships	TOTAL PRICE £ '000	% of TOTAL	NET PROFIT £	NET PROFIT % by CATEGORY	NET PROFIT % by TOTAL
SWIRE China Navigation Co.	81	2,289	16·3	260,813	11·4	39·7
HOLT Ocean Steam Ship Co	57	3,951	28·1	101,371	2·6	15·9
Other Steamships	169	7,412	52·8	286,322	3·9	43·5
Sailing Ships	19	337	2·4	1,429	0·4	0·2
Small Craft	14	53	0·4	4,533	8·6	0·7
All Merchant Ships (a)	340	14,042	100	657,468	4·7	100
NAVAL CONTRACTS						
Large Naval Ships (1903-1913) (b)	5	2,355		169,746	7·2	22·1
Sub-total prior to First World War (a)+(b)		16,397		827,214	5·0	-
Naval Vessels First World War (c)	30	6,191		598535	9·7	77·9
All Naval Ships (b)+(c)	35	8,546		768,281	9·0	100
GRAND TOTAL						
All Ships (a+b+c)	375	22,588		1,425,749	6·3	-

DIVISION OF TOTAL PRICE & PROFIT

Period		No. of Ships	TOTAL PRICE £ '000	% of TOTAL	NET PROFIT £	% by CATEGORY	% by TOTAL
1868-1913.	Merchant	340	14,042	85·6	657 468	-	79·5
	Naval	5	2,355	14·4	169746	-	20·5
	Total	345	16,397	100	827,214	-	100
1868-1920.	Merchant	340	14,042	62·2	657468	-	46·1
	Naval	35	8,546	37·8	768281	-	53·9
	Total	375	22,588	100	1,425,749	-	100

Compiled from data in Volume II - Scotts Ship List.

TABLE 5/8.

SWIRE SHIP CONTRACTS

PERIOD	No of Ships	% of period total	TOTAL PRICE £	% of period total	GROSS TONNAGE	% of period total	AVERAGE TONNAGE	AVERAGE PRICE £	AVERAGE PRICE/TON £
1874 - 1914	81	25.6	2,288,820	10.1	137,966	19.8	1703	28257	16.59
1921 - 1939	12	11.7	1,622,815	14.2	33,676	7.9	2806	135235	48.19
1946 - 1969	8	7.0	6,234,058	6.1	58 466	8.8	7308	779257	106.63

HOLT SHIP CONTRACTS.

PERIOD	No of ships	% of period total	TOTAL PRICE £	% of period total	GROSS TONNAGE	% of period total.	AVERAGE TONNAGE	AVERAGE PRICE	AVERAGE PRICE/TON
1868 - 1920	57	15.2	3,950,910	18.2	238,612	30.0	4186	69314	16.55
1920 - 1939	23	24.3	6,180,630	50.0	171,255	24.7	7445	268723	36.09
1946 - 1969	15	15.7	13,054,553	12.9	102,327	15.3	6822	870304	127.58

Compiled from data in Volume II - Scotts Ship List.

Fig. 5/1 S.S. Plantagenet - First Scott-built Ship for Alfred Holt : 1859.
Scotts Archives - Drawings - University of Glasgow - ref. GD 319/_

Fig. 5/2.

FRAGMENTARY AUTOBIOGRAPHY OF ALFRED HOLT.
Supplied from Archives of John Swire & Sons.

"Recollections of the first fifty years of my life and of the neighbourhood in which it was spent".

Written mainly in January 1897.

Page 28.

"My connection with Mr. Lindsay brought me into contact with John Scott, and through him with his family at Greenock. Our intercourse has ripened, through mutual services and esteem, and almost uninterrupted business connection, into one of the happiest and most satisfactory friendships I have ever made or probably ever shall make. I was his best man when he married his charming wife, at Sundrum in Ayrshire, and I followed his revered father to his grave at Largs. There is not, out of my own family circle, a house where I am so much at home, and so kindly welcome, as in that of John Scott at Greenock, or his mother's at Hawkhill. There facts show what pleasant possibilities there are in a business life. He and I have built together up to this date, 1880, some 25 ships or steamers, costing over £800,000."

Page 33.

"I made a contract with Scott & Co. for the "Plantagenet," and that I chose a favourable moment may be judged from the fact that, at one time, she was the only steamer on the stocks in the three great shipbuilding towns of Greenock, Dumbarton and Port Glasgow."

POSTSCRIPT ON PERSONAL BUSINESS LETTER
FROM ALFRED HOLT TO JOHN SCOTT DATED 16 JUNE, 1893.

"On Tuesday 10.00 a.m. we sail (on Argo II) for Copenhagen and thence to Norway. Should be off Mull of Kintyre daylight on Wednesday if you are able to meet us. (on Greta).

Fig 5/3.

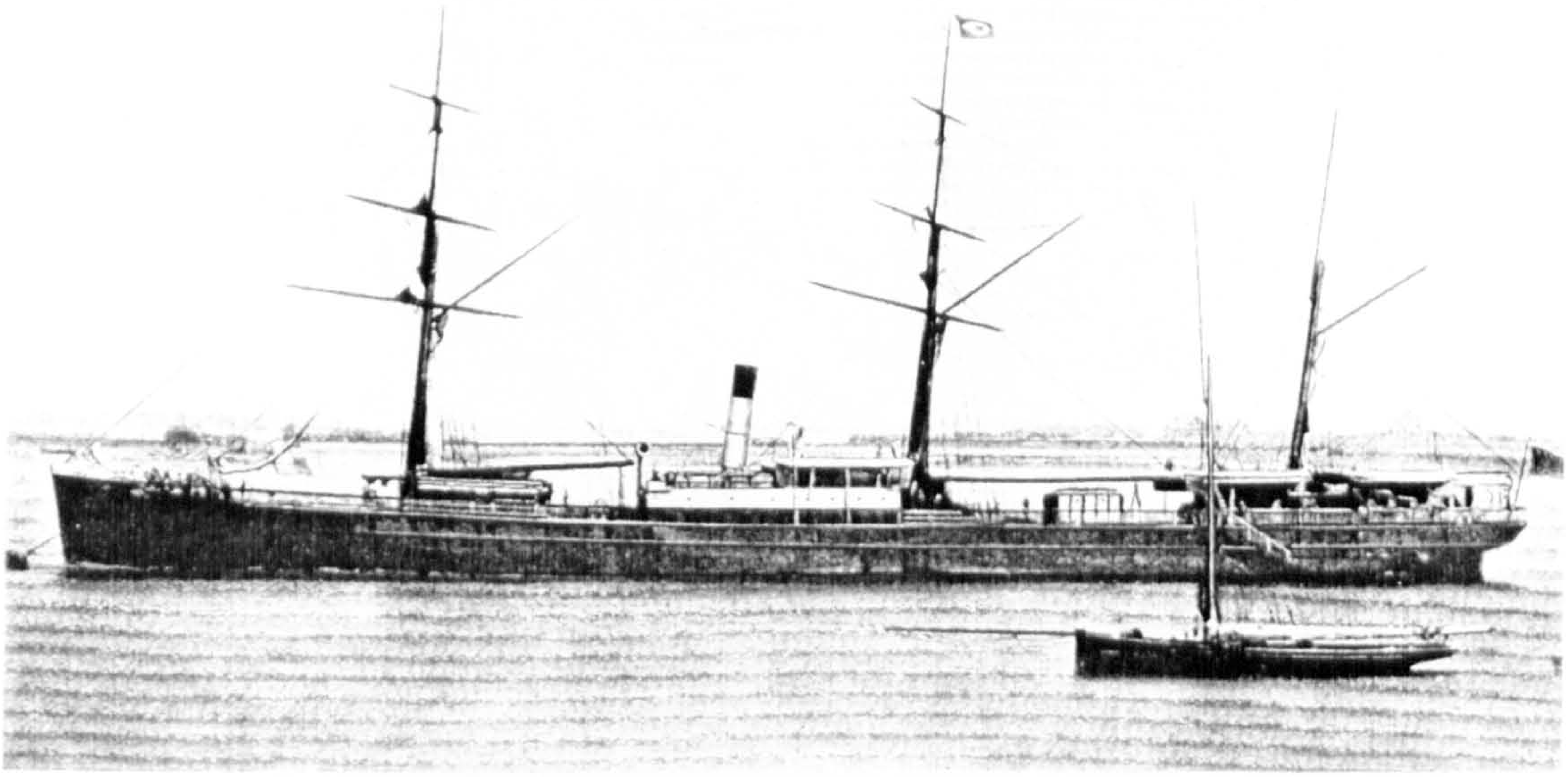


Fig. 5/3 - THE "ACHILLES" OF 1866 OFF GRAVESEND
from Scotts' 'Two Hundred and Fifty Years of Shipbuilding.'
1961

FIG. 5/4.

CLYDE SHIPBUILDERS WHO SURVIVED THE 1866-1868 DEPRESSION.

Greenock	Scott and Co.,	
	Caird and Co.,	Acquired by Harland & Wolff, 1916.
	Steele and Co.,	Acquired by Scott & Co., 1883.
	McNab and Co.,	Acquired by Caird & Co., 1872.
Port Glasgow	Laurence, Hill & Co.,	Became Cunliffe & Dunlop 1869.
	Blackwood & Gordon,	Became Clyde S. & E. Co., 1900.
	Duncan & Co.,	Acquired by Lithgows 1914.
	Reid & Co.,	Moved to Glasgow 1891.
Dumbarton	Wm. Denny & Bros.,	Voluntary liquidation 1963.
	Archd. MacMillan & Son,	Acquired by Harland & Wolff 1920.
Glasgow	Barclay, Curle & Co.,	Ceased shipbuilding 1969.
	Chas. Connell & Co.,	Became Scotstoun Division of U.C.S.
	Randolph, Elder & Co.,	Became John Elder 1870.
	A. & J. Inglis,	Sold to Harland & Wolff 1919.
	J.G. Lawrie,	Failed 1875.
	Robt. Napier & Sons,	Became Wm. Beardmore 1900.
	T.B. Seath & Co.,	Closed 1902.
	London & Glasgow. Eng. & Iron S.B. Co.,	Sold to Harland & Wolff 1912.
	Swan,	Closed 1888.
	Wm. Simons & Co.,	Merged with Lobnitz 1957.
	Tod & MacGregor,	Became D. & W. Henderson 1873.
	Thos. Wingate & Co.,	Closed 1878.
	Alex. Stephen & Sons,	Moved to Linthouse 1870.

From: Fred M. Walker, Song of the Clyde. (1984) pp.217 - 228.

Fig. 5/5.

FLEET LIST - 1883.

China Navigation Co.,		Coast Boats Ownery.	
River	Coast	Canton Line	Coast only.
Yunsin	Newchwang	Ichang	Foochow
Pekin	Wenchow		Swatow
Hankow	Taiwan		Chefoo
Shanghai	Changchow		Tientsin
	Chungking		Hoihow
	Woosung		Keelung
	Wuchang		Tamsui
			Whampoa

Wuhu was built in 1879 for the Yangtse river fleet but was wrecked in January 1883.

Pakhoi was built in 1880 for the Ownery coastal fleet but was wrecked entering Amoy in 1881.

All ships built by Scotts except Ichang and the four C.N. Co., river boats.

From: Dean, Notes on China Navigation Co. History.
Part I. p.23. (Swire Internal Documents.)

TELEGM.
"TEMSELOAF."

Ackd 27 Sep

22. Billiter Street.
London: 27 Sep 1894
E.C.

Mess^rs Scott & Co,

Dear Sirs,

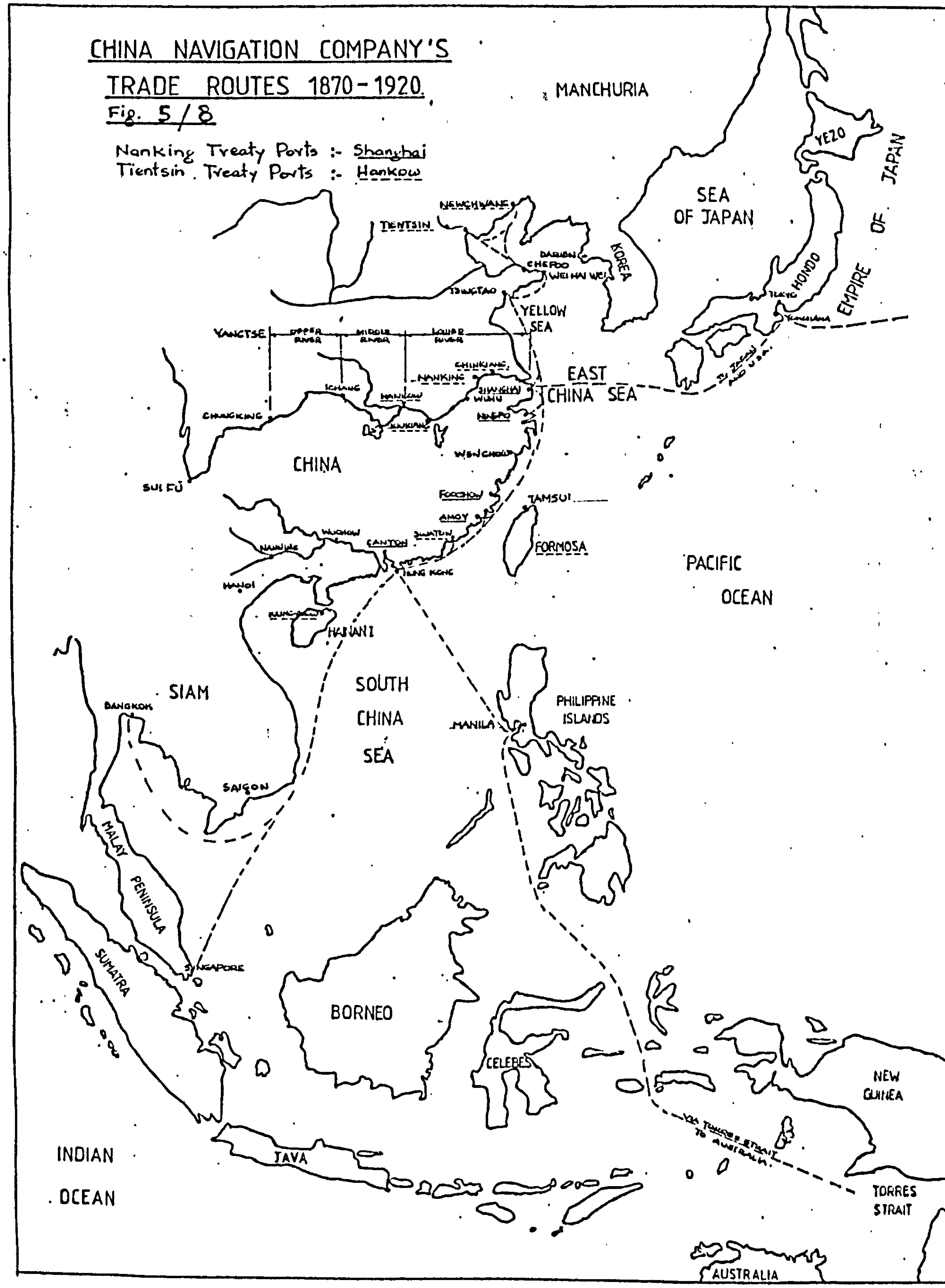
We accept your offer to build us two more Coasters, duplica of those now building, at the same price - please put them in hand at once -

Yrs truly
John Swire & Sons

Fig. 5/7

Alfred Holt John Swire John Scott IV

Fig 5/7 Launch of S.S. Menelaus 5th June 1895



CHINA NAVIGATION COMPANY'S TRADE ROUTES 1870-1920

Fig. 5/8

SCOTTS ARCHIVES - UNIV. of GLASGOW - REF GD 319/26/1/4

Fig. 5/9 - S.S. Hunan proceeding against the N.E. Monsoon in the Taiwan Straits.

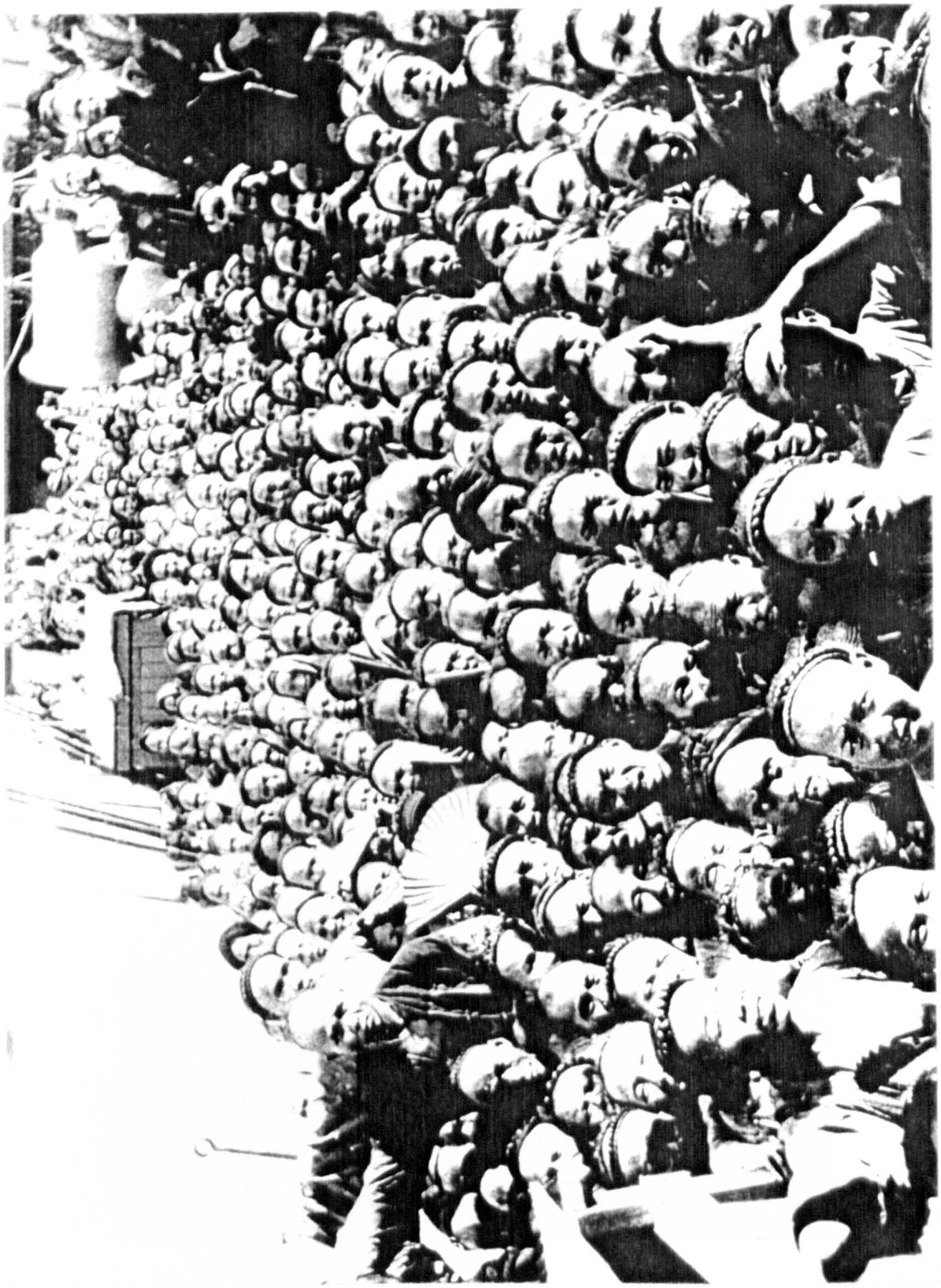


Fig 5/10 Deck Passengers on China Navigation Co. Ship - c. 1900

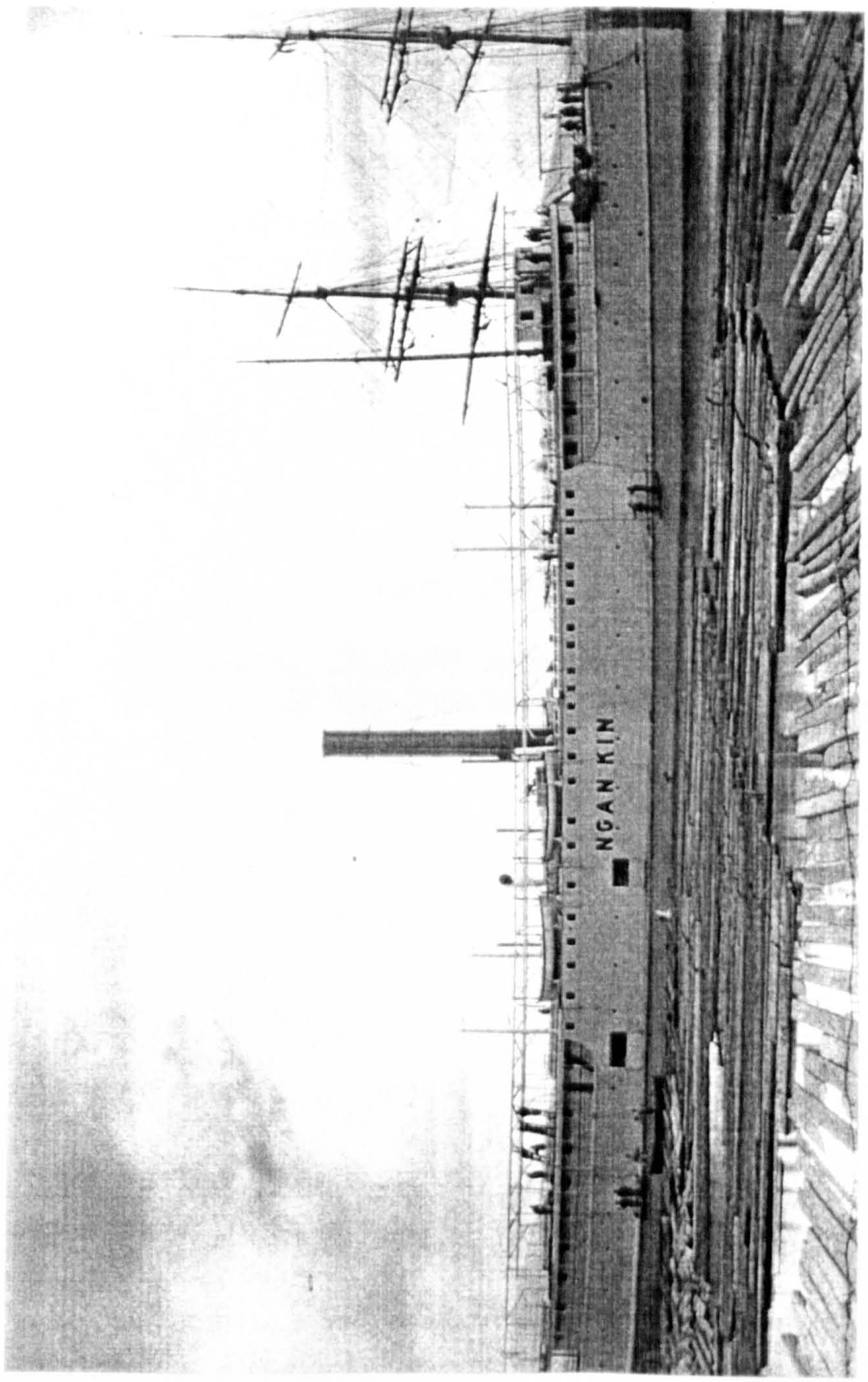


Fig 5/11 — Yangtse River Steamer 'Ngan Kin' fitting out

PART THREE.

TECHNICAL CHANGE AND THE EMERGENCE OF THE NAVAL MARKET.

CHAPTER 6.

THE SCOTTS AND THE DEVELOPMENT OF THE MARINE STEAM ENGINE.

1866 - 1920.

CHAPTER 6.

THE SCOTTS AND THE DEVELOPMENT OF THE MARINE STEAM ENGINE.

1866 - 1920.

Chapter 3 discussed the involvement of the Scotts in the development of the steamship from the early days of the 'Comet', c.1815 through to 1865 when Scotts delivered the famous Alfred Holt trio for the Ocean Steamship Co. 'Agamemnon', 'Ajax', and 'Achilles', the design and construction of which marked them as being among the leading marine engineers in the United Kingdom and made possible the establishment of economically viable long haul steamer trade routes to China and the Far East.

Chapter 4 described their chastening experience in building the first eight ocean liners for Compagnie Générale Transatlantique in Greenock and at St- Nazaire, France which ended in financial failure in 1866 for Scott & Co. and by association, for their engineering company, the Greenock Foundry Co. However, with the enthusiastic cooperation of their suppliers, both companies were soon back in business and John Scott IV brought his younger brother Robert Sinclair Scott into both companies as a junior partner.

Those firms which survived the 1866-8 slump could have had no idea as to the growth in the shipbuilding and marine engineering industries which lay ahead.

The output of the shipbuilding industry in the U.K. and on the Clyde rose by 250 and 300 per cent respectively between 1866 and 1900.

The developments in marine engineering during the period were particularly remarkable and this chapter will be largely devoted to these developments, moving from the establishment of the compound engine to the emergence of the triple and quadruple expansion engines and the development of the cylindrical 'Scotch' boiler and a variety of water tube boilers. The early steam turbine applications and diesel engine developments for the Royal and Merchant Navies will also be discussed.

The fortunes of Scott & Co. during the period under review, so far as merchant shipbuilding was concerned, were firmly linked to those of Alfred Holt's Ocean Steamship Co. and John Swire's China Navigation Co. in the latter of which Scott & Co. had a significant financial interest. They were also technical advisers to C.N. Co. John Scott, Alfred Holt and John Swire all recognised that the cost of moving cargo per ton mile was what mattered and was determined by the overall efficiency of the marine power plant including the influence of the hull form. Accordingly, every potential improvement in efficiency was evaluated and adopted, provided it was consistent with the other prime criteria, reliability of the machinery and safety of the ship.

PROGRESS IN DESIGN.

In order to set the scene for the reviews of progress in the design of boilers, steam engines, shafting and propellers which follow, a brief comparison of the main characteristics of typical Holt ships built by Scott & Co. for the China run is shown in Fig. 6/1 and illustrates the remarkable progress made over fifty years.

DEVELOPMENT IN THERMODYNAMICS.

Following the success of the 'Agamemnon' machinery, John Scott offered compound steam engines as standard in all his tenders for new tonnage. However, his enthusiasm for the compound engine was not shared by many shipowners, primarily because of their lack of understanding of the new thermodynamics which lay behind the superior efficiency of the compound engine. Up to that time the accepted bases for any scientific discussion on the design of the steam engine were two (fallacious) statements.[2]

The first of these was the Principle of Conservation of Heat (Lavoisier and Laplace,1783). This stated that:-

> "All variations in heat, real or apparent, which a system of bodies undergoes in changing state are reproduced in reverse order when the system returns to its first state."

> As Professor Cardwell has pointed out the Principle:

> "----can be, and usually was, taken to mean that if a certain quantity of heat is required to warm up and vaporise enough water for one working cycle of a steam engine then exactly the same amount of heat was delivered to the condenser at the end of the cycle."[3]

Such an interpretation resulted in greatly excessive cooling surface area being supplied in many marine condensers. There was widespread ignorance of the loss of energy from radiation and convection and the Principle was used as an excuse for the absence of insulating material from boilers, engines and their associated pipework. It was also used to justify the abandonment of the use of jacketting of the steam engine cylinder, invented by James Watt to increase engine efficiency by reducing heat loss through the cylinder walls.[4]

The second generally accepted principle was that embodied in Caloric Theory. This was widely accepted in the 18th century as an explanation of the phenomena of heat and combustion in terms of the flow of a hypothetical weightless fluid called caloric.[5] The idea of an imaginary fluid to represent heat was useful in explaining many but not all aspects of heat phenomena. It was a step towards the present concept of energy - that it remains constant through many physical processes and transformations - but it was also a deterrent to clear scientific thinking.

FIRST AND SECOND LAWS OF THERMODYNAMICS.

The emergence of the First and Second Laws of Thermodynamics in the 1850s and 1860s which completely contradicted the prevailing theories outlined above caused consternation and resulted in the difficulties that the more progressive engine builders John Scott and John Elder had in gaining acceptance of the compound steam engine.

The First Law of Thermodynamics. (or Joule's Law)

> States that when mechanical work is obtained by the expenditure of heat a definite quantity of heat disappears for every unit of work produced. The converse is also true.

By experiment, Joule established the mechanical equivalent of heat to be 778 ft.lb of work = 1 B.Th.U. (British Thermal Unit).

If the marine steam power plant comprising boiler, engine, condenser and feed pump is regarded as a system, then the heating of the boiler water to raise steam which is used in the engine to do work by expansion, followed by condensation of the steam in the condenser with loss of heat to the cooling water, and finally, the use of the feed pump to restore the condensate to the boiler is called a thermodynamic cycle. Consequently, in such a cycle the net work done by the system must equal the net heat supplied to the system (i.e. the heat supplied in the boiler - heat rejected in the condenser - losses) which is in effect an alternative illustration of the First Law of Thermodynamics.

<u>The Second Law of Thermodynamics</u>, (and a restriction on the First Law),

> States that in a thermodynamic cycle where the net work done is equal to the net heat supplied, the total supply of heat must be greater than the net work done since some heat must always be rejected by the system, i.e. heat flows from a hot source to a colder sink.

SADI CARNOT.

In 1824, long before the emergence of the 1st and 2nd Laws of Thermodynamics, Sadi Carnot published his 'Reflections on the Motive Power of Heat' which include the following extract:-[6]

> In spite of labour of all sorts expended on the steam engine, and in spite of the perfection to which it has been brought, its theory is very little advanced-----
> The production of motion in the steam engine is always accompanied by a circumstance in the passage of caloric from one body where the temperature is more or less elevated to another which is lower-----
> The motive power of heat is independent of the agents employed to develop it: its quantity is determined solely by the temperature of the bodies between which, in the final result, the transfer of the caloric occurs.

It will be noted that Carnot pointed to the difference in temperature as being the real source of 'motive power'. Note also that in 1824 he belonged to the 'caloric' school!! He also at that time conceived a perfect heat engine cycle, the Carnot Cycle, in which the working substance went through a cycle comprising four stages, two isothermal and two adiabatic processes, and he was able to prove that :-

the maximum attainable efficiency of a heat engine e is

$$e = \frac{T_1 - T_2}{T_1} = 1 - \frac{T_2}{T_1}$$

where:

T_1 is the absolute temperature at which heat is supplied

and

T_2 is the absolute temperature at which the heat is rejected.

INFLUENCES ON STEAM POWER PLANT DESIGN.

The significance of the developments discussed above was fully understood by John Scott and John Elder. Carnot's expression for cycle efficiency supported the concept of higher boiler pressures (and thus a high T_1) and of high vacuum at exhaust (a low T_2) although the latter presented practical difficulties in the case of the reciprocating steam engine. Other influences from the new thermodynamics will be discussed in the notes which follow.

BOILERS.

During the period covered by this review (1866-1920) the Greenock Foundry boiler shop produced over 1200 marine boilers comprising 100 'Oval' and 900 cylindrical 'Scotch' boilers together with 200 watertube boilers of various designs. Some 972 cylindrical or tank type boilers were installed in merchant ships and 28 in Royal Navy ships, whereas all of the water tube boilers were for warships of the Royal Navy, some of the warships having been built by Scotts and some by the Royal Dockyards.[7] The cylindrical or tank type will be discussed first, but before doing so, a little light relief - the matter of the 'Columbian' boilers.

'TOO FINE GENTLEMEN'.

In 1864, the P. & O. company ordered a passenger liner from Scotts, the 'Mongolia', (featured in Jules Verne's Round the World in Eighty Days) and in part payment they handed over another liner, the 'Columbian', on the understanding that Scotts would provide and instal new machinery (engines and boilers) whereupon P.& O. would then repurchase 'Columbian'.[8]

Not long after 'Mongolia' was delivered a complaint from P. & O. regarding performance of the machinery was investigated by John Scott and the cause was found to be due to maloperation by the ship's engineers. It is not surprising therefore that John Scott was upset on receiving criticism of the design of the 'Columbian' boilers from P. & O. following the ship's arrival at Bombay on her first voyage with the new machinery. From his letters to his London agent, T.S. Begbie who forwarded the complaint, (See Appendix 6/1) it is clear that, yet again, maloperation by ship's staff was the cause of the problem.

John Scott's comments on the P. & O. engineers competence, particularly his reference to their Chief Engineers having become 'too fine gentlemen' who have to put in an appearance too often in the saloon with clean washed hands and dandy uniform' were unlikely to have gone down well with the Owners!!

However, the correspondence highlights John Scott's concern for the reputation of his company and also the importance of having properly trained and responsible personnel in charge of valuable machinery.

THE OVAL BOILER.

In face of the demand for higher boiler pressures and in spite of massive internal stiffening, the limitations of the box boiler had finally been recognised. During the 1870s and early 1880s with the compound engine becoming well established the oval boiler was very popular. Fig. 6/2 shows such a boiler fitted to S.S. 'Woosung', a China coaster built by Scotts in 1882. It had the furnaces, combustion chamber and tube nest of the later box boiler but was more compact, stronger, lighter, cheaper and easier to manufacture.

CYLINDRICAL 'SCOTCH' BOILER.

Scotts built their first Scotch boiler in 1874, initially with a working pressure (shared with the oval boiler) of 90 p.s.i. They produced a range of standard designs and re-equipped their boiler shop with modern equipment and embarked on batch production. As mentioned earlier they built some 900 marine

Scotch boilers. They also produced a significant number for industrial purposes many of which were for export.[9] However, even though Scotts preferred the Scotch boiler, one of their major customers, Alfred Holt as his fleet expanded continued to use the locomotive type boiler. It was not until 1885 that he finally switched to Scotch boilers.

THE WEAK LINK.

In the history of the development of the cylindrical boiler over the years, the boiler furnaces and the shell, each in turn, were regarded as the weak link in the search for higher working pressures.

SAMSON FOX AND THE CORRUGATED FURNACE.

The story of the elegant solution of the furnace problem and its remarkable consequences begins in the 1860s when Samson Fox, a travelling representative with a Leeds firm of machine tool makers was visiting Clydeside and met John Scott in a business capacity. Over the years Fox obtained considerable financial backing from John Scott for the development of a number of enterprises but especially for the Fox Corrugated Furnace which was patented in March, 1877.[10] The new corrugated furnace greatly increased the resistance of boiler furnaces to collapse from compressive stress when steaming and was a remarkable success. Following its adoption and the changeover to steel boiler shells, boiler pressure rose markedly and the corresponding potential increase in expansion ratio led to the emergence of the triple expansion engine. (See Fig 6/22)

In 1874 Fox formed the Leeds Forge Co. to develop his inventions and for the next seven years he was massively supported financially by John Scott who took over the chairmanship of the company from Fox. It was in 1881 that the financial rewards finally came along.[11] In 1884, whilst contributing to the discussion on a paper delivered by D.S. Smart to the Institution of Civil Engineers, Samson Fox disclosed that, to date, some 16,000 corrugated furnaces had been sold.[12]

George A. Newby published 'Behind the Fire Doors' in 1979 which, drawing on Scotts' archive material, tells the story of Samson Fox and his achievements and the part played by John Scott in his success, for without his financial support, guidance and influence Samson Fox would have failed.

It is interesting to note that around this time, 1879, John Scott made another shrewd investment by supporting the establishment in Greenock of Hastie's Patent Engine and Hydraulic Pump Co.[13] John Hastie, Snr, formerly John Scott's foreman engineer set up in business c.1851 as a millwright. After his death the business was continued by his sons, John and William. John Hastie, jr. was extremely inventive and patented several useful inventions in connection with hydraulic machinery which led in later years to the company becoming a leading supplier world wide of ships' steering gears.

DESIGN DATA AND ANALYSIS.

The long saga of the Scott family's involvement with shipping for almost two hundred and seventy years could best be described as the pursuit of excellence. In the second half of the 19th century, as we have seen, they were particularly involved in the transition from wooden sailing ships to iron and steel steam ships involving momentous changes in design, materials and working practices. They were anxious to retain their world wide reputation in moving into the steamship era and to this end they adopted their previous practice of continuous development of their designs introducing modifications only when their worth had been established from trials in service.

As part of this process, from the early 1870s onwards, Scotts meticulously recorded details of the performance on sea trials of all vessels built by themselves or elsewhere for which they provided the machinery. Each of these sea trial reports was prefaced with a detailed description of the machinery concerned - engines, boilers, propellers and shafting and the principal items of auxiliary machinery. Some five hundred such trial reports are contained in four volumes at the Scott Archives at Glasgow University, ref. G 319/23/2/1-4 and many of the criteria used in the design of these machinery installations have been included in the data sheets describing all of the ships built by Scotts and which form the greater part of Volume II of this thesis.

An analysis has been made of the criteria used over a period of fifty years, particularly in the design of steam compound, triple and quadruple expansion engines. Wherever possible, or where considered helpful, these various criteria have been plotted, covering the period 1870-1920 and included as appropriate in this thesis together with comments thereon reflecting the technical changes involved.

BOILER DESIGN CRITERIA.

Fig. 6/3 - Boiler Pressure.

This graph indicates the increase in boiler pressure over the period and shows clearly the sudden increase following upon the adoption of Fox's corrugated furnace and the subsequent emergence of the triple expansion engine.

Fig. 6/4 - Specific Heating Surface - square feet per I.H.P.

This shows the influence of the introduction of forced draught c.1880 - a marked reduction in boiler heating surface. The comparison between the heating surfaces of cylindrical and watertube boilers is also remarkable.

Fig. 6/5 - Specific Grate Area - square feet per I.H.P.

Remarks on Fig. 6/4 also apply here.

Fig. 6/6 Specific Steam Space Volume - cubic feet per I.H.P.

A generous steam space volume was regarded as a good design feature in that it discouraged priming, but with the change over from tallow to mineral oil for cylinder lubrication the problem was greatly diminished making a reduction possible.[14]

Service Margins.

The specific values of these criteria chosen for a particular contract by Scotts always included a service margin, in the case of boilers a fouling margin, to cope with the effects of scale internally and sooting up of the heating surfaces.

Scotts were well aware that less scrupulous competitors often produced designs in which these margins were skimped or absent. These designs would produce the contract speed on sea trial. However, in many cases, after the ship had been at sea for a short time, performance deteriorated rapidly as the boilers sooted up.

IMPROVEMENTS IN BOILER EFFICIENCY.

Reference was made earlier to the introduction of the corrugated boiler furnace and later there will be some discussion on attempts made to rationalise the minimum scantlings of marine boiler shells. However, otherwise, the basic boiler remained unchanged.

Development work on the Scotch boiler over the years was targeted on improving the thermal efficiency. Before discussing the various ways of achieving this improvement reference will be made to Fig. 6/7 which shows the path of the products of combustion through the boiler and also the route followed by the feed water and steam through the working cycle.

The primary function of a boiler is to convert the chemical energy of coal or oil fuel by burning it in order to generate heat which is transferred to water thus generating steam which serves to carry the heat energy to the ship's engines and into useful work. As shown on Fig. 6/7 the hot gases give up heat in passing through the furnace, combustion chamber, and the tube bank which forms about 82 per cent of the total heating surface, and then pass via the uptake to the funnel.

Before 1880, natural draught was created by the hot column of flue gases in the ship's funnel which drew air into the boiler furnace and the rate of combustion of the fuel was controlled by the pressure difference across the fuel bed thus created. This led to very tall funnels being fitted and over the years the silhouettes of Scotts' Holt and Swire ships became known world wide because of the high funnels which were retained long after they had become unnecessary.

HOWDEN'S SYSTEM OF FORCED DRAUGHT.

In the early 1880s James Howden devised a system of forced draught whereby fans supplied heated combustion air to the furnace fronts. Its route is shown in Fig. 6/7, the air being heated by heat transfer from the flue gases on their way to the funnel. With this system the quantity and velocity of the air entering the furnace both below and above the fuel bed was regulated, giving greatly improved control of combustion and higher evaporation. The draught was now independent of weather and a much poorer quality of fuel could be burned.[15] By virtue of less air being required and the heat recovery from the flue gases in the air heater it was estimated that the boiler efficiency was increased from 70 per cent to 74 per cent.

FEED HEATING.

On 'Thetis' in 1857 John Scott employed the flue gases to heat the feed water on its way to the boiler by leading the feed pipe line in a coil around the boiler uptake, but it was to be many years before feed heating began to make a significant contribution to improved boiler efficiency.

SUPERHEATING.

Yet another means of recovering waste heat from the flue gases was to lead dry saturated steam from the boiler on its way to the engine through the flue gases, thus raising its temperature above saturation point by say 50°F.

This early application of superheat was introduced to combat the effects of initial condensation when the steam entered the engine cylinder. However, early attempts to introduce higher degrees of superheat ran into problems with materials and the scouring effect of superheated steam. So the use of superheat was abandoned and was not revived until the end of the 1914-8 war when 140°F. of superheat was in common use. However, by this time the prime purpose of superheating steam was to increase the potential heat energy available for work. Steam with 140° F. of superheat was capable of increasing the engine efficiency by 4 per cent.[16]

THE ROYAL NAVY AND THE SCOTCH BOILER.

In the 1880s and 1890s large numbers of Scotch boilers were installed in naval vessels. They were supplied by Scotts to the Royal Dockyards for the battleships 'Hercules', 'Barfleur' and 'Centurion'. However, the Scotch boiler fell out of favour with naval engineers for a number of reasons.

Whilst the Navy acknowledged that the Scotch boiler could tolerate poor stoking, was easy to clean and to repair, by 1895 it had been decided that it was unsuitable for combat ships. The weight of the boiler per lb of steam generated was considered excessive and the boiler pressure could not be increased above 300 p.s.i. without further unacceptable weight penalties.

Because of its large water volume it was not able to respond to rapid changes in load which were likely to occur in action. Probably the most serious criticism was that the time to raise steam from cold (from twelve to twenty four hours) was excessive and that any attempt to force the boiler usually resulted in serious damage. Finally, the consequences of a boiler explosion or rupture by battle damage, resulting in the flashing into steam of a large volume of high temperature water, could not be contemplated.[17]

So the Royal Navy turned to the water tube boiler to solve its problems and during the period 1899-1915 Scotts supplied a large number of water tube boilers of different designs for large warships built for the Royal Navy at Scotts and in the Royal Dockyards. (See Table 6/1) However, before leaving the Scotch boiler to soldier on serving the Merchant Navy very adequately until after the second World War, reference should perhaps be made to John Scott's remarkable research in 1888 into the strength of Scotch boiler shells.

BOILER SHELL MINIMUM SCANTLINGS.

In the 1880s the marine engineering fraternity in the United Kingdom were unhappy with the attitude of the classification societies and the Board of Trade regarding the working and test pressures for marine boilers. The Admiralty allowed boilers to be worked up to within 90 p.s.i. of the test pressure, whereas in the Merchant Service the working pressure was limited to one half of test pressure.

In 1889, John Scott was building H.M.S. 'Sparrow' and H.M.S. 'Thrush' for the Royal Navy, and being convinced that the Admiralty system gave an adequate factor of safety, he resolved to build at his own expense a test boiler generally similar to those being manufactured for 'Sparrow' and 'Thrush' and to test it hydraulically to the highest possible pressure, even up to bursting point.[18] The test boiler was 7 ft. 8.1/4 inches in diameter and ll ft. long with shell plating 19/32 inches thick and end plates 5/8 inches thick.

A series of progressive trials was carried out and ultimately a pressure of 620 p.s.i. was reached, 4.5 times the working pressure, and this was held for sometime with no problems with plating or rivets, and only slight leaks from the butt straps. It being considered that the point had been made, the test was then terminated. John Scott presented the results of the tests in a paper to the Institution of Naval Architects[19] and contended that the results proved that there was justification for a reduction in the minimum scantlings of the shells of marine boilers to at least the scale adopted by the Admiralty.

WATER TUBE BOILERS.

Scotts 'Thetis' experiments in 1857 had clearly demonstrated the link between higher boiler pressure and reduced fuel consumption. The boiler used was an early water tube boiler made by Rowan which sadly failed due to a combination of corrosion problems and poor workmanship.

Some thirty years later Scotts built and installed the first water tube boilers in a British battleship, H.M.S. 'Canopus' in 1898. The Admiralty became interested in 1890 in replacing cylindrical boilers, at that time standard fit in the British fleet, with water tube boilers in their projected new construction. A number of prototype designs were installed in Royal Navy destroyers, the first by

Thornycroft in 1893 in H.M.S. 'Speedy', followed in 1894 by Yarrow in H.M.S. 'Hornet'. As a result of these early trials on smaller warships, the Admiralty decided that the advantages of water tube boilers clearly outweighed their disadvantages.[20]

They had a number of different designs to consider, all having a common factor in that their heating surface was made up by the outer surface of numerous tubes through which the water circulation was maintained by the difference in density between the hotter and colder portions of the water.

Unlike cylindrical boilers where water circulation was casual, in water tube boilers it was systematic and this made for faster steam raising, important to the Navy. Other advantages included an ability to cope adequately with changes in demand for steam, and the significant savings in weight and space were valuable to the Navy. There was also the possibility of higher boiler pressure with its implication of greater thermal efficiency and greater operating range stemming from lower fuel consumption.

However, with the relatively small quantity of water in circulation, more skilful control of feed water and fuel supply was essential, a problem which could be overcome by training. The water tube boiler tended to form internal scale rapidly which was difficult to remove. The final advantages were the capacity of the water tube boiler to withstand forcing, and because of the small water quantity in circulation there would be less danger in the event of an explosion.[21]

BELLEVILLE BOILERS.

In any event, the Admiralty having already authorised the installation of Belleville water tube boilers in two first class armoured cruisers H.M.S. 'Powerful' and 'Terrible' (with unhappy results it was alleged) placed an order on lst August 1896 with Scotts' to supply the propelling machinery for the lead ship of a new class of battleship, H.M.S. 'Canopus' to be built at Portsmouth Dockyard, the installation to include twenty Belleville water tube boilers with a working pressure of 300 p.s.i.[22] This order was followed by a similar order in December 1900 for the machinery of H.M.S. 'Prince of Wales', building at Chatham Dockyard.

A typical Belleville boiler is shown in Fig. 6/8. Each boiler consisted of a number of elements, each element in turn consisting of an assembly of tubes arranged in zig-zag fashion, rising about 4° to the horizontal. The elements were connected at their lower end to the feed supply and at their top end to the steam drum.

A form of forced draught was employed and baffles guided the combustion gases through the elements into the combustion chamber. Good combustion requires that the quantity of air being supplied to the furnace be in excess of that theoretically required. Fig. 6/8 shows the admission of further supplementary air to the combustion chamber before the flue gases passed through the economizer (feed heater) section of the boiler on its way to the funnel. By this means the temperature of the feed water was increased from 120° F to 180°F.

A special feature of the Belleville boiler was that steam was raised at a pressure of 300 p.s.i. which was reduced to 250 p.s.i. before being supplied to the engine, this throttling process resulting in the steam being slightly superheated at entry to the engine. Fig. 6/9 shows the arrangement of the machinery in H.M.S. 'Canopus', the boilers being arranged in sets of four athwartships. As will emerge later the Scott built Belleville boilers proved to be satisfactory in service, but earlier boilers of this design fell victim to a political campaign waged by vested interests anxious to discredit the water tube boiler in order to restore the cylindrical boiler to favour. The campaign was successful in having the Belleville boiler excluded from later Navy contracts.

BABCOCK AND WILCOX BOILER.

Another contender for the Navy's favours was the Babcock and Wilcox header type boiler shown in Fig. 6/10 which was similar in some respects to the Belleville boiler.

Some seventy Babcock and Wilcox header type boilers were built by Scotts and installed in R.N. ships as under:-

1905 H.M.S. 'Argyll'	-	16
1909 H.M.S. 'St. Vincent'	-	18
1911 H.M.S. 'Colossus'	-	18
1913 H.M.S. 'Ajax'	-	18

The use of baffles to ensure efficient heat transfer between the combustion products and the boiler tube nest is clearly illustrated. Good circulation was also obtained, the water rising up through the inclined tubes past the upward headers and into the steam and water drum, returning via the downward headers.

Fig. 6/11 shows some of the 18 Babcock and Wilcox water tube boilers for H.M.S. 'St. Vincent' being made ready for shipment to Portsmouth Dockyard.

YARROW BOILER.

The third type of water tube boiler considered by the Navy was the Yarrow boiler, which was of an entirely different design. Fig. 6/12 shows a typical Yarrow boiler of the period with the top steam drum connected to the lower water drums by the two banks of steam generating tubes. Circulation was created by the hot water in the inner tubes rising and drawing cold water down the outer tubes. In their early designs (for gunboats and destroyers) Yarrow used small tubes, 1 to 1.1/8 inch diameter, but for the later and larger ships 1.3/4 inch diameter tubes were used.

In November 1904, Scotts received an order to build the machinery for H.M. Cruiser 'Defence', building at H.M. Royal Dockyard, Pembroke, the installation to include twenty four Yarrow water tube boilers.[23]

BATTLE OF THE BOILERS.

Thus within the period 1902-7 Scotts fulfilled major contracts for three prominent designs of water tube boilers competing for the approval of the Royal Navy. Notwithstanding the differences in the various designs the operations involved in assembling the boilers were very similar. Firstly, water and steam drums were accurately erected in position on rigid but temporary structures. The various banks of tubes were then inserted and expanded in position. Furnace fronts and outer casings were then fitted and followed by the installation of brickwork and refractory material. Boiler mountings were then fitted and statutory water and air tests carried out. All of these operations were part of the boilermaker's trade and many were also involved in the assembly of cylindrical 'Scotch' boilers. However, when it became clear that the Admiralty were pressing ahead with the installation of (Belleville) watertube boilers in their new capital ships a furious row broke out with questions being raised in Parliament and much criticism of government policy.[24]

The opposition was led by a number of British boilermakers who had invested heavily in specialised plant for the manufacture of the primary parts of the Scotch boiler - the shell (rolling), ends (flanging), furnaces (corrugations) boiler tubes (upset ends) together with heavy duty hydraulic riveting machines, most of which was useless in the manufacture of water tube boilers. Early experience with the new design of water tube boilers (particularly the Belleville) produced the inevitable teething troubles which were seized upon by the anti - lobby and magnified out of all proportion. Many of the difficulties encountered were in fact due to condenser leakage and bearing problems. There were also instances of incompetent handling of the boilers which an intensive training programme successfully solved.

APPOINTMENT OF COMMITTEE.

However, the Battle of the Boilers continued in the Commons and finally in September 1900 a Boiler Committee was formed under the presidency of Admiral Compton Domville "to assist the Lords Commissioners of the Admiralty in making the necessary decisions on the machinery to be installed in the fast growing battle fleet of the Royal Navy."[25] The committee was commissioned to evaluate the various boiler designs available and thereafter to carry out full scale trials of specimen boilers in H.M. ships and report.

In a series of interim reports [26] during 1901-2 the Committee made a number of pronouncements on all five designs under review, namely Belleville, Babcock and Wilcox, Niclausse, Durr and Yarrow, which included the following:-

(1) "It is undesirable to fit any more of this (Belleville) type in H.M. Navy.

(2) "The advantages of the watertube boiler are so great, chiefly from the military point of view, that provided a satisfactory type of watertube boiler be adopted, it would be more suitable for use in H.M. Navy than the cylindrical boiler."

(3) They expressed a preference for the Babcock and Wilcox and Yarrow designs for use in H.M. ships without cylindrical boilers.

(4) They recognised that watertube boilers would be more expensive to maintain than cylindrical boilers but felt that the Babcock and Wilcox and Yarrow boilers would be more economical to maintain than the others.

RESULT OF TRIALS IN SERVICE.

From the extensive trials carried out in service on all the boilers under review the Committee made a number of observations which were included in the Final Report of June 1904.[27]

Boiler Thermal Efficiency.

The figures shown below give the thermal efficiency obtained (a) under normal conditions and (b) under forced steaming conditions.

	(a)	(b)
Babcock & Wilcox	76 per cent	3-5 per cent less
Yarrow	76 " "	" " " "
Belleville	73 " "	" " " "
Durr	65 " "	" " " "
Niclausse	67 " "	" " " "

Wetness of Steam.

The Babcock and Wilcox and Yarrow boilers gave the best results.

Skilled Firing.

The Committee confirmed that a higher degree of skill was necessary for firing water tube boilers than for cylindrical boilers. The Yarrow boiler was superior to the others in this respect.

Feeding of the Boilers.

The Committee was apparently satisfied that control of feeding watertube boilers was manageable and they went on to recommend the omission of automatic feed regulators in Yarrow and Babcock and Wilcox boilers "where there is a fairly large reservoir of water."[28] This recommendation must have raised a few eyebrows and it is interesting to note that on all of Scotts large warship contracts automatic feed regulators were fitted!!

DECISIONS.

The Committee's endorsement of the Babcock and Wilcox and Yarrow boilers was clearly accepted as Scotts subsequent building programme of Babcock and Wilcox and Yarrow boilers shown on Table 6/1 makes clear.

For the smaller, faster naval craft the Yarrow boiler was first choice and, as will be discussed later, during the First World War Scotts built Yarrow boilers exclusively for R.N. combat ships. Some seventy four were installed in destroyers, cruisers and remarkably in three steam turbine driven submarines, one of which, H.M.S. 'Swordfish', was the first ever British steam propelled submarine and the type ship for the later 'K' class of fleet submarines.

Fig 6/13 shows the 'Swordfish' boiler with its superheater clearly visible.

Second Thoughts.

However, Admiral Domville in his covering letter which accompanied the final report of the Boiler Committee, and which confirmed their earlier recommendation that no more Belleville boilers should be installed, felt compelled to say that his experience on the Mediterranean Station had been very favourable to them as a steam generator!! H.M. battlehips 'Canopus' and 'Prince of Wales', engined by Scotts' served in the Mediterranean 1899-1903, and no problems were encountered with their Belleville boilers.[29] H.M.S. 'Canopus' was still in service in the First World War and for a time after the battle of Coronel, the defence of the Falkland Islands solely depended on her.[30] It is clear that the Belleville boiler was the victim of character assassination. It was the 'dog that got a bad name'.

New Capital Equipment for the Boiler Shop.

As recorded elsewhere, in the 1890s, with their close involvement with the Blue Funnel Line and the China Navigation Co. and an increasing demand for larger and faster ships to be met, Scotts' began a programme of plant improvement and expansion. In their boiler shops, where at one time output reached one boiler per week, and where the higher steam pressures called for thicker shell plating in Scotch boilers, a number of powerful machine tools (by Hugh Smith of Glasgow) were installed.[31]

These included:-

> A 13 ft gap fully automatic hydraulic plate bending machine capable of cold bending plates up to 2" thick. (£1,365).
> A four ram hydraulic machine capable of exerting a force of 160 tons for flanging the front and back plates of boilers together with its own hydraulic crane.

> Probably the largest machine installed was a 13 ft. gap hydraulic riveting machine capable of exerting a load of 200 tons on each rivet. It weighed about 60 tons and was served by its own hydraulic crane. The controls for both devices were located centrally and could be operated by one man.
> Other new equipment included plate edge planers and upgraded electric overhead cranes of 100 tons capacity.

A new boiler tube shop was built capable of processing boiler tubes on a production line basis at a rate of 50,000 tubes per year. Each tube was cut to length, pickled, electro-zinced, pressure tested,washed, dried, brushed internally and examined, corked, limed and racked, until required for bending. Thereafter each tube was cut to final length and the ends emery polished. A large multispindle drilling machine was installed to cope with jig drilling the tube holes in the steam and water drums.[32]

L.C.C. Thames River Steamer Contract.

In November 1904, Scotts' secured an order for the engines and boilers for twenty paddle driven pleasure steamers for the London County Council which were to be deployed on the Thames.[33] Fig. 6/14 shown P.S. 'Chaucer' on trials on the Clyde prior to sailing for London. This large order provided a rare opportunity for the employment of batch production techniques in the manufacture of this machinery. Fig. 6/15 shows the boilers under manufacture in Scotts' boiler shop and also a typical diagonal compound engine for the same contract.

Progress.

In the fifty years covered by this review the humble box boiler had become a memory, with the Scotch boiler becoming the mainstay of the merchant service and the watertube boiler being preferred by the Navy to cope with the massive increase in steam demand required by the new generation of warships. In the early years the emergence finally of the surface condenser with the associated fresh boiler feed water resulted in greatly reduced maintenance and prolonged boiler life. A whole series of novel design changes over the years resulted in significant improvement in boiler efficiency (from 60 to 70 per cent). These design changes included the corrugated furnace, resulting in higher permissible boiler pressures, the use of forced draught which enhanced heat release rates and the introduction of oil fuel burning.

The undoubted advantages of switching to oil fuel burning, greater speed, reduced number of stokers, increased cargo capacity due to smaller bunkers, less wear and tear on the boilers, bunkers and floorplates, the elimination of ashes, and relative ease of re-fuelling were recognised in the merchant service. However, the response here was slow and patchy mainly due to doubts about the reliability of supply of oil fuel on the trade routes to the Far East. Passenger liners led the way but Blue Funnel Ships were still burning coal in 1930 as were the majority of tramps.[34]

The impact of all of these technical developments is perhaps best illustrated on Table 6/1 showing the performance on full power trials of ten large warships for which Scotts' provided the machinery over the years 1893 to 1913. For the warships built between 1903 and 1913 for which trial consumption figures are available, reductions in specific fuel consumption per S.H.P. per hour of 32 per cent were achieved.

RECIPROCATING STEAM ENGINES.

Of all the elements in the marine power plant, the propelling engine underwent the greatest development during the period 1870-1920. The compound reciprocating steam engine held sway through the 1860s, 1870s and into the 1880s and was followed in the 1880s and beyond by the 'workhorse of the British Empire', the triple expansion steam engine, which retained its popularity into the twentieth century and through two world wars. During the period under review Scotts built and installed some 400 compound and triple expansion engines and much of the commentary which follows was derived from an analysis of Scotts records of the sea trials of these engines.[35]

THE COMPOUND ERA.

Unlike some of their contemporaries Scotts had no difficulty during the 'compound period' in persuading shipowners to accept their recommendation that compound engines be installed in their ships. Faulty design in some early engines led to indifferent performance and frightened off many prospective buyers. A typical Scott compound engine of the period had two cylinders, inverted, operated with boiler steam at 75 p.s.i., had two cranks at right angles, an expansion ratio of 5.8, a cylinder diameter ratio of 2 and piston speed of 480 feet per minute and had the air pump, boiler feed pump, condenser circulating pump, and sometimes fresh water and bilge pumps driven by levers connected to the engine crossheads.

The propeller thrust in the early engines was taken on a combined thrust and journal bearing located at the aft end of the engine. For his ocean going fleet Alfred Holt remained faithful to the single crank tandem design with a large diameter flywheel which served to prevent fluctuations in speed when the engine was running, as illustrated in Fig. 3/22.

However when Scotts built the 'Argo', Alfred Holt's private yacht in 1885, a conventional two cylinder, inverted two crank compound engine was specified presumably in consideration of his guests comfort! The engine is illustrated in Fig. 6/16. During the compound period Scotts' built one hundred and fifty sets of machinery for ships which apart from those for Ocean Steamship Co. were of modest size (average 500 tons register) and with engine powers of the order of 800 I.H.P. Ships speeds on trial were around 10 knots.

PADDLE STEAMERS.

Only nine paddle steamers were built in the period, with diagonal compound engines for special shallow draught applications, mainly on the Indian rivers. Of the four paddle steamers built for the Rivers Steam Navigation Co. in 1887, (See Fig. 6/17) recent enquiries have established that two of these vessels are still in use in India as (dumb) receiving flats. Fig. 6/15 shows a typical diagonal paddle engine. Scotts were to build a further 35 sets of compound machinery in the years ahead, mainly for steam yachts and other small ships.

EFFICIENCY IMPROVEMENTS.

Compounding was one method of improving engine efficiency.

Difficulties encountered with some engines were related to phasing of the cylinder cranks, the lack of an adequate receiver between the cylinders, and in some instances too low an initial steam pressure providing too small an expansion ratio. Another method of improving efficiency was to provide steam jacketting of the engine cylinder thereby significantly reducing the loss of heat by condensation of steam on the cylinder walls during the working stroke, but as stated earlier its purpose was often misunderstood and it was frequently shut off at sea as being unnecessary and wasteful.[36]

A further improvement was obtained by increasing the temperature of the steam before it entered the engine by leading the steam pipe through the flue gases on their way to the funnel. Whilst the idea was thermodynamically sound, practical difficulties with the materials available in the 1870s through the 1890s resulted in superheating being abandoned in merchants ships until c.1920.[37]

TRIPLE EXPANSION ENGINES.

By the 1880's Scotts were recognised internationally as a builder of high class passenger and cargo vessels. This was partly due to their Holt and Swire connections but they continued to receive orders from French owners operating in the Mediterranean coastal trade and in Indo China. They also built extensively for the Indian and South American coastal trades. The growth in seaborne trade resulted in a demand for larger and faster ships having greater horsepower, which necessitated a significant increase in boiler pressure and an increase in expansion ratio resulting in the introduction of the triple expansion engine. (See Fig. 6/18) - Expansion Ratio which reflects (Fig. 6/3) - Boiler pressure.

The principal attractions of the triple expansion engine were in effect extensions of the advantages which the compound expansion engine had over the simple expansion engine.

(1) more uniform torque applied to the propeller shaft.

(2) less power developed per cylinder compared with a compound engine of the same total horsepower, resulting in reduced stress on the engine running gear, (piston, piston rod, connecting rod, crosshead, guides. etc.,)

(3) most important of all, a greater heat drop available (heat in steam at inlet to engine minus heat in steam at exhaust), stemming from higher boiler pressure resulting in increased efficiency as displayed in Fig. 6/19 and consequent reduced fuel consumption.[38]

Fig. 6/20 which shows the fuel consumption per I.H.P. hr. as measured on Scotts ship trials, clearly illustrates the last point.

The first triple expansion engines built by Scotts were installed in four magnificent passenger/cargo liners delivered in 1886 to John Swire for the establishment of his China/Australia service - the 'Changsha' class already referred to in Chapter 5 - (See Fig. 6/21) Other high class passenger/cargo liners with triple expansion machinery built at this time included five ships for the Portuguese Royal Mail Co. service to their African Colonies, all delivered in 1889.

Alfred Holt was a little more cautious, but after experimenting with his first triple expansion engine built for 'Ulysses' II in 1888, he finally abandoned his beloved single crank tandem engine and fitted 'triples', in his new and larger tonnage in 1892 and thereafter.[39] Fig. 6/22 shows the triple expansion engines fitted in the Holt ships, Ulysses III, 'Pyrrhus', 'Tantalus' and 'Ixion' in 1892.

The base workload at Scotts up to the outbreak of the First World War was supplied by orders from Holt and Swire.

Over two hundred triple expansion engines were built between 1886 and 1920 ranging in horsepower from 1600 I.H.P. on the 'Changsha' in 1886 to 27540 I.H.P. on the cruiser H.M.S. 'Defence' in 1908. A famous vessel with triple expansion machinery was the oil tanker 'Narragansett' built in 1903. In design she was far ahead of her time. She was twice the size of any previous tanker and was for many years the largest tanker in the world. (until World War One) She was a most handsome vessel with her machinery amidships, and was torpedoed off the Scillies in March 1917.[40]

As a final example of the wide range of ship produced, two twin screw shallow draught ships were delivered to the Amazon Steam Navigation Co. in 1890, 'Guarany' and 'Tabatinga' which for over forty years sailed up and down the river Amazon from Para at its mouth via Manaos and Iquitos to Yurimaguas in Peru 250 miles short of the Pacific Ocean - a round trip of 5300 miles. Bearing in mind the difficulties likely to be encountered on this service it is not surprising to find that the spare gear carried by each ship for the machinery included a full set of pistons and cylinder covers, two propeller shafts, and one thrust shaft, one crankshaft, two propeller bosses and thirty two propeller blades!

QUADRUPLE EXPANSION ENGINES.

Competition early in the new century from the marine steam turbine, discussed later, resulted in pressure for further development of the reciprocating steam engine. By increasing boiler pressure above 200 p.s.i. and thus making possible a greater heat drop and larger expansion ratio, the quadruple expansion engine became a real proposition. In the event, it had a mixed reception. During the years 1911-2-3 Scotts' built only eight such engines, mainly for the twin screw passenger liners they built at that time - 'Hildebrand' for the Booth Line and 'Andania' and 'Alaunia' for the Cunard Line. All of these engines were modified to control the out of balance forces present in this four crank configuration and thus reduce vibration. Cargo ship owners considering adopting the new design engine had to balance the potential economic advantages against the cost of an extra cylinder.

COMBINATION ENGINE.

For the larger horsepowers then in prospect there was a widespread feeling that the multi-expansion engine was approaching the limit of size, particularly the limitation on attainable vacuum imposed by the low pressure cylinder volume.

A variety of combinations of reciprocating engines and exhaust turbines were tried out by both the Royal Navy and certain commercial shipowners with undoubted advantage from the higher vacuum stemming from these arrangements due to the final expansion of the steam in the turbine. However, with the introduction of single and double reduction gearing the direct drive turbine disappeared and the combination installations were phased out.

An exception was the Bauer Wach system, in which the power from a small high speed turbine, driven by exhaust steam from the L.P. cylinder, was transmitted to the reciprocating engine propeller shaft through reduction gearing and a hydraulic coupling. As will become clear later, Scotts preferred and promoted the double reduction geared turbine where the gain in economy from high speed turbines more than compensated for the friction loss in the gearing.[41] Alfred Holt's Ocean Steamship Co. persevered with the triple expansion engine at Scotts' until 1917 when they built 'Diomed' the first of a long series of turbine steamers.

STEAM TURBINES.

For some sixteen years, between 1892 and 1908, Scotts' provided triple expansion steam propelling machinery of steadily increasing horsepower to many capital ships of the fast growing Royal Navy, built by themselves and by the Royal Dockyards. (See Table 6/1) The twin screw installation supplied by them in 1908 to H.M.S. 'Defence' of 27540 I.H.P. was the largest ever installed in a major British warship. (See Fig. 6/23) However, the 1897 Royal Navy Spithead Review in celebration of the Diamond Jubilee of Queen Victoria changed all that!!

A small experimental steam turbine driven craft careered up and down the ranks of British and foreign warships assembled there at a speed in excess of 34 knots. The 'Turbinia' was powered by steam turbines developing 2,000 shaft horsepower and was the product of years of research and development by Charles A. Parscns and the impact of its remarkable demonstration on Admiralty policy was immediate.[42]

Two new destroyers, 'Viper' and 'Cobra' equipped with 11,000 S.H.P. steam turbine machinery, were shown on trials in 1900 to be more efficient than comparable reciprocating machinery at full power. Following this success, the first naval vessel of significant size, the cruiser H.M.S. 'Amethyst', similarly equipped with turbines, completed successful trials in 1904.[43]

H.M.S. 'Dreadnought', delivered in 1906 was the culmination of evolutionary trends in gunnery, machinery and hull design as well as the prototype for all the capital ships of the First World War.[44] Its radical design involving larger calibre naval guns and heavier armour protection incorporated in a ship of moderate size, was made possible by installing a steam turbine power plant. The turbines were lighter, occupied less space, more reliable and were free from vibration and other reciprocating engine problems, including contamination of feed water by cylinder lubricating oil.

In contrast with the tortuous stop-go shuttle passage of the steam through the triple expansion engine and the constraints imposed by the size of the low pressure cylinder, steam flow through the turbine was smooth and continuous and a higher vacuum could be utilised than with the reciprocating engine, resulting in higher efficiency. So the Admiralty was delighted and gave clear signals that all large warships would in future be turbine driven.

Scotts' quickly began negotiations with the Parsons Marine Steam Turbine Co. and in June 1905 a licence was granted allowing Scotts to make, use and sell marine steam turbines, the initial royalty payment being 2/6d. per shaft horsepower.[45] The company received its first order for steam turbine machinery from the Admiralty in March 1908, for the Dreadnought type battleship 'St. Vincent', built at Portsmouth Dockyard. This was followed in May 1909 and March 1910 by further orders to build (and engine) the Dreadnought battleship 'Colossus' and the super Dreadnought 'Ajax'.

Scotts' were of course still building reciprocating steam engines for merchant passenger and cargo ships and because the manufacturing techniques for turbine manufacture were so different from those used on steam engine manufacture, new workshop space, craneage and specialist machine tools had to be provided.[46] An order was placed in early 1908 with Sir William Arrol & Co. for the construction of a new turbine shop at a cost of £6,700. Machine tools ordered for the new shop included a Shanks turbine lathe costing £6,300 and a horizontal boring machine costing £1,400. Fig. 6/24 shows the new shop and Figs. 6/25 and 6/26 show these machines working on a turbine rotor and turbine cylinder for H.M.S. 'Colossus'.[47]

DESIGN FACTORS.

The only common factor between reciprocating and turbine engines is that both develop power by the controlled expansion of steam in stages from boiler pressure down to condenser vacuum. The design shaft horsepowers for the Dreadnought type battleships engined by Scotts' ranged from 25,000 to 28,000 S.H.P. Each turbine set comprised a high pressure turbine exhausting to a low pressure turbine which in turn exhausted to the condenser. Each turbine was directly connected to a propeller so that with two turbine sets each ship had a total of four propellers, all rotating at 320 r.p.m. the revolutions being chosen to avoid problems with cavitation.

Now the turbine, being essentially a high speed machine, required a high blade speed for high operating efficiency. In the case of the battleships under discussion, and as will be evident from studying Fig. 6/25 and 6/26, with fixed revolutions the inevitable compromise between the number of expansion stages, blade speeds and blade heights resulted in large diameter rotors and relatively heavy machinery.

INTRODUCTION OF REDUCTION GEARING.

At the turn of the century the marine steam turbine was achieving a phenomenal success. The total shaft horsepower in service of turbine machinery in 1903 was 23,000 - by 1906 it had risen to 3,000,000 S.H.P.[48] However, all of this machinery was for the Royal Navy or for large high speed, high powered passenger liners - all direct drive - and in the majority of cases there was an unsatisfactory compromise between turbine and propeller rotational speeds. The use of turbine drive on full formed cargo ships with large slow running propellers and small engine rooms was regarded as impossible but the introduction of reduction gearing changed all that.

The Admiralty, recognising the constraint on the improvement of turbine efficiency represented by propeller revolutions, and after earlier experiments on the torpedo boat destroyers H.M.S. 'Badger', and H.M.S. 'Beaver', arranged for the torpedo boat destroyers H.M.S. 'Leonidas' and H.M.S. 'Lucifer'to have reduction gearing installed. Both vessels were commissioned after extensive trials just before the outbreak of war in August 1914. Nevertheless single reduction gearing was not fitted as standard on Scott built warships until 1916 mainly due to lack of high quality gear cutting machines.[49]

As will be observed on Figs. 6/27 and 6/28a the speed reducing gearing employed on steam turbine installations bears little resemblance to the speed increasing gear designed by Scotts for the steamships, 'Clyde', 'Ebro' and 'Scindian' in the 1850s. (See Figs. 3/12 and 3/13)

On turbine installations the gear ratios were much higher and the teeth much smaller. The earlier spur gearing was replaced by double helical gearing carrying very much higher specific loading. The teeth were of involute form, machine cut with great accuracy and finely pitched and could accommodate variation in the distance between the wheel and pinion centres. Various helical angles were tried and during World War One an angle of 45° was adopted as standard. Lubricating oil at a pressure of 5 to 10 p.s.i. was sprayed on to the line of contact of the teeth across the whole face of the gear. Some difficulties were experienced from misalignment due to working of the ship's structure when under way but this was cured by bolting the after ends of turbines on to stiff extensions of the gear case forming a rigid unit.[50]

FIRST TRANSATLANTIC LINER WITH GEARED STEAM TURBINES.

Scotts', who had received an order from Cunard in January 1913 for a large twin screw passenger liner for their Atlantic service for which twin quadruple expansion engines were originally specified, carried out an interesting design exercise, exploring the steam turbine alternative with single reduction gearing. Scotts' were able to demonstrate that they could accommodate steam turbines of 11,000 S.H.P. in an engine room 12 ft. 6 in. shorter than that for the 9,500 I.H.P. quadruple expansion engines originally planned. They also forecast an increase in ship's design speed from 15.5 knots to 16.75 knots together with a reduction in consumption of 15 per cent in coal, oil and stores compared with quadruple expansion engines of similar power. Fig. 6/29 shows very clearly the reduction in length of the machinery spaces. The cross section views show the additional cargo and passenger space made available. It also emerged that the geared turbine installation resulted in a reduction in total machinery weight of 12 per cent.[51]

The turbine alternative was chosen and in August 1914 on 'Transylvania's' sea trials there was complete freedom from vibration. The turbines ran at 1,500 r.p.m. with a high thermal efficiency whilst the gearing brought the speed of the propeller down to 120 r.p.m. giving good propeller efficiency. Fig. 6/30 gives a clear picture of the turbines and gearing of the port engine - note the large number of stages in the Parsons reaction turbines.

Reference will be made later to Scotts' having taken a licence in May 1914 to build Brown Curtis impulse turbines. Fig. 6/27 is included showing a set of impulse turbines built in 1922 for S.S.'Teno' of similar power to the 'Transylvania' set and the much shorter length of the impulse turbine is clearly displayed. Sadly, 'Transylvania', Scotts' first commercial turbine steamer, was torpedoed and sunk in the Gulf of Genoa in May 1917 whilst on trooping duties.

DOUBLE REDUCTION GEARING.

In preparing for the postwar boom which was anticipated, Scotts', in pursuit of higher propulsive efficiency, produced designs embodying higher steam pressures and superheat. They also introduced double reduction gearing. The higher steam conditions were designed to get more energy out of the fuel and the double reduction gearing was intended to reduce propeller losses and improve turbine efficiency by employing higher turbine r.p.m. However, the introduction of double reduction gearing was accompanied by many and varied difficulties. Torsional vibrations stimulated by the particular configuration of turbines and gearing chosen were blamed for some of the difficulties encountered. The standard of accuracy obtainable with the gear cutting machines was another contributory factor, but generally the extreme rigidity of power transmission from the primary reduction to the secondary reduction gearing was assumed to be proving too much for the material.[52]

This led to a reversion to single reduction gearing by many shipowners. However, Scotts' with the support of the Ocean Steamship Co. persisted, and produced an ingenious solution to the problem by introducing flexibility into the transmission of power between the primary and secondary gears.[53] A.E. Fothergill, a young Scotts' design engineer devised the solution which is illustrated in Figs. 6/28a and 6/28b. Fig. 6/28a shows the turbines and gearing for S.S. 'Asphalion' for the Ocean Steam Ship Co. being erected in Scotts' turbine shop and the flexibility between the turbines and the primary pinions is clearly seen. However, it is necessary to refer to Fig. 6/28b to identify the in built extra flexibility in the drive from the primary wheels to the secondary pinions. These arrangements proved highly successful and were patented.

At the same time as the new design was being developed, another young member of the Scotts' design team, J.P. Anderson, invented a device to take account of turbine overspeeding. A small piston was attached to the end of the turbine rotor and held in position by a coil spring. Should the turbine overspeed the centrifugal force overcame the spring load and moved the piston causing the main steam stop valve to close and bring the turbine to a stop. This device was patented in many countries in Europe, America and the Far East. Over the period from 1909 to 1920 some one hundred and ten patents were obtained by Scotts' reflecting the company's design work on submarines, steam turbines and oil engines.[54]

COMPARISON OF PERFORMANCE.

Reciprocating Engine v Turbine - Single Screw v Twin Screw.

During the first World War, 95 per cent of Scotts total horsepower output (540,000 shaft horsepower) consisted of steam turbine machinery for the Royal Navy and this will be discussed in a later chapter. In the period from 1913 through the First World War into the early 1920s the Ocean Steam Ship Co. built at Scotts' two distinct groups of steamships, one group fitted with single screw machinery and the other group with twin screw machinery.

Initially, triple expansion machinery was installed, but in 1917 the first Ocean Steamship turbine steamer was delivered and thereafter, whilst some reciprocating engines were supplied, the company increasingly favoured double reduction geared turbines. The dimensions and hull form of all ships within each group were identical. The boiler installations were also identical, excepting that superheaters were fitted only in the turbine steamers. The circumstances described above provided a unique opportunity to compare the performance in service of the respective types of engines installed. With the cooperation of Ocean Steamship Co. Scotts' carried out appropriate trials on specific vessels from each group and the results of their analysis of the results obtained are included as Fig. 6/31 and are largely self explanatory. They certainly endorse Scotts' advocacy of geared turbine machinery.

SINGLE SCREW VESSELS.

On the single screw vessels Ocean Steamship Co. were of course, delighted with the performance of the turbine steamers showing significant savings in fuel consumption, machinery weight, and space occupied. The increase in speed of almost one knot was due to the greater horsepower obtained with the same boilers because of the higher efficiency of the steam turbine machinery. The turbine machinery also used less lubricating oil and required much less maintenance work in comparison with the reciprocating engine.

TWIN SCREW VESSELS.

Here again the results again favoured the geared turbine machinery. In fact, the coal consumption per 1,000 ton miles was 10.5 per cent less for the turbines.[55]

REDUCTION IN MACHINERY SPACES.

Reduction in the volume of machinery spaces provided more cargo space on merchant ships as mentioned above. Similarly such reductions in naval vessels made it possible to carry more armament and ammunition. Fig. 6/32 shows how this was achieved in Scott built warships over the years - due mainly to higher steam conditions, the changeover to oil fuel from coal and the progression from direct coupled turbines through single reduction to double reduction gearing installations. The vast above floor space occupied by coal bunkers on H.M.S. 'Ajax' is absent on the later ships, where the oil fuel was stowed in double bottom tanks.[56]

CONDENSERS.

By 1870, as a result of the earlier work by Hall and Spencer, certain elements of good condenser design had been established with cooling water circulated through the tube nest and the paths of cooling water and exhaust steam were arranged contra flow. The impact on efficiency of the condenser of the velocities of the steam and cooling water chosen was also recognised. By 1880, attention was concentrated on the steam flow path to ensure uniform steam velocity and to eliminate short circuits, and also to attain the maximum hotwell temperature by directing some steam straight to the bottom of the condenser.

Another problem being tackled was the presence of air in the exhaust steam. By Dalton's Law, when steam and air are present in a condenser, the total absolute pressure therein is the sum of the pressures that steam and air would exert if they were each occupying the entire volume of the condenser. It was therefore vital that, in order to obtain a high vacuum, as much air as possible should be expelled from the condenser. (In later years, with the advent of the steam turbine and its remarkable ability to handle large volumes of exhaust steam, the previous point was clearly extremely important).

Studies of this problem led to three recommendations.[57]

These were:-

(1) Separate pumps should be used for air and water.

(2) The air outlet from the condenser should be located as far away from the steam inlet as possible.

(3) The air in the air pump suction passage should be cooled.

CONDENSER AUXILIARIES.

In 1870, the condenser auxiliaries, the air pump (removing condensate and air) and the cooling water circulating pump, together with the boiler feed pump were lever driven on reciprocating main engines. With a little ingenuity these pumps could also be employed on general service duty - fire bilge, sanitary and wash deck services. However, gradually these arrangements changed. By 1890 a small portion of the condenser tube surface area was formed adjacent to the separate air pump suction for air cooling purposes. The condensate was extracted by a separate pump controlled by float gear located in the condenser hotwell.

FEED HEATING.

Whilst engine driven pumps were practically standard equipment, the advantages of separate steam driven pumps were becoming recognised. The boiler feed pumps and the condenser cooling water circulating pump were the first to become independent. Then a general service 'donkey' pump was introduced followed by steam driven forced draught fans and electric lighting sets.

As discussed earlier the exhaust steam from all of these engines and pumps was fed into a heat exchanger through which the boiler feed water was circulated before entering the boiler and the feed water temperature raised accordingly. The latent heat of the exhaust steam was thus recovered instead of being lost overboard in the condenser cooling water. A variant of this practice was to extract live steam from the main engine before its expansion was complete and use it for feed heating.

In later years on high power installations with higher boiler pressures this practice was extended to involve three or four such tappings at various pressure stages, particularly on turbine steamers.[58]

EVAPORATORS.

Evaporators were used to obtain distilled water for boiler feed and domestic purposes from sea water. The heating steam for the evaporators was provided by tapping the main or auxiliary engines at a point where the steam had already done some work.

CONDENSER COOLING SURFACE.

Fig. 6/33 shows the specific rate of cooling surface provided in square feet per I.H.P. on Scott-built engines and shows the reduction in area as boiler pressure increased with the years.[59]

TRENDS.

Accepting the inevitable reflection of fluctuations in international trade into the prosperity of the shipping and shipbuilding industries, there can be no doubt that the period under review saw a remarkable expansion in the activities of the U.K. shipyards and engine works. This chapter has examined the marine engineering scene during the period in some detail, especially the important part played by Scotts' in fostering many significant developments. Their comprehensive technical records over the period, especially sea trials results, whilst relating only to Scotts' ships or engines built by them for other shipbuilders, are a reliable guide to the best shipbuilding and marine engineering practice in the U.K. at that time. The triple alliance of Scott, Holt and Swire working together surely justifies such an assertion.

From this material graphs have been prepared showing trends during the period in some of the more important criteria reflecting changes in ship and machinery design. Fig. 6/34, 6/35, and 6/36 all indicate steady growth in three interdependent criteria - register tonnage, indicated horsepower and ships speed, all showing increases over the period of the order of 800,1,000 and 50 per cent respectively.

Figs. 6/37 and 6/38 also show interdependent criteria- piston speed and revolutions per minute. Piston speed which is a function of stroke and r.p.m. doubled during the period but the r.p.m. which in turn influenced the propeller efficiency, increasing only very slowly. A comparison of two Holt ships, built at the extreme ends of the period, 'Priam' (1870) and 'Tyndareus' (1916), shown on Fig. 6/1, clearly indicates the progress made during the period. Trends in the development of naval propelling machinery are well illustrated in Table 6/1 which records thc performance of Scott built naval engines spanning the period 1892-1913. These include the changeover from reciprocating engines to steam turbines and from cylindrical to water tube boilers. The increase in boiler pressure is matched by the reduction in steam and fuel consumption. The period saw the establishment of forced draught as standard.

Overall, both horsepower and ship's speed grew steadily over the years.

TRANSMISSION.

The rate of work done by steam on the pistons of a reciprocating steam engine is calculable and is known as indicated horsepower. Not all of this power reaches the propeller, some is lost in driving engine driven air, feed and bilge pumps, some is lost in overcoming inertia forces within the engine mechanism and some lost in overcoming friction within the engine and in the shafting system connecting the engine to the propeller. The power delivered to the propeller is known as the brake horsepower, the name being derived from the method used to measure the nett engine output.

The ratio of $\frac{\text{Brake Horsepower}}{\text{Indicated Horsepower}}$ is known as the mechanical efficiency of the engine.

Unlike present day practice where every marine oil engine is load tested in the workshop prior to installation, in the period under review steam engines were rarely tested in this way. However, when such records do exist, the values of mechanical efficiency obtained from engines having indicated horsepowers between 1,500 and 4,500 ranged from 89 to 93.5 per cent.[60] Tests also showed that the difference between the i.h.p. and b.h.p. remained substantially constant over a wide range of load which resulted in the mechanical efficiency being greatest at full load.[61]

The chief sources of friction loss included the pistons, guides and slides, stuffing boxes, bearings, valves and valve gear and over the years much of this loss was reduced with the introduction of white metal bearings, improved surface finish of all bearing surfaces, forced lubrication of the principal bearings, and the introduction of metallic packings. On turbine steam ships with direct coupled turbines, friction losses were negligible but with the introduction of speed reduction gearing, transmission losses were incurred of 1 to 1.1/2 per cent on single reduction and 2 to 3 per cent on double reduction machinery.[62] However such small losses were overcome by the increase in turbine efficiency stemming from the higher turbine revolutions made possible by the gearing.

MICHELL THRUST BLOCK.

In 1911 the old multi collar type thrust block gave way to the new Michell single collar block employing wedge film lubrication. The new thrust block with tilting pads made it possible to employ only one thrust collar with much higher bearing pressure. With a coefficient of friction of only one tenth of that of the old design block the thrust power loss was greatly reduced.

PROPELLERS.

The remarkable increase in engine horsepower, particularly during the latter period from 1890 to 1920, with the emergence of the Parsons steam turbine, set the propeller designers many problems. For high powered naval vessels the problem was eased by the adoption of twin, triple, and quadruple screws with the attendant advantages of greater mobility in manoeuvring, both in restricted waters and at full power.

The higher powers on merchant ships saw the end of cast iron as a propeller material with bronze becoming the universal choice. Some shipping companies changed to built propellers where bronze blades were bolted to a cast iron boss, and were prepared to accept the slightly poorer efficiency of the built type in exchange for smaller propeller damage repair bills. Scotts' designed their own propellers for merchant ships up to and through the First World War but thereafter manufacture was undertaken by specialist firms.

The design of a ship's propeller is extremely complex and carries no guarantee of success.[63] Factors such as diameter, pitch, material, number and cross section of blades, and r.p.m. are entirely controlled by the specified duty and are matched to the individual characteristics of each ship including the ship's speed, lines, wetted surface, draught, block coefficient etc., In modern times, we may add the desirability of avoiding cavitation, erosion, vibration and singing to the design process!!

All of the power which reaches the propeller is not converted into ship propulsion. The losses of energy which affect the propeller efficiency are three fold, the slip stream, a component of the thrust, and finally blade friction.[64]

Typical values of propeller efficiency during the period under review were of the order of 60 per cent.

OVERALL PLANT EFFICIENCY.

Around the end of the period under review the overall efficiency of the typical marine steam reciprocating engine plant had risen due to higher efficiency of the boiler and of the engine from Professor Dyer's 6 per cent to around 10 per cent - still an abysmally low figure[65]. Whilst there were prospects of further improvement from higher steam pressure and temperature the Scotts' recognised that the efficiency of steam power generation was approaching its limits. Their thoughts were already turning to alternative and more efficient forms of motive power as will emerge in the next chapter but that was going to be the task of the next generation as John Scott IV and Robert Sinclair Scott died in 1903 and 1905 respectively.

So before discussing the Scotts' progress in the early years of the 20th century let us review the role of the Scott brothers during the period 1870-1905 in which they prepared Scott and Co. for the challenges which lay ahead.

END OF AN ERA.

During the greater part of this remarkable half century when steam finally prevailed over sail and British shipping dominated world sea borne trade the fortunes of Scott & Co. and the Greenock Foundry Co. remained in the hands of John Scott and his brother Robert Sinclair Scott. They continued the policy laid down by their father, Charles C. Scott I in 1851, when he opened the Cartsdyke shipyard, of building iron ships exclusively and installing whenever possible the latest steam propelling machinery.

In fact, during the next fifty years they only built some fifty iron (later steel) sailing ships. However, the majority were of substantial size and a number became world famous.

It was during the first half of the 19th century that Scotts' had established their reputation as master builders of sailing ships. They owned and operated many sailing ships built by themselves in home waters which together with their ship repair interests had been instrumental in establishing the family fortune. However, in determining the policy of building only iron ships, Charles C. Scott (aided and abetted by the young John Scott IV it is suspected), must have been convinced that he was reading the signs correctly and the subsequent evidence shown in Figs. 6/39 - 6/40 clearly endorses his decision.

Fig. 6/39 demonstrates the spectacular trend in the growth of steamship construction in the United Kingdom during the period, compared with the fairly steady periodic peak values in the tonnage of sailing ships built in the period 1855 to 1892. There is in fact every indication of irreversible decline in the latter, the annual tonnages in 1910 and 1921 being 28,250 and 24,517 tons respectively in contrast to the peak output tonnages of sailing ships, namely 274,778, and 287,072 attained in 1864 and 1892 respectively.[66] Further confirmation is provided in Fig. 6/40 which shows the tonnage of vessels of all countries engaged in foreign trade which entered or cleared U.K. ports in cargo or ballast in the period. Here is clear evidence of the accelerating trend towards steamers from around 1870.

From statistics available covering the period, it has been possible to illustrate the pace at which steamships penetrated the market during this time. The leading role played by Scotts towards this end is evident in the following Table 6/2 showing for ships built during the period in the U.K. on the Clyde and at Scotts, the relative proportion of sailing ships and steamships.[67]

Table 6/2.

Proportion of Sailing Ships and Steamships built showing penetration of shipbuilding market by steamers.

Ships Built		Percentage	
Period.	Location.	Sailing Ships	Steamships
1850-90	United Kingdom	33	67
1866-90	Clyde	21	79
1850-99	Scotts	6	94

Source - W.S. Cormack - Economic History of Shipbuilding and Marine Engineering Table C.1. - Unpublished Thesis - University of Glasgow - 1930.

Finally, between 1850 and 1900 the proportion of sailing ships/steamships in the United Kingdom had changed from 90/10 to 5/95, almost a complete reversal.[68]

There were mini revivals in sailing ship building in the 1870s, 1880s and 1890s during periods of dull trade[69] (See also Fig. 6/39) and while Scotts were dedicated to building iron steamships they did build some clippers for high class customers during that time, particularly for the New Zealand emigrant trade,[70] using a family of designs based on their record breaking tea clipper, "Lord of the Isles".[71]

When trade was slack, merchants having cargoes to ship were looking for the cheapest rather than the speediest mode of transport. Similarly the shipowner was attracted by savings in first cost, fuel cost and greater carrying capacity for the same deadweight tonnage which the sailing ship offered against the steamship. However, as the century drew to its close the battle was clearly lost.[72]

John Scott IV, who was the older brother by thirteen years, had the advantage of serving under his father in the early years at Cartsdyke before taking over c.1860 as senior partner whilst still a young man. He built up a considerable clientele of foreign owners and his international reputation helped secure the French C.G.T. contracts. As we have seen he was an impatient visionary always searching for improvement in the technical aspects of the business and was prepared to back his judgement financially whether it be in sponsoring experiments in higher steam pressure or in maintaining the reputation of his shipyard as the most up to date on the Clyde.

Robert Sinclair Scott, on the other hand had the responsibility of maintaining Scotts reputation in the international shipping community for the quality production of modern ships and machinery. Together they were responsible for the construction of nearly three hundred ships of all kinds including machinery and in addition they supplied some sixty sets of machinery for ships built by other shipbuilders. (See Vol. 2.)

Whilst the business claimed the greater part of their attention, both men were active in public life both locally and nationally. Particulars of these activities and their many and varied leisure pursuits are contained in Appendix 6/2.

THE PURSUIT OF NAVAL CONTRACTS.

By 1880 the close relationships with Alfred Holt and John Swire were firmly in place and formed a substantial base load for the Cartsdyke shipyard.

However, with an eye to the future the Scotts' were keen to re-establish contact with the Admiralty. They saw orders being placed on the river for large naval vessels but were conscious that if they were to enter that field they would require to expand their facilities quite substantially. The greatly increased involvement of the outfitting trades would also affect the Engine Works.

The Scotts early endeavours to secure naval work were unsuccessful presumably because their prices were too high. The experience of other warship builders who obtained orders was not a very happy one. It is amusing to read of their complaints of frequent changes in specification and time-consuming delays in production as the Admiralty strove to include the latest developments in gunnery and appliances into every ship that was built.[73]

The writer cannot resist commenting that, from personal experience, one hundred years later, nothing has changed in this regard!

EXPANSION PLANS - SHIPYARDS.

Around this time, Scotts near neighbours, Robert Steele and Co. shipbuilders, were having difficulty in obtaining orders. This famous firm had ignored the threat of the iron steamship and in their latter years had relied heavily on orders for sailing ships from local shipowners who suffered in the 1870s and 1880s from both the Newfoundland trade and the Java sugar trade going to pieces.[74] In July 1883, Steele and Co. went into liquidation and in September 1883 the business was put up for sale at a price of £87,000.[75] There were no immediate buyers and the creditors agreed to lease the yard to the Port Glasgow shipbuilder, Joseph Russell for a period of six months. Before the lease ran out -in fact in November 1883 - Scott and Co. bought the yard for £42,500.[76] They had clearly recognised the potential of the site in the light of their expansion plans, in particular the availability of longer and wider berths, and the possible conversion of the large timber pond into a fitting out basin, both essential requirements for the larger naval contracts. (See Fig. 6/41) Unfortunately, orders for these larger ships continued to elude the Scotts, and, as described earlier in this chapter, it was not until nearly twenty years later that the Cartsburn naval yard was put to the test. In 1886 orders were taken (at a loss) for two composite type sloops, H.M.S. 'Sparrow' and H.M.S. 'Thrush'. The large naval orders, as we have seen, when they did come, were for high powered machinery for large Dockyard - built battleships all of which were very profitable.

Scotts continued to pursue naval orders but in the meanwhile they progressed the conversion of the Cartsburn yard at a pace determined by the availability of finance. Between 1883 and 1889 the industry went through a period of severe depression. As mentioned earlier the yard was used initially for the construction of iron sailing ships. Ultimately ten building berths were available in the two yards, ranging in length up to 700 ft. In addition to the new and extensive material handling and storage facilities provided, new workshops were built for the steel working and outfitting trades. The centre piece of this development built c.1900, was a large four storey building fronting the main street and housing on the lower floors extensive joinery and cabinet making workshops.

The third floor was a moulding loft with an adjacent model making shop and the top floor was initially used as a store for completed furniture, but later was modified to provide a new shipbuilding drawing office and a French polishing shop. The handsome building which had a total floor area of 50,000 square feet was adorned with a large clock tower which in the years that followed became a landmark for all mariners frequenting the Clyde.

The increasing demand for electrical power from the shipyards and the engine works was met from a new 1,200 kw power station located at Cartsburn. Hydraulic power was provided from two 800 p.s.i. pumping units with accumulators, the pressure pipes were led underground throughout the shipyard to the various hydraulic machine tools.[77] Scotts' had taken the lead in adopting pneumatic tools for many operations previously performed manually and had installed steam driven air compressors for the purpose.

In 1902 they played host through the Clyde Shipbuilders Association to all the leading U.K. shipbuilders who were invited to Scotts' yard to witness a six weeks demonstration of American pneumatic tools being used on a merchant vessel building there and performing a complete range of operations including shell and deck riveting, caulking, shipping, drilling and reaming.[78]

So whilst the entire programme of modernisation and expansion of the facilities at Scotts' was centred on securing orders for large naval vessels, it was in fact merely an extension of the policy started at the beginning of the 19th century by John Scott II having the aim of maintaining Scotts' reputation as the finest shipbuilders in the United Kingdom.

The nature and scale of Scotts' modernisation programme in the early years of the century was exceptional. However, the enthusiastic response of the U.K. shipbuilders to the pneumatic tool demonstration seems to suggest that the general momentum towards modernisation triggered by the changeover from iron to steel fabrication continued to roll.

EXPANSION PLANS - ENGINE WORKS.

Scotts engine works, the Greenock Foundry Co. from 1883 became progressively engaged on contracts for the supply of propelling machinery for large naval vessels, mainly battleships and heavy cruisers, under construction in the Royal Dockyards up to the outbreak of the First World War. Satisfactory performance on these contracts together with Scotts' modernisation and expansion plans finally resulted in the award of the contract for the construction of the armoured cruiser H.M.S. 'Argyll' to the company in December 1901.[79]

For the engine works this meant that, in addition to the supply of the main engines and boilers, there would be a very large outfitting load, perhaps, in manhour terms, in excess of that for the propelling machinery. Larger horsepower meant larger engines and more boilers - more space would be required also for the outfitting trades. As we have seen earlier, steam turbine machinery was soon to replace the traditional reciprocating engines, requiring new workshops, new machine tools and new techniques. So the investment in the engine works was also substantial and is best illustrated by comparing Figs. 6/42 and 6/43. Fig. 6/42 shows the original site purchased in 1825 superimposed upon the works in 1859 when John Scott IV purchased Scott, Sinclair & Co. and founded the Greenock

Foundry Co. Fig. 6/43 shows the situation in 1912 when all the improvements and additions planned by John Scott and Robert Sinclair Scott were almost complete. In the main engine section there had been added, turbine erection, turbine blading, light machine and fitting shops, a toolroom and materials laboratory. In the outfitting section new brass finishing, boiler tube, light boilerwork, piping and sheet metal shops massively upgraded Scotts' ability to cope with large scale naval contracts.

THE COST OF PROGRESS.

The transformation of the facilities at Scotts was planned by the Scott brothers in the late 1880s and its ultimate completion c.1912 was a tribute to their foresight and great courage observing that in the period the U.K. shipbuilding industry had endured no less than five mini depressions. In a submission to the Admiralty in 1915 - General Statement in support of Proposed New Standard Profits [80] - Scotts' recorded that in the period 1900 to 1912 they had incurred capital expenditure of £350,000. When account is taken of the purchase in 1883 of the Cartsburn Dockyard and the associated capital expenditure it is reasonable to assume that the entire programme of alterations and additions must have cost £500,000 which for a firm like Scotts' was truly remarkable.

FORMATION OF A LIMITED COMPANY.

As the end of the century approached the brothers turned their thoughts to the future control of the business.

Scott and Co. and the Greenock Foundry Co. had been operated since 1868 as partnerships, the partners of the former being John Scott and Robert Sinclair Scott. Fig. 4/10 shows the original partnership agreement. For the greater part of the time the Greenock Foundry Co. was also run as a partnership with the same partners. However, by 1899, with John Scott having retired due to indifferent health and Robert Sinclair Scott approaching retirement it was clearly necessary to organise the business on a different footing.

Accordingly, in May 1899, Scotts' Shipbuilding and Engineering Company, Limited, was incorporated as a private limited company under the Companies Act, 1862-1898 with John Scott as chairman and the process of merging Scott and Co. and the Greenock Foundry Co. into the new company began. This proved to be a lengthy process and in the meanwhile John Scott, C.B. died on the 19th May 1903. He was succeeded as chairman on the 16th December, 1903 by his brother Robert Sinclair Scott. At long last, at a special meeting of the company held on 29th April 1904, with Robert Sinclair Scott in the chair, a special resolution adopting the new Articles of Association was confirmed. Under the terms of that resolution, Robert Sinclair Scott together with Charles Cunningham Scott II, and Robert Lyons Scott (both sons of John Scott, IV) and Carl Mumme, shipyard manager, were appointed the first directors of the company.[81]

On 30th April, 1904, at a meeting of the directors of Scotts' Shipbuilding and Engineering Co. Ltd. the directors resolved to pay Mr. John Scott's trustees and Mr. Robert Sinclair Scott the sum of £285,000 Stg. and to pay Mr. Carl Mumme the sum of £15,000 Stg. making together £300,000 Stg. being the price of the businesses of Scott & Co. and the Greenock Foundry Co. purchased by the Secretary on behalf of the company.[82]

On 6th May at a meeting of the directors the company secretary reported having received payment from the Allottees of the following amounts (at £10 per share) for shares allotted to them:-[83]

From the Trustees of the late John Scott IV.		
2,500 Preference Shares	-	£25,000
19,133 Ordinary Shares	-	£191,330
Total	-	£216,330
From Robert Sinclair Scott		
6,867 Ordinary Shares	-	£68,670
From Carl Mumme		
1,500 Ordinary Shares	-	£15,000
in all	-	£300,000

The new private limited company had been operating for only ten months when its chairman, Robert Sinclair Scott died suddenly on 28th February 1905. So within two years the two brothers who had carried the company for almost forty years were gone. However, they left the company well equipped for the challenges of the future, and had the satisfaction of having secured the long sought after large naval contract - that for H.M.S. 'Argyll' - in December 1901. John Scott saw the keel of 'Argyll' laid and Robert Sinclair Scott saw her launched but neither survived to see her join the fleet. At a Board meeting on the 10th March 1905

Charles Cunningham Scott II was appointed chairman of the company. A motion by the chairman that Mr. Robert Lyons Scott be appointed deputy chairman of the company was approved.[84]

The next and final chapter will continue the Scotts' story from the death of Robert Sinclair Scott up to the First World War and its aftermath. It will discuss the role of Mr. James Brown in organising the new management systems consistent with the enlarged shipbuilding and engineering facilities at Scotts' and the development also of the technical strength of the company.

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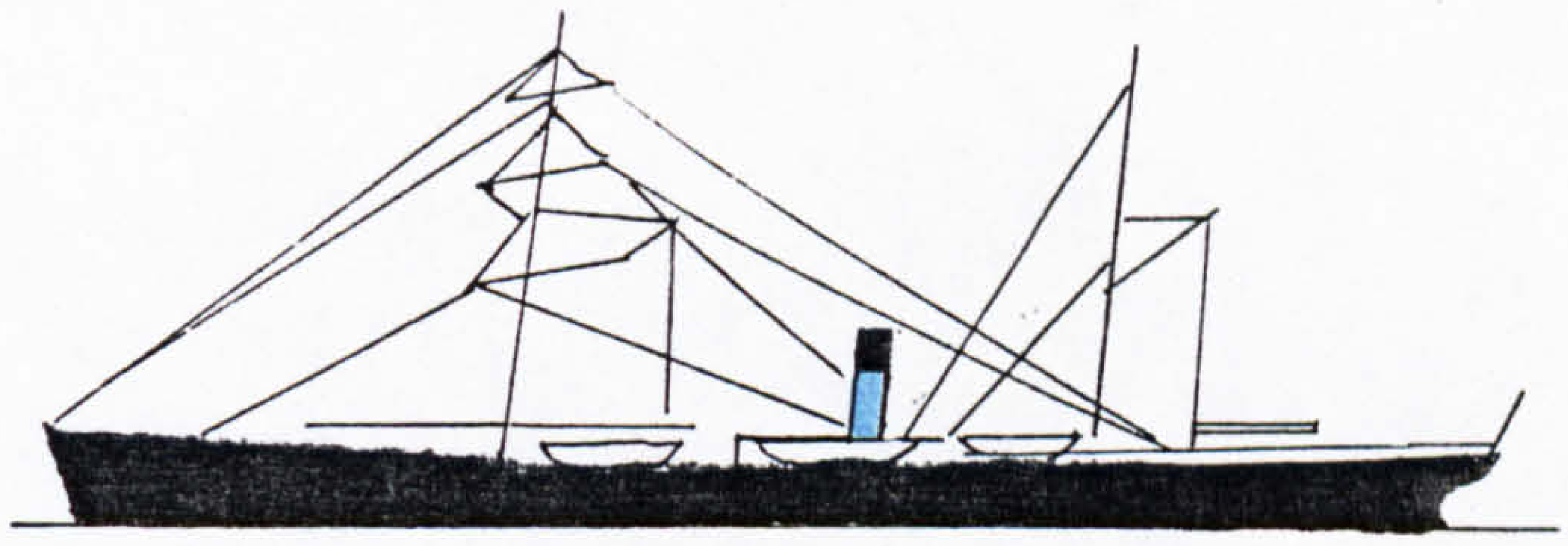
Table 6/1 PERFORMANCE ON FULL POWER TRIALS OF LARGE WARSHIP MACHINERY BUILT BY SCOTTS - 1892-1913.

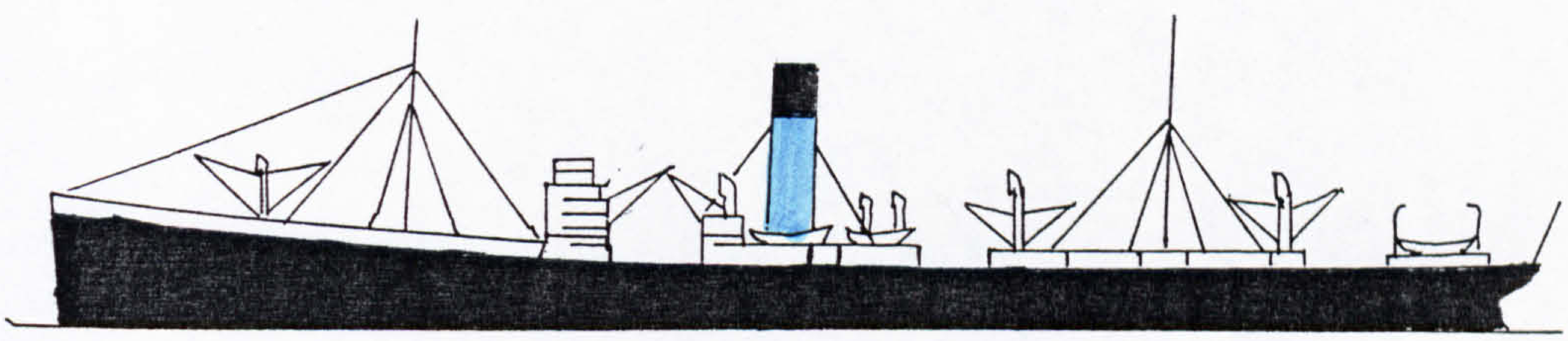
YEAR	H.M.S.	TYPE	ENGINES: No & TYPE	cylinder dias. - ins. & stroke 'S' - ft.: 1	2	3	4	'S'	HORSEPOWER & R.P.M.	BOILERS: No & TYPE	DRAUGHT	BOILER PRESSURE p.s.i	CONSUMPTION: Coal lbs. per IHP. hr. or lbs. per SHP. hr.	Steam lbs. per IHP. hr. or lbs. per SHP. hr.	SPEED knots
1892	HERCULES	BATTLESHIP	Single Screw Recip. Triple Expansion	49	72	108	-	4.5	7404 I.H.P. - 81.7 8536 I.H.P. - 88.05	8 cylindrical.	Natural. Forced.	140	-	-	14.4 15.58
1893	CENTURION	BATTLESHIP.	Twin Screw Recip. Triple Expansion	41	62	95	-	4.0	9703 I.H.P - 96.6 13174 IHP 104.8	do.	Natural. Forced.	150	1.90 2.24	-	17.5 18.81
1893	BARFLEUR	BATTLESHIP.	do	41	62	95	-	4.0	9934 IHP - 95.6 13163 IHP - 105.6	do.	Natural. Forced.	150	-	-	17.17 18.5
1899	CANOPUS	BATTLESHIP.	do	30	49	80	-	4.25	13781 I.H.P. 108.5	20 Belleville	Forced	300	1.72	-	18.5
1903	PRINCE of WALES	BATTLESHIP.	do	31.5	51.5	84	-	4.25	15364 I.H.P. 113.0	do.	Forced	300	2.02	19.0 ✓	17.9
1905	ARGYLL *	CRUISER.	do	41.5	65.5	73.5	73.5	3.5	21190 I.H.P. 138.9	6 cylindrical 16 Babcock & Wilcox.	Forced	210	2.2	18.9 ✓	22.38
1908	DEFENCE	CRUISER.	do	40.63	65.5	74.63	74.63	4.0	27540 I.H.P. 127.0	24 Yarrow	Forced	210	1.87	16.4 ✓	23.30
1909	ST. VINCENT	BATTLESHIP	Four Screw Parsons Turbines	-	-	-	-	-	25080 S.H.P. 323.0	18 Babcock & Wilcox	Forced	235	1.50	14.3 ✓	21.67
1911	COLOSSUS *	BATTLESHIP.	do	-	-	-	-	-	27814 S.H.P. 325.0	do	Forced	235	1.60	13.8	21.57
1913	AJAX *	BATTLESHIP.	do	-	-	-	-	-	28326 S.H.P. 329.0	do	Forced	235	1.71	14.6 ✓	21.07

* Ships built by Scotts.
✓ Consumption for all purposes.
'Defence' and subsequent ships were equipped to burn coal or oil fuel.
Information derived from Scotts sea trials archives at the University of Glasgow - ref. GD 319/23/2/1-4.

Fig. 6/1 : Comparison of vessels built by Scotts for Holt's Ocean Steamship Co. in 1870 and 1916.



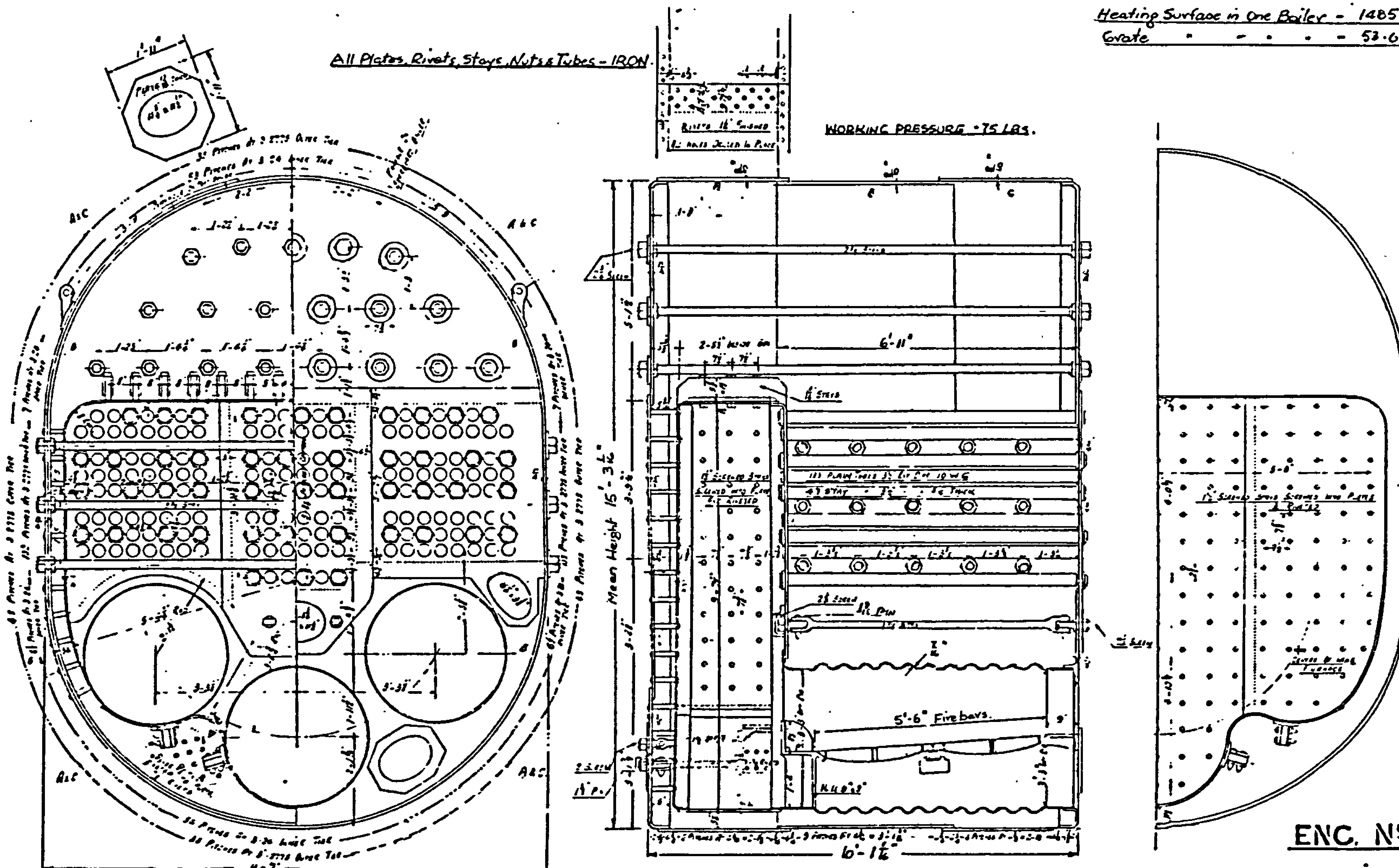
S.S. PRIAM (1870)



T.S.S. TYNDAREUS (1916)

ITEM	S.S. PRIAM (1870)	T.S.S. TYNDAREUS (1916)	(1870 = 100) 1916
Dimensions - ft.	309·7 × 34·0 × 29·08	503·0 × 63·0 × 44·5	
Tonnage gross.	2039	11347	556
" nett.	1634	7172	439
.. invoiced iron/steel.	1000	5500	550
.. deadweight.	2881	14278	496
Indicated Horsepower.	620	5750	927
Trial Speed - Knots	10	14	140
Contract price.	£22000	£203000	920
Cost per gross ton.	£ 10·78	£ 17.89	165

Heating Surface in One Boiler - 1485 sq ft.
Grate - - - - - 52·625 sq ft



ENG. No 277
S. S. 'WOOSUNG'
MAIN BOILERS.
1882
Scotts' Archives - Univ. of Glasgow.
Drawings - GD 319/17
Fig. 6/2

Fig 6/2

SCOTT BUILT SHIPS
Boiler Pressure
p.s.i.

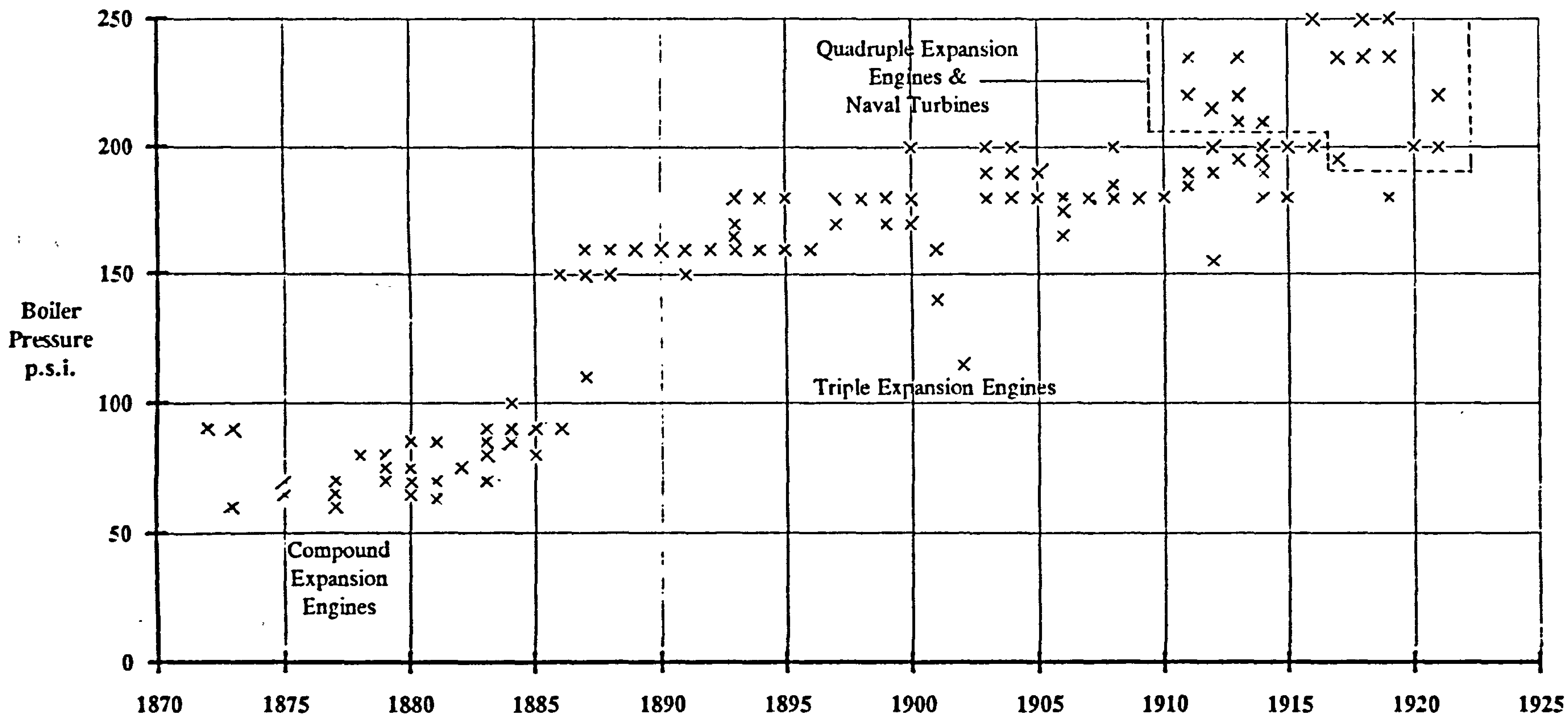


Fig.6/3 Compiled from Scotts Sea Trials Data Books, Archive Ref. GD319/23/2/1-4

SCOTT BUILT SHIPS

Boiler Heating Surface Square Feet per I.H.P.

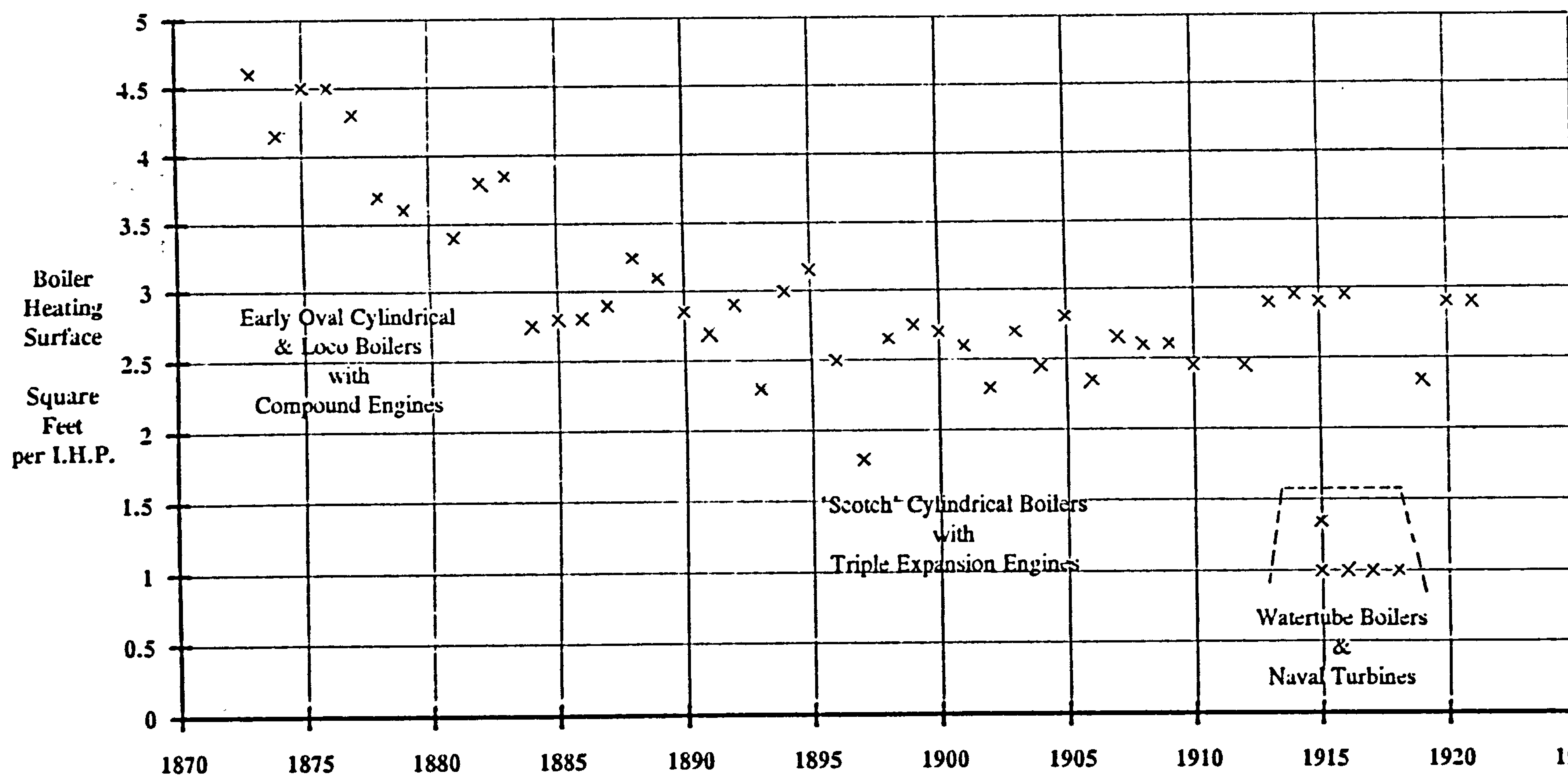


Fig. 6/4 Compiled from Scotts Sea Trials Data Books, Archive Ref. GD319/23/2/1-4.

SCOTT BUILT SHIPS
Grate area Square Feet per I.H.P.
Cylindrical Boilers.

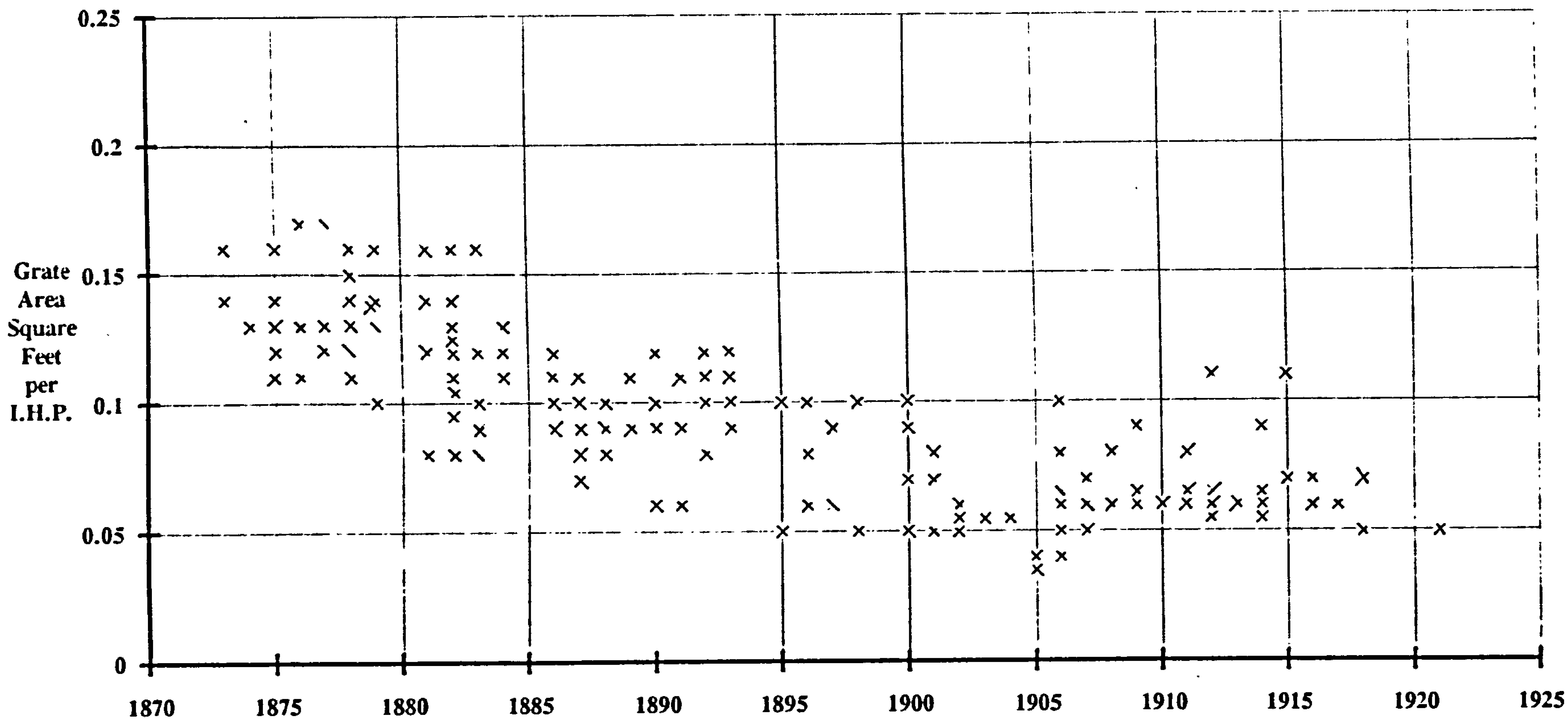


Fig 6/5 Compiled from Scotts Sea Trials Data Books, Archive Ref. GD319/23/2/1-4.

Fig. 6/6

SCOTT BUILT SHIPS
Steam Space Volume. Cub. ft. per I.H.P.
Cylindrical Boilers.

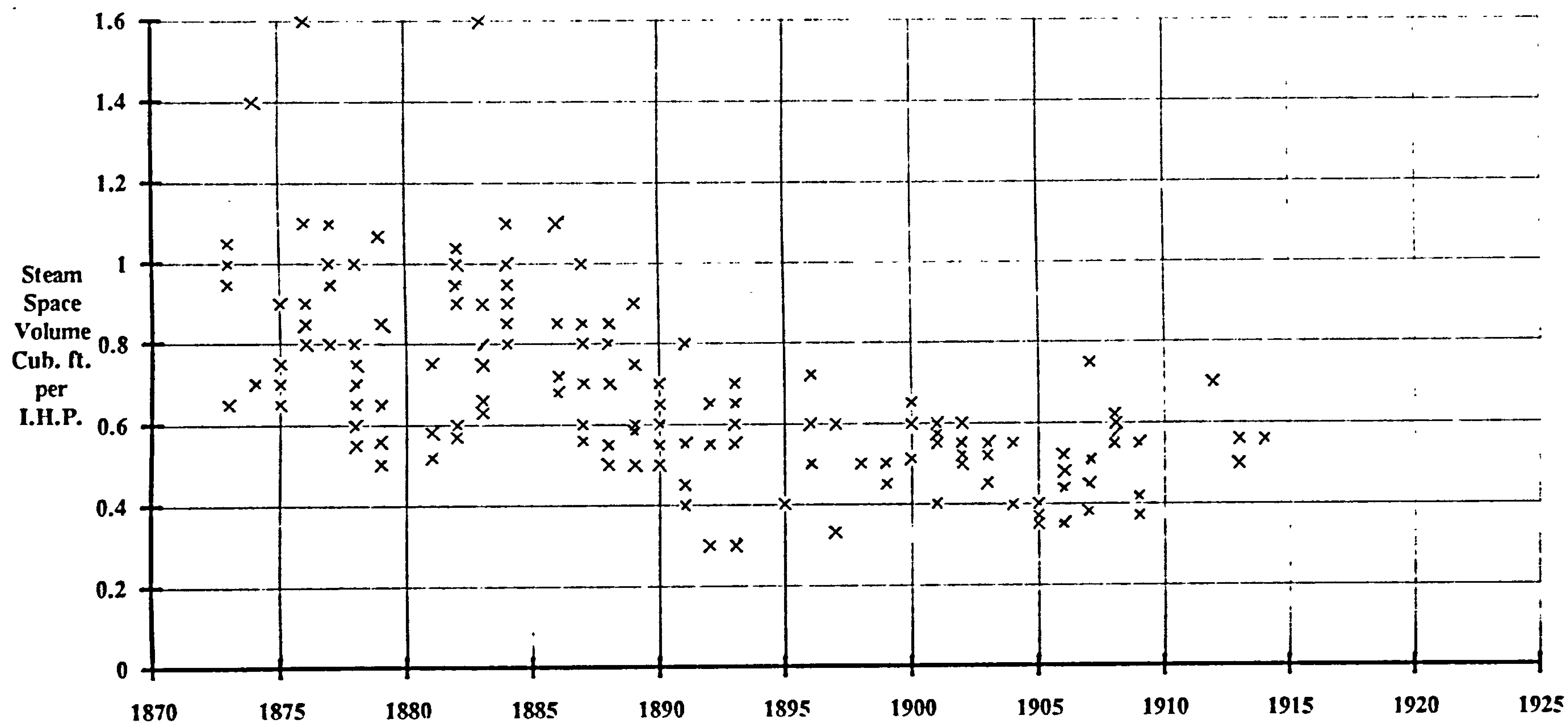
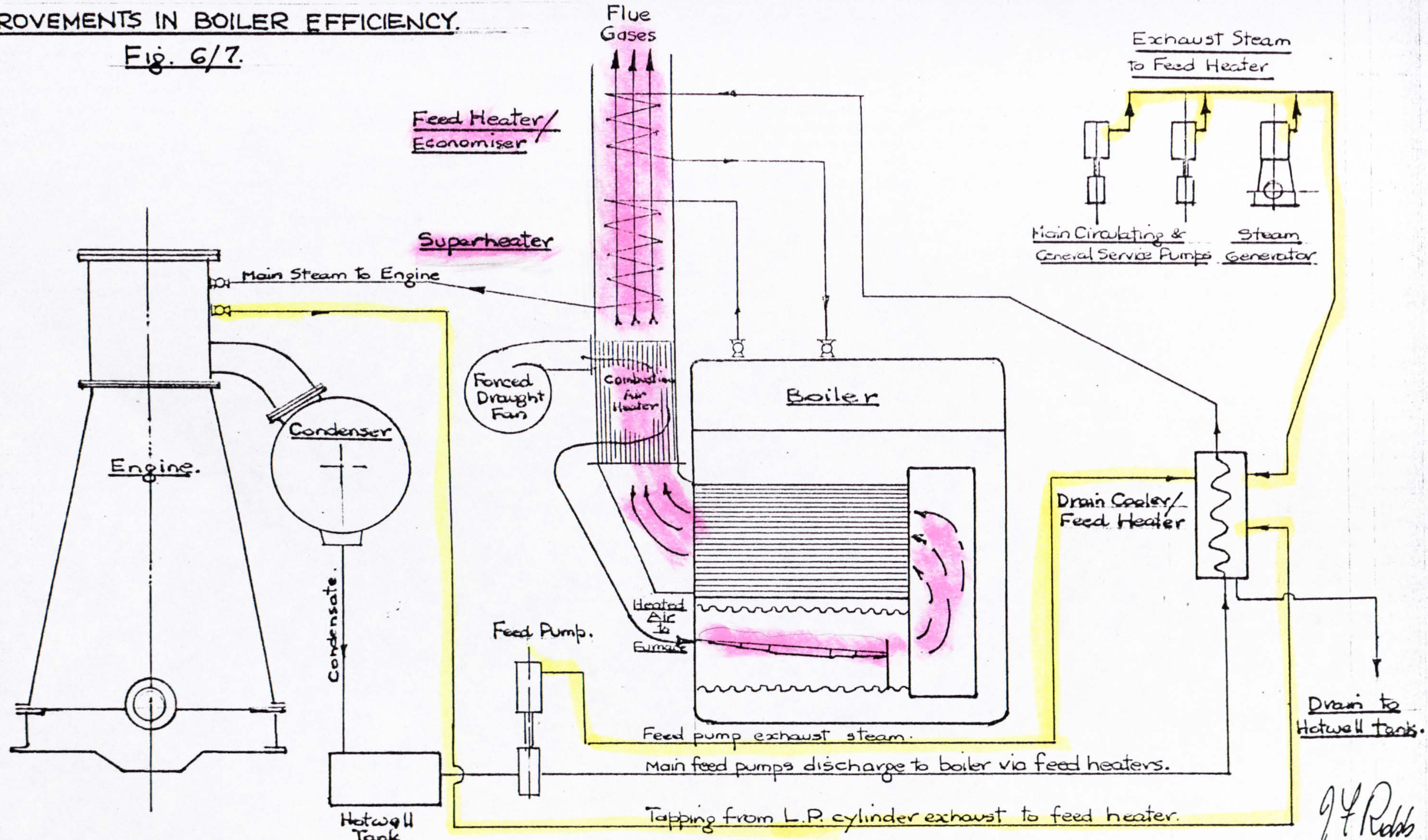


Fig. 6/6 Compiled from Scotts Sea Trials Data Books, Archive Ref. GD319/23/2/1-4.

IMPROVEMENTS IN BOILER EFFICIENCY.

Fig. 6/7.

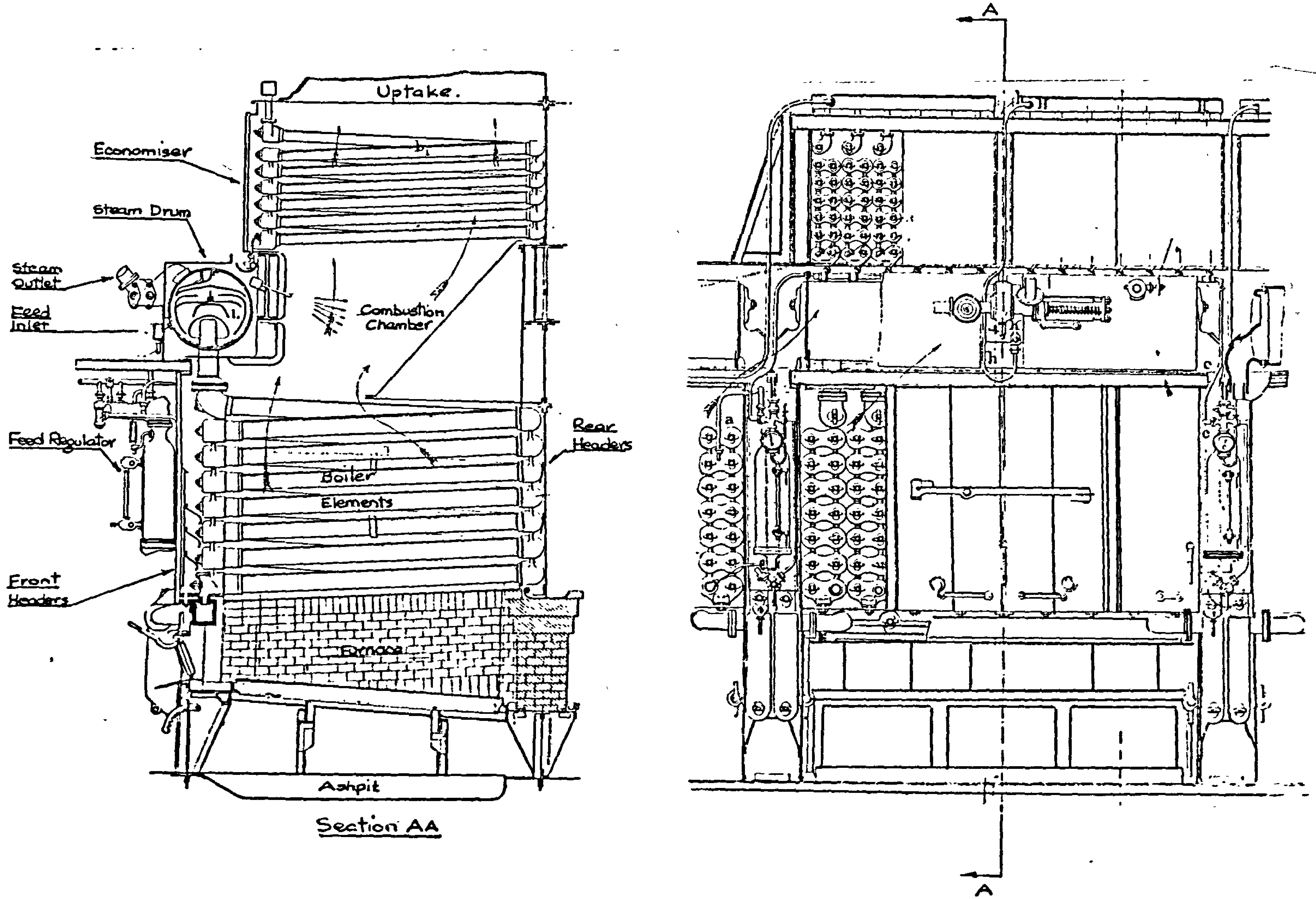


(a) Waste heat recovery from flue gases for superheating, feed heating and air heating.

(b) Enhanced combustion rates from the use of forced draught.

(c) Recovery of latent heat from l.p. cylinder exhaust and exhaust of auxiliary engines for feed heating.

Fig. 6/7



Belleville Water Tube Boiler. c. 1900.
As installed on H.M. ships 'Canopus & Prince of Wales'.
Fig. 6/8.
from 'Marine Engines & Boilers' by Bauer & Robertson
London 1905

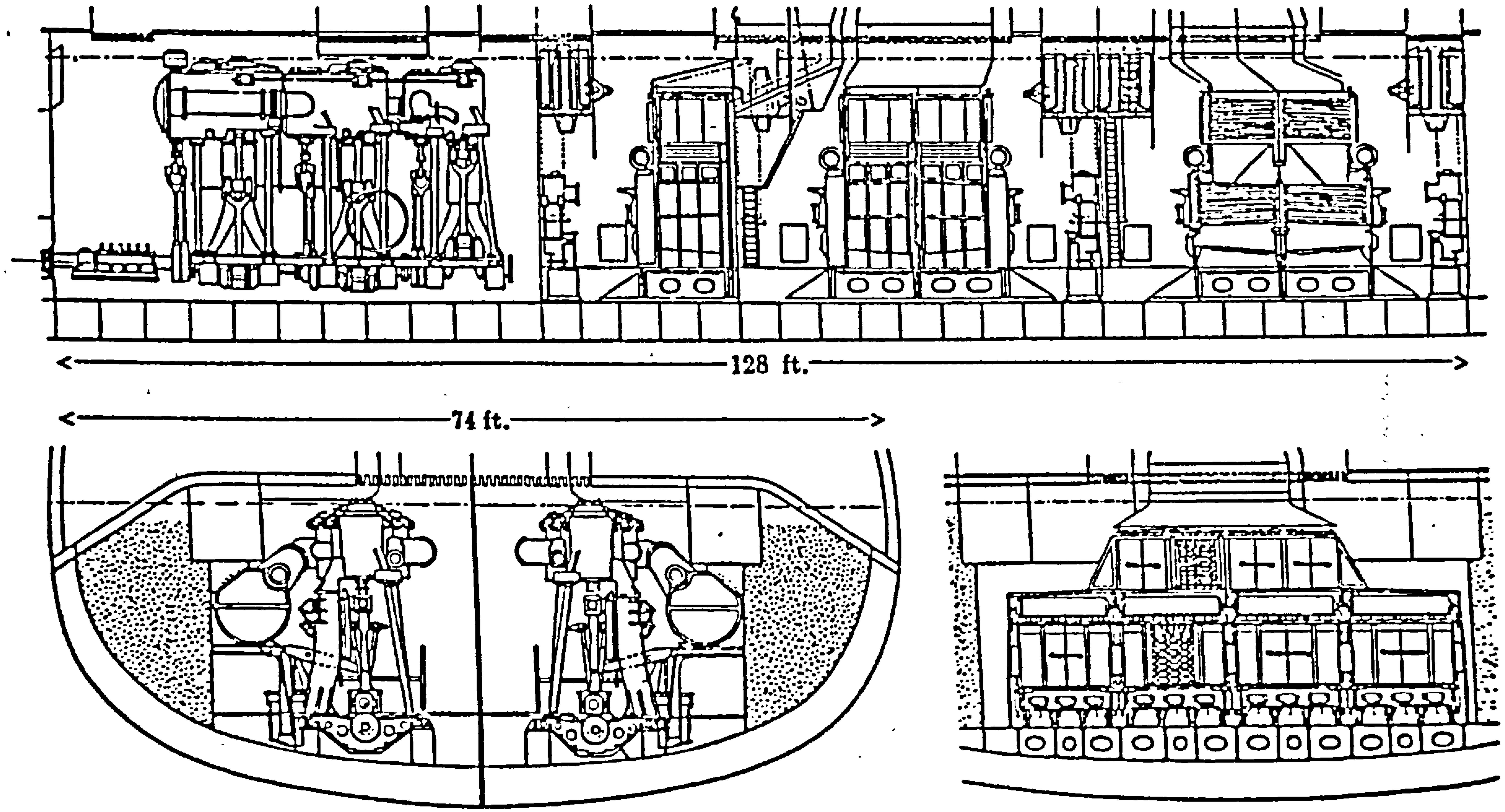
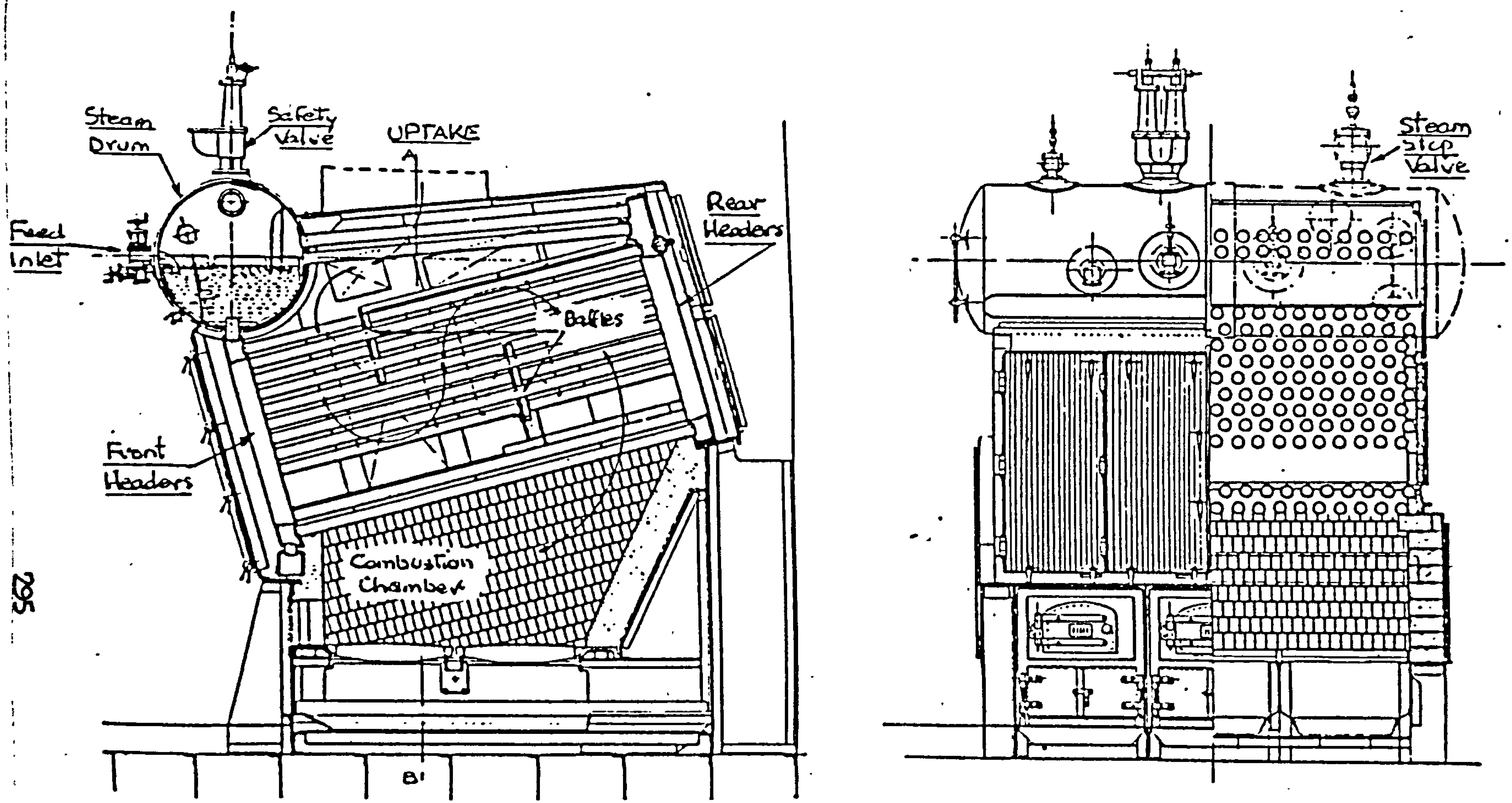


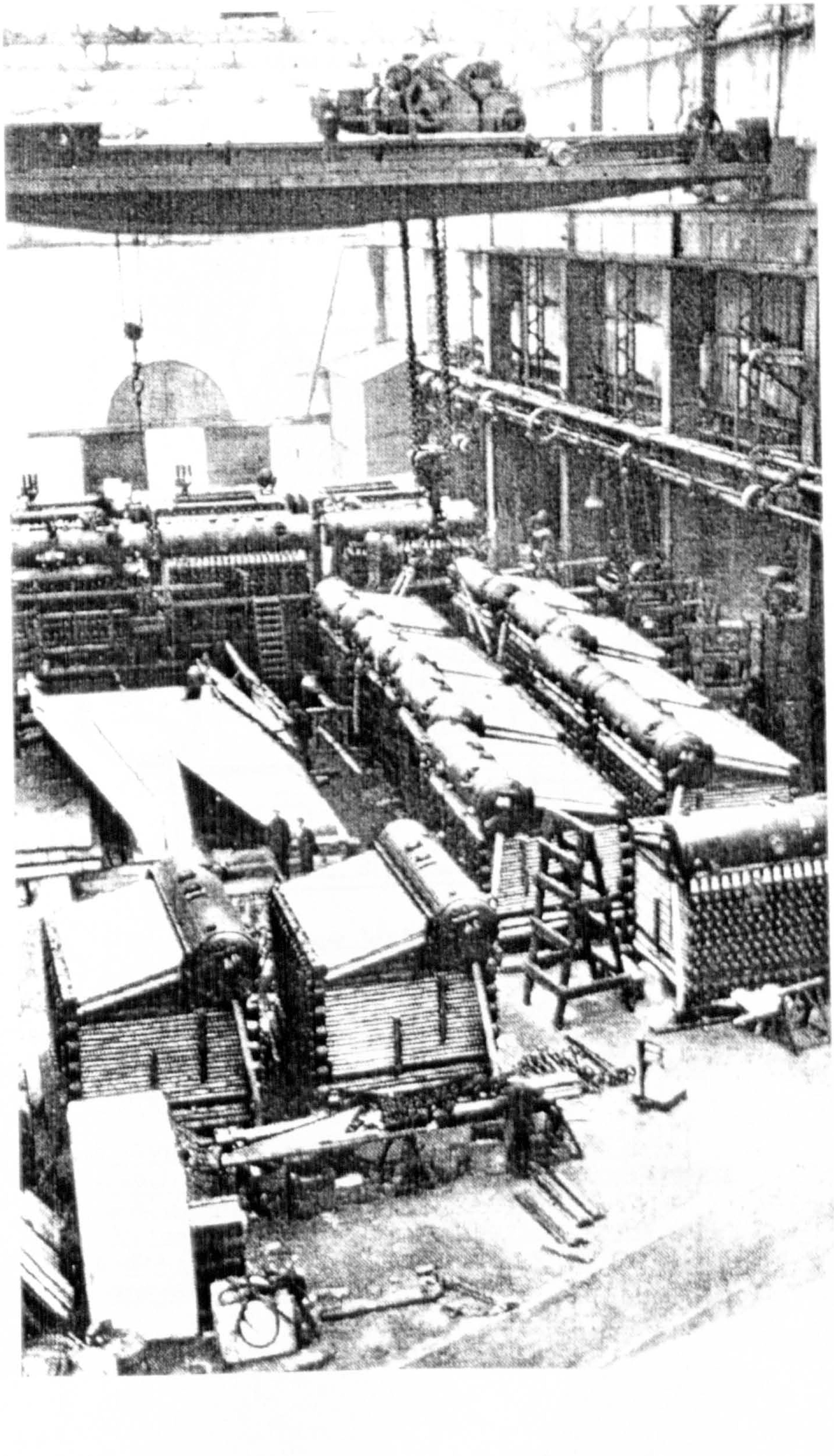
Fig. 6/9 —MACHINERY OF THE BATTLESHIP "CANOPUS", 1900,—13,500 I.H.P.
from Scotts' 'Two Hundred & Fifty Years of Shipbuilding' 1961.

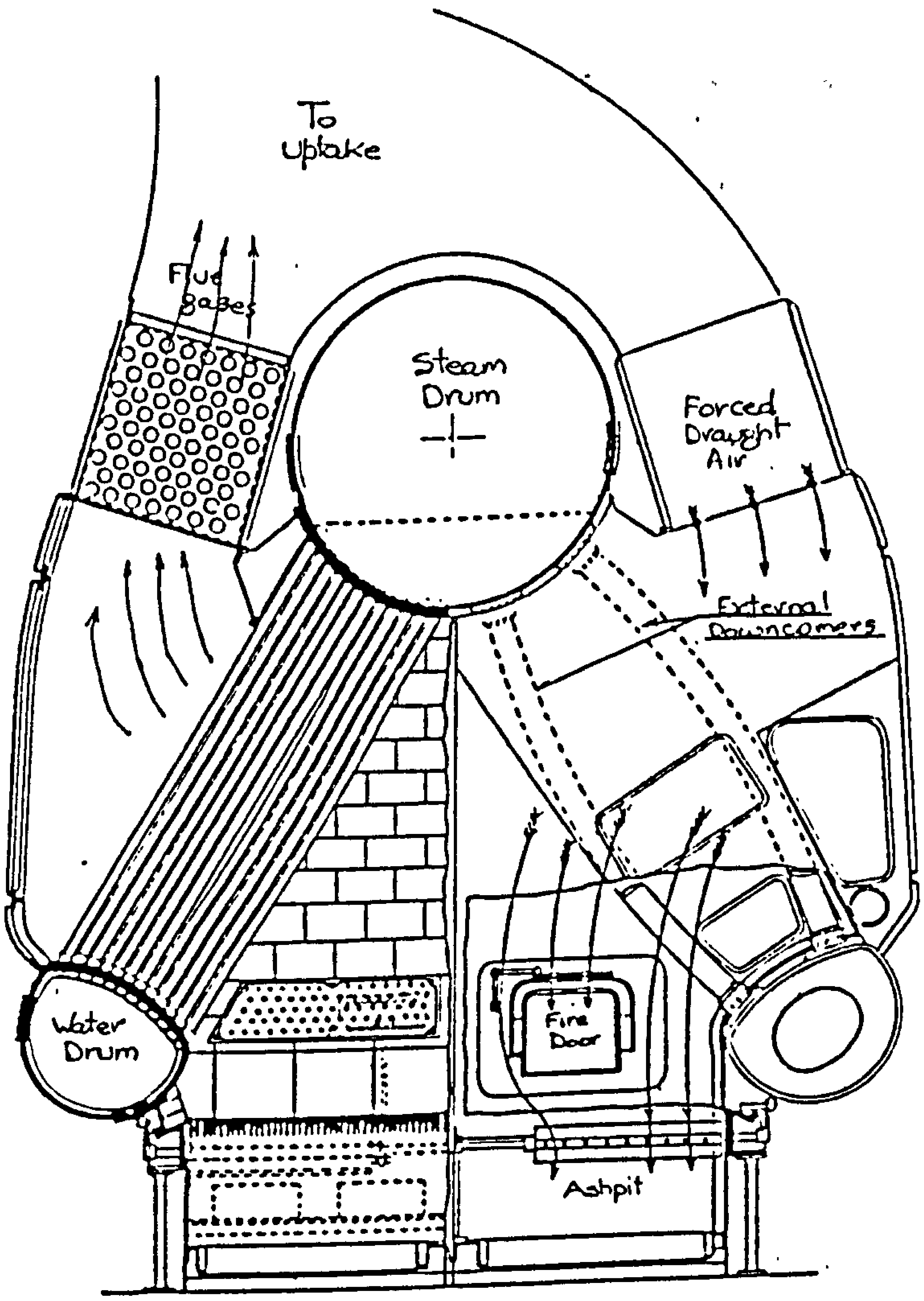


Babcock & Wilcox Header Type Water Tube Boiler c. 1900.
As on H.M. Ships Argyll, St. Vincent, Colossus & Ajax.
From Sothern's 'Verbal Notes & Sketches for Marine Engineers – 1918.

Fig. 6/11

The Babcock & Wilcox water tube boiler installation for HMS St. Vincent being made ready for shipment to Portsmouth Dockyard.





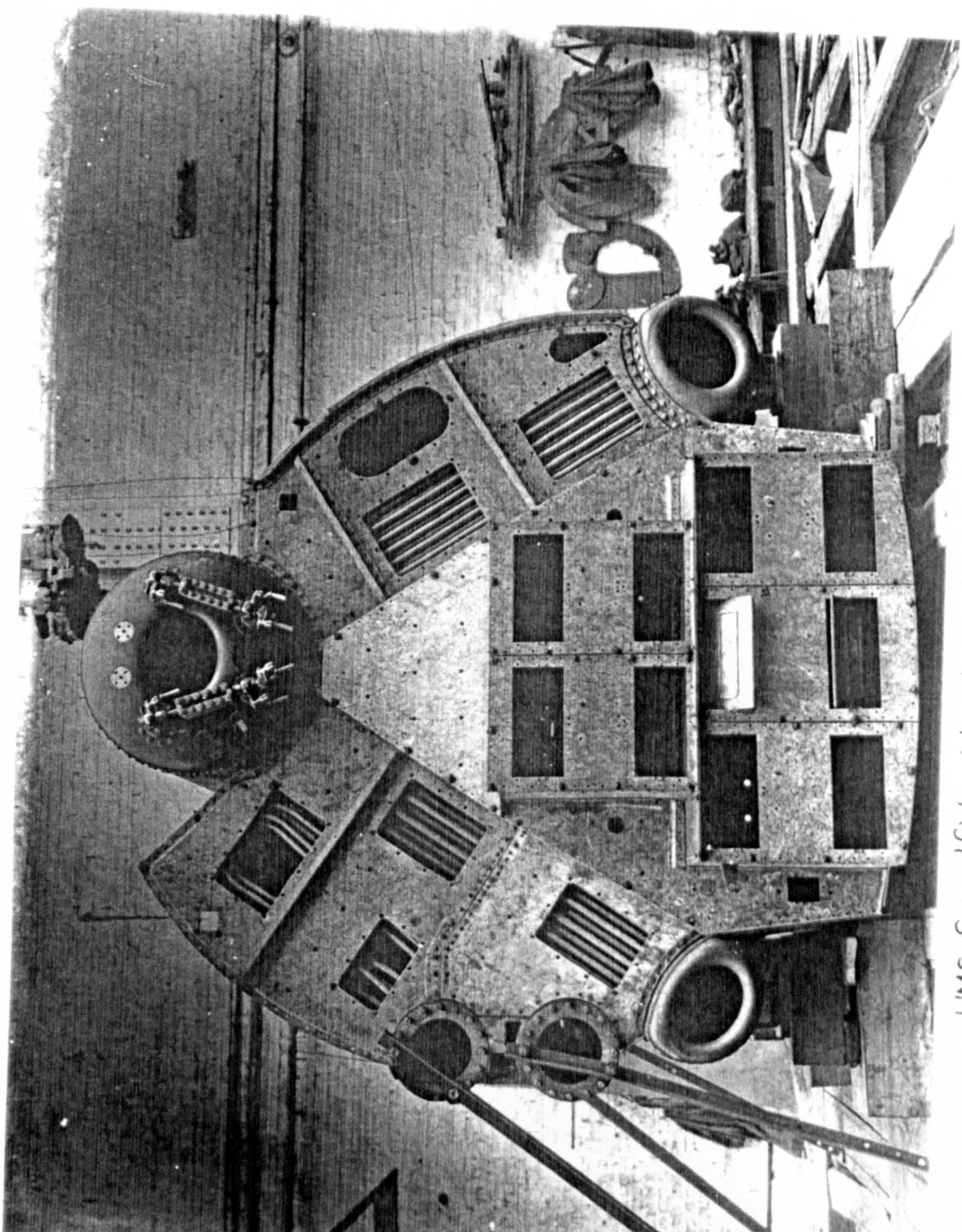
Yarrow Watertube Boiler
c. 1900

Left Hand Section — Shows watertubes and path of flue gases through the watertubes and thereafter through air heaters which are part of the forced draught system.

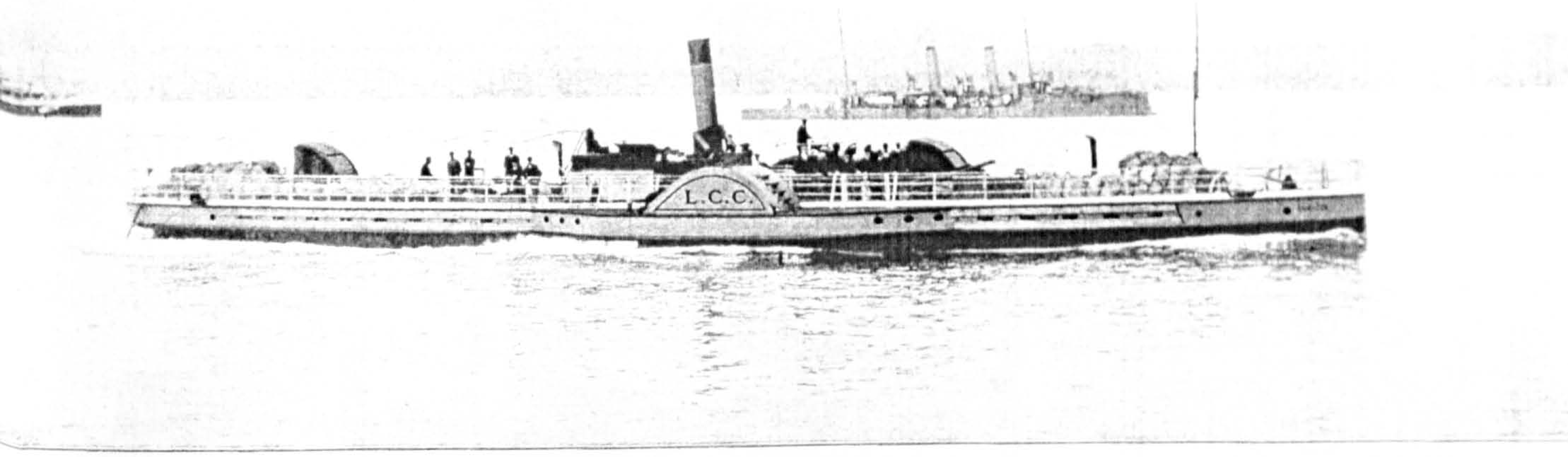
Right Hand View — External view showing forced draught air being ducted externally from air heaters to the fire doors and ashpit.
As heated water rises in main tube banks cold water flows down external downcomers keeping circulation going.

J F Robb
1991

Fig. 6/13

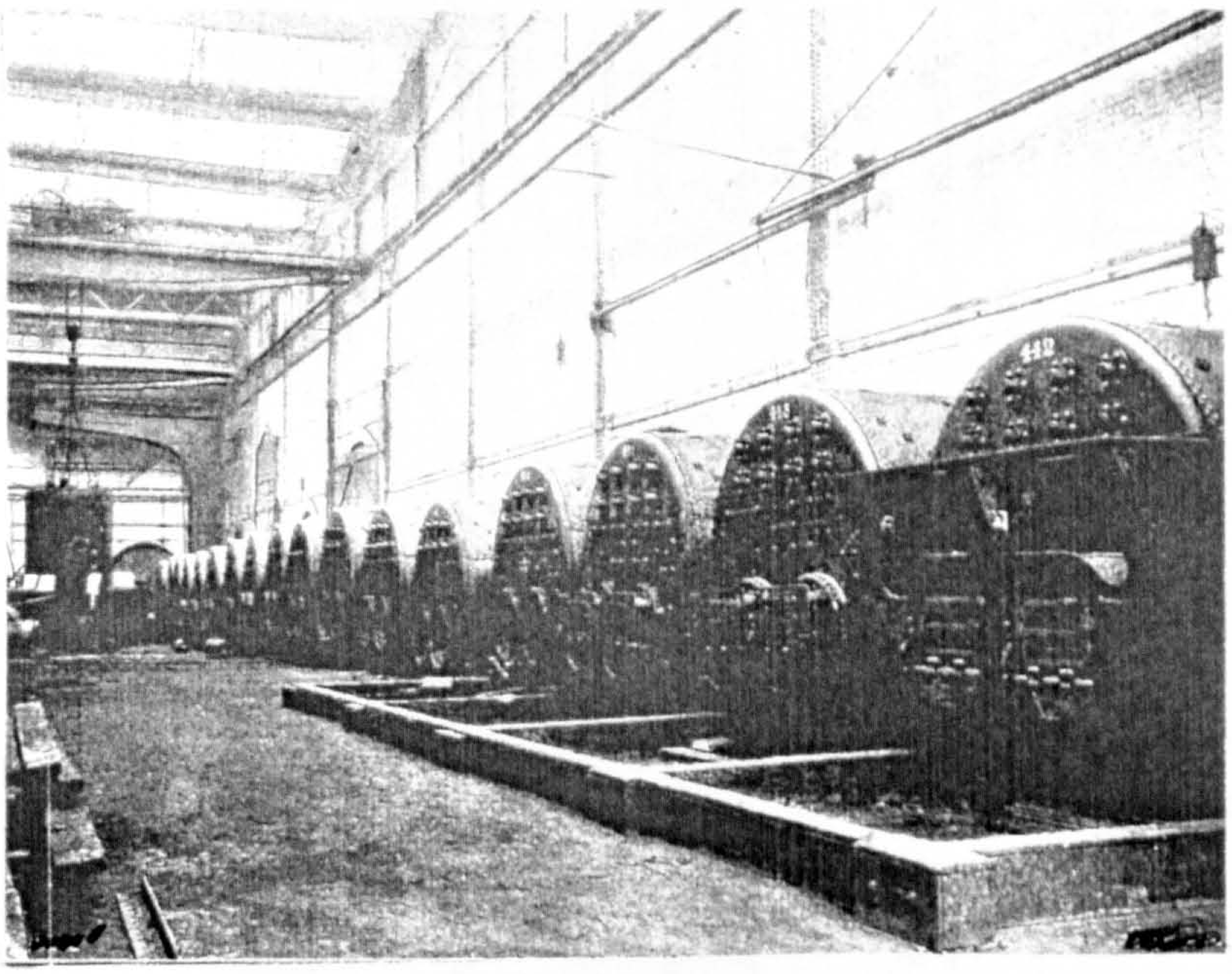


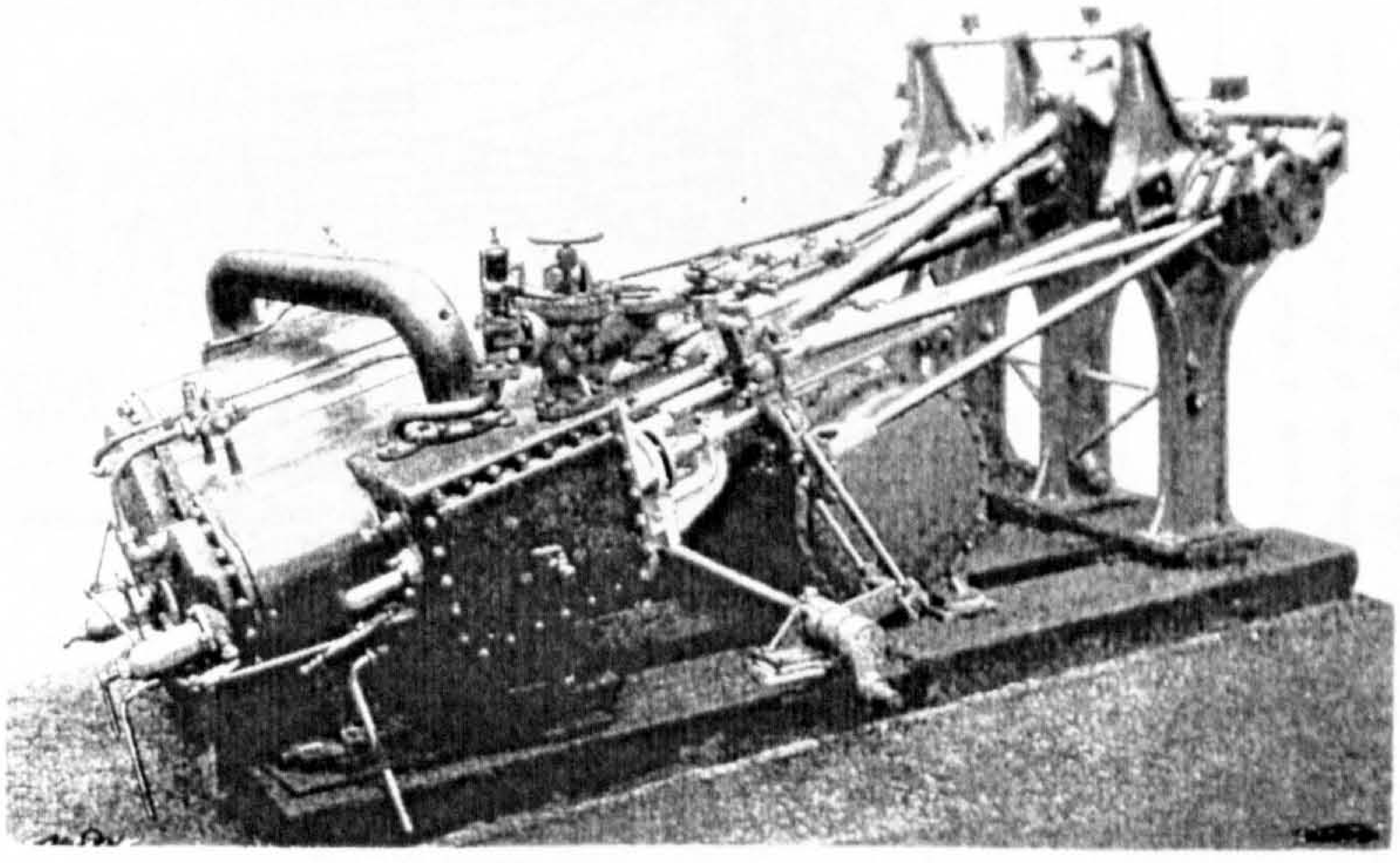
H.M.S. Swordfish - Watertube Boiler with Superheater.



ONE OF TWENTY THAMES STEAMERS ENGINED BY THE SCOTTS. 1905

Fig 6/14



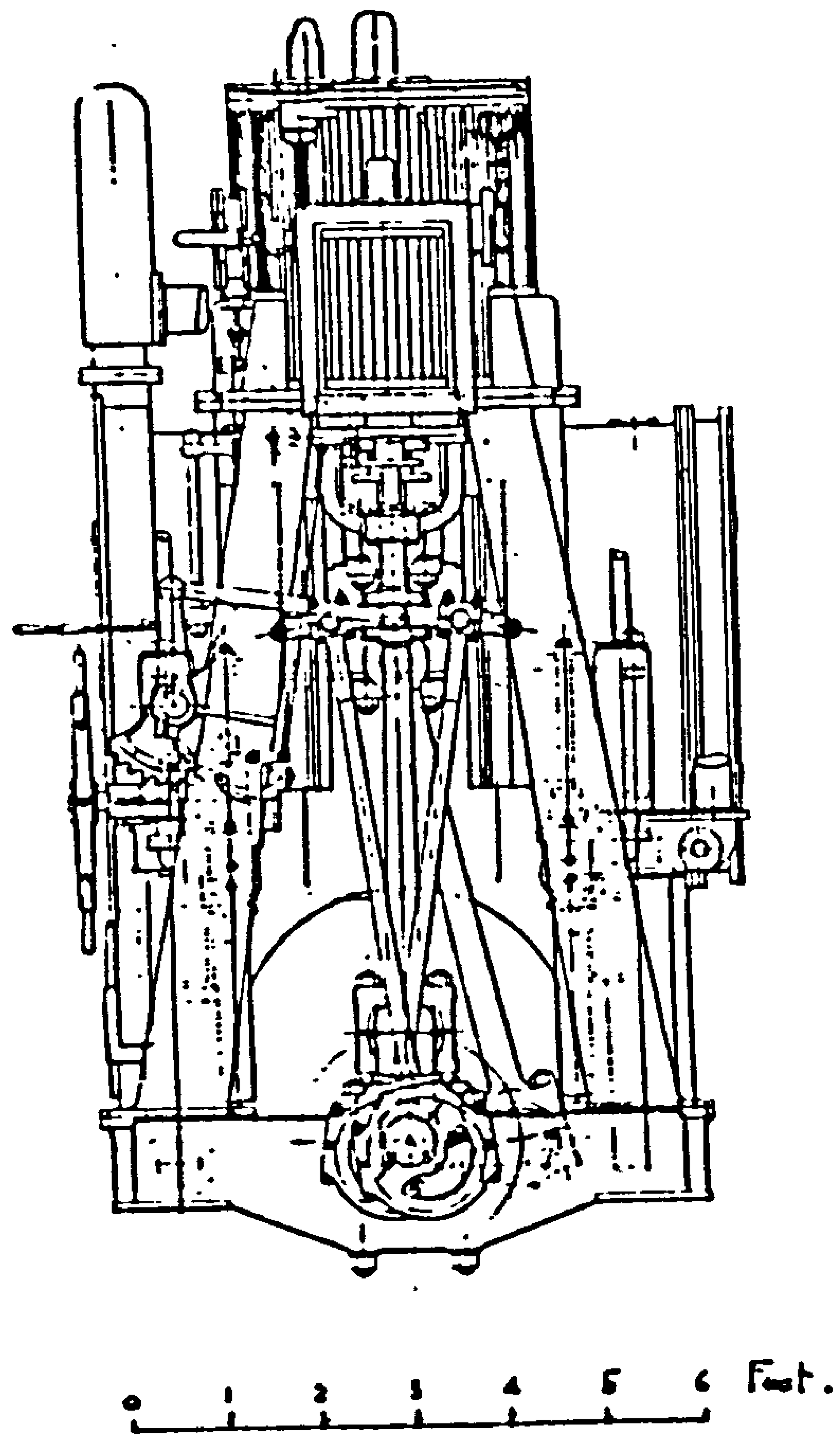


Boilers and Typical Engine for L.C.C. Steamers.

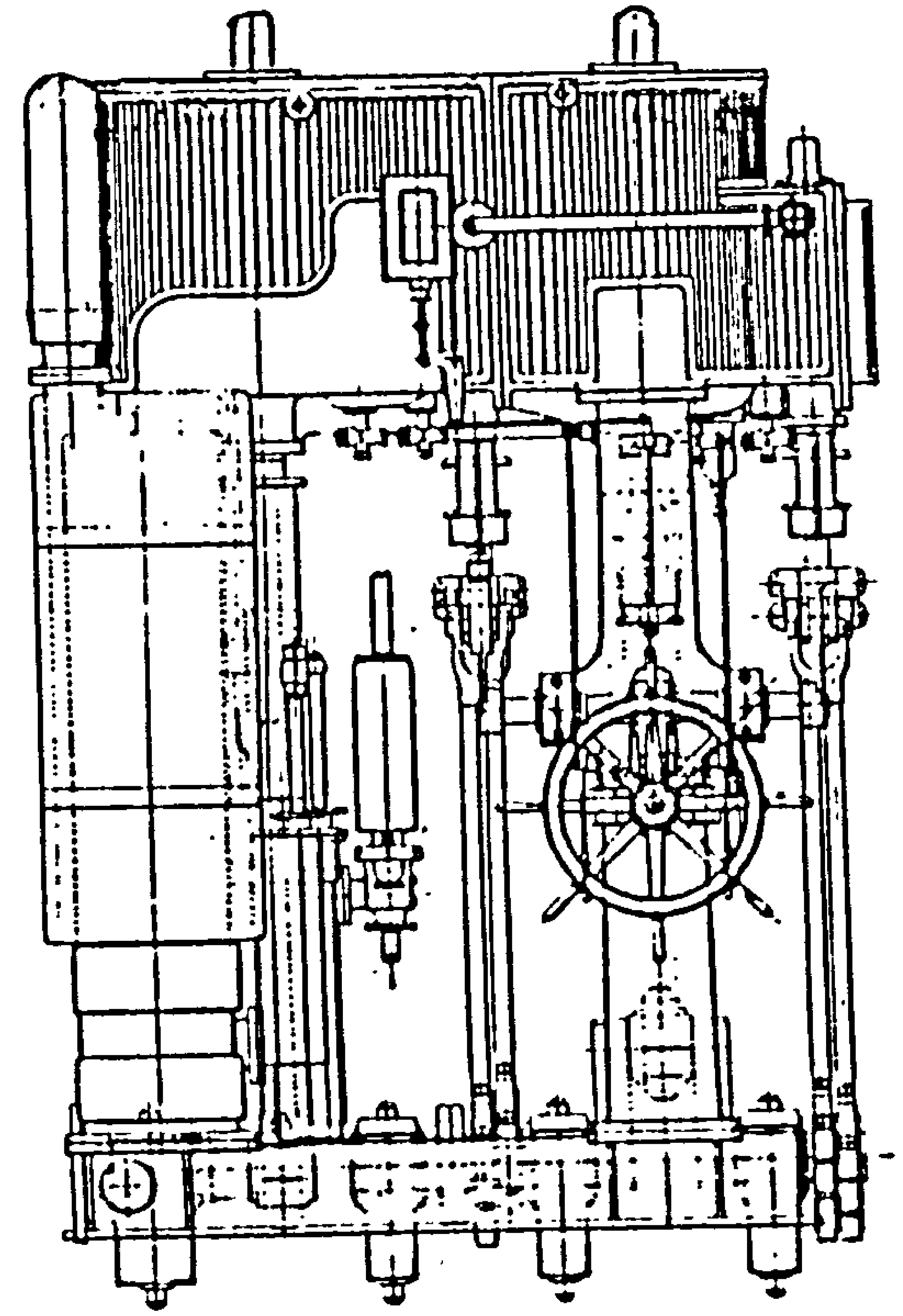
Fig 6/15

from Scotts' 'Two Centuries of Shipbuilding - 1906 Edition.

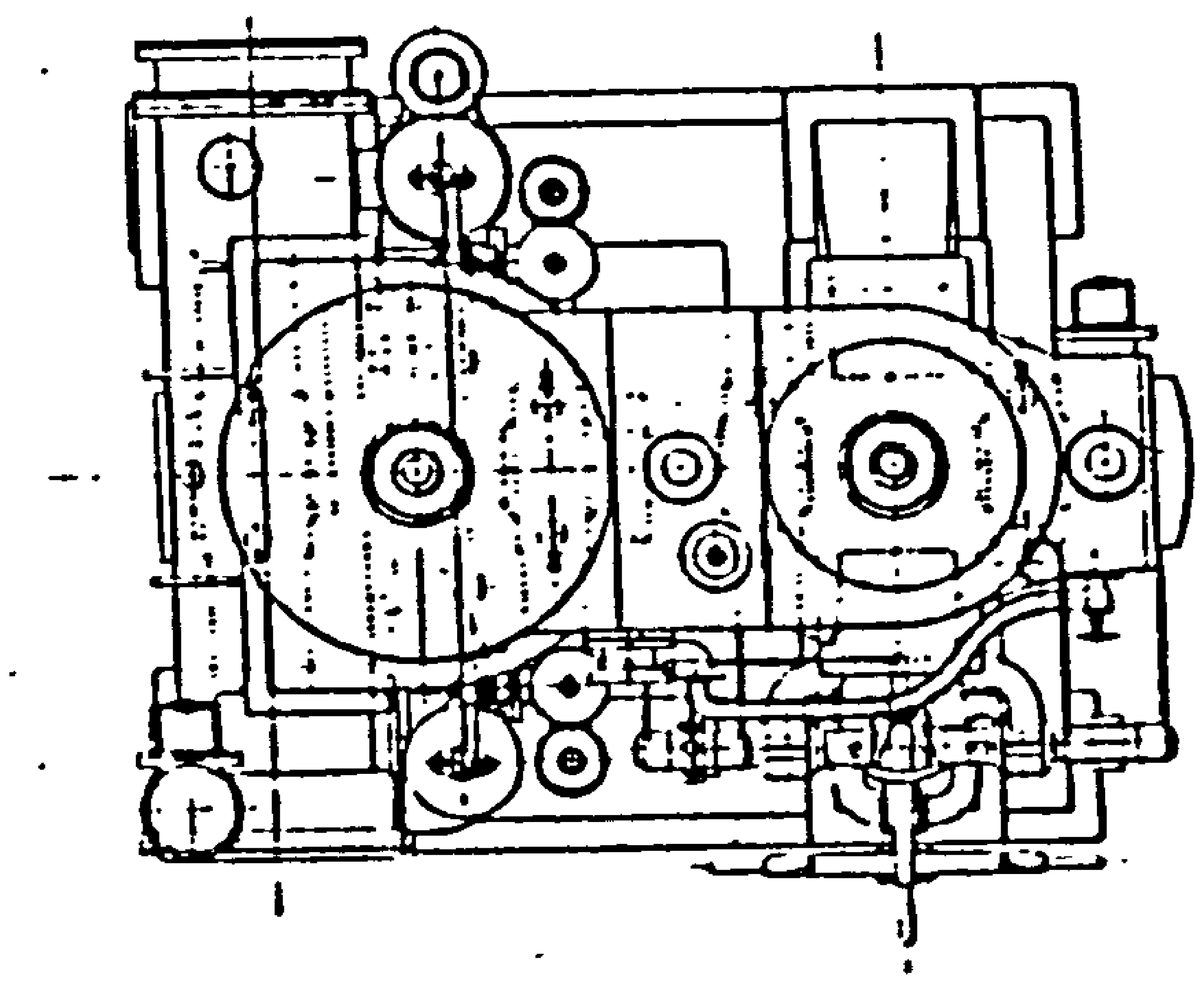
Fig. 6/16



Diameter of High Pressure Cylinder	16"
Diameter of Low Pressure Cylinder	32"
Stroke of Piston	28"
Length of Connecting Rod, between Centres	63"
Diameter of Air Pump. single acting	8"
Diameter of Circulating Pump, double acting	5½"
Diameter of Feed Pump	2"
Diameter of Bilge Pump	2"
Stroke of Pumps	18"
Crank Shaft	6½"
Working Pressure	90lbs
Cooling Surface in Condenser	338 sq ft

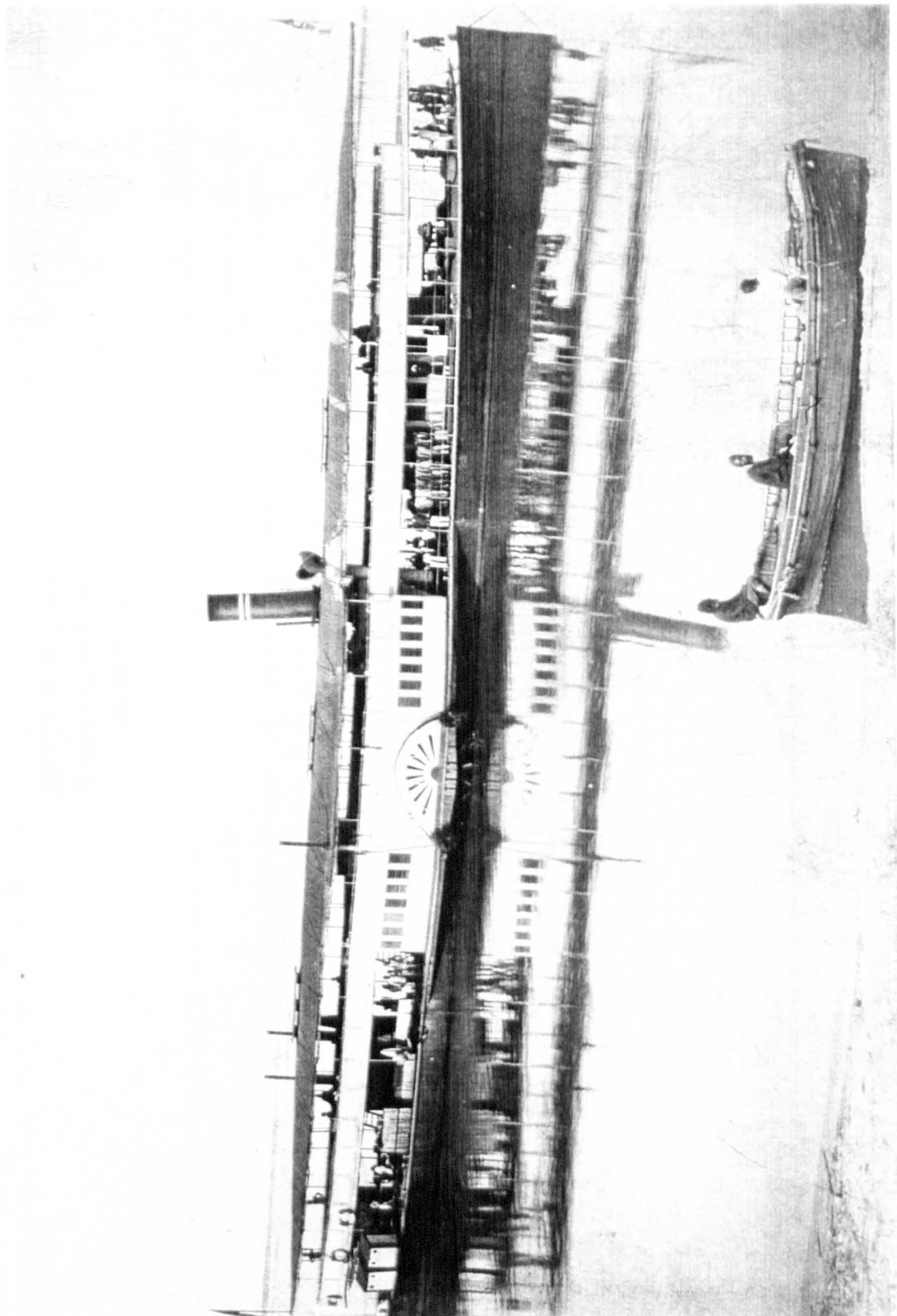


From Scotts Archives - Univ. of Glasgow - Drawings - GD 319/17



ENGINES
No 300 ARGO
Drawing No 3015
Engine Arrangement
GREENOCK FOUNDRY
1886

Fig. 6/17



P.S. Loohit. Bengal: 1887.

SCOTT BUILT SHIPS
Reciprocating Engines
Expansion ratio

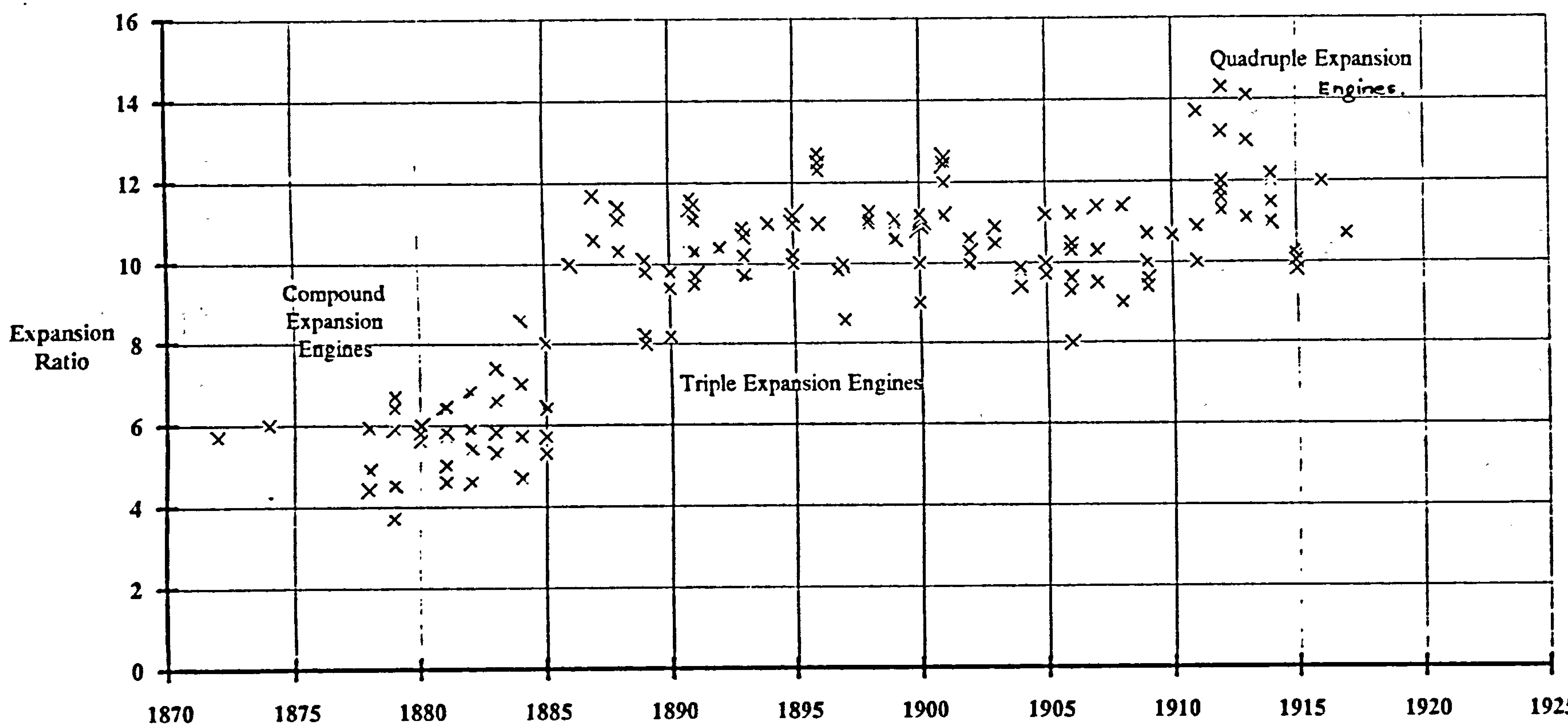


Fig 6/18. Compiled from Scotts Sea trials Data Books, Archive Ref. GD319/23/2/1-4.

Fig. 6/19

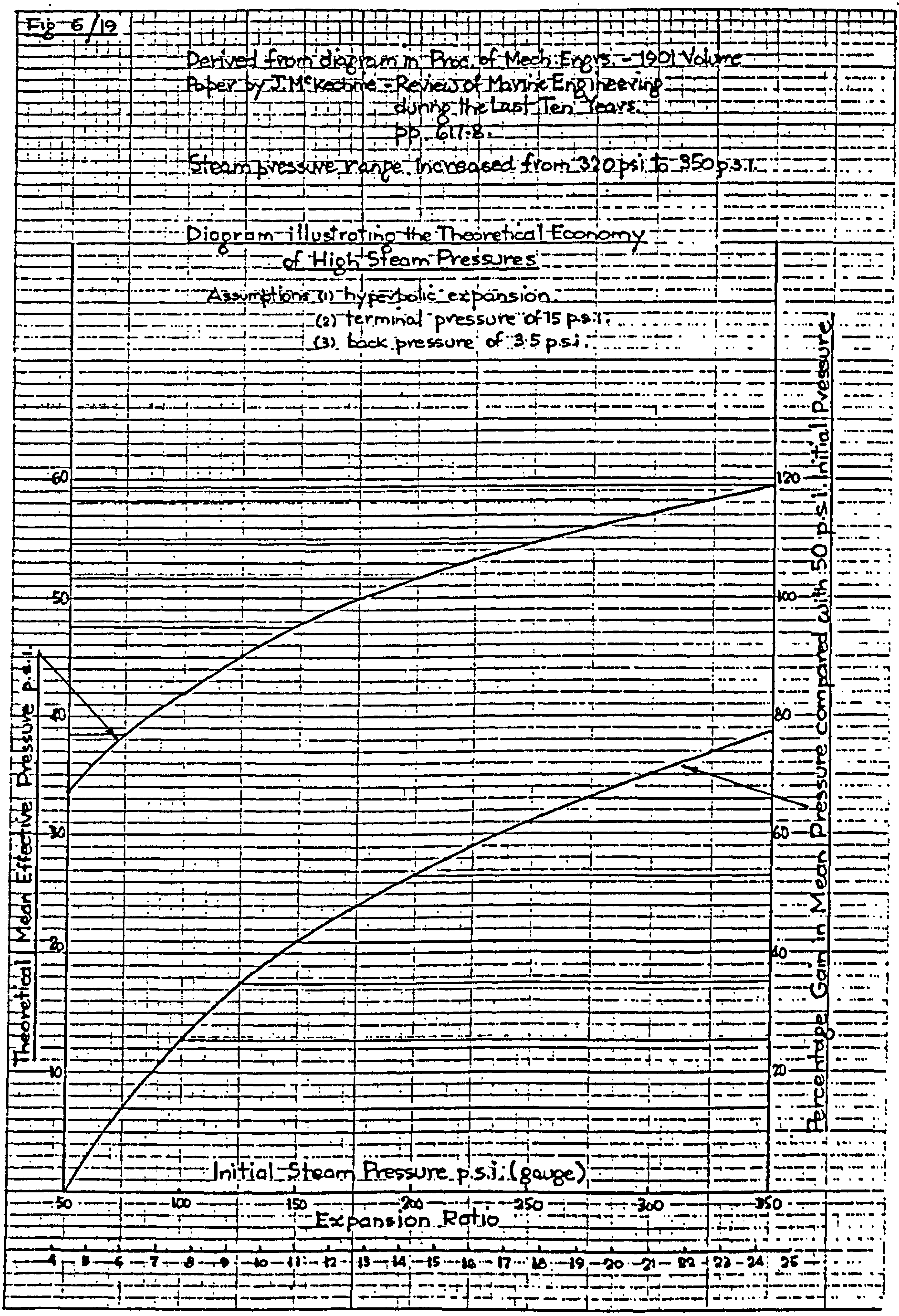


Fig 6/19
Derived from diagram in Proc. of Mech. Engrs. - 1901 Volume
Paper by J. McKechnie - Review of Marine Engineering during the Last Ten Years.
pp. 617-8.
Steam pressure range increased from 320 psi to 350 p.s.i.
Diagram illustrating the Theoretical Economy of High Steam Pressures
Assumptions (1) hyperbolic expansion.
(2) terminal pressure of 15 p.s.i.
(3) back pressure of 3.5 p.s.i.
Theoretical Mean Effective Pressure p.s.i.
10
20
30
40
50
60
Percentage Gain in Mean Pressure compared with 50 p.s.i. Initial Pressure
20
40
60
80
100
120
Initial Steam Pressure p.s.i. (gauge)
50
100
150
200
250
300
350
Expansion Ratio
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

SCOTT BUILT SHIPS
Coal Consumption lbs. per I.H.P. hr.

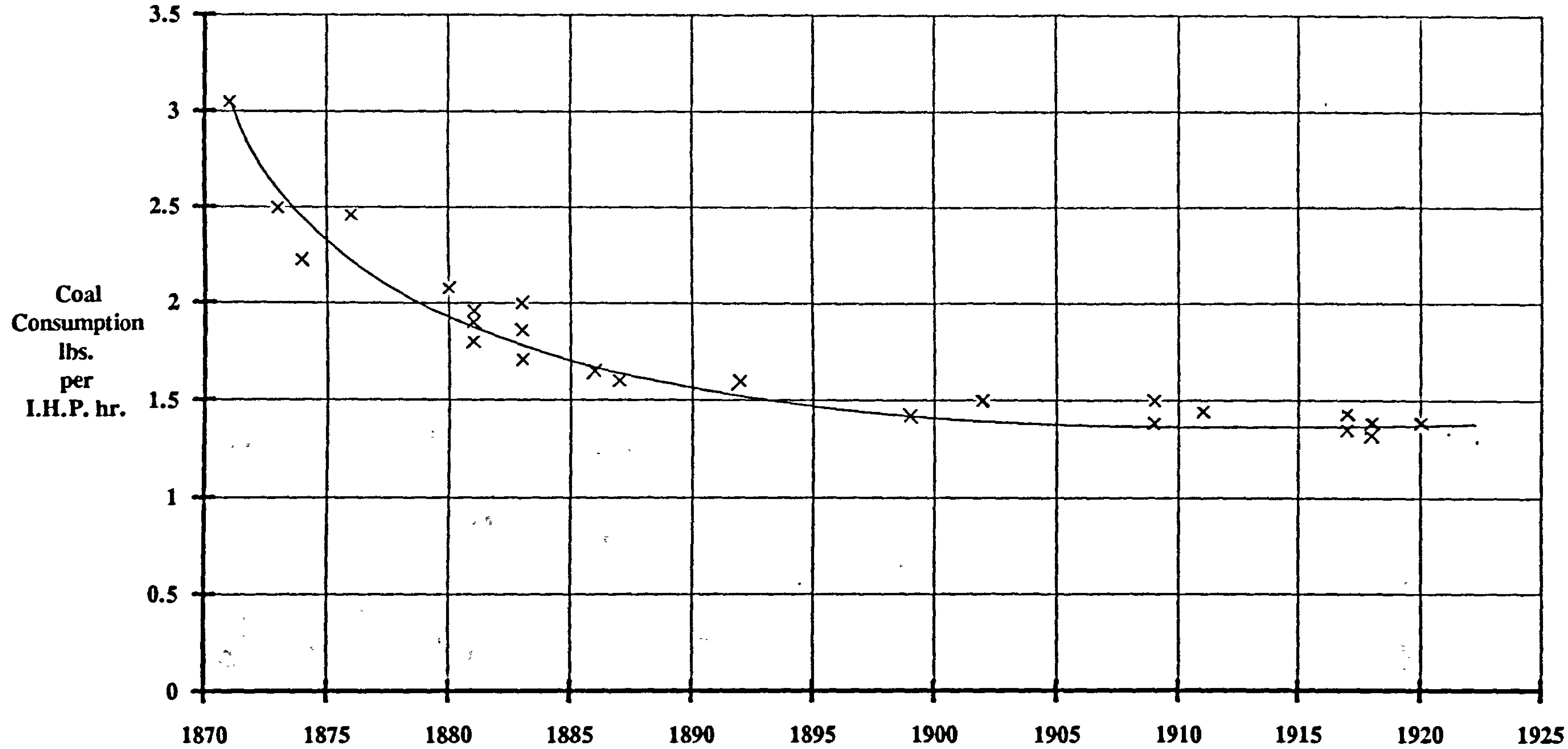
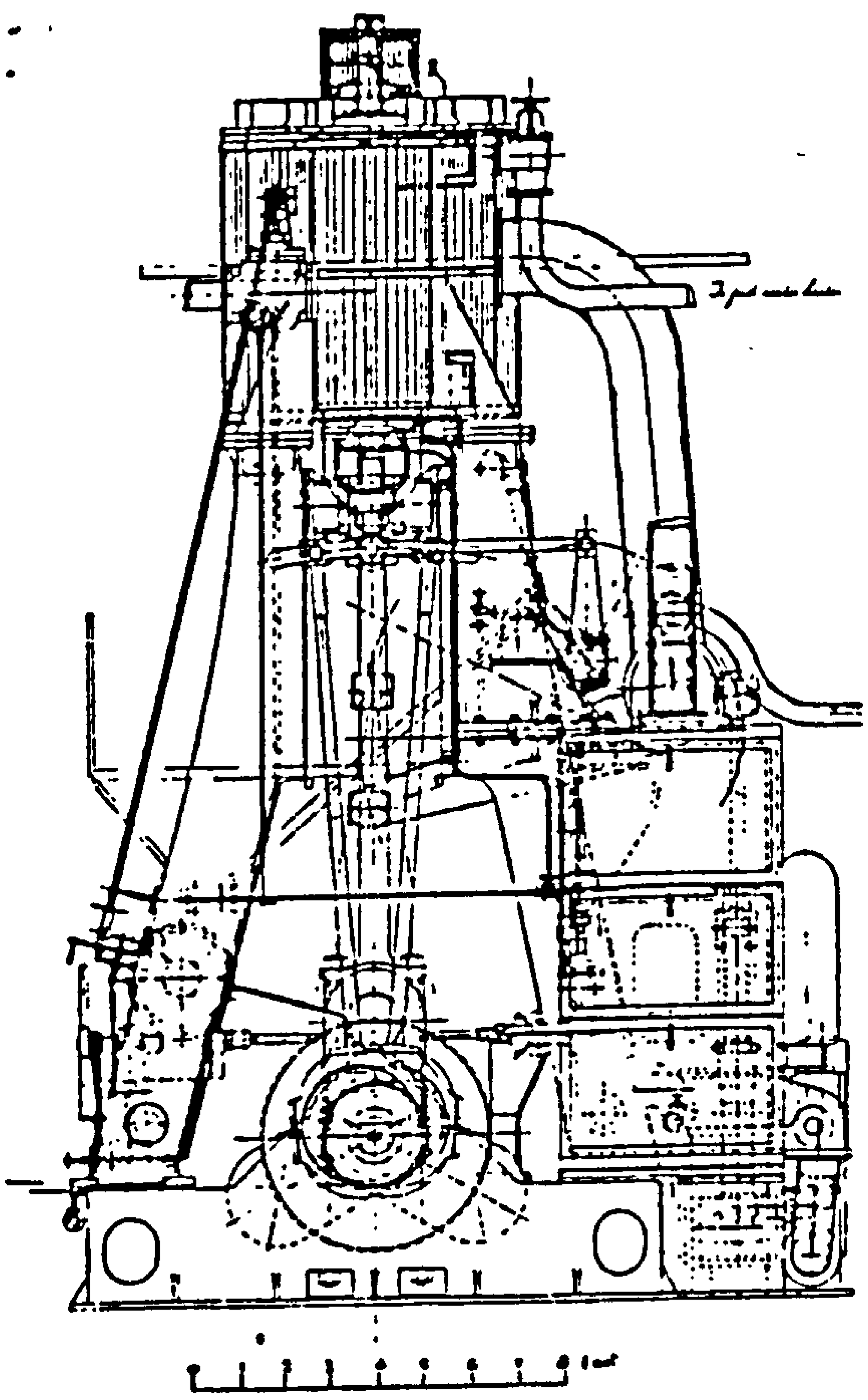


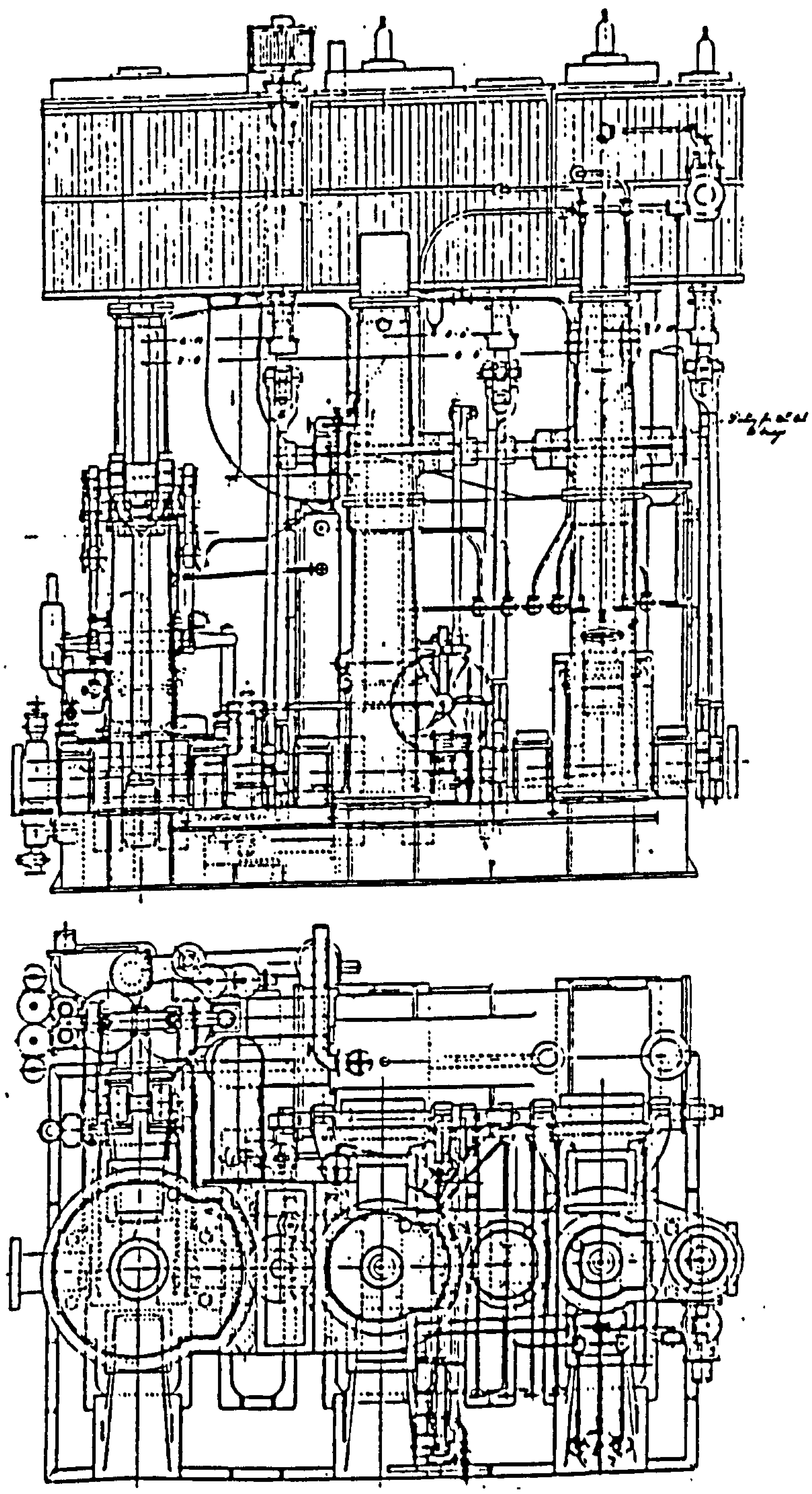
Fig. 6/20 Compiled from Scotts Sea Trials Data Books. GD319\23\2\1-4.

Fig. 6/21

s.s. Changsha
b. 1886.

John Swire
and Sons



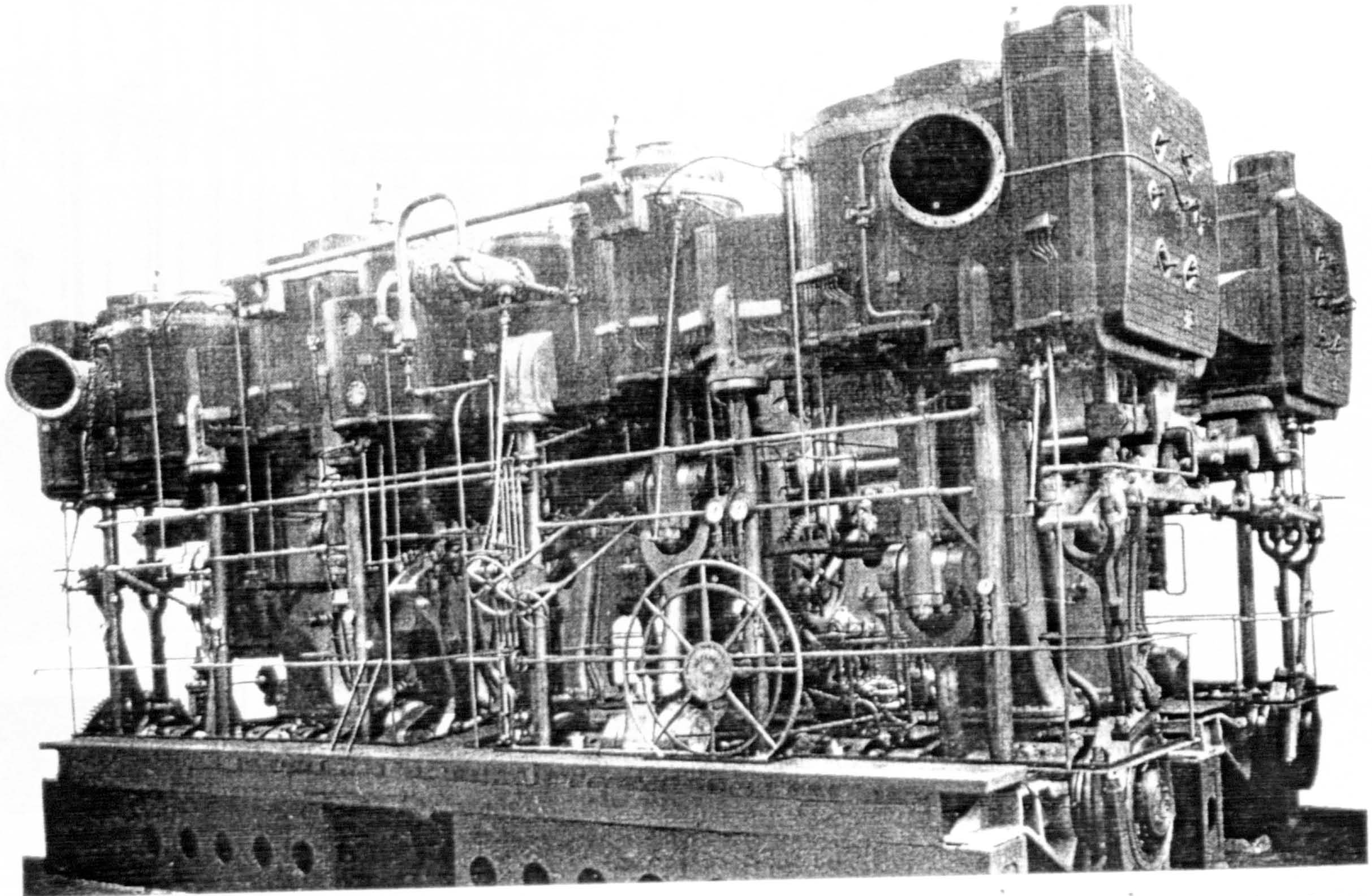


From Scotts Archives - Univ. of Glasgow
Drawings - GD 319/17

Diameter of High Pressure Cylinder	23"
" Intermediate Pressure Cylinder	38"
" Low Pressure Cylinder	62"
Stroke of Piston	4' 6"
Length of Connecting Rod between Centres	10-0"
Diameter of Air Pump single acting	18"
" Circulating Pump double acting	13½"
" Feed Pump	4½"
" Bilge Pump	4"
Stroke of Pumps	2' 3"
Crank Shaft	1' 11"
Working Pressure	160 lb
Cooling Surface in Condenser	3800 sq ft

Fig. 6/22 — Triple Expansion Engines - Nos. 356 - 9
Drawing No 4161
Greenock Foundry - May 1892

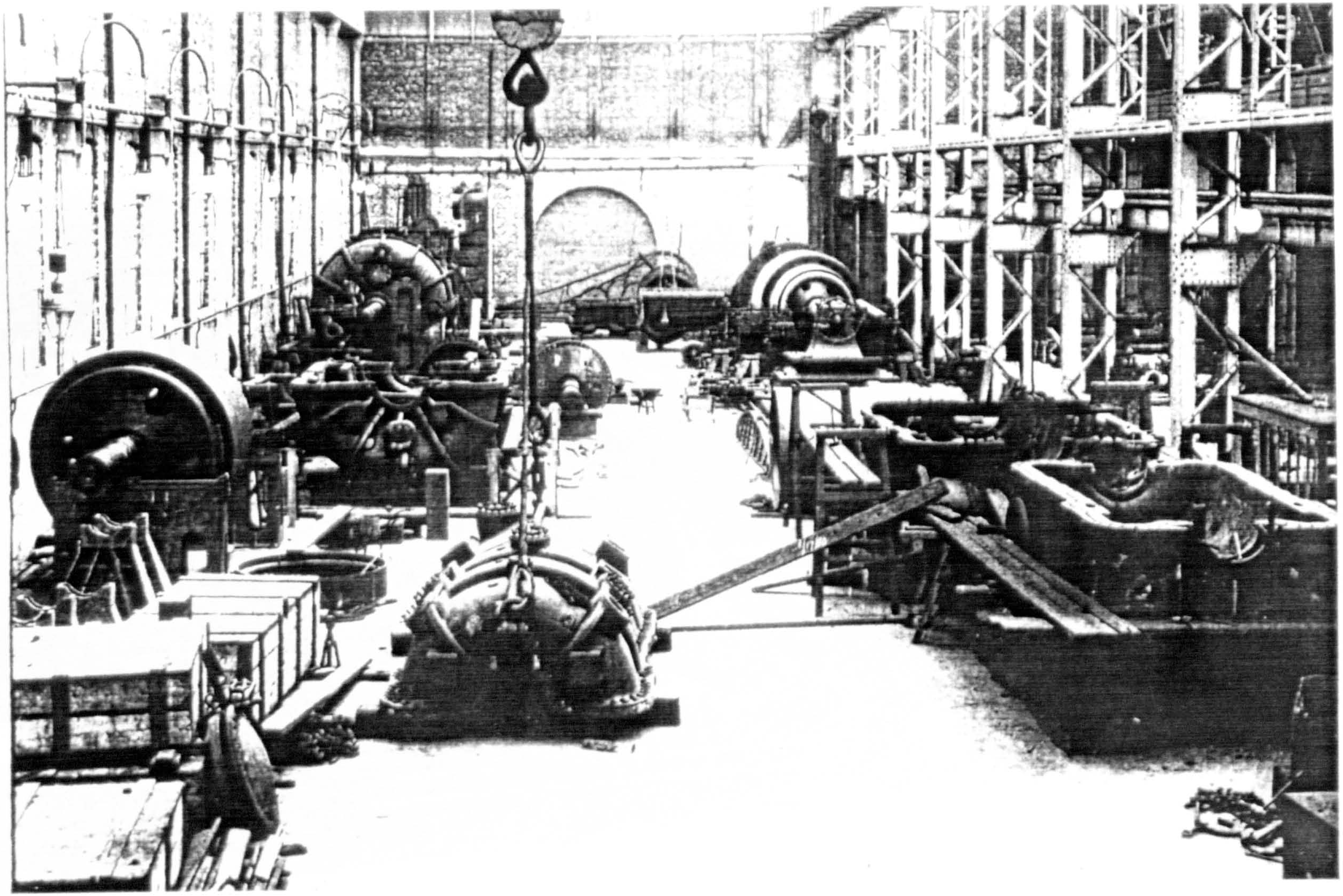
Fig. 6/23



HMS. Defence - Twin Screw Steam Reciprocating Machinery. - 1908
27540 I.H.P. — Highest powered installation of this type fitted in a major British warship.

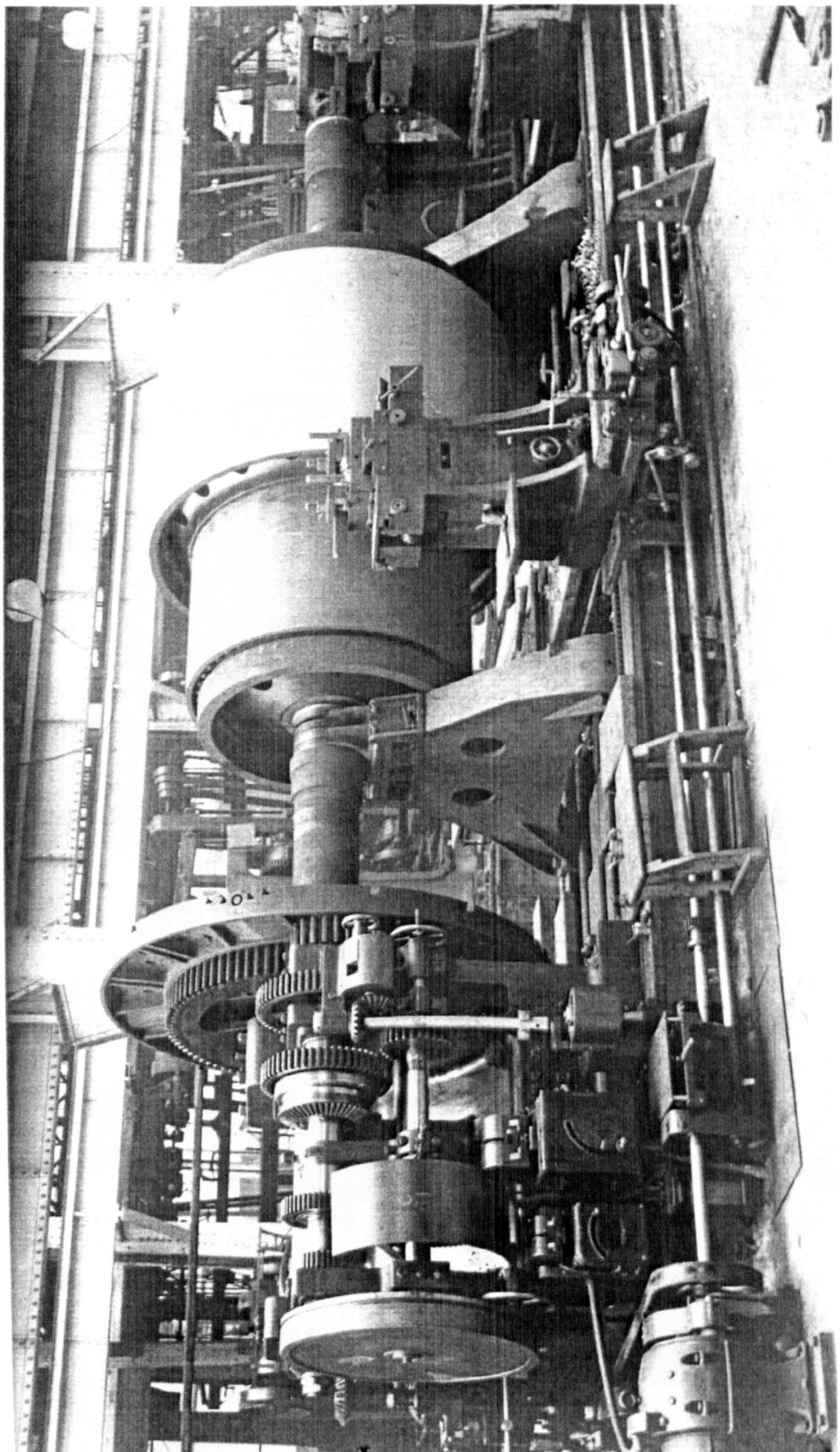
Fig. 6/23

Fig. 6/24



New Turbine Shop - 1910.
Machinery for HMS Colossus in hand.

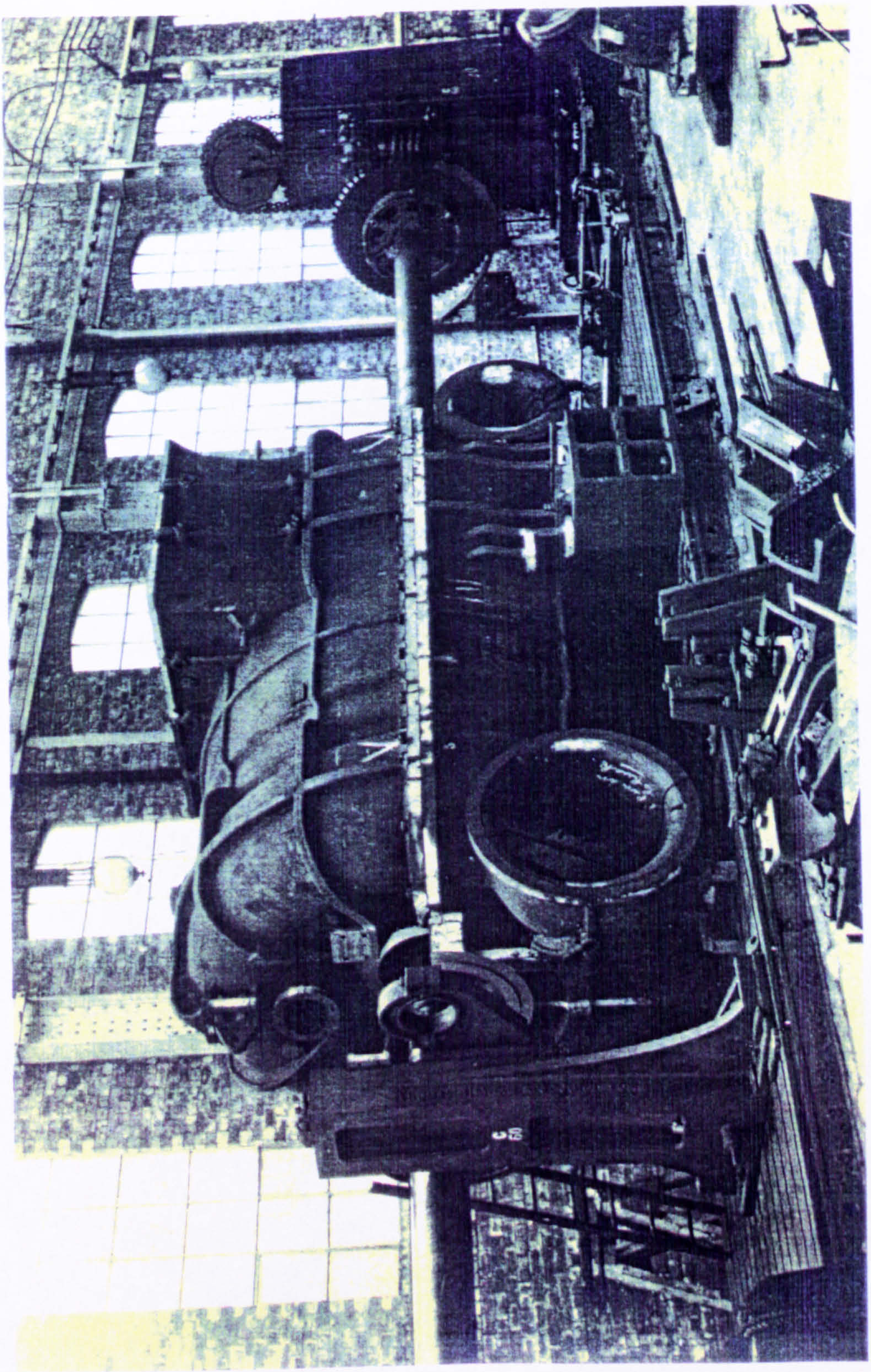
Fig - 6/25



HMS. Colossus L.P. Ahead & Astern Turbine Rotor in Lathe.

Fig. 6/26

Fig- 6/26



HMS Colossus L.P. Ahead & Astern Cylinder on Boring Mill.

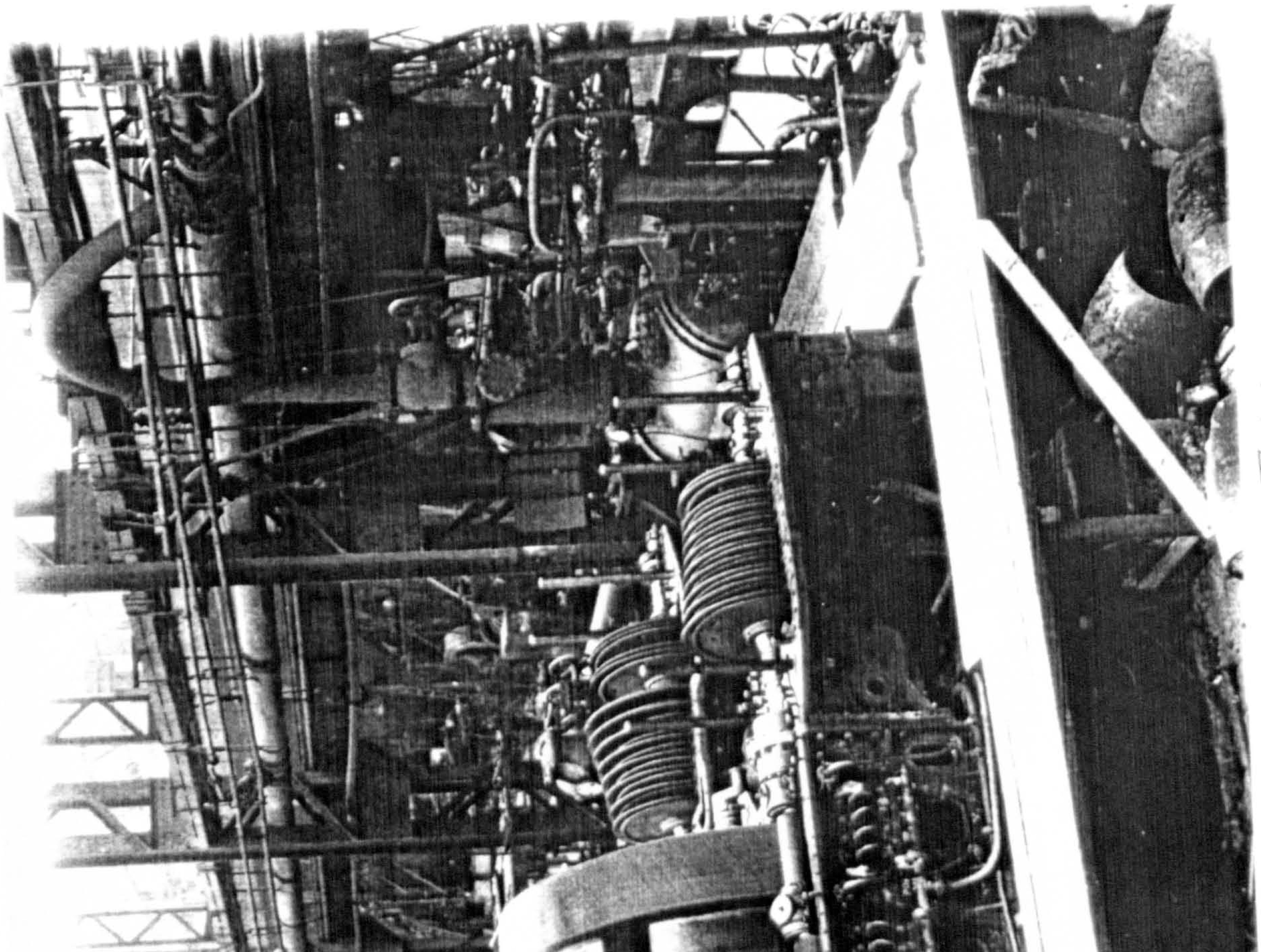


Fig. 6/27 T.S.S. Tero - Brown Curtis Impulse Turbines.

Fig. 6/28a

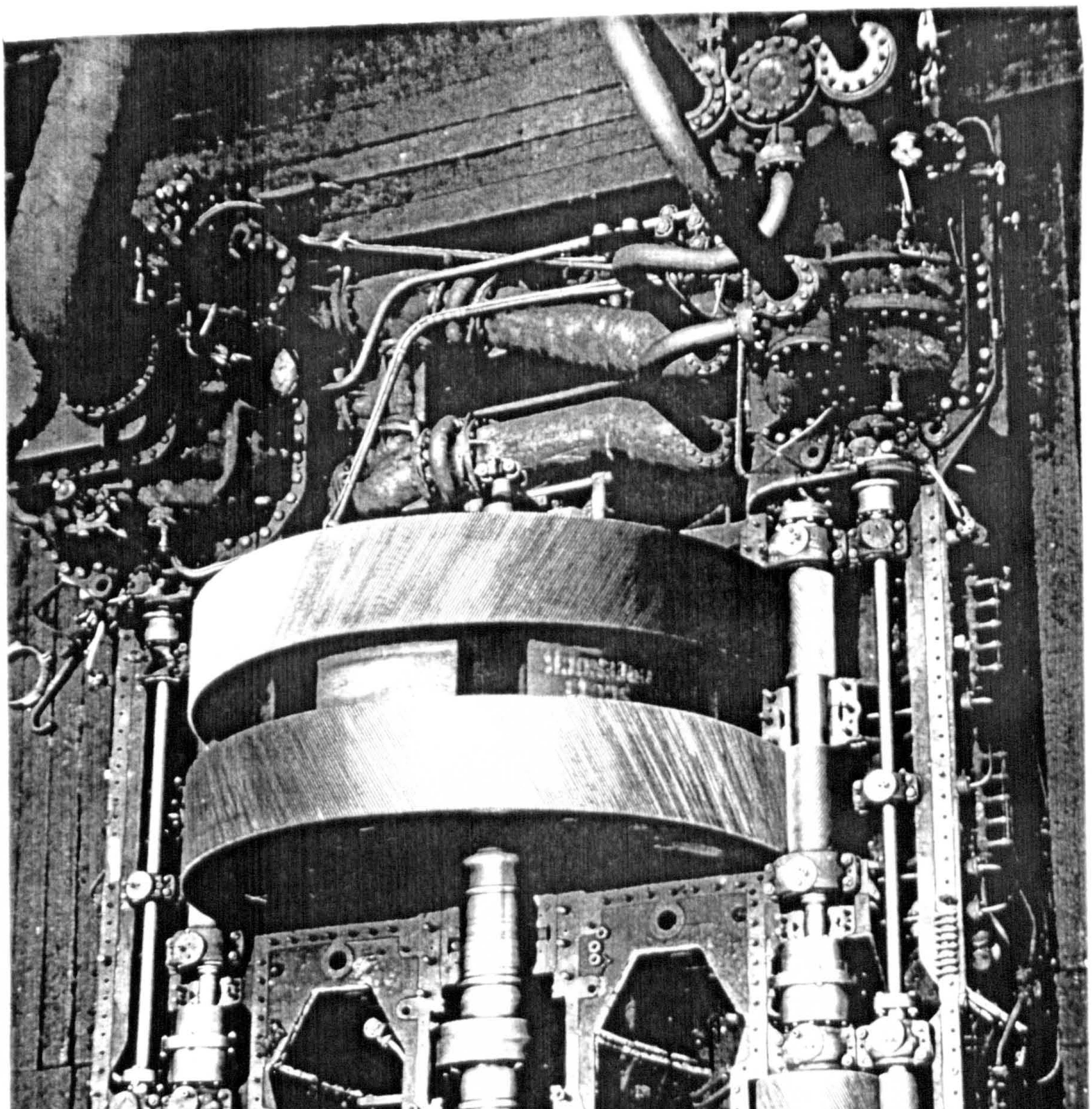


Fig. 6/28a - S.S. Asphalion - Arrangement of Turbines & Gearing.

S.S. ASPHALION

Double Reduction Gearing Installation - 3700 S.H.P at 78 r.p.m.
Additional Flexibility between primary wheels output and secondary pinions input by using quill shafts through hollow secondary pinions - see detail.
Reduction Ratios : H.P. 1/44 : L.P. 1/33

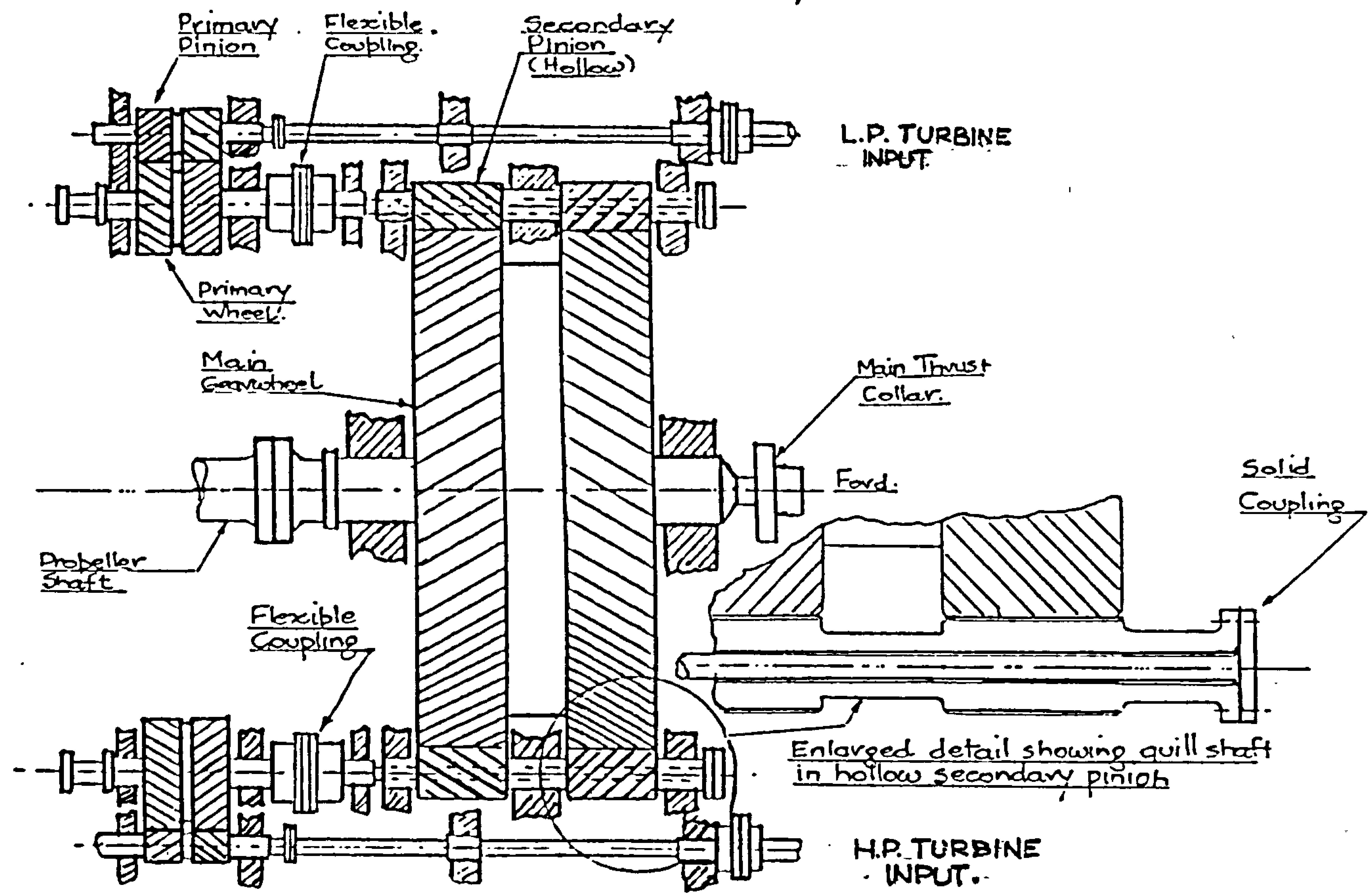


Fig. 28b. - From Scotts 'Two Centuries of Shipbuilding.' (London 1951)

J Y Robb.
1992

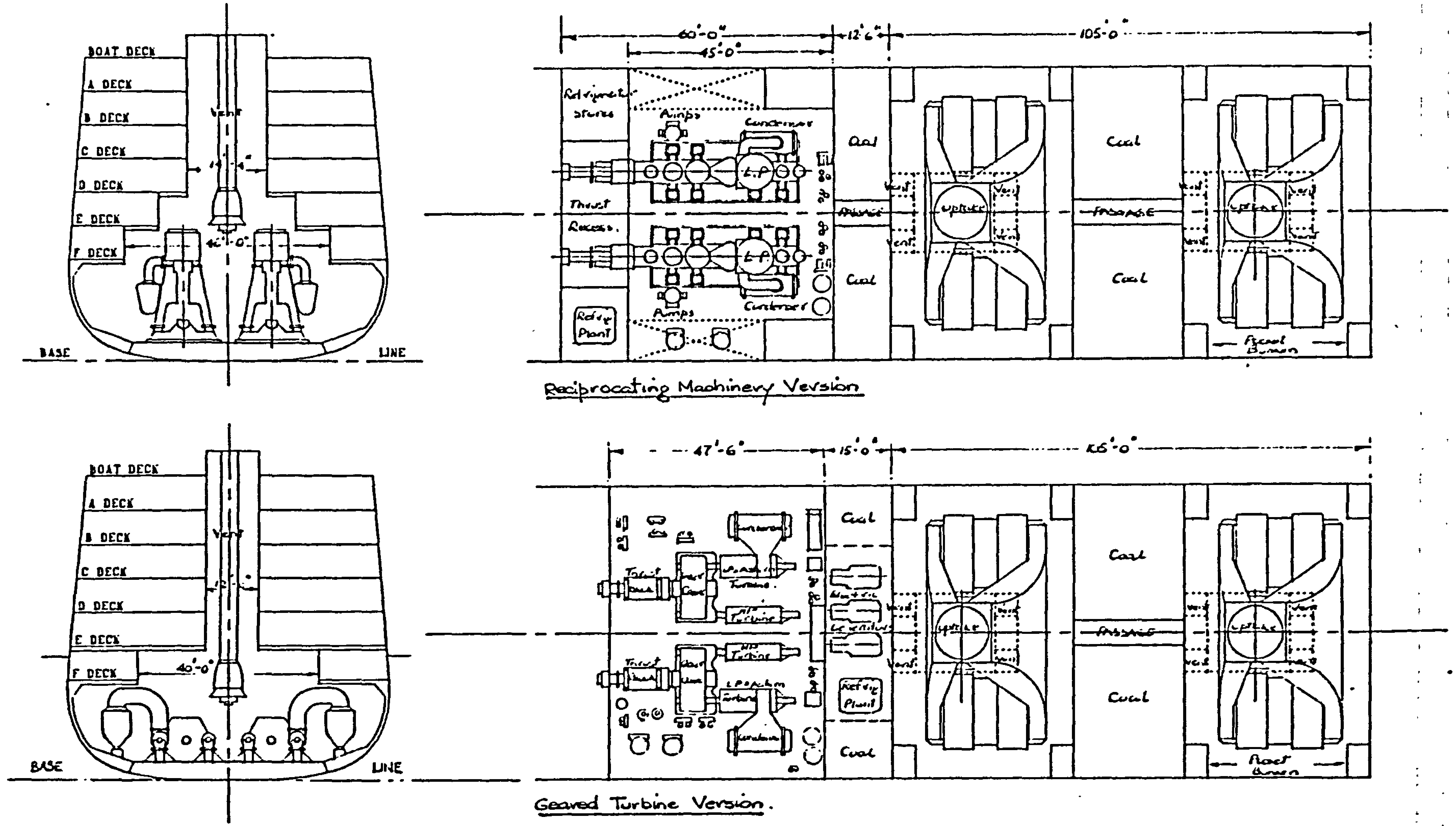
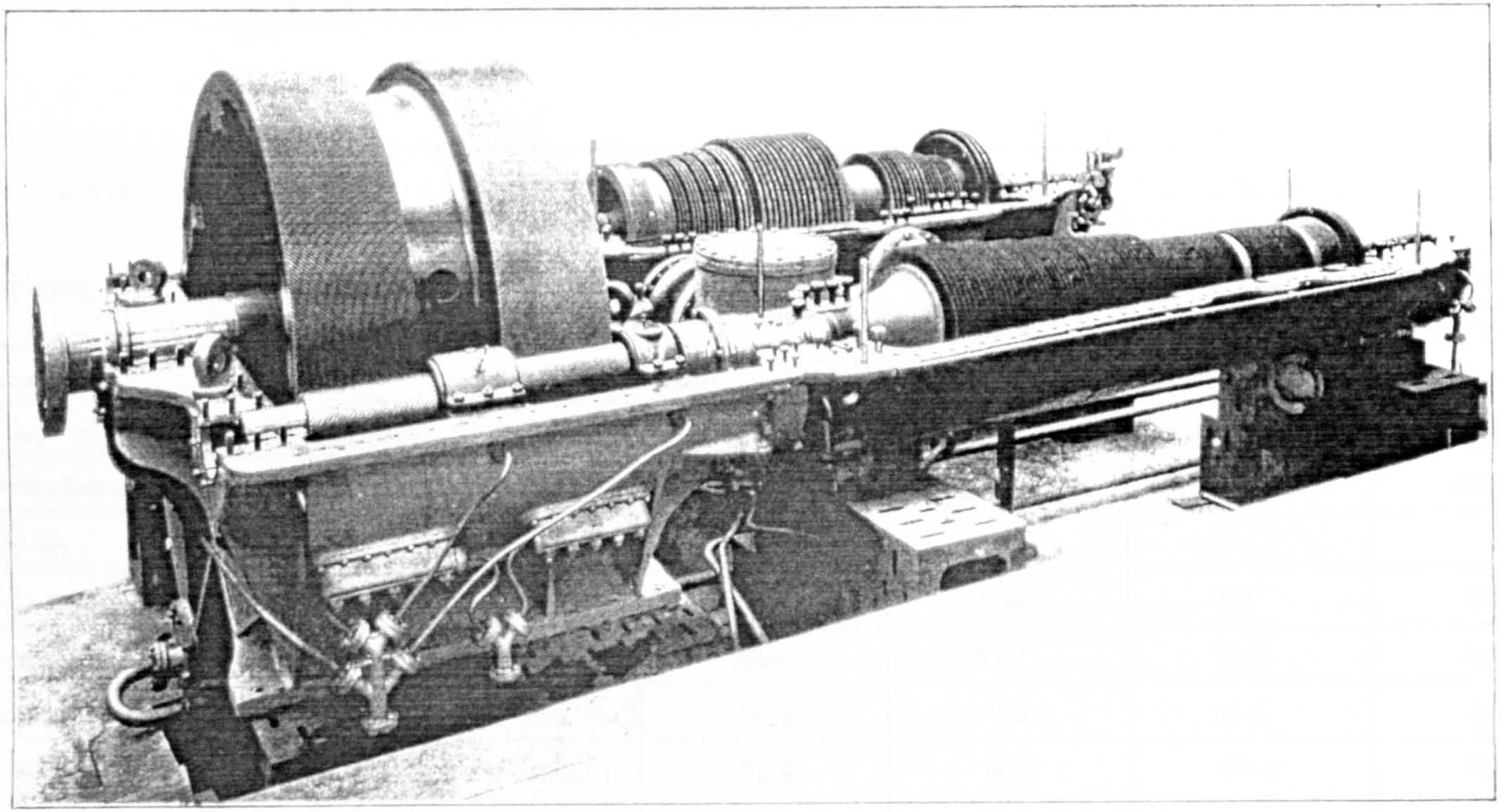


FIG 6/29 - ALTERNATIVE RECIPROCATING AND GEARED TURBINE MACHINERY FOR THE TRANSYLVANIA.



PERSPECTIVE VIEW OF TURBINES OF "TRANSYLVANIA," WITH TOP PARTS OF CASINGS REMOVED.

Fig. 6/30

Fig. 6/30

Fig 6/31

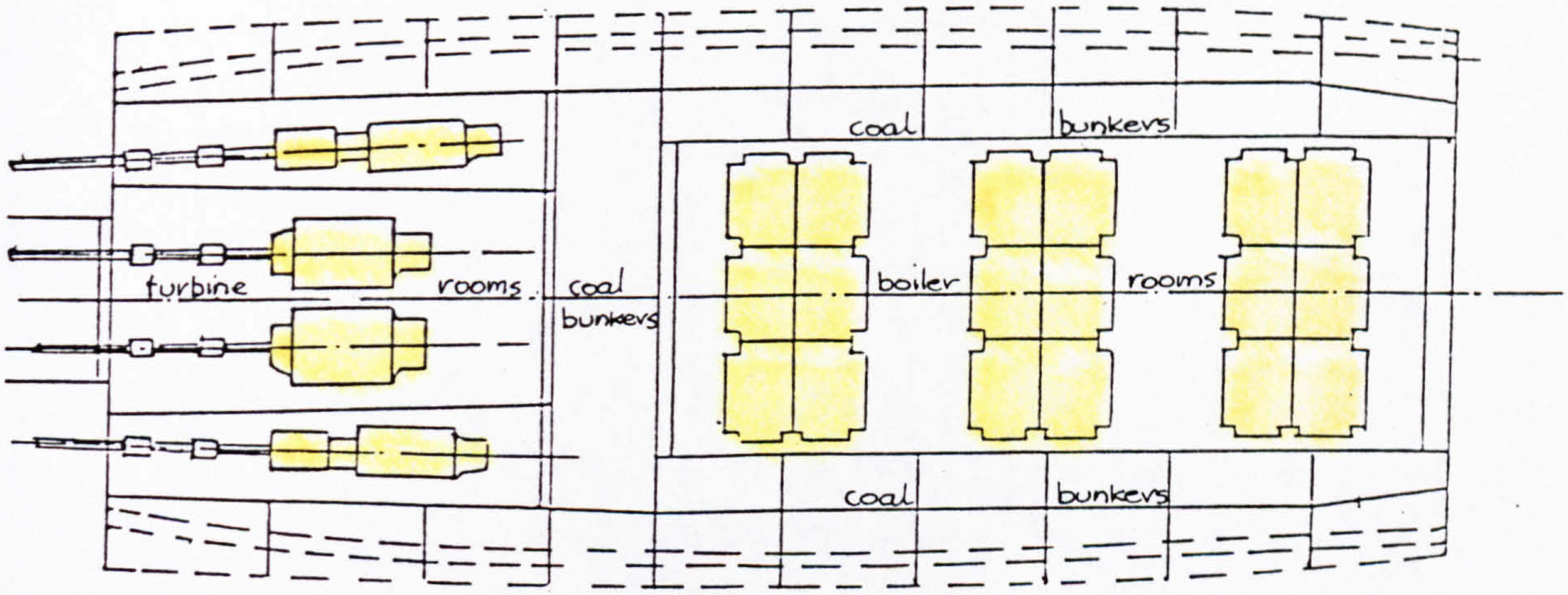
COMPARISON OF PERFORMANCE IN SERVICE OF SINGLE AND TWIN SCREW HOLT STEAMERS WITH DIFFERENT TYPES OF MACHINERY.

PARTICULARS	SINGLE SCREW VESSELS		TWIN SCREW VESSELS	
TYPE OF MACHINERY	Triple Expansion Reciprocating	Double Reduction Geared Turbines	Triple Expansion Reciprocating	Double Reduction Geared Turbines.
Name of vessel.	Helenus. (1913)	Troilus (1921)	Tyndareus (1916)	Achilles (1920)
Saturated or superheated steam.	Saturated.	Superheated.	Saturated.	Superheated.
Relative horsepower (at engine coupling)	4500	6200	5200	6800
Turbine r.p.m. (service)	-		-	
Propeller r.p.m. (service)	75	90	85	80
Weight of machinery per horsepower. (lbs)	510	367	545	402
Area of machinery space per horsepower (sq.ft.)	0·63	0·435	0·8	0·6
Cubic capacity of space per horsepower (cub.ft.)	22·2	16·2	24·0	18·7
Water consumption - lbs per horsepower. hr.	17·25	11·2	17·25	11·3
Coal consumption - lbs. per horsepower hr.	1·8	1·29	1·8	1·3
Coal per 1000 ton-miles of voyage (lbs).	60·5	54·5	47·5	42·5
Percentage saving in coal per 1000 ton-miles.	norm	9·75	norm	10·5
Percentage saving in cubic space.	norm	23·0	norm	22·0
Percentage saving in weight per horsepower.	norm	28·0	norm	26·0
Ship's speed - knots.	13·8	14·75	13·9	14·6

From Scotts' 'Two Centuries of Shipbuilding' - 1950 edition.

Fig. 6/31

COMPARISON OF MACHINERY SPACES OF SCOTT BUILT WARSHIPS FITTED WITH STEAM TURBINE MACHINERY SHOWING EFFECT OF IMPROVEMENTS IN BOILER & ENGINE EFFICIENCY & INTRODUCTION OF OIL FUEL & REDUCTION GEARING.

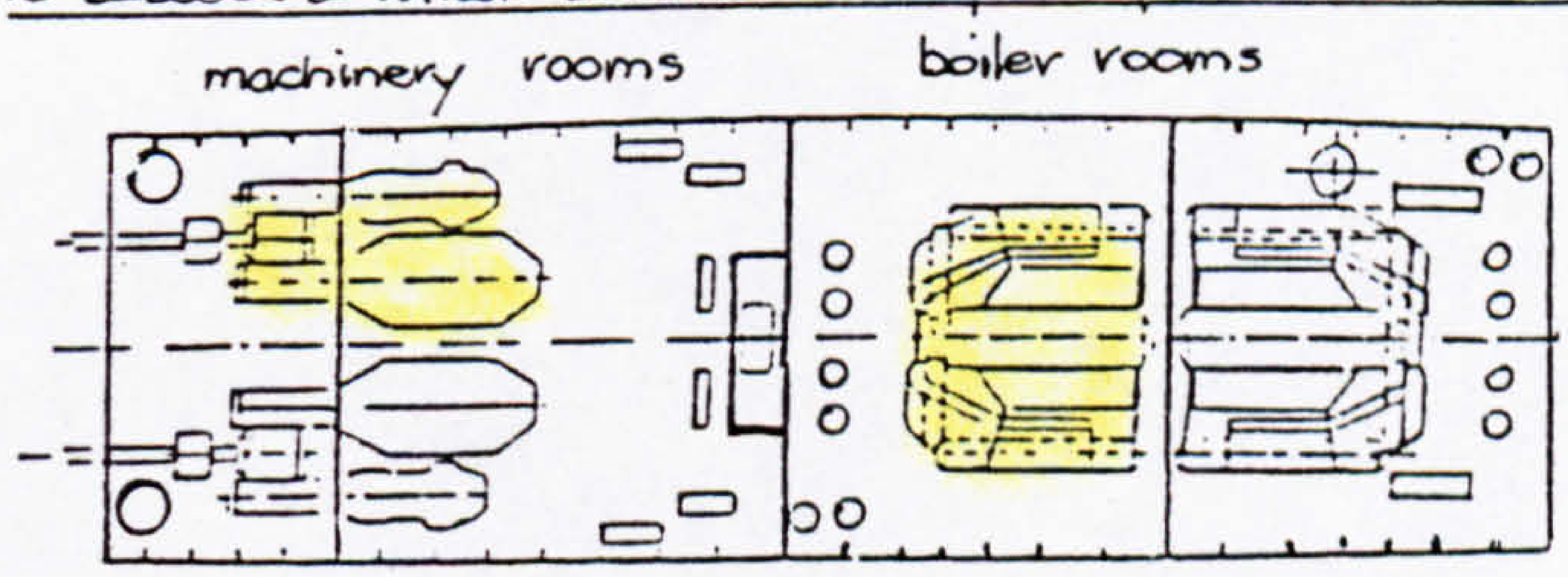


HMS 'AJAX'

Super Dreadnought Battleship - 1913

Total trial horsepower (4 direct coupled screws) - 28300 at 329 rpm.

18 Babcock & Wilcox boilers - 235 p.s.i. pressure. (saturated steam)

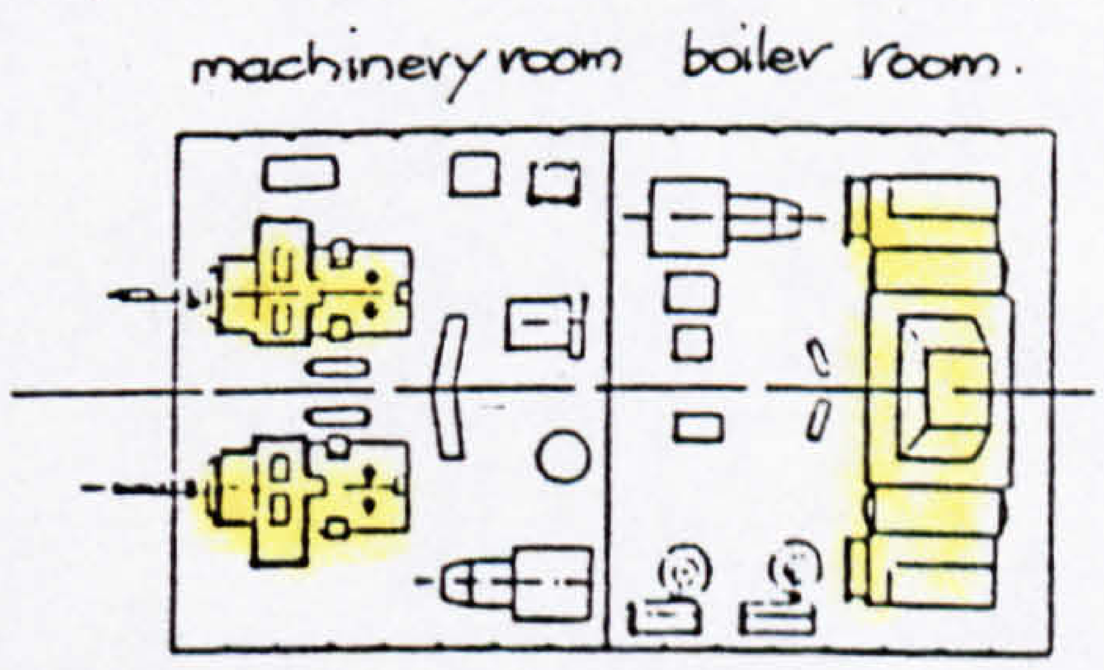


HMS 'LOOKOUT'

'L&M' Class wartime Destroyer - 1942.

Total trial horsepower (twin screw, single reduction gearing) - 48000 at 336 r.p.m.

2 Admiralty 3-Drum boilers - 300 psi pressure, 660°F suphtr. outlet.



HMS EURYALUS

Leander Class Frigate - 1964

Total trial horsepower (twin screw, double reduction gearing) - 30,000 at 230 rpm.

2 Babcock and Wilcox Integral furnace controlled superheat boilers,

550 psi. pressure, 950 °F suphtr. outlet

Units shaded represent roughly comparable horsepower.

Drawings are to scale.

I F Robb.
1992

SCOTT BUILT SHIPS
Condenser Cooling Surface
Square Feet per I.H.P.

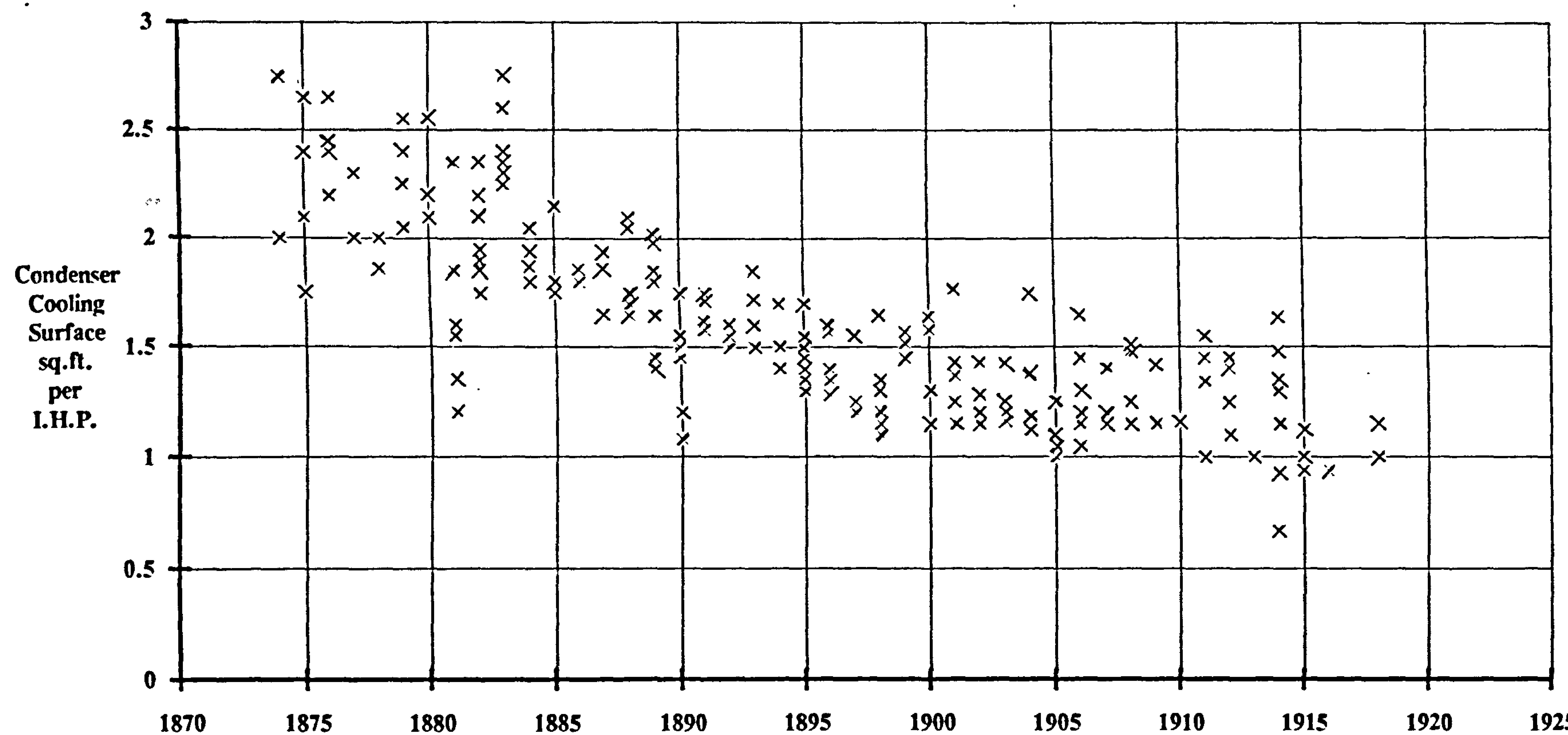


Fig.6/33. Compiled from Scotts Sea Trials Data Books, Archive Ref. GD319/23/2/1-4.

Fig 6/33.

Fig.6/34

SCOTT BUILT SHIPS
Register Tonnage.

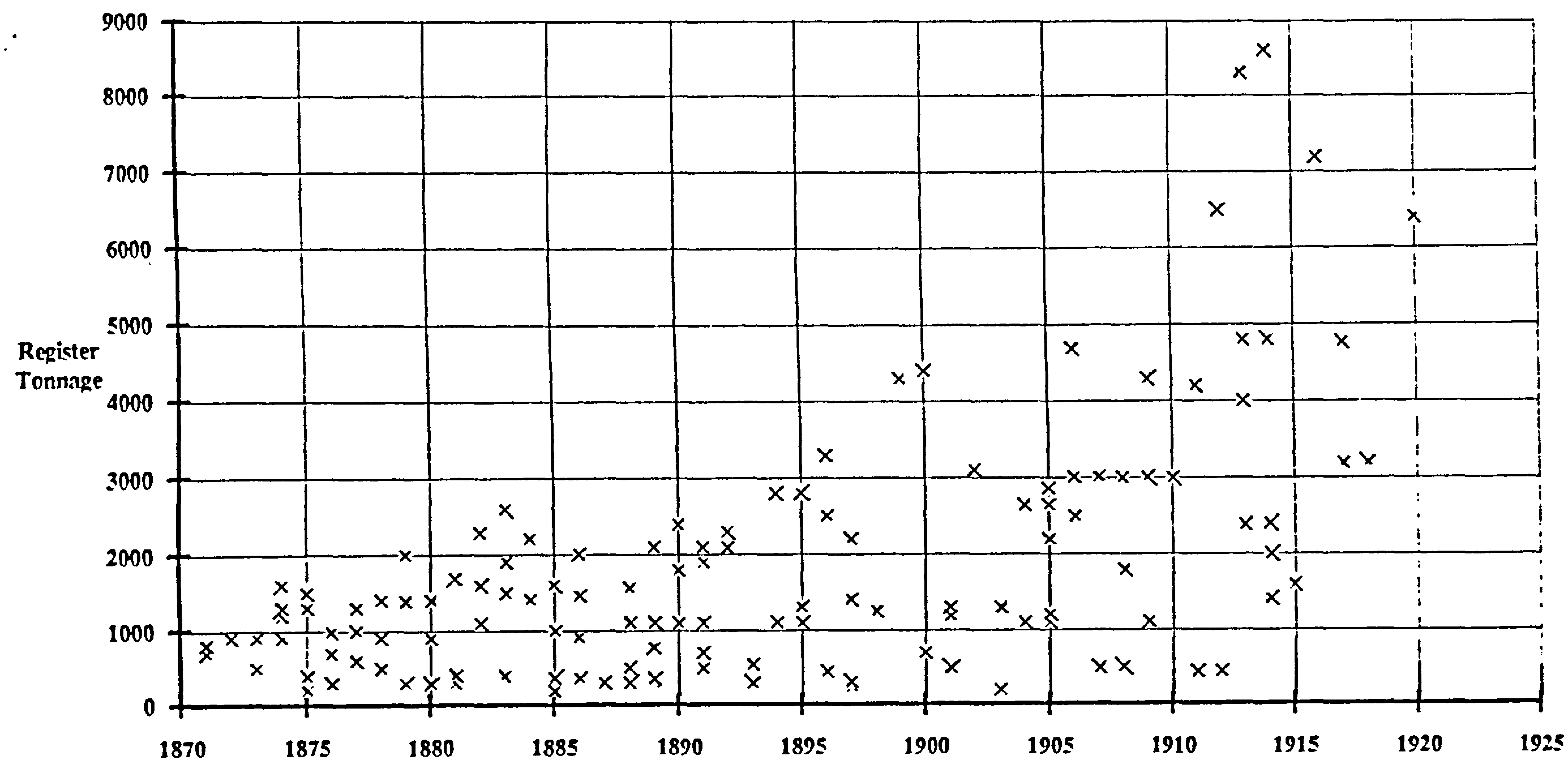


Fig.6/34 - Compiled from Scotts Sea Trials Data Books. Archive Ref. GD319/23/2/1-4.

SCOTT BUILT SHIPS
Reciprocating Steam Engines
Indicated horsepower

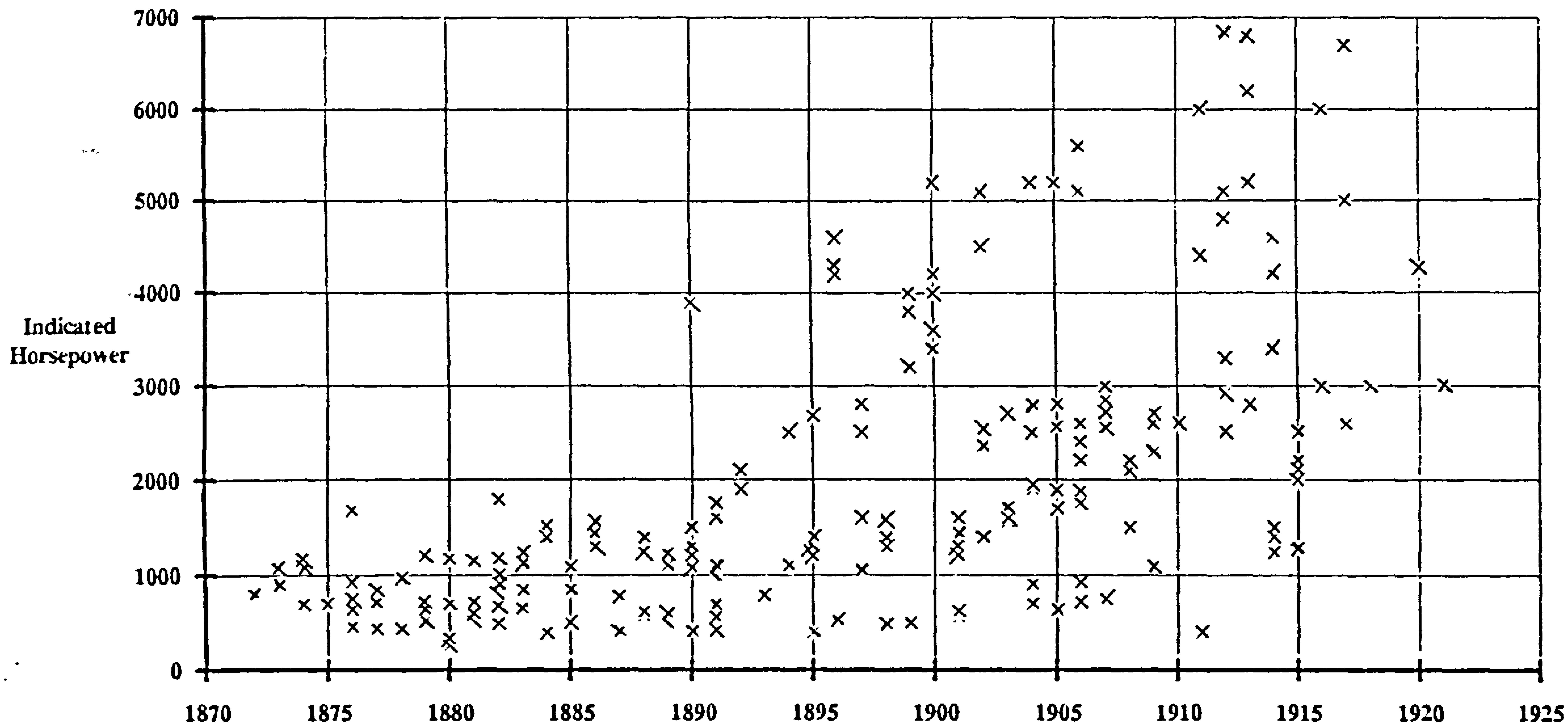


Fig. 6/35 Compiled from Scotts Sea Trials Data Books. Archive Ref. GD319/23/2/1-4.

SCOTT BUILT SHIPS
Trial Speed. Knots.

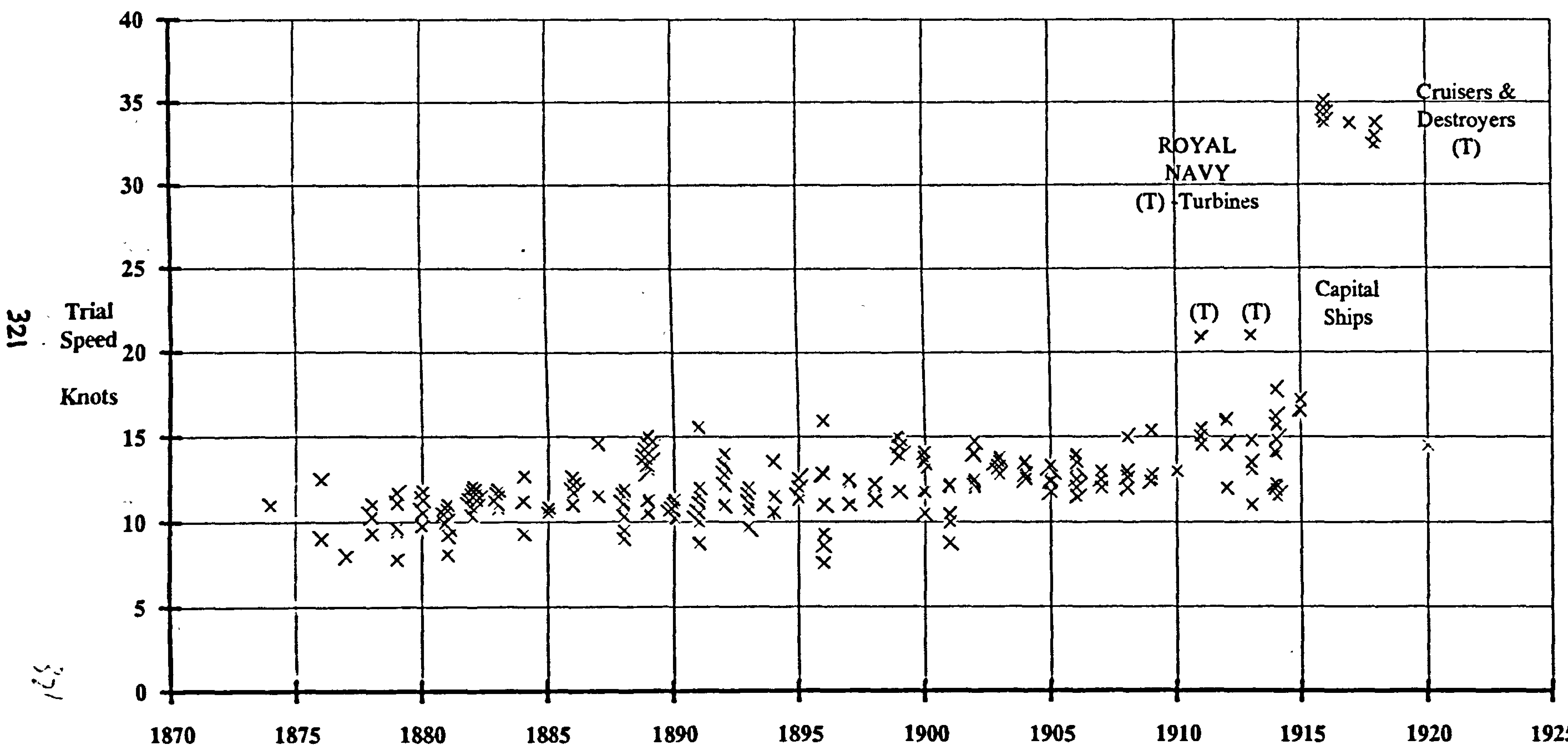


Fig. 6/36 Compiled form Scotts Sea Trials Data Books, Archive Ref. GD319/23/2/1-4.

SCOTT BUILT SHIPS
Reciprocating Engines
Piston Speed. Feet per Minute.

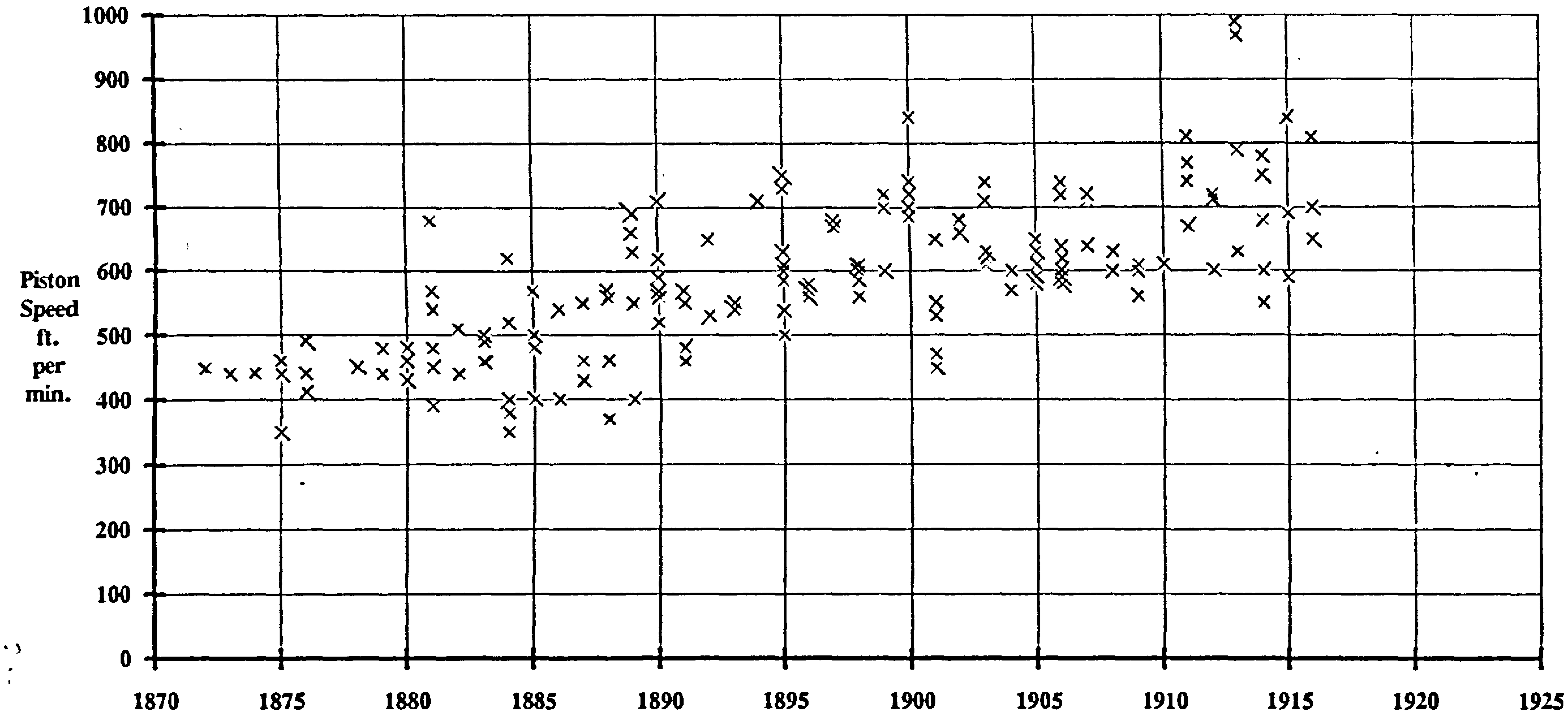


Fig. 6/37 Compiled from Scotts Sea Trials Data Books, Archive Ref. GD319/23/2/1-4.

SCOTT BUILT MERCHANT SHIPS
(Excl. yachts & other specialist shallow draught craft.)
Revolutions per Minute.

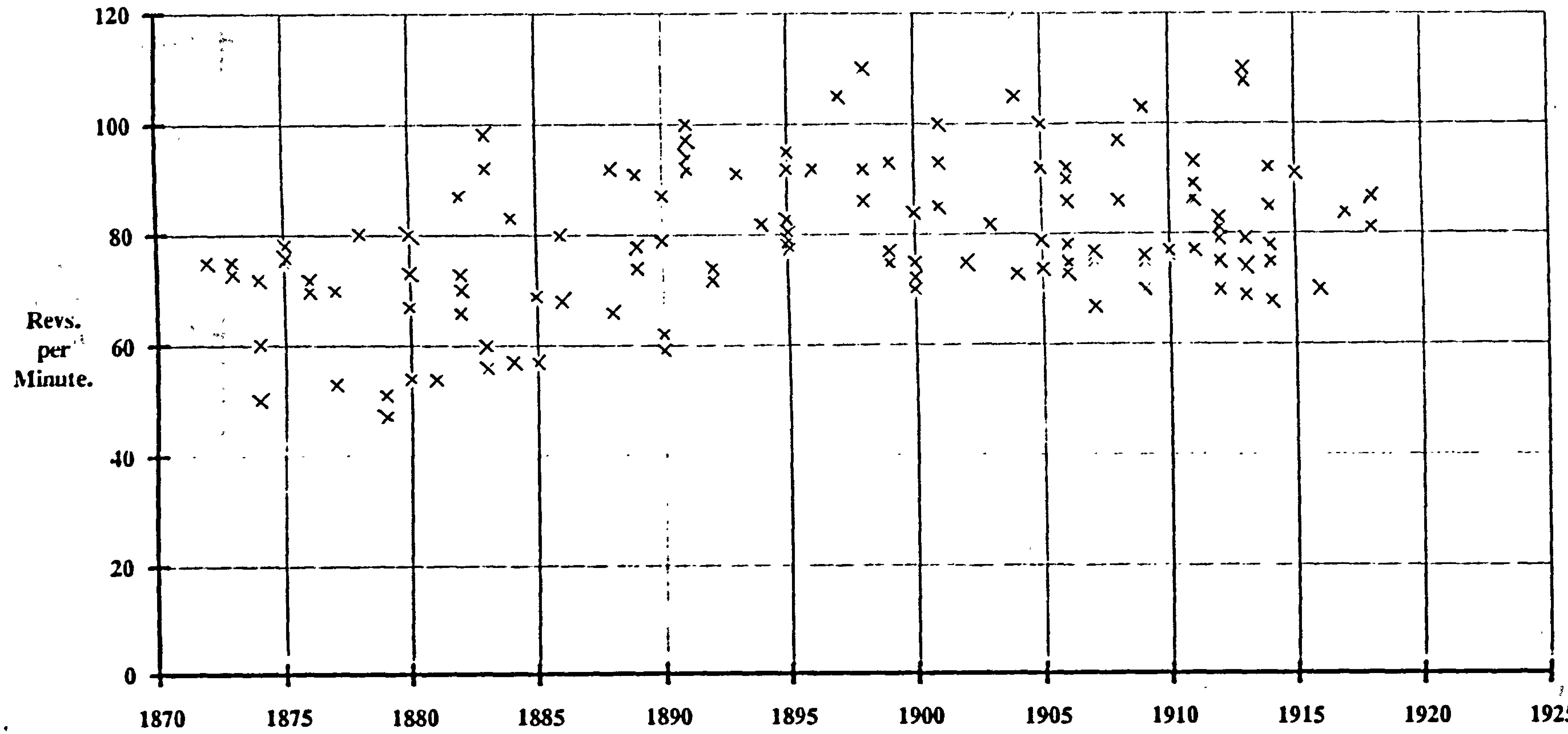


Fig. 6/38 Compiled from Scotts Sea Trials Data Books, Archive Ref. GD319/23/2/1-4.

Fig. 6/39

Nett Tonnage of Ships Built in the United Kingdom.

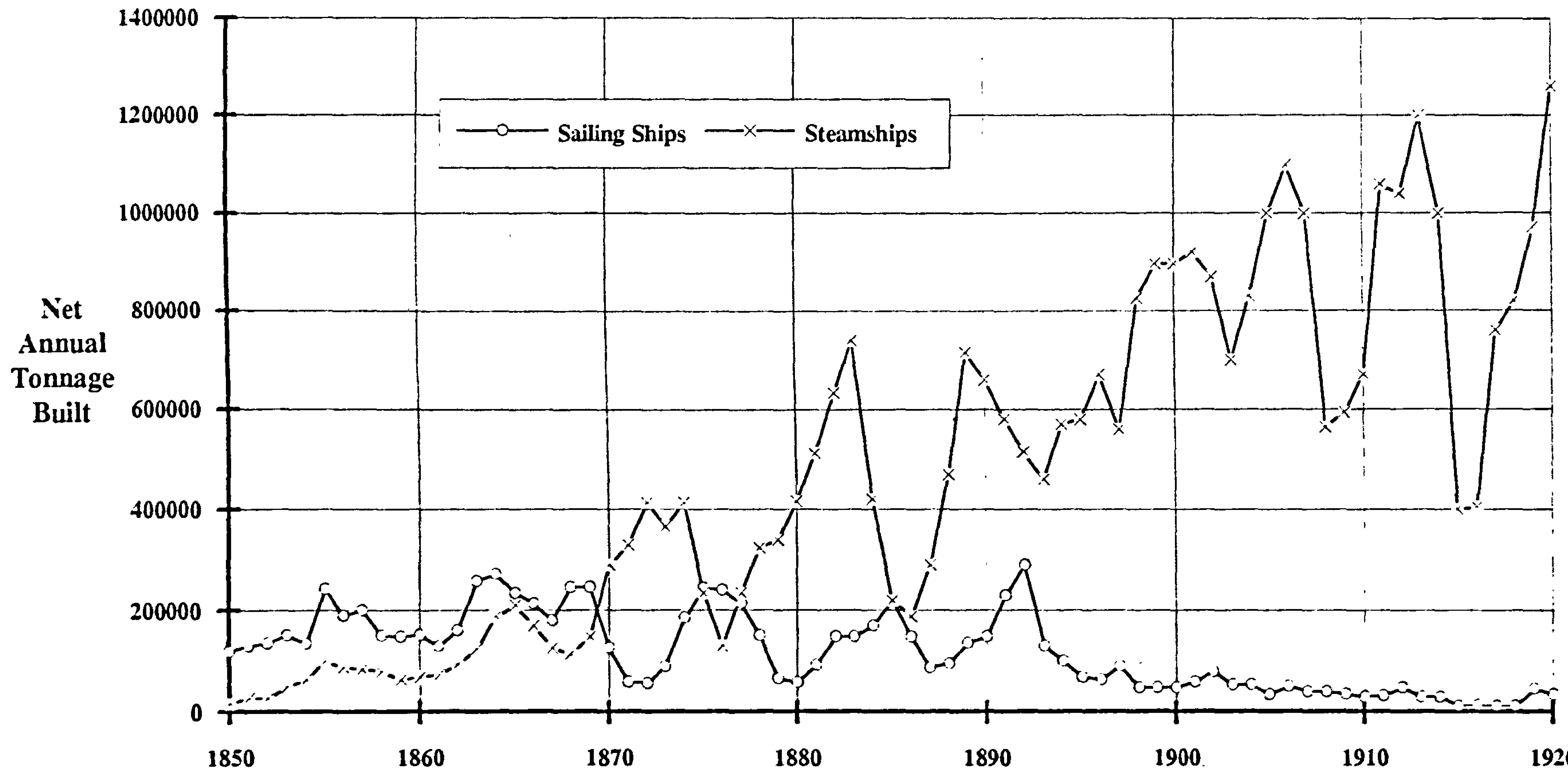


Fig. No. 6/39 - from W.S. Cormack - Unpublished Thesis - Univ. of Glasgow - 1930.
(Economic History of Shipbuilding and Marine Engineering - Table C1.

Fig.6/40

Tonnage of Vessels of All Countries engaged in foreign trade which entered or cleared UK ports in cargo or ballast.

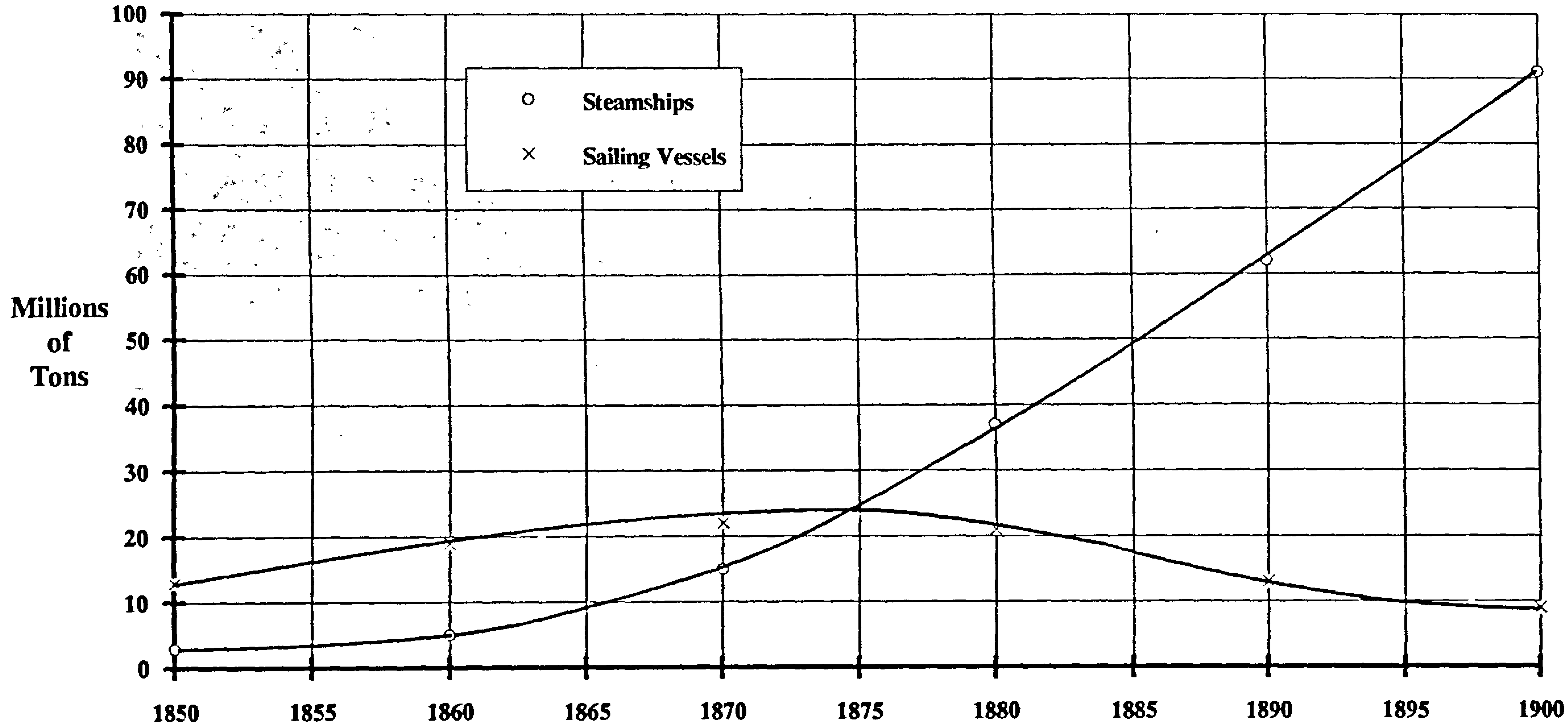
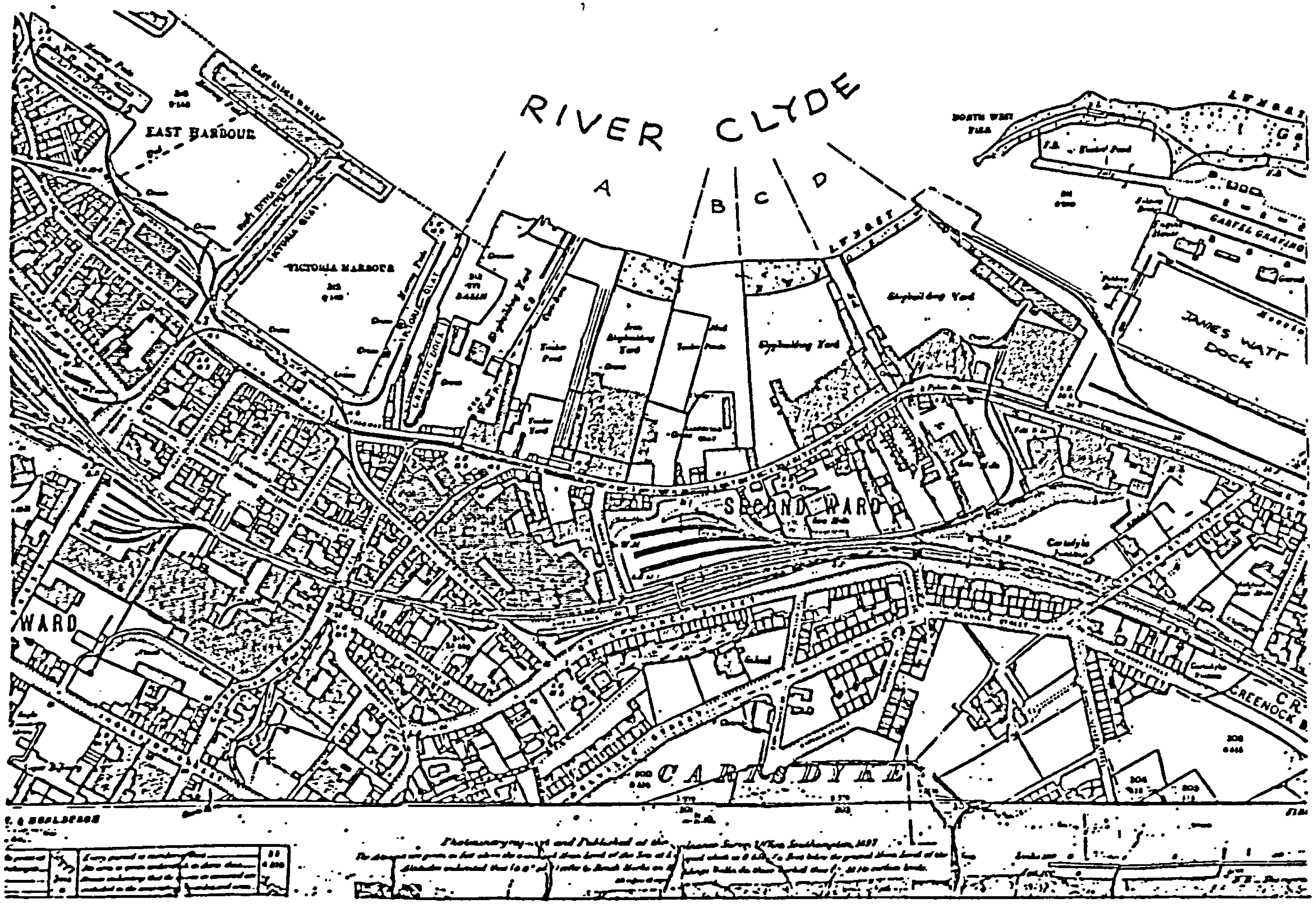


Fig. 6/40. From W.S. Cormack - Unpublished Thesis - Univ. of Glasgow - 1930 (Economic History of Shipbuilding and Marine Engineering p. 146.



A. — Cartsburn Dockyard - Purchased by Scotts' from Steele & Co - 1883.
B. — Former Cartsdyke Harbour - Absorbed into Cartsburn Dockyard - 1920.
C. — Cartsdyke Mid Yard - Occupied by Russell & Co until 1900; G & G Co until 1920: Greenock Dockyard Until 1934.
D. — Scotts' Cartsdyke Shipyard. Exchanged for C in 1934.

1966 — Scotts took over C - Greenock Dockyard Co. & thereby occupied A+B+C+D.

Fig.6/41 Cartsburn & Cartsdyke Shipyards - 1897

1897 - Ordnance Survey:

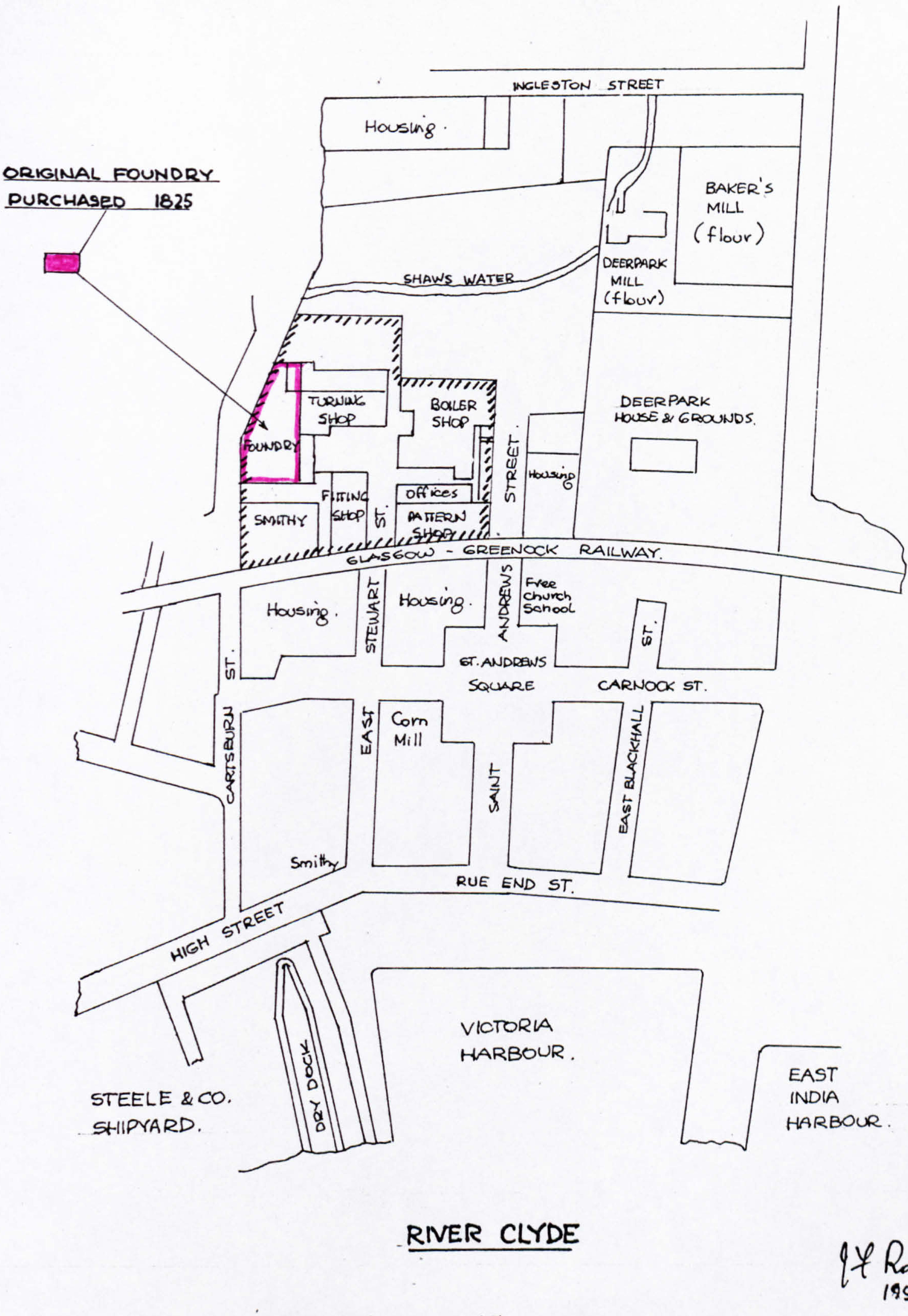


Fig. 6/42 **SCOTTS ENGINE WORKS 1859**

Derived from old maps of Greenock — Reid (1818) & Wood (1825) and the 1857 Ordnance Survey.

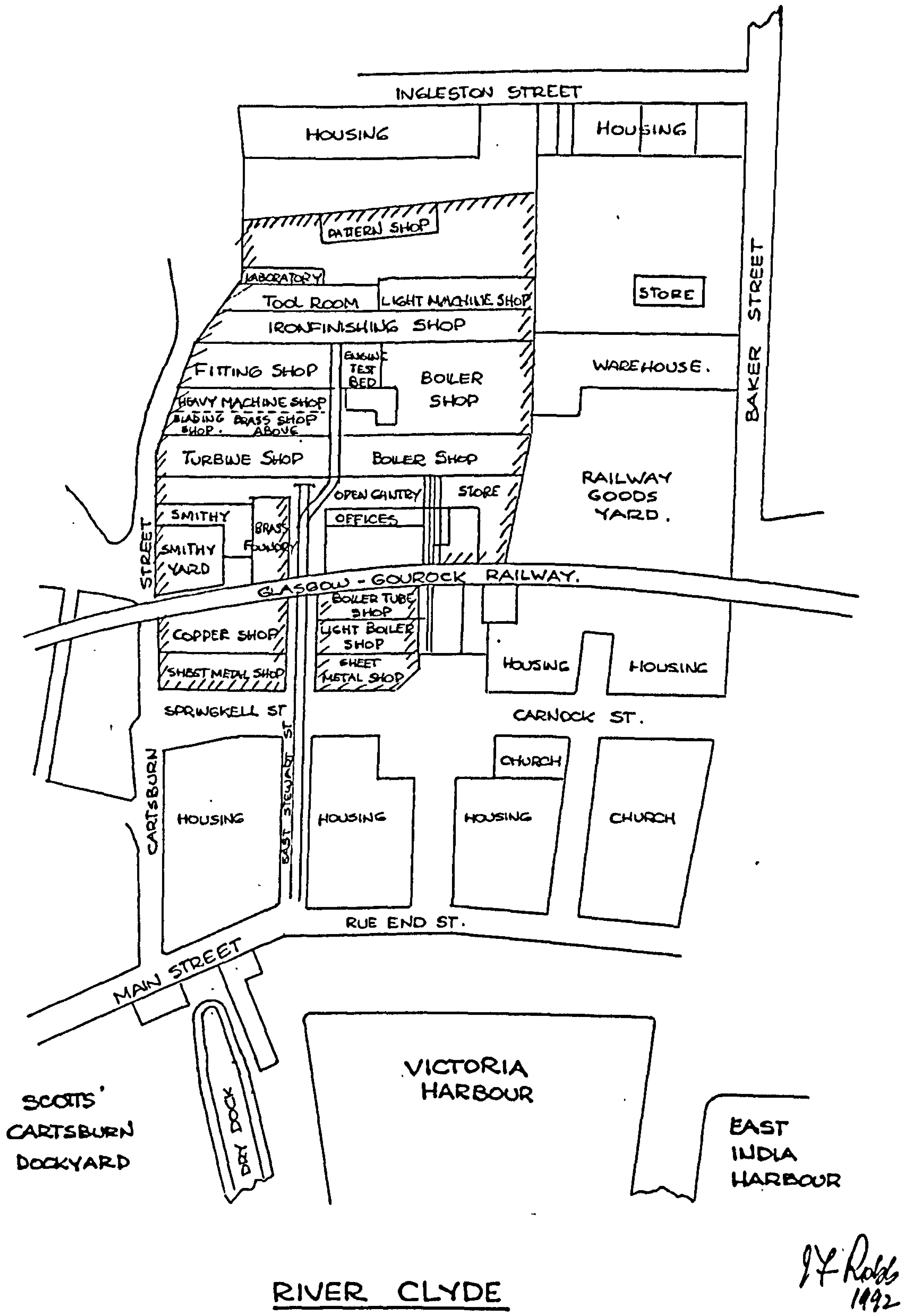


Fig.6/43 - SCOTTS' ENGINE WORKS - 1912

CHAPTER 7.

MODERNISATION, WAR AND THE AFTERMATH.

CHAPTER 7.

MODERNISATION, WAR AND THE AFTERMATH.

The end of the previous chapter described how during the forty year partnership of John Scott IV and Robert Sinclair Scott, they ran the business in much the same way as their father and grandfather had done in their day. It was very much a hands-on operation with the Scotts in direct daily communication with their foremen. It had long been understood that Charles C. Scott II would succeed to the chairmanship of the company when his father and uncle passed on. Consequently, on completion of his education, Charles joined the firm and spent nearly twenty years in management preparing for the task ahead.

When Charles took over as Chairman in 1905 with his younger brother Robert Lyons Scott as his deputy, a number of factors combined to encourage a change in management style. Perhaps the most important was that the role of the family in the running of the business was already changing. Professional managers of the shipyards and the engine works had been appointed to the board of the new limited company and were progressively modifying the overall company management structure.[1] The introduction of these men was designed to obtain the maximum advantage from the modernisation and expansion of Scotts' facilities put in hand in the 1890s and which was to continue into the early years of the war.

In parallel with these developments, Scotts' at this time were heavily involved with the contract to build the armoured cruiser 'Argyll', which was drawing to a satisfactory conclusion, and which had required considerable investment in new facilities. These included a new wet dock and a 120 ton fitting out crane which involved an outlay of £170,000 over the four years to 31st December 1905.[2] The magnitude of this contract and its complexity (in particular the heavy outfitting load and Scotts' first contact with heavy naval ordnance) led to a form of project management which was adopted on the later Dreadnought battleship contracts, H.M.S. 'Colossus' and H.M.S. 'Ajax'.

To the changes in management structure and the modernisation of the yards was added a third factor making for change. In 1909 the company negotiated a licence agreement for the construction of naval submarines of the Laurenti design with Fiat San Giorgio, Spezia, Italy. The initiative for this enterprising move came from Scotts' and was the beginning of a period of seventy years of building and refitting submarines for the royal and foreign navies during which the company gained an international reputation for the quality of its products in this specialist field.[3]

It was at this point also that Scotts' moved to exploit the economies of scale and management inherent in their construction programme. They recognised that large warships and passenger liners had much in common, in that they were large, powerful, fast and represented a very large outfitting load. So Scotts' began to build a series of passenger ships which figured prominently in their programme for the next twenty years.

Fig. 7/1 shows the production programme executed by the company during the period 1906-1914. After a dull period in 1907 the programme developed into a range of complex and diverse contracts, with the emphasis in Cartsburn Dockyard on a mixture of large warships and passenger liners and in the Cartsdyke shipyard on passenger liners. The general cargo tonnage was shared between the two yards. The Scotts' won fifty one contracts in this period which included thirty three general cargo vessels, seven passenger liners, eight lighters, two barges, one oil tanker, one steam yacht and a lighthouse tender in the merchant field. Naval work included two battleships, two submarines and a submarine depot ship. All the naval orders were obtained after 1909.

Another fundamental change in working practices at Scotts' at that time stemmed from the remarkable growth on the larger naval and merchant contracts of special and novel auxiliary equipments and their supporting systems, located outwith the principal machinery compartments. Because the preponderance of the installation work was of an engineering nature, it was decided that the responsibility for the design, manufacture and installation of all such equipments and systems should be borne by the engineering division of the company. This delegation of responsibility and function change which became permanent, differed from that which applied in the U.K. shipbuilding industry where responsibility for hull engineering matters was handled by the shipbuilders.

Some typical examples of installation work included steering gear, electric generators, refrigeration plants and deck machinery. On large warships the installation of large calibre naval guns with the mechanical handling plant for the transfer of ammunition was an extremely complex affair. On submarines, control systems for hydroplanes, steering gear, periscopes, and the installation of torpedo handling and control systems were essentially engineering tasks. Finally, on oil tankers, at this time a very new development, the design, manufacture and installation of the cargo oil systems were undertaken by the engineers.

The impact of these changes on the company organisation was felt throughout the firm, but most strongly on the engineering division, and their implementation became the responsibility of the engineering director, James Brown. Mr. Brown who joined the company in 1903 became a director in 1905, and a joint managing director in 1912, had previously gained wide managerial experience both at home and abroad, and was responsible for introducing the company's graduate training programme referred to earlier. With the assistance of a number of young graduates he devised a complete range of company standard procedures covering the activities of the design and drawing offices and the estimating and purchasing departments, linking their 'servicing' activities to the production departments. Consequently, the extremely diverse order book at Scotts' in the immediate prewar period provided not only the stimulus for the introduction of these changes, but also an excellent opportunity to evaluate the effectiveness of the company's new procedures in executing these contracts.(See Fig. 7/1)

ORGANISATION AND ADMINISTRATION.

The challenges of the immediate pre World War One programme were felt in a number of areas, but primarily in the production facilities and the technical departments. Whilst both the engineering and shipbuilding departments were able to take advantage of the new equipment installed under the aegis of John Scott IV and Robert Sinclair Scott, the nature of the contracts undertaken, and in particular, the range of types of machinery installation required, placed greater demands on the engineers than on the shipbuilders.

The shipbuilders were building larger ships but employing much the same techniques as before. The engineers, in contrast, had to cope, not only with the familiar compound and triple expansion machinery, but also with the new steam turbines, reduction gearing, a variety of water tube and cylindrical boilers, and of course Scotts' new interest, the 'submerged torpedo boats' as the early submarines were called.

In anticipation of these challenges James Brown introduced wide ranging changes in company organisation. (See Fig. 7/2) He produced a line and staff organisation with clear indications as to the area of responsibility of each manager. He introduced a new category of assistant manager to coordinate the activities of the various grades of foreman, and he provided what in modern management is known as 'services to production' - planning, methods study, a materials laboratory (the only one on the Clyde), stores control etc., thus relieving the foremen of many duties, and allowing them to concentrate on the quality of their department's products. Where appropriate, similar innovations were introduced in the shipyards by the shipbuilding director, J.B. Hutchison.

PLANNING.

When John Scott and Robert Sinclair Scott were running the company, all propulsion machinery was of the steam reciprocating type - some 304 sets were built and installed between 1868 and 1905. (See Volume Two) Over the years few production problems were encountered. James Brown recognised that something very different would be required if the potential delays in his current programme were to be avoided.

With a group of his young graduate management trainees he established a planning organisation which in liaison with the shipyard management produced an integrated cardinal date programme embracing the critical dates for each individual contract such as when boilers, engines, shafting and propellers were to be at the fitting out quay prior to installation, and subsequent basin and sea trials. From this grand design a family of departmental programmes were produced and circulated to the pattern shop, machine shops, fitting shops, boiler shops and other outfitting departments.

However, the detail planning began in earnest following approval by the Owner and classification society/design authority of the machinery specification, machinery arrangement drawings and piping system diagrams. Thereafter the design and drawing offices were responsible for ordering through the purchasing department all significant long lead items such as auxiliary machinery, forgings, castings, boiler plates and tubes etc., For the vast majority of piece parts fitted on board and which were manufactured in-house by Scotts', a new production control system was introduced based on parts lists issued by the drawing office.

As each production drawing was completed, a parts list was prepared covering all items to be made from that drawing. The parts list master document was held in the production control office but was copied to all production and service departments, and was designed to cater for the needs of all such departments. In addition to basic information such as part identification, number required, material source etc., blank columns were provided for use by all departments for feedback purposes. For example, inwards goods and finished parts stores reported progress to production control, and the methods study group gave manufacturing data including details of jigs, templates etc., The all important feedback was analyzed by the planning staff and reviewed at weekly progress meetings at which remedial action was recommended as necessary.

The new production control arrangements briefly outlined above were nurtured in the early years by the young graduate team which helped to devise them, and they were of great assistance to management in coping with the periods of exceptionally heavy load which they encountered later.[4]

PREMIUM BONUS SYSTEM.

Throughout the company all boiler making and other metal working trades were employed on a piecework system. However, in 1902 the company introduced a premium bonus system for all engineering personnel, fitters, turners and machinists, as an aid to increasing productivity. The company had already derived equitable standard times for many production operations and from the start of the new scheme the firm had guaranteed that these standard times would not be altered unless entirely different methods were to be employed.[5]

If an operator required the full standard time he was paid his full wage as before. However, if he completed the job in less than the standard time, his rate of wages per hour was increased in direct proportion to the saving in time: the shorter the time taken, the greater the rate of bonus. The bonuses earned ranged from 20 to 30 per cent over the time-rate wage. Before the bonus payment was sanctioned the quality of the work performed was checked to ensure that it was to the required standard.[6] Consistently good performers received merit increases in their time rate. The accumulated performance data was of great value to both the planning and the estimating departments. A further innovation was the introduction of additional shop floor personnel who were responsible for ensuring that all completed work was delivered to the finished parts stores and that no personnel were short of work.[7]

TECHNICAL DEPARTMENT CHANGES.

The other areas within the company faced with new challenges were the design, drawing and estimating departments. During the decades of building compound and triple expansion engines it had not been difficult to cope with the design changes stemming mainly from the increase in steam conditions. However, in the first decade of the new century these departments suddenly became involved in designing new and advanced types of machinery and their supporting systems for large passenger liners and Dreadnought battleships, on top of which they had to come to grips with the company's new interest - submarines.

In the shipyards, at this time, the design and construction of the large passenger liners for the Cunard, Donaldson and Booth Lines and the Dreadnought battleships had to conform to the requirements of their respective owners and their regulatory bodies. Such constraints were normal and accepted. However, in respect of machinery type, layout and detailed design at this time, when the pace of development was remarkable, the liner owners and the Admiralty allowed considerable licence in these areas to firms with ability, experience, and reputation in order to encourage the development of competitive designs.

So at this juncture Scotts' were designing triple and quadruple expansion machinery installations and a Parsons single reduction geared turbine installation for their merchant workload and for their Royal Navy contracts they were designing high powered direct coupled turbine installations for their Dreadnoughts. When the development work on the Laurenti submarines is also taken into account it will be appreciated that the engineering design and drawing offices were under extreme pressure.

Here again the graduate engineers were brought into play and gained invaluable experience in working on the detail design work of these contracts. A number of these young men progressed to senior positions within the company and others did likewise in other shipyards both at home and abroad. The engineering drawing office was organised in two main sections. The main engine section was responsible for the production of manufacturing drawings for all prime movers built by the company and the so-called pipe arrangement section was mainly concerned with producing arrangement and detail drawings for the multitude of piping systems associated with the prime movers.

All drawings produced had to conform to the requirements of the Owner's specification and of the classification societies and both sections made great use of standard drawings of components which greatly reduced drawing office costs and the cost of casting patterns. Fig. 7/3 - Instructions to Draughtsmen - is an interesting commentary on the company policy towards good design. Between 1907 and 1909 the number of draughtsmen employed by the company doubled.[8]

Before moving on to the outbreak of the First World War it may be helpful to discuss the impact on Scotts', of this unusual mix of contracts.

EARLY SUBMARINE DEVELOPMENT AT GREENOCK.

As mentioned earlier, Scotts' interest in submersible craft began in 1908 and centred on those of the Laurenti design which were at that time being built by the Fiat San Giorgio Society of Spezia, Italy. The Laurenti submersible torpedo boats were considered superior to other contemporary designs. They were of double hull construction with the outer hull form like a conventional ship which resulted in good power-speed characteristics on the surface with a corresponding increase in range of action. Their hulls were exceptionally strong with a large reserve of buoyancy and had performed well in service with the Italian Navy.[9] After extended technical appraisals and negotiations Scotts' took out a licence from Fiat San Giorgio for the construction of Laurenti design submarines in 1909. The areas covered by the licence included Britain and the Colonies. Early in 1912 a further licence was negotiated for the manufacture by Scotts' of Fiat heavy oil engines.[10]

The contract for the building of Scotts' first submarine, 'S.1'. was signed on 16th December, 1912 with the engines being supplied by Fiat. Further orders for submarines, 'S.2'. and 'S.3'. followed in May 1913 with Fiat heavy oil engines being supplied by Scotts'. As a consequence of these orders it was decided to build a new machine shop in the engine works at a cost of £500[11] to manufacture oil engine parts and after viewing a number of possible locations for a covered submarine building berth it was decided to build the fabricating shed in Cartsburn. It was completed in late Spring 1913 at a cost of £3,174.[12]

All the submarines building for or in service with the Royal Navy at this time were of modest size and classed as coastal craft. However, the Admiralty had plans for submarines capable of accompanying the Fleet and in August 1913 they announced that they had placed an order with Scotts' for the design and construction of the Royal Navy's first steam driven submarine, H.M.S. 'Swordfish'.[13] As will emerge later 'Swordfish' was essentially an experimental craft and the typeship and basis for the 'K' class, the largest submarines built for the Royal Navy in the period up to the end of the First World War.[14]

PASSENGER LINER TONNAGE.

The high reputation earned by Scotts' for the quality of the accommodation on their passenger ships and steam yachts had its origins in early wooden cross channel steamers at the beginning of the 19th century. Their subsequent involvement in the creation of the Holt and Swire fleets ensured that their reputation was sustained through the following decades.

It will be recalled that when the Scott brothers developed the Cartsburn dockyard in 1900 a considerable part of the large four storey workshop building became a furniture factory fitted out with the most modern equipment. The quality of the production from the factory is illustrated in Fig. 7/4 showing the dining saloon in a Scott built Portuguese passenger liner, S.S. 'Malange'. So when in the early 1900s ocean pleasure cruising became increasingly popular coupled with fresh growth in the emigrant trade, Scotts' were able to secure a succession of contracts for passenger liners which provided a substantial base work load for the company into the 1920s (with the exception of the war years), and particularly for the outfitting trades. In the period under discussion seven large passenger liners were delivered to prestigious liner companies, four for the U.K. - Canada service, one for service between Mediterranean ports, and two for pleasure cruising to Madeira and South American ports. (See Table 7/1) Of all the challenges being faced by Scotts' during the period before the outbreak of the First World War this was one they were best equipped to handle.

SCOTTS' AND THE DREADNOUGHTS.

For some years before 1905, the year Scotts completed their contract for H.M.S. 'Argyll', the Admiralty had been involved in great secrecy in the design of a revolutionary new battleship, a process which gained Britain two years advantage over Germany's naval designers. H.M.S. 'Dreadnought' was the culmination of evolutionary trends in gunnery, machinery and hull design as well as the prototype for all the capital ships of the coming war.

The adoption of steam turbine machinery made possible a combination of high power with light weight which permitted her powerful armament to be mounted in a ship still of moderate size. H.M.S. 'Dreadnought' of 17,900 tons displacement was laid down in October 1905 at Portsmouth Dockyard and delivered less than a year later. Her turbine machinery developed 23,000 shaft horsepower and gave her a speed of 21 knots. She was armed with five pairs of 12 in. guns, arranged in three turrets on the centre line, and two mounted on the broadside, opposite each other, and her armour belt was 11 in. thick midships.[15]

Following the success of 'Dreadnought' the Admiralty embarked on a development programme in successive years, the later ships being progressively larger, more powerful and more heavily armed. Scotts' first involvement with that programme was in 1908 when they secured the order for the supply of the propelling machinery for H.M.S. 'St. Vincent' building at Portsmouth Dockyard. She was 10 ft longer than 'Dreadnought', had 2 ft. more beam and a displacement of 19,250 tons. Then, at last, in May 1909, Scotts' received an order for the first Clyde built dreadnought type battleship, H.M.S. 'Colossus', followed in December 1910 by an order for a super-dreadnought battleship H.M.S. 'Ajax'. (See Volume Two)

The pace of battleship development from the original 'Dreadnought' concept is well illustrated in Table 7/2. where the main characteristics of 'Dreadnought' are compared with those of the later ships in which Scotts' were involved. It is very clear from Fig. 7/1 that the period of their involvement with these magnificent ships 'Colossus' and 'Ajax' was the supreme test of all of the modernisation and expansion projects undertaken by Scotts' in the prewar years, particularly during the year 1912-13 when in addition to the super 'Dreadnought' 'Ajax', three transatlantic liners were in the production programme.

This is confirmed on Fig. 7/5 which displays the manpower employed by the company in the prewar, wartime, and post war periods. The shipyard manpower virtually doubled at the end of 1910 and was sustained at that level until the spring of 1913 (3,500 employees) when it reverted to the 1910 level. (2,400 employees), by which time 'Ajax' and the two Cunard liners had been delivered, and the abnormal steelwork and outfitting load had gone. The increase in the engineering workforce was, in contrast, relatively modest at around 40 per cent.

PERFORMANCE.

Scotts' actively sought orders for large naval ships and passenger liners during the pre World War One period, from 1906 to 1914, and these categories represented 67 per cent of their turnover and 87 per cent of their profit during the period. On that turnover (£6.745m) an overall profit of 5.1 per cent was achieved.

From Table 7/3a below showing the percentage profit achieved in all categories of contract it is very clear that they were better off with their battleship contracts than without them.

Table 7/3a - Outcome of Contracts undertaken (1906-1914).

CATEGORY OF CONTRACT	No. OF SHIPS	TOTAL INVOICE PRICE £	PROFIT PERCENTAGE
GENERAL CARGO	26	1,144,200	2.7
OCEAN STEAMSHIP	10	950,000	0.5
CHINA NAVIGATION	3	140,200	6.8
PASSENGER LINERS	7	1,355,140	2.9
NAVAL SHIPS	6	2,355,335	7.2
NAVAL MACHINERY	4	723,370	11.1

From: H.B. Peebles - Warship Building on the Clyde 1839-1939 - A Financial Study - Unpublished Ph.D. Thesis. University of Stirling 1986.

The relatively poor performance in the general cargo sector probably reflected the depression in 1908, 1909 and 1910 when prices were low. Ocean Steamship were of course well known for ordering new tonnage at the bottom of the market. Delivery times for the merchant ships were fairly typical at between 9 and 10 months and for the larger passenger liners were around 18 months.

What is remarkable about Scotts performance in building 'Colossus' and 'Ajax' is the very short construction time from keel lay to delivery. The upper Clyde yards, Fairfield, Clydebank, and Beardmore all began building battleships some years before Scotts but from Table 7/4 which lists all the Clyde built battleships which were in hand during the period under review, the construction times for 'Colossus' and 'Ajax' were the shortest by some months. The performance on 'Colossus' was particularly noteworthy as she was lead ship of her class, a situation which inevitably resulted in delays due to design changes.

Table 7/3b below clearly indicates the relative importance of the passenger liner and battleship contracts to Scotts.[16]

Table 7/3b - **Outcome of Typical Scotts Contracts, (1906-1914).**

Type of Contract	Year of Build	Invoice Price £	Material Cost £	Labour Cost £	Contribution to Overheads and Profit £
General Cargo Ship (Glenorchy)	1909	46,720	29,278 (62.7%)	12,296 (26.3%)	5146 (11.0%)
Passenger Liner (Andania)	1911	283,905	171,034 (60.2%)	81,904 (28.8%)	30,967 (10.9%)
Dreadnought (Colossus)	1913	717,597	390,361 (54.4%)	239,400 (33.4%)	87,836 (12.2%)

From: H.B. Peebles - Warship Building on the Clyde 1839-1939 - A Financial Study - Unpublished Ph.D. Thesis. University of Stirling 1986.

Figure shown for 'Colossus' are for Scotts' direct involvement and exclude armament and armour etc.,

PROJECT MANAGEMENT.

Scotts' success in meeting their programme dates during the period 1906 - 1915 owed much to their new production control systems which greatly eased the problems inherent in the complex work programme undertaken in the latter years of the period. Another significant contribution came from the adoption of an early form of project management applied to the 'Dreadnought' contracts H.M. Ships 'Colossus' and 'Ajax' and first tried on the armoured cruiser H.M.S. 'Argyll'.

James B. Hutchison, shipyard manager at Cartsburn Dockyard who had undertaken the role of project manager on 'Argyll' was appointed shipbuilding director of the company in March 1910 in succession to Carl Mumme who had retired. Mr. Mumme remained on the Board as a non-executive director. Mr. Hutchison was given full authority to ensure the timely completion of the Dreadnought contracts and in this, as described earlier he was very successful.[17] In May 1912 James Brown was appointed a joint managing director of the company.

With the delivery in 1913 of H.M.S. 'Ajax', Scotts naval activity at that time centred on submarine production, three of the Laurenti type and a subsequent contract referred to earlier, for the design and construction of H.M.S. 'Swordfish'. In the United Kingdom at this time merchant ship orders were in extremely short supply but Scotts' with the cooperation of their old customers, Ocean Steamship Co. and the China Navigation Co. obtained a number of contracts for cargo liners which took Scotts' through 1913 and 1914 and all of which were profitable.[18]

THE WAR YEARS, 1914-1919.

On August 4th 1914 Great Britain declared war on Germany. On that day a corporal's guard of the Royal Scots was sent to guard Cartsburn Dockyard, the Engine Works and the vessels under construction for the Royal Navy.[19] A letter was sent to the company's insurers advising them that the men were located in No. 54 shed and that no smoking or cooking food was allowed therein. Each man carried one hundred rounds of ammunition. The letter solemnly requested permission for these arrangements!!

There was little immediate impact of the war on Scotts' activities. Submarine 'S.1'. was delivered the day after war broke out and the passenger liner 'Transylvania' and cargo liner 'Mentor' were delivered before the end of 1914. 'Sinkiang' for China Navigation Co., was handed over in February 1915. However, in 1915 during negotiations with the Admiralty on a New Standard Profits System, Scotts' pointed out that during the last four months of 1914, they had been required to hold their berths at the disposal of the Admiralty for orders which were slow in appearing. In fact in a period of six weeks in November/December 1914, orders were received for two destroyers, two submarines, three minesweepers and a mortar. They also recorded the loss to the Colours of large numbers of their workmen, many of whom were Reservists or Territorials.[20] An order had also been received from Holt and Co., for a cargo liner 'Diomed' but work on her and on 'Tyndareus' was suspended in favour of naval contracts.

So, somewhat belatedly, by the end of 1914, and with the reconstruction and modernisation of the shipyards and the engine works approaching completion, Scotts' entire resources were totally committed to work for the Royal Navy. It had already become apparent from the conduct of the war to date that the heavy losses of merchant shipping from mines and 'U'-boats would require a programme heavily biased towards smaller counter-measure vessels.

DEATH OF CHARLES C.SCOTT II.

Mr. Charles C. Scott, the company chairman, who had been ill for some time, died on February 11th 1915, aged forty eight years. His tenure of office from 1905 to 1915, whilst short, was remarkable for a number of reasons.

Firstly, he had spent some twenty years in the business before succeeding his uncle as company chairman and he had inherited the task of completing the modernisation and expansion of the company's facilities set in train by John Scott and Robert Sinclair Scott to ensure that the company retained its pre-eminent position in the British shipbuilding industry. In assessing this task it has to be remembered that it had to be undertaken simultaneously with the introduction of a modern management system and applied to a programme of diverse and complex contracts. During his period as chairman, he saw the establishment of submarine building in the yard, and the commencement of manufacture of oil engines, fields in which the company was to gain world renown.

Charles C. Scott was succeeded by his brother Robert Lyons Scott as chairman of the company on 25th February 1915. Prior to assuming the chairmanship, R.L. Scott had been a joint managing director of the company since 1904. The other joint managing director, James Brown, was appointed as deputy chairman. The remaining members of the Board were Carl Mumme and James B.

Hutchison.[21] These changes were confirmed at a board meeting on 31st March 1915. At a later meeting on 19th July 1915 the chairman announced that he had been advised, that as from 12th July 1915, by the terms of the Munitions Act, Scotts were to be a Controlled Firm.[22] This would virtually eliminate merchant shipbuilding at Scotts for the duration of the war.

However, being a controlled firm had its advantages and on 16th July 1915 R.L. Scott wrote to the Admiralty asking for assistance in obtaining certain categories of skilled labour in short supply at Scotts'. He subsequently wrote again on 16th September 1915 pointing out that there were empty berths in the yard and reminded the Admiralty that Scotts were capable of producing larger craft than minesweepers and destroyers. This led to an order for a light cruiser, H.M.S. 'Caradoc' in December 1915.[23] He also successfully pleaded for permission to resume work on the suspended Ocean Steamship vessels 'Diomed' and 'Tyndareus' in order to free further building berths. However, permission to resume work on these vessels was conditional on there being no consequent delays in warship production. In the event the ships were not delivered until the end of 1916 and 1917 respectively.

Before leaving 1915 reference should be made to an oral agreement reached by the chairman, R.L. Scott and Alfred Holt and Co. on 29th November, 1915[24] as follows:-

> We undertake to build ships continuously on two berths in the East (Cartsdyke) Yard for a period of 5 years, dating from the date of laying the first.
>
> The berth chosen in each case to be the most suitable that is available for the size of ship.

Terms of payment for each ship:

Time and material plus 15 per cent for charges plus 10 per cent for profit.

The Memorandum of Agreement for the building of each ship to be the one now commonly used by the Ocean Steam Ship Co., Ltd.,

The precise purpose of such an agreement is not known but was presumably in anticipation of exceptional demand for replace tonnage at the end of the war. If so, it was extremely premature. Reference to further cooperation between Scotts' and Alfred Holt & Co. is made later.

By 1916 the entire resources of the shipbuilding and marine engineering industries in Britain had been made available to counter the ravages of the U-boats which continued to grow. All factories and shipyards were working excessive overtime including Sundays but the battle was not being won. In face of an increasing desperate situation, dilution of labour was introduced in 1916 after negotiations between the Clyde Dilution Commission and the district committees of the various unions.[25] The agreements saw the suspension of all internal lines of demarcation for the duration of the war, and the introduction into the various unions of skilled men from allied or other trades and of unskilled men and women.

By August 1916 the Ministry of Munitions was able to announce that dilution had been established in one hundred and fifty out of three hundred controlled engineering establishments on the Clyde and fourteen thousand women had been introduced into the workforce by the Clyde Commission for the Dilution of Labour.[26] At Scotts', typical examples of dilution in the engine works included the employment of hydraulic and jobbing engineers in the fitting shop, copper tank makers in the pipe shop and iron moulders in the brass moulding shop.

Some one hundred and fifty women were also employed as dilutees ,[27] engaged in a wide variety of tasks, ranging from very skilled operations such as the machining of turbine blading and the assembly of turbine blading segments (See Fig. 7/6a) and working on the boiler shop water tube production line (See Fig. 7/6b) through light bench work and storekeeping to light labouring. Their employment on such work made it possible to release men for the Services.

That part of Fig. 7/5 which shows the number of workers employed by Scotts during the war years, firstly indicates the continued fall in 1914 following the departure of H.M.S. 'Ajax' followed by a surge in recruitment as the orders for warships began to appear, and then a fall in numbers in mid 1915 probably due to departures to the Services. The number employed in the engine works remained steady thereafter during the remainder of the war at about two thousand, whereas in the shipyards dilution had more impact, resulting in average numbers of around two thousand three hundred and fifty.

PRODUCTION PROGRAMME 1915-1920.

During the war years an endless stream of warships sailed from the Clyde to join the British Fleet, some four hundred and eighty new ships in all. Scotts' contribution to this procession is displayed on Fig. 7/7 - Production Programme - 1915-1920 derived from data in Volume Two and which also embraces the immediate postwar period. The warships delivered by Scotts comprised three light cruisers, fifteen destroyers, eight submarines, one monitor and three minesweepers. They also supplied and installed the propelling machinery for one light cruiser, one submarine and one fleet auxiliary oil tanker.

Notwithstanding Scotts' role as a controlled firm in warship building, six substantial merchant ships were delivered in the war years or immediately thereafter, three for the Ocean Steam Ship Co. one passenger liner for the Cunard Steam Ship Co., and two 'standard' ships for the Shipping Controller. Particulars of all of these contracts are given in Table 7/5 (2 sheets) together with an analysis of the financial outcome of all contracts individually and collectively by ship type and by year on Table 7/6.

Before discussing this analysis, reference should be made to another important aspect of Scotts' wartime activities, namely ship repairing. By virtue of Scotts' location close to the anchorage at the Tail of the Bank, a great deal of ship repair and docking work was undertaken. In all, some 190 naval vessels of all types were docked and or repaired including the following:-[28]

1	Battleship
6	Cruisers
50	Destroyers
21	Minesweepers
13	Submarines
4	Armed Merchant Cruisers

and a host of tugs, patrol yachts, tankers and trawlers.

WARTIME PERFORMANCE-SHIP CONSTRUCTION.

It is virtually impossible to make realistic comparisons of the performance of warship builders in wartime. A variety of factors such as the availability of material and labour, the supply of naval guns, the variety of ship type in a particular yard, and the never ending changes in design can affect the date when the warship enters service. If a particular ship is designated 'first of class' it will certainly take longer to build than the other ships of that class.

However, in comparing the performance of the recognised Clyde shipbuilders before and during the First World War, it is clear that remarkable reductions in building times were achieved in very difficult circumstances. The average production time, keel lay to delivery, for light cruisers was reduced from twenty three months to fifteen months and for destroyers from eighteen months to fourteen months.[29]

One particularly noteworthy performance by Scotts in 1915 was the building of the armoured monitor 'Sir John Moore' which carried two 12 inch guns.[30] Work commenced on 13th January 1915: the launch of this very substantial vessel took place on 31st May and the machinery was installed and the ship completed ready for trials on 30th June 1915: that is twenty four weeks from laying the keel. Because of her great beam (87 feet) the unusual expedient was adopted of launching the monitor from three lines of sliding ways. The launching weight was 4416 tons.

Details of the contribution made to the war effort by the recognised Clyde shipbuilders and marine engineers are given in Warship Building on the Clyde (Peebles 1987). An abbreviated list of the warships built is shown on Table 7/7 and excludes minor vessels and propelling machinery contracts for the Royal Dockyards.

WARTIME PERFORMANCE - FINANCIAL.

Competitive tendering for naval contracts was abandoned by the Admiralty at the beginning of the war, thus eliminating the prospect of unprofitable contracts. Excess Profits Tax legislation introduced in 1915 was designed to prevent firms from profiting unduly from the national emergency.[31] Nevertheless the period of the war years was one of great prosperity for the Clyde warship builders.

Typical examples of the trading profits before depreciation earned in five years to 1919 by the warship builders are shown below:-[32]

Fairfield	£ 1,910,555
Beardmore	£ 1,569,177
Scotts'	£ 975,288

Comparison of the profit earned by Scotts' in the five years of the war (£975,288) with that earned by the firm in the nine years immediately before the war (£280,390) shows clearly the transformation which the war had created in their finances.[33] Bank borrowings had all been repaid by 1917. By 31st December 1919 there was cash in hand of £104,321, the company had an investment of £50,625 in War Loan and including wartime provisions which would not be required, reserves and retained profits amounted to £528,373. At Scotts, the relatively modest net additions to fixed assets in the five years to 1918-9 (£87,967) reflected the very extensive development programme undertaken by the firm in the pre-war years.[34]

So, in general, it was from a position of strength that the Clyde warship builders entered the immediate post war period. Scotts' and Denny's had the added advantage of being able to resume long established merchant connections interrupted by the war. This was especially so at Scotts where their connection with Alfred Holt & Co. was doubly strengthened as a result of two agreements made between the two companies in 1915 and 1917. As a result of the first agreement referred to earlier Scotts reserved two berths for the construction of Holt ships for a period of five years. By virtue of the second agreement Alfred Holt and Co., acquired one third of the ordinary shares in the company which were registered in the name of the Ocean Steam Ship Co., and the China Mutual Steam Navigation Co.[35]

Arising from the consequent changes on the company shareholding, two new directors were appointed to the Board on 1st July 1917, Mr. H.B. Wortley and Mr. Cedric Sinclair Scott, to represent the interests of Alfred Holt & Co. and the interests of the executors of the late Robert Sinclair Scott respectively. Sadly, Mr. Wortley who was the Naval Architect of Alfred Holt & Co. died in February 1919 and Mr. Lawrence Holt took his place on Scotts' Board in April 1919.

A further agreement made by Scotts in March 1917 was with the Engine Development Co. for a licence to build a revolutionary new engine which was a combination of an oil engine and a steam engine. As will emerge the development of this engine had to await the end of hostilities.[36]

Before moving on to review events affecting Scotts' in the immediate post war period it will be important to record details of the extensive research and development undertaken by the firm on behalf of the Royal Navy during the war.

RESEARCH AND DEVELOPMENT WORK. (1914-1918)

Scotts' primary and unique contribution to the war effort during the war years was the development of their expertise in submarine design and construction.

Their submarines 'S.1', 'S.2', and 'S.3' were the first built on the Clyde and whilst other Clyde yards became involved briefly in building submarines during the war, only Scotts specialised in this activity in later years. (See Fig 7/8).

Remarkably, most of the young group of technical and production personnel involved in submarine development work in the First World War were still with the company during the 1939-1945 conflict.

ELEMENTS OF SUBMARINE DESIGN.

Of the many types of combat vessel found in the world's navies, the submarine, or submerged torpedo boat as it was originally known, is unique in a variety of respects. It has the ability to stalk and destroy enemy ships when submerged and in the early days was virtually free from detection. One British admiral was reputed to have described submarine warfare as 'damned unsporting'!! Whether afloat on the surface or submerged, the submarine is extremely vulnerable to the effects of enemy counter attack or failure of any of the many complex systems vital to its military role. At diving depth the pressure hull together with the multitude of hull penetrations associated with these systems are subject to significant stress. It will be readily understood also that the efficiency of the submarinc as a fighting unit under the stress of engagement with an enemy depends on the skill and team work of the entire crew who must at all times be able to rely on the integrity of the hull structure and of the navigation, propulsion and weapons systems of the boat.

However, designers of submarines are under pressure to make the maximum use of the space available aboard for the installation of weapons and their support systems, machinery and controls, fuel etc., with consequent low priority for the crew's living quarters. To keep weight to a minimum, the operating speeds and working pressures of all equipment were raised over the years resulting in increased working stresses in components and underlining the need for high quality materials and workmanship.

Scotts' as builders were responsible for the quality of all materials and equipment installed in their submarines by themselves and their subcontractors. To this end, a materials test house was built in 1916 by Scotts' in their engine works fully equipped for this work with extensive physical, chemical and research laboratories and qualified staff - the first such establishment on the Clyde.[37]

The teamwork of the crew in action, in extremely cramped conditions, is greatly influenced by the location and layout of the operational controls of the boat. The contributions to the war effort of Scotts' submarine design teams in the First World War were many and varied but the team specialised on the centralisation of system controls, in particular the development of (hydraulic) telemotor systems. Practically all the multitude of devices and systems used on submarines, irrespective of their location in the boat, could be hydraulically operated from the submarine control room.

'OVERSEAS' SUBMARINES.

All British submarines built before the First World War and in the early months of that war had a limited operating range and could best be described as 'coastal'. In the immediate prewar period the Admiralty budget was heavily biased in favour of building capital ships on the presumption that any future war (with

Germany) would involve major sea battles between the opposing fleets. The Admiralty felt that there was a role for the submarine in such fleet actions. However, any such submarine would require to keep station with the fleet and this in turn would require greater speed, power and operating range, and this new 'overseas' submarine would be much larger than those then in service with the Royal Navy.[38]

THE CHALLENGE.

Both Vickers and Scotts were contacted and asked to submit proposals for a fleet submarine capable of 20 knots on the surface with a brief high speed capability whilst submerged. The boat was to be of double hull (Laurenti) construction, and have a surface displacement of about 1,000 tons. In April 1913 Vickers received an order for H.M. submarine 'Nautilus' which had a surface displacement of 1441 tons and was fitted with two diesel engines developing a total of 3700 shaft horsepower giving a surface speed of 17 knots.[39]

Due to more important priorities at Barrow she was not delivered until four and half years later in October 1917. There can be little doubt that her large surface displacement arose from the need to accommodate her large diesel engines. In preparing their submission Scotts' were advised by Laurenti to consider proposing geared steam turbine machinery for surface propulsion and in August 1913 they received an order for H.M.submarine 'Swordfish' of 932 tons surface displacement having twin sets of Parsons geared steam turbines developing a total of 4000 shaft horsepower designed to produced a maximum surface speed of 18 knots.[40] Fig 7/9 (3 sheets) show 'Swordfish', and 'E.31', and 'G.14' in May

1915 under construction in the specially built submarine construction shed at Cartsburn Dockyard.

'Swordfish' was delivered in July 1916. Fig 7/10 shows 'Swordfish' on sea trials. In the event, neither 'Nautilus' or 'Swordfish' saw much operational service during the war but in the case of 'Swordfish', which was the first British steam powered submarine, the development work associated with some of the novel elements of her design was incorporated in the subsequent Admiralty design of the later and much larger 'K' class steam powered fleet submarines.

Unlike modern nuclear powered submarines which are independent of fossil fuels, steam was raised on 'Swordfish' using a watertube boiler, oil fired, the flue gases being led to atmosphere via conventional uptake and funnel. It is essential that any submarine, proceeding at speed on the surface, should in the event of an operational emergency be able to close and secure all hatches and dive as quickly as possible. On 'Swordfish' a novel element was present in this operation in that the boiler had to be shut down, the funnel housed inboard and water tight hatches put in place over the apertures and secured.

Scotts' produced a number of alternative designs embodying ingenious ideas and from these an arrangement was adopted employing electric gear for the funnel and the valve at the funnel base, and hydraulic gear for the top cover. The entire operation of closing down took seventy five seconds which was considered good at that time.[41]. Most of the early steam driven 'K' class submarines designed later by the Admiralty were fitted with funnel gear of this design. Scotts' received an order in September 1915 for the propelling machinery of 'K.5', an early 'K' class submarine, and in February 1916 for the construction of 'K.15'.

For 'K.15', Scotts proposed and designed the funnel gear, this time with all-hydraulic drive, which was duly installed in the boat. (See Fig. 7/11) The new gear was a marked improvement on the earlier version with the funnel and top doors closing in ten seconds and the lower doors in four or five seconds. The improved gear was subsequently fitted in all subsequent submarines of the 'K' class.[42]

RESEARCH INTO WORKING CONDITIONS IN MACHINERY SPACES OF 'SWORDFISH'.

In the absence of any guidance data for steam powered submarines there was concern as to the temperatures likely to be encountered on 'Swordfish' when the machinery spaces were closed down for operational reasons. (e.g. boat stopped or under way on electric motors).[43] Extensive instrumentation was installed in and around the engine and boiler rooms and various manoeuvring trials were carried out with Swordfish both on the surface and submerged. The results of the readings taken half hourly over a period of forty eight hours did not justify the fears previously expressed, being little if any higher than those obtained from submarines with diesel propulsion.

There was also concern that it might be unsafe for crew members to enter the boiler room at any time after closing down due to the possibility of harmful vapours arising from drops of oil fuel reaching the hot plates. Here again trials were carried out under a variety of operational conditions and samples of air were drawn from the boiler room for chemical analysis with satisfactory results. The composition of the air was pronounced satisfactory for breathing purposes. The results of these investigations were regarded as invaluable by the Admiralty which was at that time formulating the design of what became the 'K' class fleet submarines.

TELEMOTOR SYSTEM.

Among a number of new and far reaching departures from established practice introduced by Scotts' on 'Swordfish' was a telemotor system which made it possible to control and operate valves hydraulically at a distance from a central control position. Fig. 7/12 shows a typical application whereby the system was applied successfully to the superstructure vent and flooding valves. Later in the war the telemotor system was also introduced to the 'G', 'J', 'K' and 'L' class submarines. Before, during and after the Second World War, Scotts' prepared arrangement and detail drawings for the telemotor systems on the 'S', 'T', 'A', 'P' and 'O' class submarines.[44]

ARRANGEMENTS FOR DRIVING SUBMARINES BY MAIN ENGINES WHEN IN AWASH OR PARTIALLY SUBMERGED CONDITION.

In 1916 the Scotts' engineering design staff produced a concept whereby a submarine could be driven at three quarters of full speed when awash or in partially submerged condition, with nothing more than the neck of the air induction pipe visible. The air intake was arranged in such a manner as to ventilate the submarine. To ensure the proper working of the system, various safety devices were fitted.[45] This made it possible for the main batteries and the high pressure air bottles to be recharged underway and in the awash condition. This was a considerable advance on current practice at that time which required the submarine to surface before re-charging could take place. The concept was subsequently patented and submitted to the Admiralty in 1916 (See Fig. 7/13). It bears a striking resemblance to the 'Snorkel' concept developed between the wars by the Dutch Navy and commandeered by the German Navy during World War Two.

THE WEIR CLOSED CIRCUIT FEED WATER SYSTEM.

Although the technical developments associated with the operation of submarines were Scotts' major contribution during the war, the company was also involved in many other technical experiments, proposals and advances. One of the most significant of these was linked to the Weir closed circuit feed water system.[46]

There has been reference earlier in this work to the problems caused by corrosion in marine boilers. In the early days the use of vegetable and animal oils for lubrication of the moving parts of steam engines led to the formation of oxygen concentration cells and fatty acids which attacked the internal surfaces, tubes, and plates of boilers. Considerable improvement was achieved by banning these oils and replacing them by a combination of high grade mineral oils and towelling/sponge filters.

With the advent of the marine steam turbine, filters became necessary, but with the open type of boiler feed system, corrosion remained a problem due to dissolved oxygen entering the system and attacking the internal surfaces of the boilers. It also became clear that oxygen pitting was accelerated by the higher feed water temperatures associated with higher boiler pressures being used at the turn of the century. It was therefore imperative that a method be found of reducing the dissolved oxygen content of the boiler feed water to the lowest possible level.

G. & J. Weir, Glasgow already famous for the design and manufacture of auxiliary equipment - marine pumps, condensers, feed heaters, etc., contacted Scotts' in 1916 concerning the possibility of installing a new feed system in a Scott built destroyer under construction at the time. The new 'closed feed system' was designed to prevent boiler corrosion by keeping air from entering the boiler feed water, and at the same time to improve the fuel economy by considerably increasing the temperature of the feed water returned to the boilers. Messrs. Weir's proposals were carefully considered and Scotts' had meetings with Weirs and the Admiralty. As a result Messrs. Weir continued to develop the idea and in 1917 they submitted a more complete proposal, whereupon the whole question was investigated again and calculations made in connection with various aspects of the scheme.

Scotts' proposed a number of modifications designed to make the system less liable to breakdown and bring the arrangements more into line with destroyer practice, and Messrs. Weir incorporated them in their final proposals. A full report was then sent to the Admiralty embodying investigations as to the expected weight, economy and working of the system. Shortly afterwards the Admiralty ordered the system to be installed in H.M. destroyer, H.M.S. 'Strenuous' then building at Scotts'.

Drawings prepared by Scotts', showing the new arrangements, were circulated by Scotts' to other warship builders building sister vessels. During the period of construction and installation of the plant close liaison was maintained with Messrs. Weir and the Admiralty, and in December 1918 H.M.S. 'Strenuous' went on her sea trials.

The trials, after the usual teething troubles, were successful and resulted in a saving of 3 tons of oil fuel over the four hours trial compared with sister vessels fitted with the old system. At the first in-service boiler inspection the boilers were found to be in a very clean condition. The new system ensured that the condensate from leaving the condenser until it entered the boiler had no opportunity to absorb air. All feed water was deaerated in the condenser before entering the circuit. Finally, all air and non condensible gases were removed separately from the water and discharged to atmosphere.[47] It would have given John Scott IV particular pleasure to know that Scotts' were once again involved in a most significant advance in the development of steam power engineering.

HIGH SPEED BOILERS.

In 1917, Professor Mellanby of the Royal Technical College, Glasgow, aware of the wide ranging research and development work going on at Scotts' approached the firm and suggested the use of high gas speeds to get high heat transmission rates in naval watertube boilers.[48] A number of proposals were investigated and finally a simple design of naval watertube boiler offering significant reductions in weight and space occupied was chosen. Because of its potential, the firm advised both the Admiralty and the Committee of the Privy Council for Scientific and Industrial Research of the project and sought backing for the construction and testing of a prototype boiler. Sadly, this was not forthcoming.

SILENT PROPULSION EXPERIMENTS.

A striking example of the great diversity of research work undertaken by the Scotts' research and development team was their work on silencing propulsion noise made by ships under way. From a variety of suggested methods of quietening the sound emitted from the propellers and shafting of ships, Scotts' chose as the best prospect , the sound screening effect of air bubbles.[49]

Numerous experiments were carried out by Scotts' using model propellers and later with apparatus for producing bubbles under water. Eventually a practical method of applying the results of these trials to a ship in motion was devised and with cooperation of the Admiralty the apparatus was installed on 'PC.43'. Whilst the results of a limited series of trials were disappointing these were certain features of the trials which suggested that Scotts' were working on the right lines.

It is interesting to note that the 'air bubble' method of avoiding detection by sonar at sea is currently in use in the world's navies some seventy years later.

OIL ENGINE DEVELOPMENTS.

The wide range of research and development projects described above provided the Scotts' design team with invaluable experience which stood them in good stead in the immediate post war period when their efforts were diverted along very different paths. Scotts' had recognised with their traditional foresight that the low fuel consumption of the marine oil engine would result after the war in the demand for slow speed engines of this type, suitable for driving the cargo/passenger liners which would form the major part of their projected post war programme.

They were attracted by early reports of a new unconventional engine, a combined heavy oil and steam marine engine, double acting, with diesel power on top of the engine piston, and steam power on the underside of the piston, the steam being raised from the heat in the oil engine exhaust and the jacket circulating water, resulting in considerable improvement in economy over the diesel engine. (See Fig. 7/14) In addition to the possibility of a lower fuel consumption than was currently available, the new engine was likely to occupy less space and be of less weight than a steam engine of the same power. Accordingly, in 1916 Scotts' began negotiations with the Engine Development Co. holders of the patent rights of the new engine. The war prevented rapid progress but some preliminary work was undertaken on the design of a single cylinder experimental engine.

END OF THE WAR.

The First World War came to an end with the signing of the Armistice on 11th November 1918 and the ending of hostilities brought many new problems in its wake. Scotts' and the other Clyde warship builders, keen to take advantage of the anticipated post war boom in merchant shipbuilding, were in a difficult position since most of their building berths were occupied by naval ships under construction. At that time Scotts' had under construction one cruiser, five destroyers, four submarines, and had recently received orders for four further destroyers, with the keel of the first two already laid. In addition, limited progress had been made with orders taken during the war for five substantial merchant ships - one each for Ocean Steamship Co. China Navigation Co. Cunard Line and two for the Donaldson Line.

CANCELLATIONS AND NEW ORDERS.

On 26th November 1918 the Admiralty cancelled two destroyers and two submarines followed on 28th March 1919 by the cancellation of two further destroyers and a submarine. To add further to the confusion, orders were received in December 1918 from the Donaldson Line for two more cargo liners and from the China Navigation Co. for four steamships for their China coastal services.[50] By June 1919 all the remaining naval ships had been launched and were fitting out. This made it possible for the steelworkers to lay keels for the ships newly ordered and to step up production on the merchant ships laid down earlier in the war.

The Admiralty, looking for work for the Royal Dockyards, transferred the cruiser H.M.S. 'Durban', largely complete, to Devonport Dockyard and the submarine 'L.71' to Rosyth Dockyard for final outfitting and sea trials. So, at last, one year after the Armistice, Scotts' was once again a merchant shipyard building for old and long established customers.

In the immediate post war programme (See Fig. 7/7) sixteen out of twenty one ships built were for the Ocean Steam Ship Co. and the China Navigation Co. the remaining five being high class passenger liners for the Cunard and Donaldson Lines, and the Compania Sud Americana de Vapores, of Valparaiso - all extremely profitable contracts.

IN RETROSPECT.

The brunt of the warship new-building programme on the Clyde during World War One was borne by six firms, Brown, Fairfield, Beardmore, Scott, Denny and Yarrow who collectively received orders over the period of the war for a virtual battle fleet - (See Fig. 7/7). Scotts' share of the warship tonnage ordered was 10 per cent and of the horsepower produced was 12 per cent. By virtue of their geographical position at the Tail of the Bank Scotts' also undertook a major share of the naval repair work which came to the Clyde.

However, the significance of their contribution is not to be measured simply in terms of tonnage, horsepower or contracts undertaken. Their major modernisation and expansion of their facilities in the immediate pre-war years together with their development of new production planning and control procedures meant that at the outbreak of war Scotts' was among the most modern composite shipbuilding and marine engineering companies in the country. Their performance in building the battleships, 'Colossus' and 'Ajax' just before the war and the monitor 'Sir John Moore' during the war in quick time was particularly outstanding.

Scotts' contributions to the development of prototype submarines particularly in respect of machinery layout, applications of hydraulics to submarine system controls etc., were to have long term consequences for submarine design and construction. The versatility and expertise of the Scotts' design team was diverted in the immediate post war years to the development of what became the Scott-Still engine - yet another example of the tradition at Scotts' of providing financial backing for advanced technical ideas.

Their financial position had been totally transformed by the war. As shown earlier, from owing their bankers £215,177 just before the war began, they had by the end of the war repaid this debt entirely and had large resources totalling over £680,000. So in 1920, in the knowledge that they were in a strong position to cope with any trading problems which inevitably lay ahead, and after two hundred years of shipbuilding, Scotts' were embarking on their third century in good heart. Still a private family firm and with their modernised shipyards and engine works, they were set to resume their proud role as suppliers to the world of cargo/passenger liners of the highest class.

Chapter 7. REFERENCES.

No.

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3. Licence Agreement with Fiat San Giorgio signed on 4th November 1909. This marked the beginning of Scotts' involvement with submarine construction which, with the exception of a gap between the wars, was to last 70 years. During the period Scotts' built 44 submarines for the Royal Navy and the Australian, Chilean and Italian Navies. They also carried out many major overhauls and modernisations on Royal Navy submarines.

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27. Scotts - Record of Work Done by their Engineering Depts. during the War Period (1914-8). published privately 1919. GD319/25/1/1 p.7.

28. Ibid. - p.31.

29. Peebles - pp.178-189.

30. Scotts' - Two Hundred and Fifty Years of Shipbuilding (Glasgow 1961) pp.106-7.

31. Ibid - p.91.

32. Ibid - pp.91-2.

33. loc. cit.

34. loc. cit.

35. Scotts Archives - ref GD 319/1/1/2 - Minutes of Board Meeting, 26th February 1917.

36. Ibid. - Meeting 24th February 1917.

37. Scotts - Two Hundred and Fifty Years of Shipbuilding (Glasgow 1961) p.220.

38. Rippon - The Evolution of Engineering in the Royal Navy. (Tunbridge Wells 1988) p.217.

39. loc.cit.

40. loc.cit.

41. Scotts - Record of War Work (1914-8) p.45.

42. Ibid. - p.46.

43. Ibid. - pp.53-6.

44. Ibid. - p.46.

45. Ibid. - p.52.

No.

46. Scotts' - Two Hundred and Fifty Years of Shipbuilding
(Glasgow 1961) p.89.

47. Rippon - Ibid. - p.144-6.

48. Scotts Archives - ref GD 319/25/1/1. p.65.

49. Ibid. - p.66.

50. Scotts Archives - ref GD 319/1/1/2 - Minutes of Scotts Board Meeting of 16th December 1918.

TABLE 7/1. SCOTT BUILT PASSENGER LINERS — 1903-1924.

Year of Build.	Ship's Name	Owner.	Dimensions - ft. L × B × D.	Displ. tons	Speed Knots	Machy. Type.	Horse Power	Passengers. No.	Passengers. Class.	Service.
1903	BHARATA	B.I.S.N. Co London	373 × 45 × 29.5	7625	16.0	Steam Triple	5000 i.h.p.	42 36 large no.	1st 2nd native	London - India
1906	CASSANDRA	Donaldson Line - Glasgow	455 × 53 × 32.0	13955	14.0	do	5500 i.h.p.	250 950	cabin emigrants	Clyde - Canada
1908	MANCO	Booth Line Liverpool.	300 × 45 × 23.5	5932	12.0	do	2200 i.h.p.	62 large no.	1st 3rd.	Liverpool - Brazil - Amazon
1911	HILDEBRAND	"	440 × 54 × 30.0	10.014	15.0	Steam Quadple	5000 i.h.p.	213 232 230	1st 3rd - permt. 3rd - temp.	Liverpool - Portugal - Spain - Madeira.
1912	LETITIA	Donaldson Line - Glasgow	470 × 56.7 × 31.5	14420	14.0	Steam Triple	6500 i.h.p.	308 220 782	2nd 3rd - permt. 3rd - temp.	Clyde - Canada
1913	ANDANIA.	Cunard Line Liverpool.	520 × 63.8 × 38.0	19540	14.5	Steam Quadple	7500 i.h.p.	522 1566	2nd 3rd	Liverpool - Canada
1913	ALAUNIA	"	"	19540	14.5	do	7500 i.h.p	522 1566	2nd 3rd	Liverpool - Canada
1914	TRANSYLVANIA	"	548 × 66.3 × 37.0	21986	14.0	Geared Steam Turbines	11000 s.h.p.	343 180 1858	1st 2nd 3rd	Mediterranean - USA Ports.
1920	ALBANIA	"	522 × 63.8 × 38.8	20188	14.5	do	6800 s.h.p.	487	2nd	Liverpool - New York
1922	ACONCAGUA	Co. Sud. Amer. de Vapores - Chile	422 × 56 × 33.0	11207	17.0	do	7500 s.h.p.	106 88	1st 3rd	Valparaiso - New York
1922	TENO	"	"	11207	17.0	do	7500 s.h.p	106 88	1st 3rd	Valparaiso - New York
1923	PATROCLUS	Ocean Steamship Liverpool	491 × 62 × 39.0	19363	15.0	do	7500 s.h.p.	157	1st	Liverpool - Far East
1924	HECTOR	"	"	19363	15.0	do	7500 s.h.p	157	1st	Liverpool - Far East
1924.	CENTAUR.	"	310 × 48 × 24.0	6115	11.0	Diesel	1500 b.h.p	17 44	1st 2nd	Singapore - Western Australia

Compiled from data contained in Volume II - Scott Ship List.

DEVELOPMENT OF DREADNOUGHT DESIGN. Table 7/2

YEAR	SHIP	BUILT	DISPLACEMENT TONS	LENGTH FT.	BREADTH FT.	TRIAL PERFORMANCE	MAIN ARMAMENT
1906	Dreadnought.	Portsmouth Dockyard.	17900	480	82	23000 SHP - 21 Knots	10 - 12" Guns.
1910	St. Vincent.	do	19250	500	84	28200 SHP - 21·7 "	do
1911	Colossus.	Scotts'	20000	510	85	29300 SHP - 21·6 "	do
1913	Ajax.	do	23100	555	89	32900 SHP - 21·85 "	10 - 13·5" Guns.

From: Scotts Two Hundred and Fifty Years of Shipbuilding - 1961

CLYDE BUILT BATTLESHIPS — Table 7/4.

Keels Laid - 1902-1913

YEAR	CLASS	NAME	BUILDER	Displacement Tons.	Time Keel Lay - Delivery.
1905	King Edward VII.	Commonwealth.	Fairfield.	15 610	37 months
1905	do	Hindustan.	Clydebank	15 885	33 "
1908	Lord Nelson.	Agamemnon.	Beardmore	15 925	37 "
1911	Colossus.	Colossus.	Scott	20000	24 "
1912	Orion.	Conqueror.	Beardmore	22 200	31 "
1913	King George V	Ajax.	Scott	23 100	25 "
1914	Iron Duke	Benbow.	Beardmore	25 000	29 "
1915	Queen Elizabeth	Barham.	Clydebank	27500	32 "
1916	do	Valiant.	Fairfield	27500	37 "
1917	Revenge	Ramillies.	Beardmore	28000	46 "

from: H.B. Peebles.- Warship Building on the Clyde. Edinburgh 1986.

Table 7/5 WARSHIP CONTRACTS WORKED ON BY SCOTTS DURING WORLD WAR I Sheet 1.

SHIP	DATE		TYPE	DISPLACEMENT	HORSEPOWER	VALUE	OUTCOME	
	ORDER	DELIVERY		Tons.		£	Profit. £	Loss. £
Caradoc	DEC 1915	JUN 1917	Cruiser	3 890	40 000	471,985.	21,757.	–
Dragon	SEP 1916	AUG 1918	"	4 723	40 000	612,999.	50,836.	–
Durban	JUN 1917	NOV 1919	"	4 723	40 000	600,860.	52,295.	–
Obedient	NOV 1914	FEB 1916	Destroyer	1 123	25 000	158,161.	14,100.	–
Obdurate	NOV 1914	MAR 1916	"	1 123	25 000	143,573.	12,796.	–
Paladin	FEB 1915	MAY 1916	"	1 123	25 000	145,724.	12,959.	–
Plucky	MAY 1915	AUG 1916	"	1 123	25 000	143,557.	12,806.	–
Parthian	FEB 1915	SEP 1916	"	1 123	25 000	147,108.	13,114.	–
Portia.	MAY 1915	OCT 1916	"	1 123	25 000	145,933.	13.012.	–
Tirade	MAR 1916	JUL 1917	"	1 123	27 000	180,163	11 948.	–
Ursula	MAY 1916	SEP 1917	"	1 123	27 000	179,940	20.071.	–
Westminster	DEC 1916	APR 1918	"	1 425	27 000	205,676	20,330.	–
Windsor	DEC 1916	AUG 1918	"	1 425	27 000	204,376	20.611.	–
Swallow	APR 1917	SEP 1918	"	1 123	27 000	190,222	16.705	–
Strenuous	JUN 1917	JAN 1919	"	1 123	27 000	195,324	17,111	–
Swordsman	APR 1917	APR 1919	"	1 123	27 000	191,086	16.864	–
Stronghold	JUN 1917	JUL 1919	"	1 123	27 000	192,178	17.124	–
Sturdy	JUN 1917	OCT 1919	"	1 123	27 000	197,776	17.130	–

Table 7/5 WARSHIP CONTRACTS WORKED ON BY SCOTTS DURING WORLD WAR 1 Sheet 2

SHIP	DATE		TYPE	DISPLACEMENT	HORSEPOWER	VALUE	OUTCOME	
	ORDER	DELIVERY		Tons		£	Profit £	Loss £
S.2.	May 1913	Jun 1915	Submarine	380	650	78,761	12,210	–
S.3.	May 1913	Sep 1915	"	380	650	78,800	14,780	–
E.31.	Nov 1914	Dec 1915	"	807	1600	76,919	8.089	–
E.51.	Mar 1915	Jan 1917	"	807	1600	84.014	7,522	–
G.14.	Aug 1914	Aug 1917	"	1 026	1600	161,205	14,109	–
Swordfish.	Sep 1913	Jul 1916	"	1 117	4000	206,401	–	9633
K.15.	Feb 1916	May 1918	"	2 566	10500	364,113	74.150	–
L.71.	Mar 1917	Jan 1920	"	1 150	2400	139,559	10,933	–
Sir John Moore	Dec 1914	Jul 1915	Monitor	5 906	2600	197,453	45,348	–
Bluebell.	Dec 1914	Aug 1915	Minesweeper	1 207	2200	64,370	14.236	–
Daffodil.	Dec 1914	Sep 1915	"	1 207	2200	64,305	17,515	–
Magnolia.	Jan 1915	Sep 1915	"	1 207	2200	68,168	18,537	–
								–
'SUPPLY AND INSTAL' MACHINERY CONTRACTS FOR ROYAL DOCKYARDS.								
Conquest.	Aug 1913	Jul 1915	Cruiser	3750	40,000	169,257	10 873	–
K.5	Sep 1915	May 1917	Submarine	2566	10.500	104,998	7 266	–
Servitor.	Mar 1913	Jun 1915	Fleet Oil Tanker.	1800	450	26,051	–	8969

Tables 7/5, sheets 1&2 derived from Volume II, Scotts Ship List.

Table 7/6 ANALYSIS OF SCOTTS WORLD WAR I NAVAL & MERCHANT CONTRACTS - YEARLY.

YEAR	NAVAL CONTRACTS: CRUISERS	DESTROYERS	SUBMARINES	MINE SWEEPERS	MONITOR	MACHINERY SUPPLIED to ROYAL DOCKYARDS		OUTPUT YEARLY: DISPLACEMENT tons	HORSEPOWER	VALUE £	PROFIT £	%
1915	—	—	3	3	1	FLEET OILER	'C' CLASS CRUISER	6 988	52,550	824.084	132.619	16·1
1916	—	6	1	—	—	—	—	7 855	154,000	1,090,457	69,154	6·3
1917	1	2	2	—	—	'K' CLASS SUBMARINE	—	7 969	107,700	1,182,305	82,673	7·0
1918	1	3	1	—	—	—	—	11,262	121,000	1,577,386	182,632	11·6
1919	1	4	—	—	—	—	—	9.215	148,000	1,377,224	120,524	8·8
1920	—	—	1	—	—	—	—	1,150	2400	139,559	10933	7·8
							Totals	44,439	585650	6,191,015	598,535	9·7

MERCHANT CONTRACTS.

YEAR	SHIP	OWNER	Gross tons	HORSEPOWER	£	£	%
1916	Tyndareus.	Ocean S.S. Co.	11 347	5 750	203.014	12 000	6·0
1917	Diomed.	"	7 523	5 700	258.141	8 000	3·1
1918	War Angler.	Shipping Controller.	5 210	3 000	169 964	15 148	8·9
1918	War Duck.	"	5 193	3 000	154 754	12 550	8·1
1920	Achilles.	Ocean S.S. Co.	11 426	7 000	538 056	48 989	9·1
1920	Albania.	Cunard S.S. Co.	12 768	6 800	692 103	39 604	5·7
		Totals	53467	31,250	2,016,032	136,291	6·8

Compiled from Vol. II. Scotts Ship List.

Table 7/7 FIRST WORLD WAR

WARSHIP ORDERS - MAIN CLYDE SHIPBUILDERS.

All major repair work, machinery contracts for Royal Dockyards & minor craft excluded.

FIRM	BATTLE CRUISERS	LIGHT CRUISERS	AIRCRAFT CARRIERS	MONITORS	DEPOT SHIPS	DESTROYERS	SUBMARINES	RIVER GUNBOATS	SLOOPS/ MINESWEEPERS
BROWN	2	3	1	-	1	37	3	-	-
FAIRFIELD	2	5		-	-	29	13	-	-
BEARDMORE	-	2	1	-	-	19	13	-	
SCOTT	-	3	-	1	-	19	8	-	3
DENNY	-	-	1	-	-	30	8	-	-
YARROW	-	-	-	-	1	29	1	16	-
STEPHENS	-	-	-	-	-	18	-	-	-
HARLAND & WOLFF	-	-	-	3	-	6	-	-	3
BARCLAY CURLE	-	-	-	-	-	-	-	-	39

From. Peebles: Warship Building on the Clyde - 1839-1939.

Fig. 7/1.

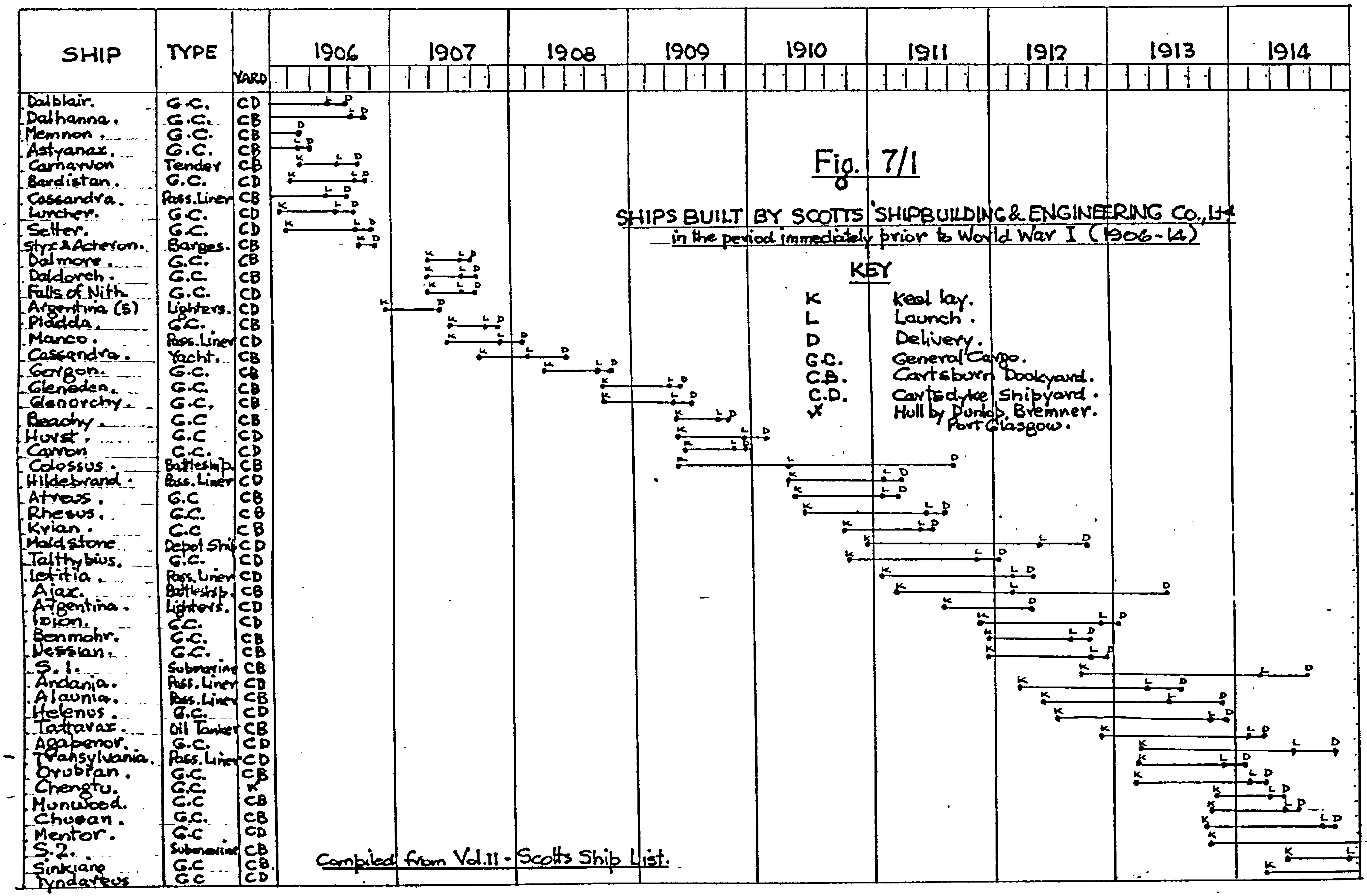
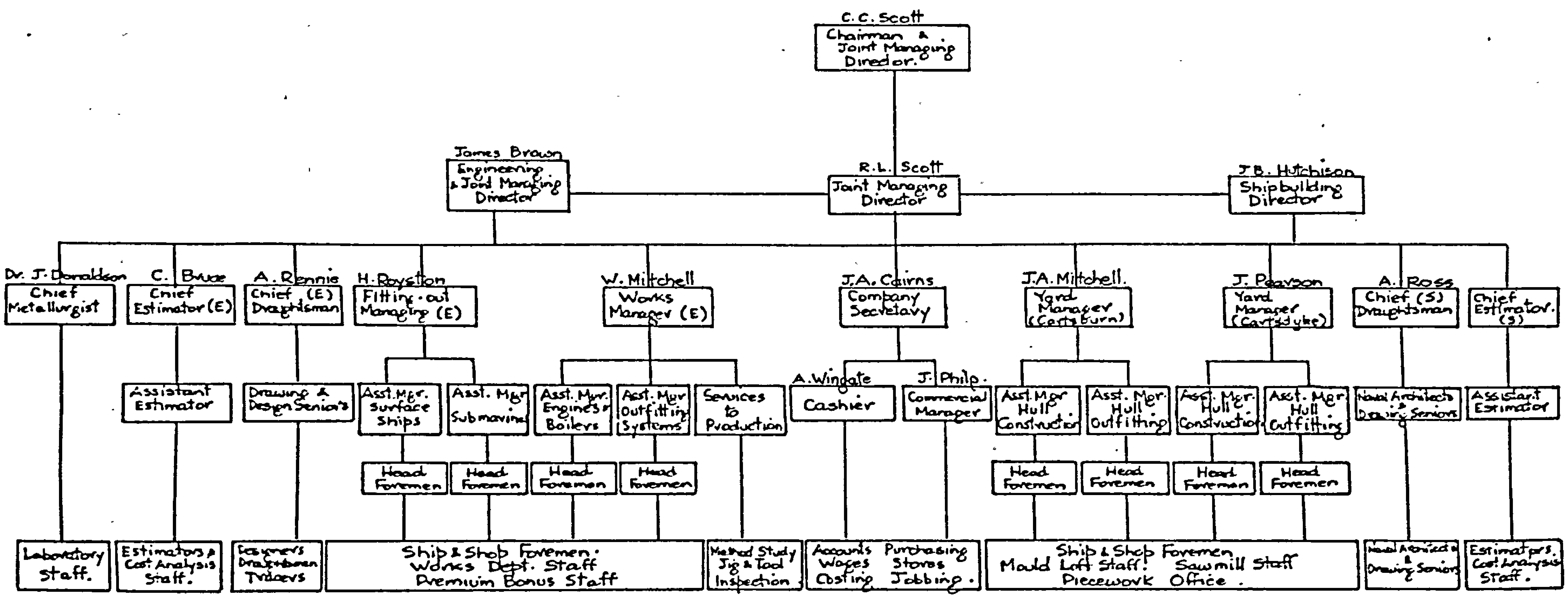


Fig. 7/1
SHIPS BUILT BY SCOTTS' SHIPBUILDING & ENGINEERING Co., Ltd
in the period immediately prior to World War I (1906-14)
KEY
K Keel lay.
L Launch.
D Delivery.
G.C. General Cargo.
C.B. Cartsburn Dockyard.
C.D. Cartsdyke Shipyard.
X Hull by Dunlop, Bremner. Port Glasgow.
SHIP
TYPE
YARD
1906
1907
1908
1909
1910
1911
1912
1913
1914
Dalblair. G.C. CD
Dalhanna. G.C. CB
Memnon. G.C. CB
Astyanax. G.C. CB
Carnarvon Tender CB
Bardistan. G.C. CD
Cassandra. Pass. Liner CB
Lurcher. G.C. CD
Setter. G.C. CD
Styx & Acheron. Barges. CB
Dalmore. G.C. CB
Daldorch. G.C. CB
Falls of Nith. G.C. CD
Argentina (5) Lighters. CD
Pladda. G.C. CB
Manco. Pass. Liner CD
Cassandra. Yacht. CB
Gorgon. G.C. CB
Glenaden. G.C. CB
Glenorchy. G.C. CB
Beachy. G.C CB
Hurst. G.C CD
Carron G.C. CD
Colossus. Battleship. CB
Hildebrand. Pass. Liner CD
Atreus. G.C CB
Rhesus. G.C. CB
Kyian. G.C CB
Maidstone Depot Ship CD
Talthybius. G.C. CD
Letitia. Pass. Liner CD
Ajax. Battleship. CB
Argentina. Lighters. CD
Ixion. G.C. CD
Benmohr. G.C. CB
Nessian. G.C. CB
S.1. Submarine CB
Andania. Pass. Liner CD
Alaunia. Pass. Liner CB
Helenus. G.C. CD
Tattarax. Oil Tanker CB
Agapenor. G.C. CD
Transylvania. Pass. Liner CD
Orubian. G.C. CB
Chengtu. G.C. X
Hunwood. G.C CB
Chusan. G.C. CB
Mentor. G.C CD
S.2. Submarine CB
Sinkiang G.C CB.
Tyndareus G.C CD
Compiled from Vol. II - Scotts Ship List.

Fig. 7/2 SCOTTS' SHIPBUILDING & ENGINEERING CO., LTD.

1914

COMPANY ORGANISATION CHART,
embracing
CARTSBURN DOCKYARD, CARTSDYKE SHIPYARD
& ENGINE WORKS.



Compiled from Scotts Archives : GD 319/3/4/11
and Scotts - Two Centuries of Shipbuilding - 1906 edition

Instructions to Draughtsmen.

The "Printed Instructions to Draughtsmen" throws light on the general principles which influence design, and one or two quotations may be made :—"Every machine or structure is designed with a certain object in view; therefore, in designing, keep that object always to the front. Go straight to the point, and let the object be attained in as simple a manner as possible. Avoid all curves and indirect lines, except those conceived to give uniform strength or stifiness, or required for some definite purpose. There should be a reason for the contour and shape of every detail. It should be remembered that designs made in this way, requiring least material for the work to be done, usually look best. Besides keeping the object clearly to the front, it is necessary in designing to remember that certain facilities must be attended to for moulding, machining, and erecting. It is also necessary to keep in view the circumstances in which the structure or machine is to be used. Every little detail should be definitely attended to on the drawings, and not left to the judgment of the men in the shops; remember that it is usually the unexpected which happens, and that even the want of a split pin may cause a breakdown. In making drawings or sketches for ordering material or for the shops, assume that those who have to interpret the instructions have no knowledge of, or information concerning, the work in question, except what is contained in the drawing or order you are making out. This will ensure that all information issuing from the drawing-office is complete, and that no work is done in the shops without drawing-office instructions."

The draughtsman, in designing work, must so arrange details as to fully utilise, as far as is compatible with progress, the special machine tools available, the system of gauges, templates, and jigs extensively applied in the shops and existing patterns.

Fig 7/3 From Scotts 'Two Centuries of Shipbuilding - 1906

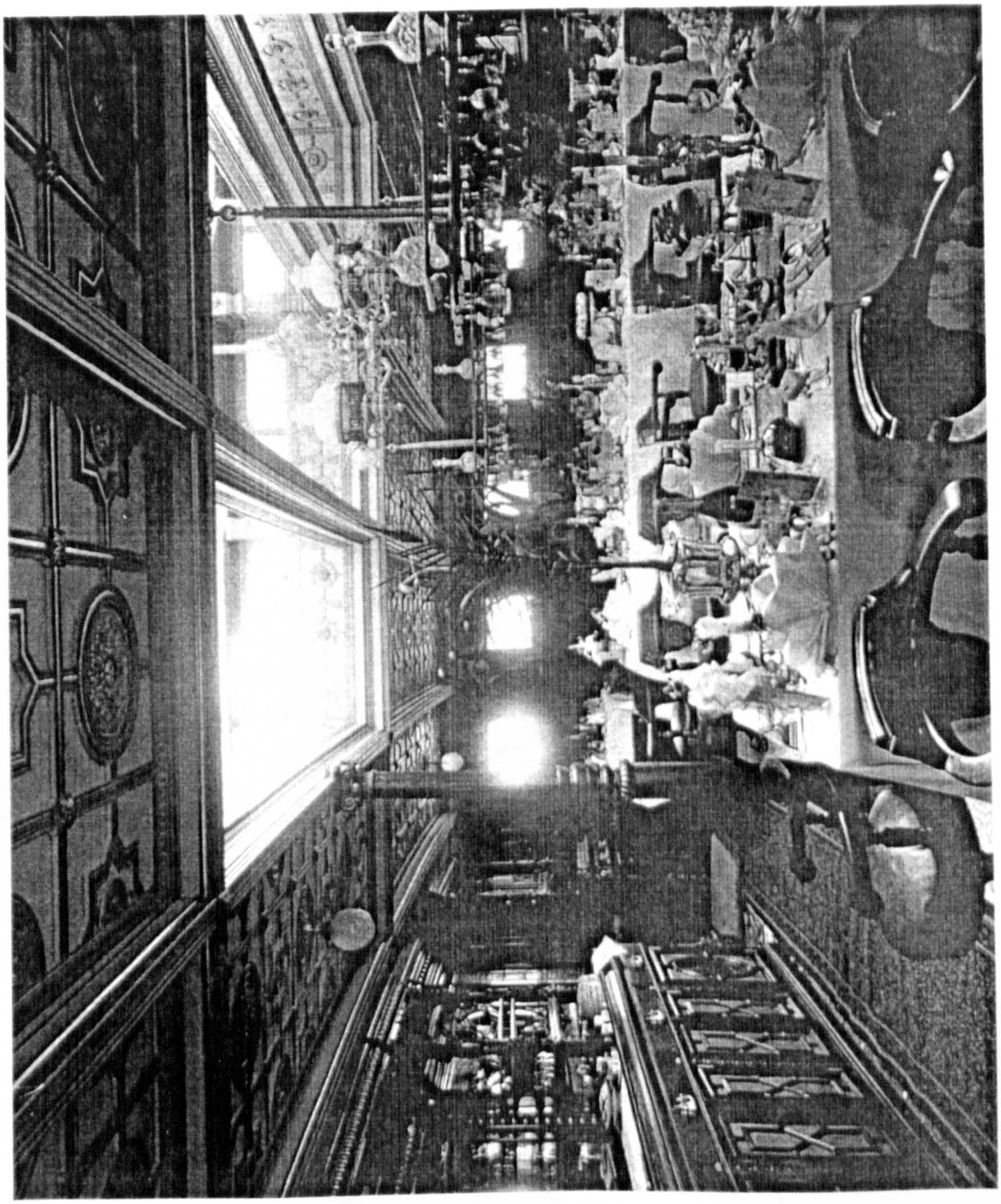


Fig. 7/4.

Dining Saloon - S.S. Malange
c. 1890.

Fig. 7/5 SCOTTS SHIPBUILDING & ENGINEERING CO. LTD.

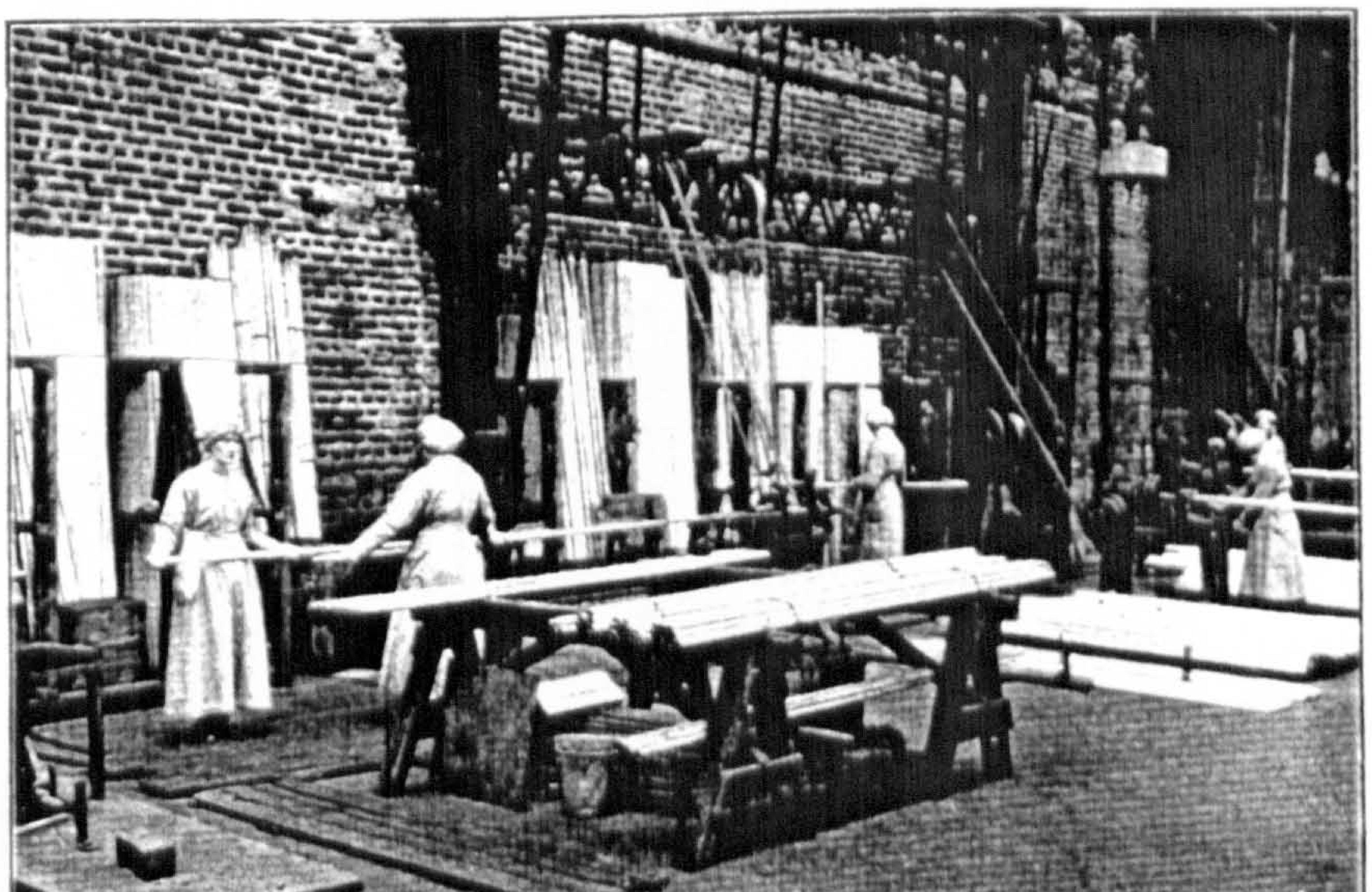
NUMBER OF EMPLOYEES.

1910 - 1921.

Fig. 7/5

Fig. 7/6a&b.

Fig 7/6a THE TURBINE BLADING SHOP.



THE GALVANIZING SHOP, SHOWING DILUTION OF LABOUR, 1915-18.
Fig. 7/6b.

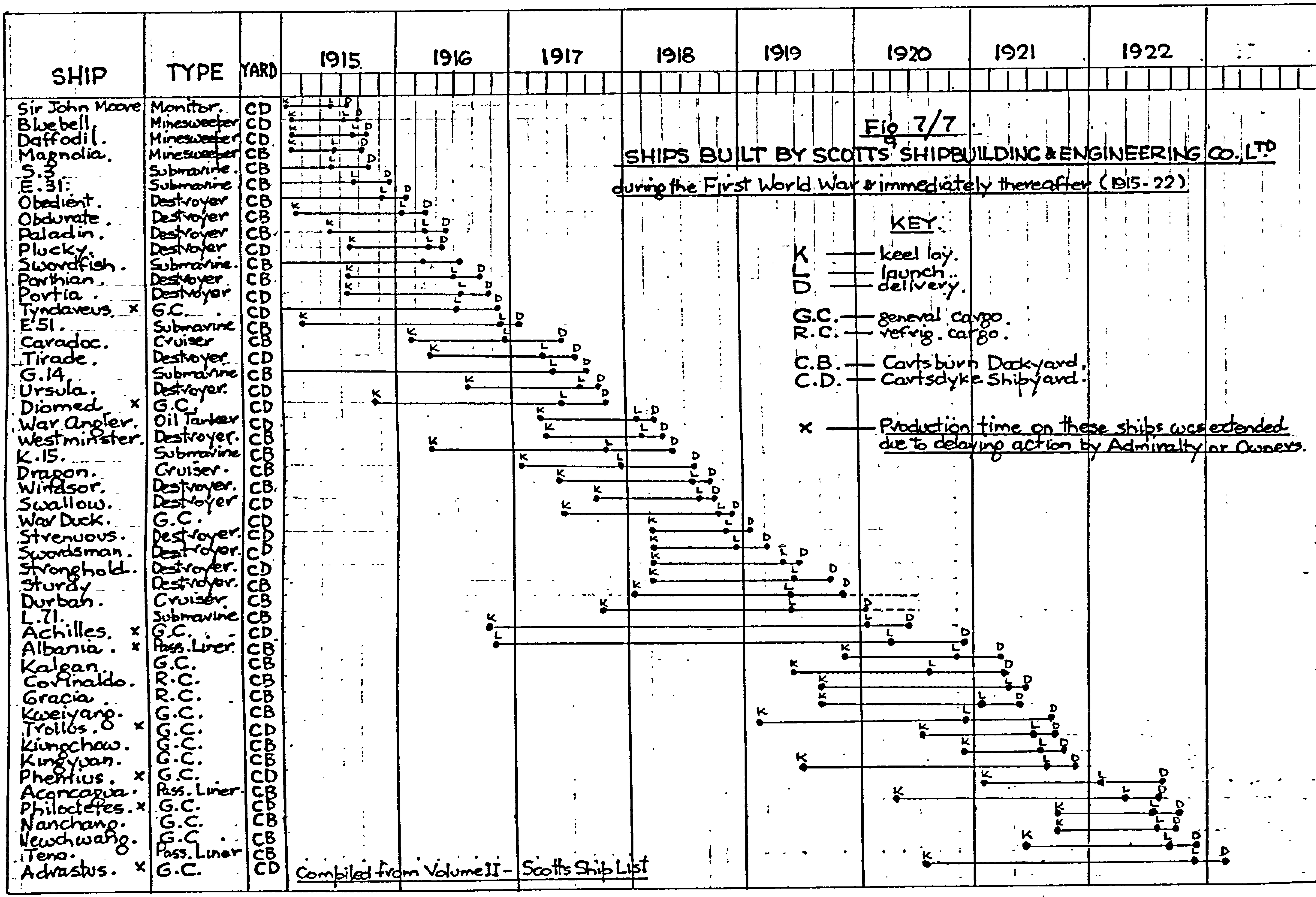


Fig 7/7
SHIPS BUILT BY SCOTTS' SHIPBUILDING & ENGINEERING CO. LTD
during the First World War & immediately thereafter (1915-22)
KEY.
K — keel lay.
L — launch.
D — delivery.
G.C. — general cargo.
R.C. — refrig. cargo.
C.B. — Cartsburn Dockyard.
C.D. — Cartsdyke Shipyard.
x — Production time on these ships was extended due to delaying action by Admiralty or Owners.
SHIP
TYPE
YARD
1915
1916
1917
1918
1919
1920
1921
1922
Sir John Moore Monitor. CD
Bluebell. Minesweeper CD
Daffodil. Minesweeper CD
Magnolia. Minesweeper CB
S.3. Submarine. CB
E.31. Submarine CB
Obedient. Destroyer CB
Obdurate. Destroyer CB
Paladin. Destroyer CB
Plucky. Destroyer CD
Swordfish. Submarine. CB
Parthian. Destroyer CB
Portia. Destroyer CD
Tyndareus. x G.C. CD
E.51. Submarine CB
Caradoc. Cruiser CB
Tirade. Destroyer. CD
G.14. Submarine CB
Ursula. Destroyer. CD
Diomed x G.C. CD
War Angler. Oil Tanker CD
Westminster. Destroyer. CB
K.15. Submarine CB
Dragon. Cruiser. CB
Windsor. Destroyer. CB
Swallow. Destroyer CD
War Duck. G.C. CD
Strenuous. Destroyer. CD
Swordsman. Destroyer. CD
Stronghold. Destroyer. CD
Sturdy Destroyer. CB
Durban. Cruiser. CB
L.71. Submarine CB
Achilles. x G.C. CD
Albania. x Pass. Liner. CB
Kalgan. G.C. CB
Corinaldo. R.C. CB
Gracia. R.C. CB
Kweiyang. G.C. CB
Trollus. x G.C. CD
Kiungchow. G.C. CB
Kingyuan. G.C. CB
Phemius. x G.C. CD
Aconcagua. Pass. Liner. CB
Philoctetes. x G.C. CD
Nanchang. G.C. CB
Newchwang. G.C. CB
Teno. Pass. Liner CB
Adrastus. x G.C. CD
Compiled from Volume II - Scotts Ship List

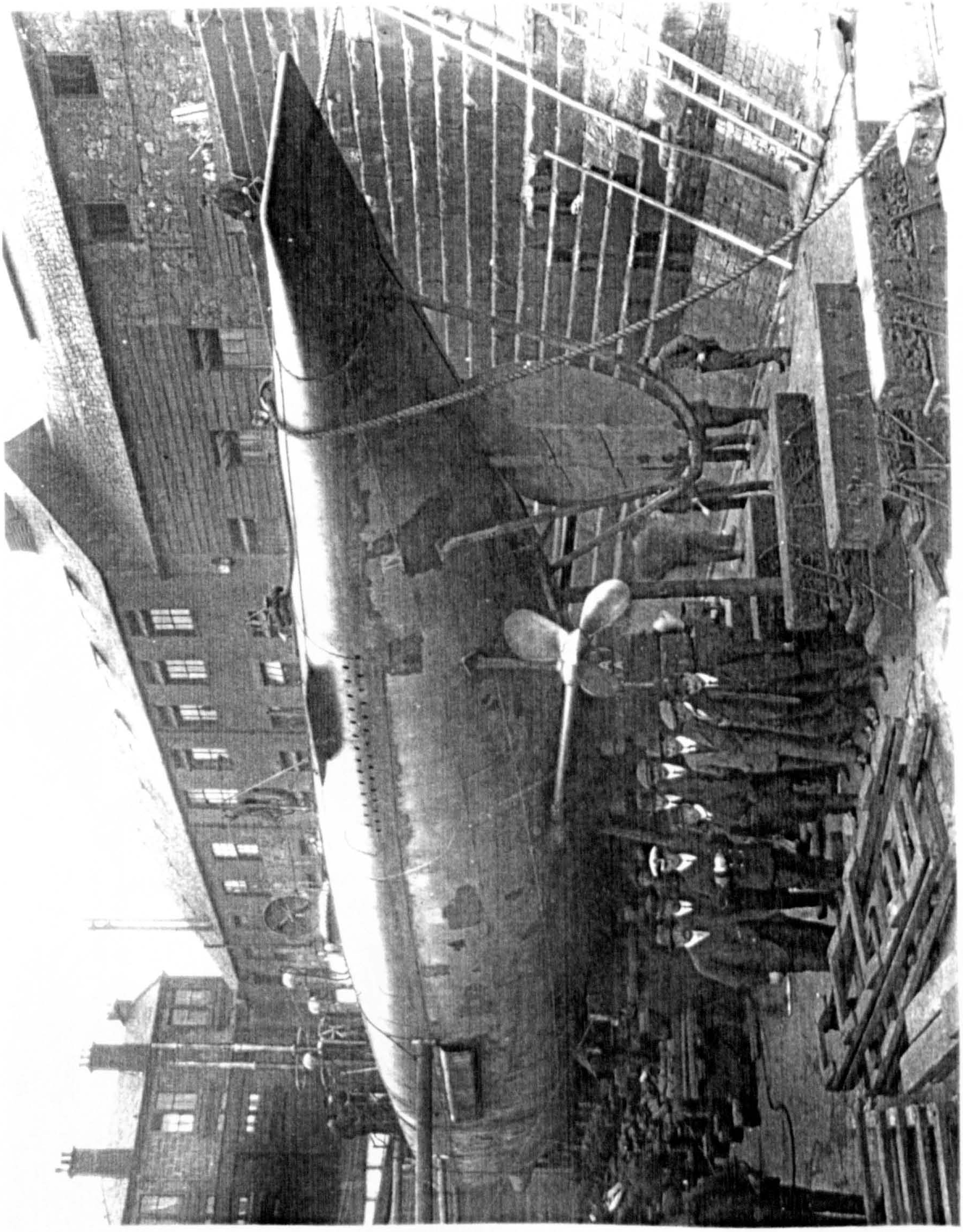


Fig 7/8 – Submarine S.1 in drydock. – June 1914.

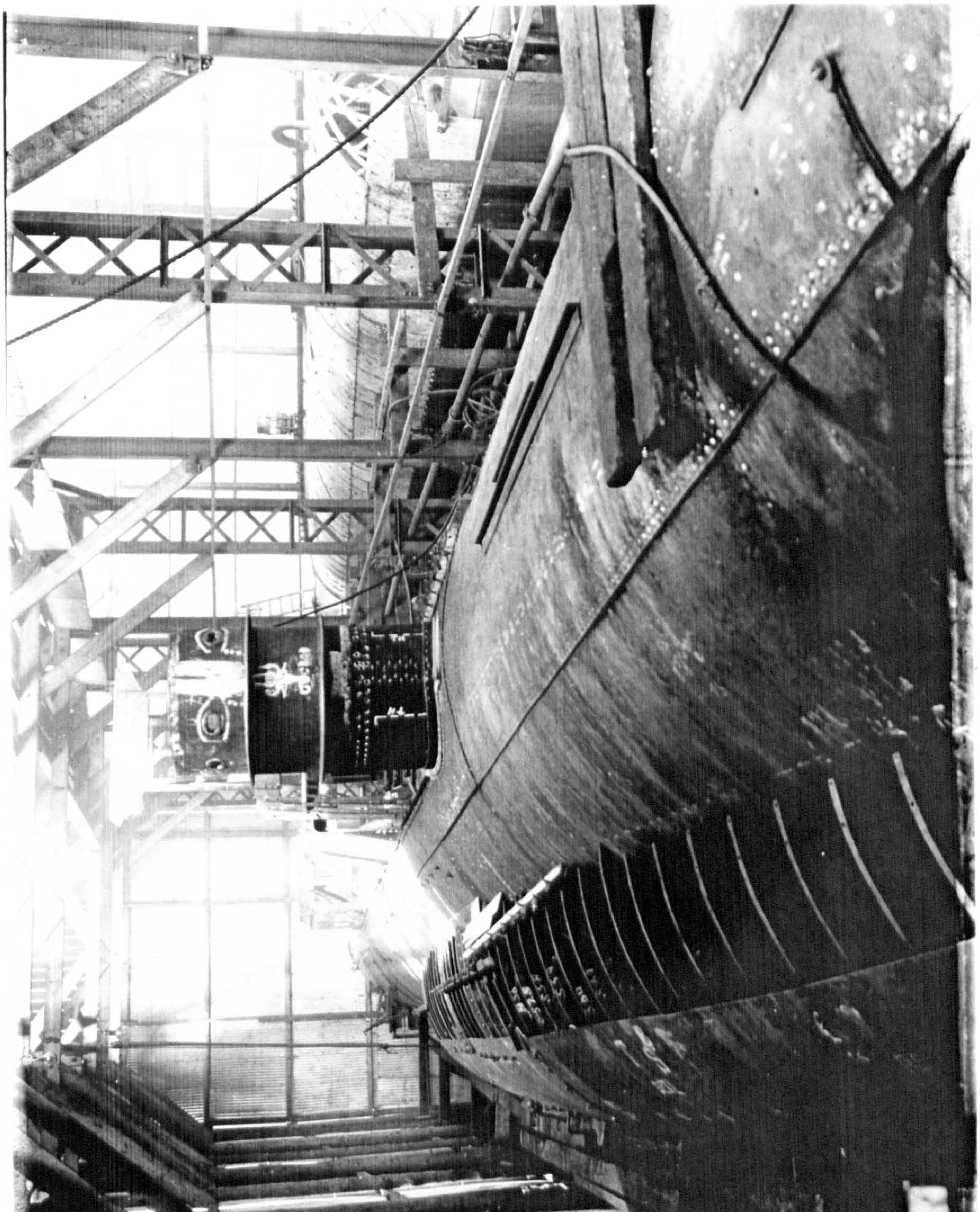


Fig. 7/9 (1) Scotts Submarine Building Shed showing H.M. Submarine E.31 under construction. (1915).

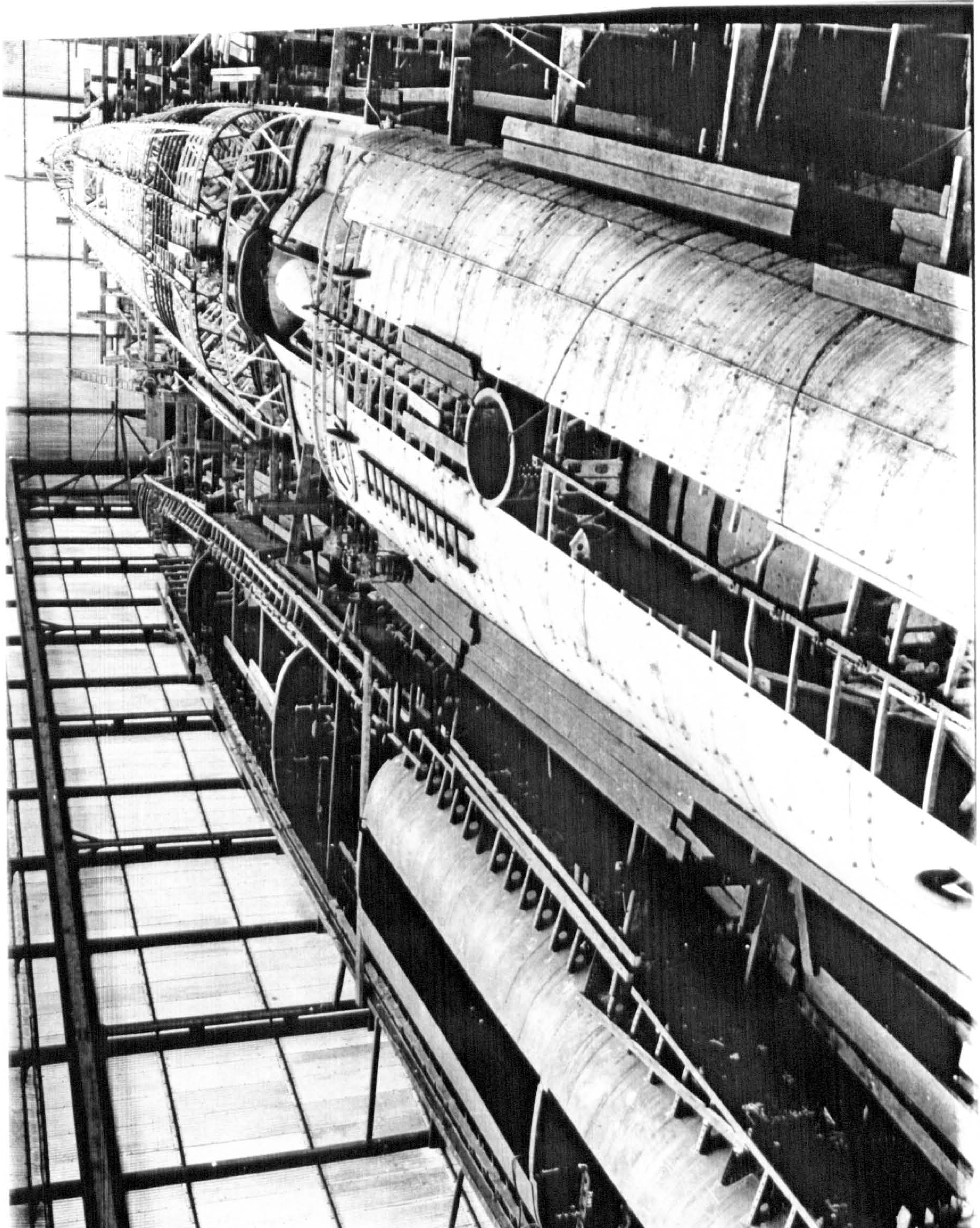


Fig. 7/9(2) showing (left to right) HM. Submarines, G14 and 'Swordfish' under construction (1915)

Fig. 7/9
(3)

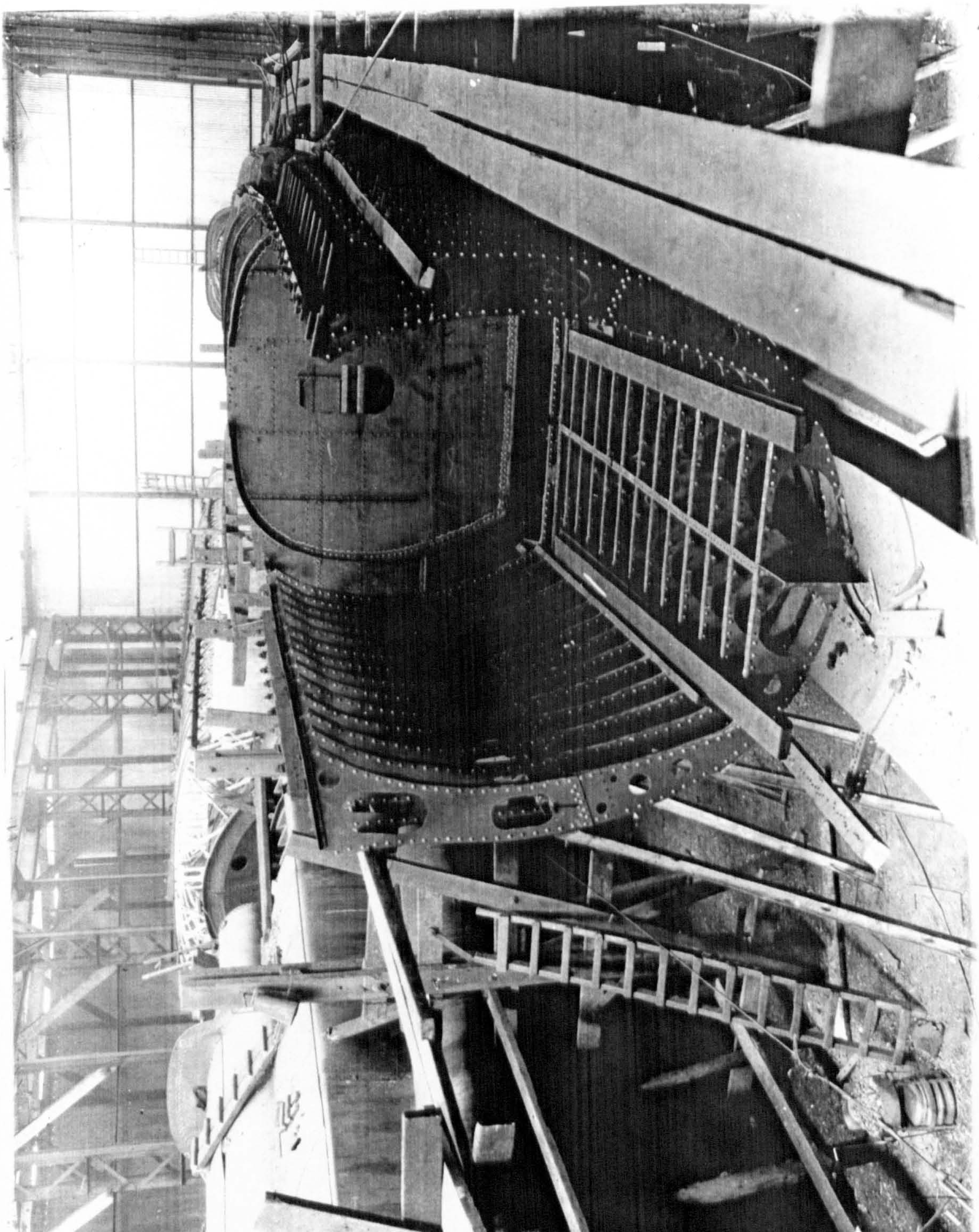


Fig. 7/9 (3). showing (left to right) H.M. Submarines 'Swordfish' and G.14. under construction (1915)

Fig. 7/10

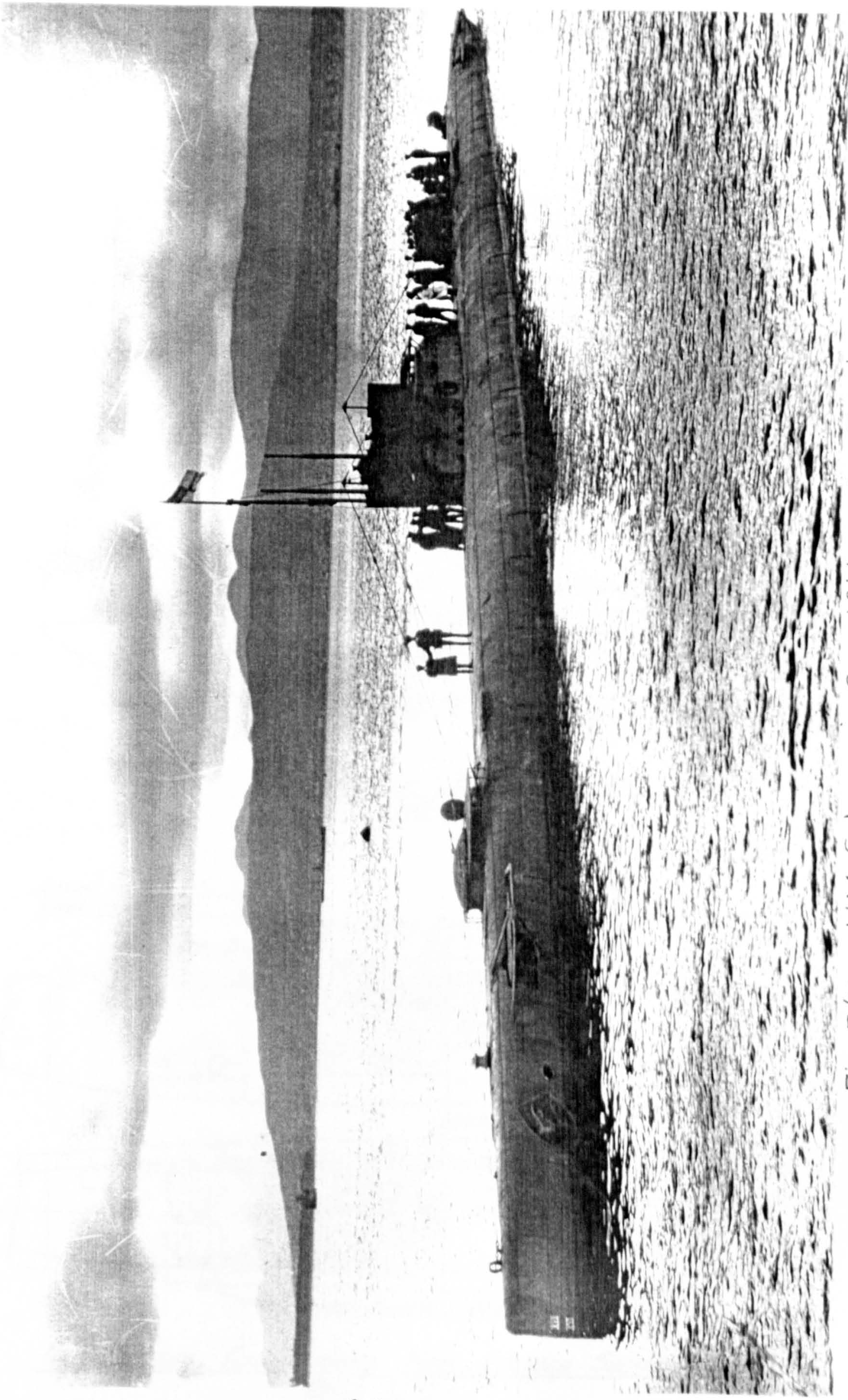
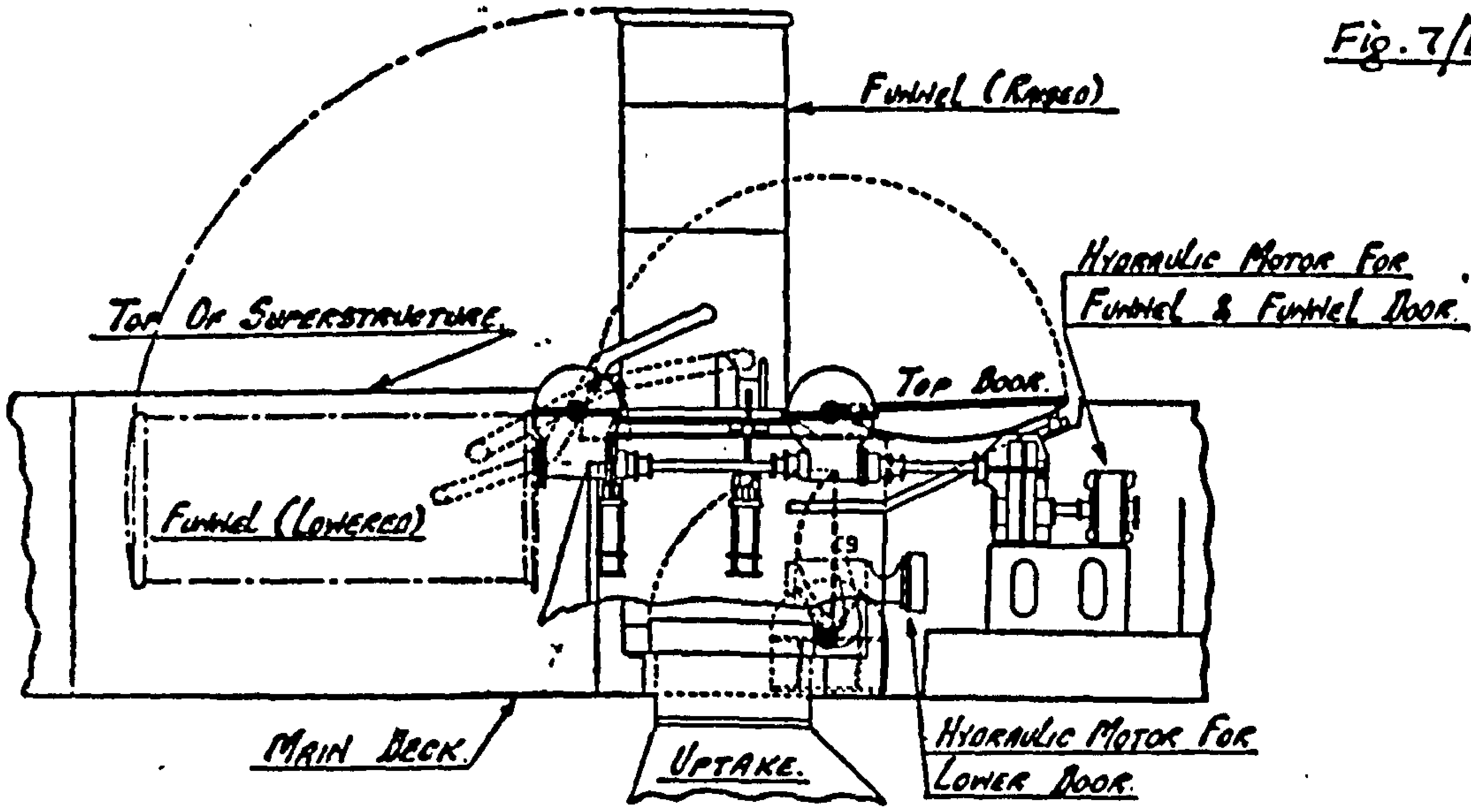
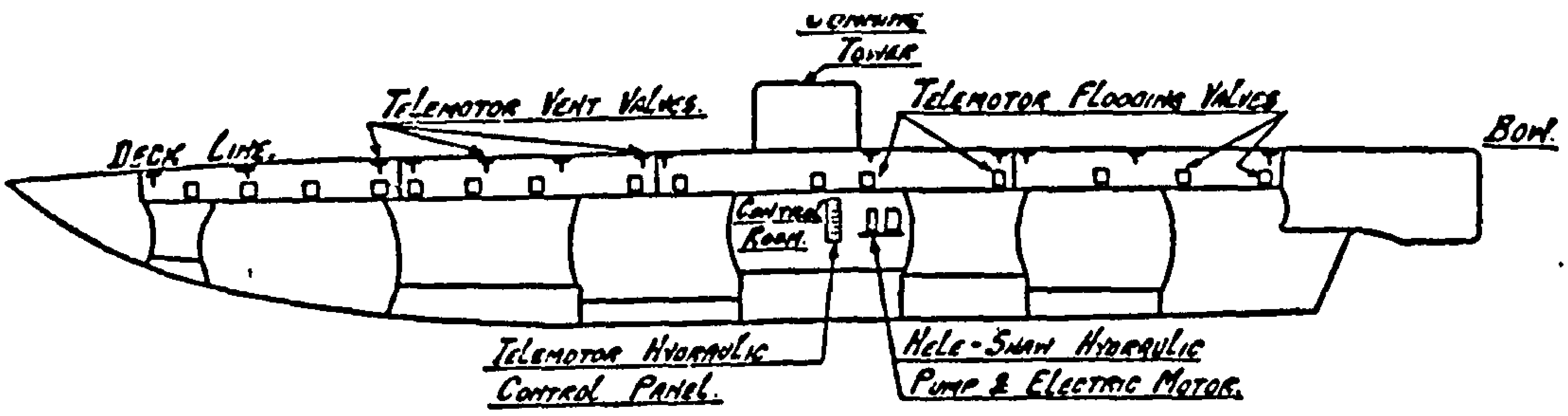


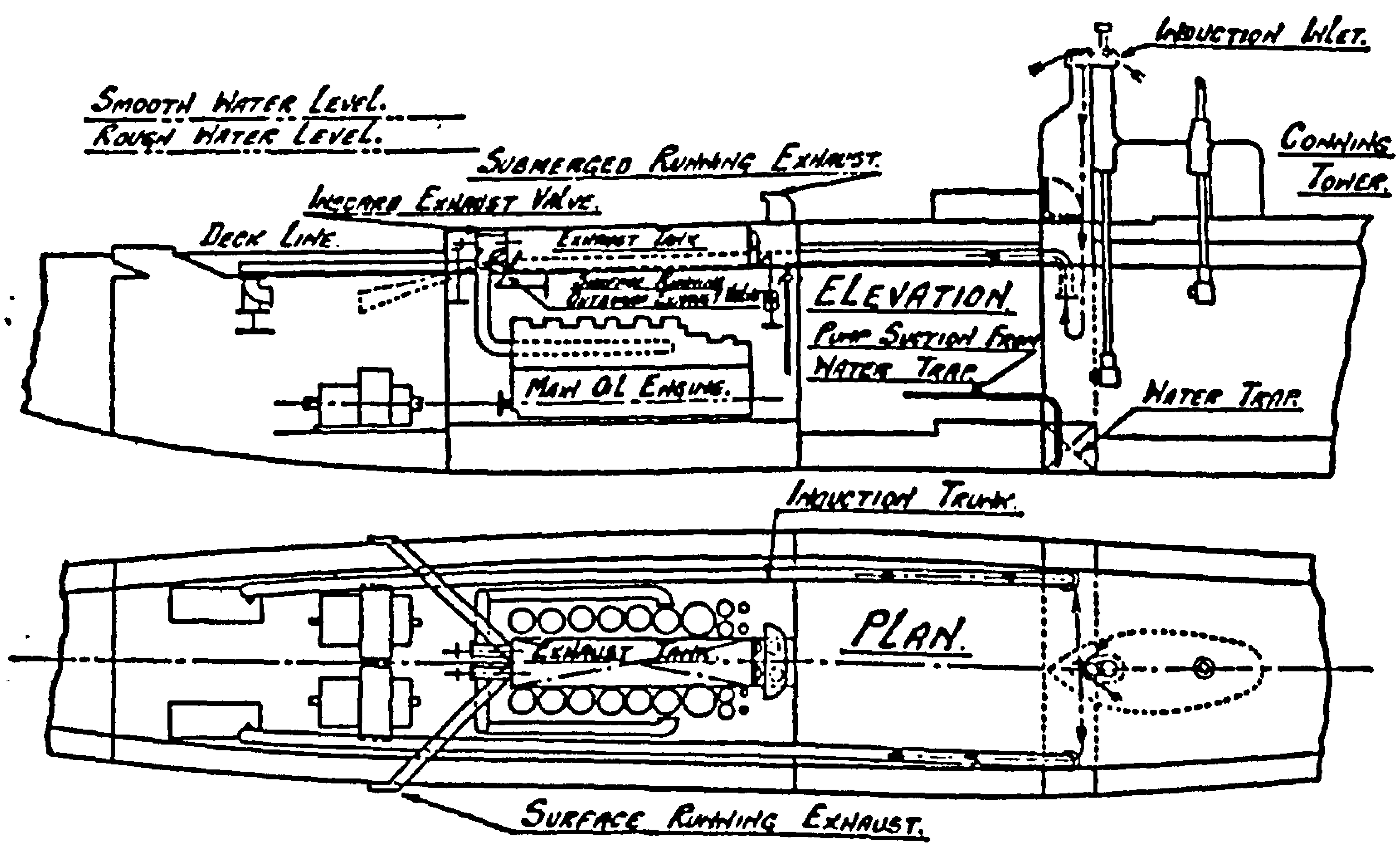
Fig 7/10 — H.M. Submarine Swordfish on Sea Trials.



HYDRAULIC FUNNEL GEAR.
FIG. 7/11



TELEMOTOR VALVE SYSTEM.
FIG. 7/12



ARRANGEMENT FOR RUNNING MAIN ENGINES SUBMERGED.
FIG. 7/13.

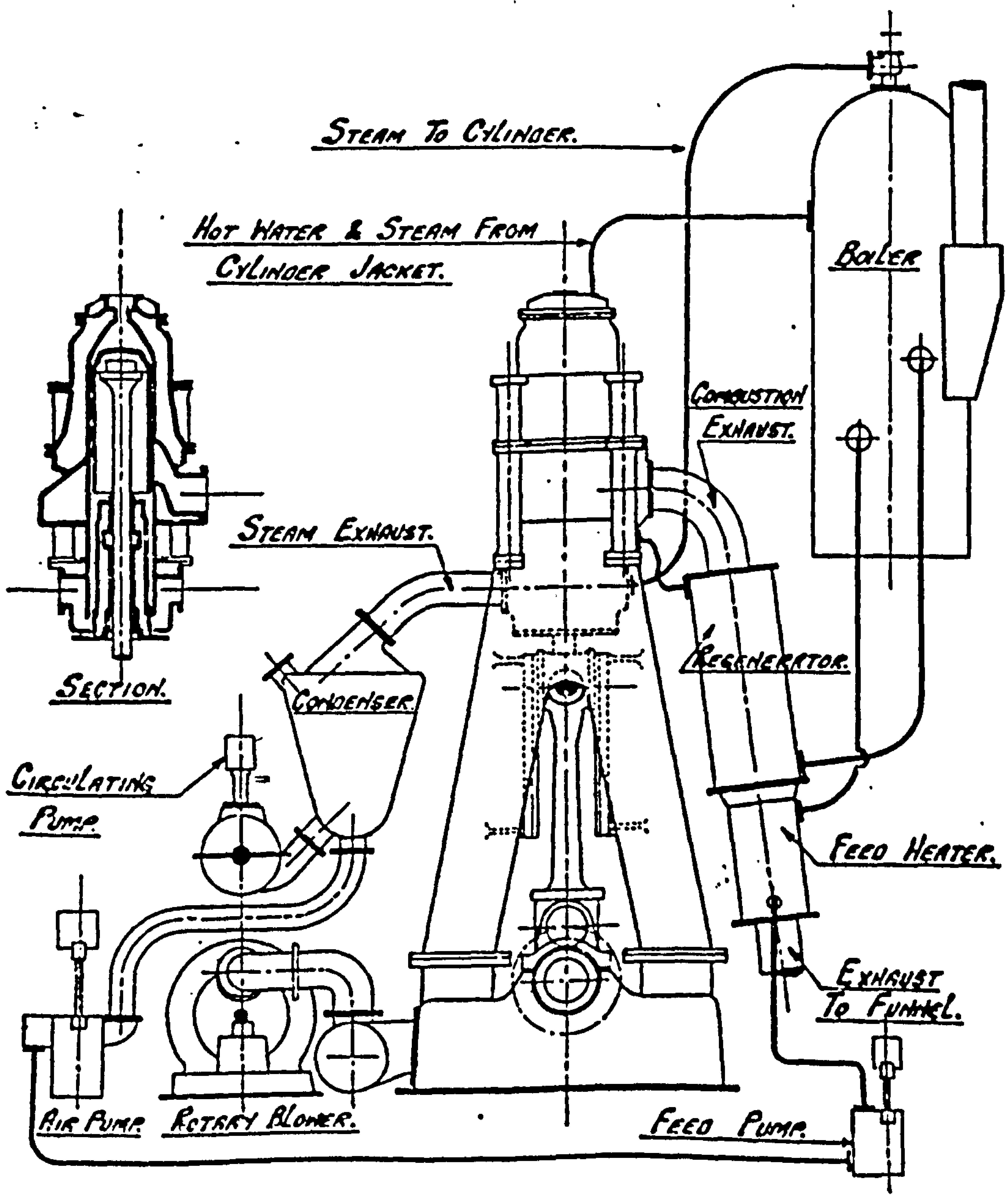


Fig. 7/14. ARRANGEMENT OF "STILL" ENGINE.
From: Scotts Archives - ref. GD 319/25/1/1.

CHAPTER 8.

CONCLUSIONS.

CHAPTER 8.

CONCLUSIONS.

The history of shipbuilding and marine engineering throughout the ages reflects the cyclic nature of the business with its jagged profile of boom periods followed by depressions and littered with casualties along the way. The odds were so heavily against any shipyard surviving for any length of time in the early years that it is remarkable to find in the Scott story a family enterprise that not only survived for some two hundred and seventy years but made such an outstanding contribution to the development of the shipbuilding and marine engineering industries during that time. With an unbroken line of succession stretching from the reign of Queen Anne till the present day the 'clogs to clogs' expression is wholly inappropriate!!

In reviewing the story of the Scott family as set out in the earlier chapters, outlining their activities in Greenock and around the world, the opportunity will be taken in these final remarks to isolate and record the many factors, both creditable and fortuitous, which contributed to their success, many of which in these modern times are regarded as the hallmarks of a successful business.

It is made clear in the Introduction that the Scotts set up in business in 1711 to serve a local market for fishing vessels generated by the thriving fishing trade on the Firth of Clyde and based at Greenock. During the 18th century thousands of barrels of cured herrings were exported annually from there to Europe and the Caribbean islands and the early harbour development was prompted by the herring trade. In addition to new building work John Scott I's shipyard undertook ship repair work on the foreign vessels which were involved in the fishing trade. John

Scott's elder son, James had a blacksmith's business locally specialising in anchors and chains.

In addition he owned a number of sailing vessels trading in timber and other commodities in the Irish Sea and around the south coast of England. His younger son, William joined his father in the shipyard. Following the death of their father in 1745 the two brothers jointly ran the business which continued to prosper as Greenock developed into an international port.

By the 1760's they were building ocean going sailing ships and were quietly acquiring ground adjacent to their West Burn shipyard for future expansion. There was emerging a series of profitable and diverse enterprises, all very profitable and embracing shipbuilding, ship repair, ship operation and ship chandlery. When William Scott died in 1769, his brother James carried on the various businesses until William's eldest son John Scott II had completed his education and took over in 1773. He had been left comfortably off by his father but in association with his brother William continued to develop the business. Ship repair work at this time with Greenock's trade continuing to grow was extremely profitable. It was however seasonal and so John Scott II decided to embark on speculative shipbuilding which ensured continuity of employment for his workforce. It was a policy which the Scotts were to operate fairly regularly over the next hundred years and which of course required capital to sustain it. He also invested in property near the shipyard to provide accommodation for his key workers.

Brother William left the partnership in 1797 and set up as a timber merchant in Barnstaple leaving John Scott II as sole partner.

From his surviving correspondence covering the period 1795 to 1820 there emerges many examples of the sterling qualities of this remarkable man. He took his responsibilities to his business empire very seriously. He re-invested capital in his various enterprises, in particular, c.1800 he greatly enlarged the shipyard and added a private drydock and basin which made him more or less independent of the public facilities and allowed him to increase his turnover considerably. He was a man of strong character and this emerges from his Canadian shipbuilding venture in St. John, N.B. Canada at the turn of the century. The imaginative nature of this episode and the risks involved emerge clearly from his correspondence with his brother Christopher, a master mariner acting as his agent there. His probing questions and observations clearly display the depth of his knowledge of ships and shipping and the letters leave no doubt as to who was in charge of the entire operation! Christopher Scott's subsequent career shows that he also possessed a spirit of adventure which in other fields made him also a very wealthy man. John Scott's standing instructions to his captains also leave no doubt as to what was expected. The fate of the errant Captain Pincher was clearly predictable.

It was however, in technical matters that John Scott II was most uncompromising. By the turn of the century West Burn shipyard had already accumulated ninety years of building wooden sailing vessels and acquired a reputation for ships of the highest quality. There were limitations on increasing the size of wooden ships because of the stresses induced thereby and at this time the Admiralty introduced the new Seppings system of framing incorporating additional diagonal members which greatly strengthened the hull structure and reduced working of the hull in heavy weather. Scotts immediately adopted the new system. Another quality element in their production was to apply both wood and felt covering under the copper hull sheathing. His terse comments on the quality of the native Canadian produced ships were revealing! His trading activities were wide ranging. In the early 1800s he had a fleet of twelve ships trading mainly in timber but also including copper sheet, tar, turpentine, flax, hemp, varnish, resin and salt. He also undertook salvage operations in the Irish Sea and up the west coast of Scotland as far as Lochinver.

As we approach the period of transition from sail to steam propulsion two other shrewd investments made by John Scott II should be recorded. He recognised the long term potential of the steamship (having been responsible for building the largest steamers in the United Kingdom in the years 1819, 1820 and 1821) and decided that in future he would build his own propelling machinery. Accordingly, in 1825 he converted a local foundry into a marine engineering works, an investment which years later was to provide an entrée to the naval market. In 1832 he purchased the local Garvel Park estate located to the east of the town and bordering the River Clyde. The disposal of this estate in 1867 to the Greenock Harbour Trust rescued Scott and Co. from disaster after the Saint-Nazaire adventure.

In 1810, John Scott II had purchased the Hawkhill estate in Largs, Ayrshire in anticipation of his retiral but it is clear that although he spent an increasing amount of time developing the estate he never did retire. By the 1820s his sons John Scott III and Charles C. Scott I were running the shipbuilding and repair facilities and his son-in-law Robert Sinclair was the managing partner of Scott, Sinclair and Co. under his guidance. The years which followed up to this death in 1837 saw the Scotts capitalise on their one hundred years of experience in the design and construction of sailing vessels and steamers of the highest class by embarking on what must have been a very early research programme into hull and rudder design involving systematic testing of fully rigged ship models of about 5 ft. long on a local reservoir and in their flooded dry dock.

In that part of our summary of the Scott family business so far covering the period from 1711 to 1837 there has emerged a story of steady progressive development and remarkable success in a trade notorious for casualties along the way. It has been shown that of some seventy shipbuilding businesses started in the Greenock and Port Glasgow areas during the period only the Scotts had a continuing presence beyond that period. They had progressed from fifty ton herring busses to sailing ships of around six hundred tons. They had also led in the development of ocean going steamers for prestigious liner companies including Peninsular & Oriental and the Royal Mail lines. Their success was due to a number of factors and it was achieved against a background of steady growth of Greenock as an international port.

Continuity of family 'hands on' involvement was an important contribution to success as we've seen throughout the entire story together with their policy of diversifying their investment which mitigated the inevitable cyclical trade variations. The various elements of the business were profitable and much of that profit was re-invested in the business. They had a first class product, constantly being improved on the basis of their ship repair and ship operation experience and were quick to adopt new methods (e.g. Seppings new system of framing) They trained their apprentices in accordance with their high standards and were able to retain their skilled tradesmen. However, much of their success was achieved during the tenure of John Scott II and was due to his personal qualities, his business acumen, his foresight and imagination which led to Scotts being able to exploit situations. It is perhaps worth recording that during his time the business was still of a size which allowed him to exercise personal control over all aspects of it.

The period covered in Part One of this thesis and particularly the years immediately following the death of John Scott II was a turbulent one for the shipbuilding industry in general and for the Scott family business in particular. Before he died, John Scott II, being anxious that the family would be satisfied, made the terms of his will known to them. His elder son, John Scott III was extremely unhappy with his lot and even after the terms were amended he remained very dissatisfied. His father had finally bequeathed the shipyard to him and the family estate went to his younger brother Charles, although the father clearly had the view that Charles was younger and better equipped to cope with the challenges already facing Scotts of iron ships and steam engines and should have taken charge of the shipyard. John Scott III complained in the years that followed that he should have had both the shipyard and the estate. This soured his relations with his brother and sister and taxed the patience of his brother-in-law, Robert Sinclair. It also led ultimately to the brothers partnership being split up.

Another factor of significance in this period was the death of Robert Sinclair in 1841 who had managed Scott, Sinclair & Co. since it was founded in 1825. As a result Charles and his widowed sister, Margaret were now majority partners in Scott, Sinclair & Co. and Charles decided to take over the running of the engineering business. During the period 1825-1837 Scotts led penetration of the U.K. steamer market with a production ratio of one steamer to 1.17 sailing vessels compared with a ratio of 1: 16.4 for the United Kingdom as a whole. In the years 1837-1851, with John Scott III in sole command in the shipyard, Scotts performance had fallen back to ratio of 1: 4.5 and Charles C. Scott at Scott, Sinclair and Co. who relied largely on Scott and Sons for machinery orders saw this as confirming his suspicions that John Scott III preferred to build sailing vessels.

In the light of later events he was probably correct. However, in fairness to John Scott III, reference must be made to a country wide depression which started in 1842 but affected the shipbuilding industry mainly in 1843 and 1844. The depression was devastating with 50% of industrial workers unemployed at its height. Of the eleven shipbuilders with an established presence in Greenock and Port Glasgow prior to the depression, only Scotts and three others survived.

Once again diversification came to the Scotts rescue, on this occasion the West Burn yard concentrated on ship repair operations and at Scott, Sinclair and Co. Charles Scott diversified into the manufacture of railway engines (including four for I.K. Brunel) and a wide range of machine tools, lathes, drills, punching and shearing machines. He also managed to secure orders for a number of sets of propelling machinery for naval vessels building in the Royal Dockyards at home and abroad and was also developing a range of industrial boilers. In spite of all his efforts Scott, Sinclair and Co. was not very profitable, partly due to onerous charges for hydraulic power to drive the workshop machinery. In spite of the wary attitude being taken in the 1840s by shipowners and other shipbuilders he was convinced that the iron hulled steamer would ultimately prevail. He was also conscious that brother John was quite content to continue building his superb wooden sailing ships for which there was still a substantial market. John had no relish for the trauma of re-equipping his shipyard with metal working machinery and retraining his shipwright workforce in entirely new production methods. Nationally the shipwrights were bitterly opposed to the new developments and many left the industry in protest. John Scott III's views were widely shared around the country but not on the Clyde which was emerging as the national and world leader in the production of iron steamships. Sensing there was no encouragement coming from brother John, Charles took the brave step of submitting Scott, Sinclair tenders for iron steamers. After all, in 1839 the Scott, Sinclair boiler shop had fabricated two small paddle steamers for river service in Portugal, each 91 ft. long and of 154 tons gross. By arrangement with Scott and Sons they had been erected and launched in the West Burn yard.

As a result Scott, Sinclair and Co. on 11th January 1845 were awarded a contract to build and engine the first Clyde built steam frigate H.M.S. 'Greenock' for the Royal Navy. There were many delays in the building of H.M.S. 'Greenock', all attributable to the Admiralty, including a delay of seven months in supplying guidance drawings and a later delay due to an alteration to the lines of the after body. The keel was not laid until two and a half years after receipt of order.

H.M.S. 'Greenock' was finally handed over in May 1850 and by this time Charles C. Scott I realised that after nine years at Scott, Sinclair working in iron, latterly building this substantial vessel, he could fare much better by becoming an iron shipbuilder on his own account. With his limited resources he required to dispose of his holding in Scott, Sinclair and Co. to obtain the necessary capital to fund his brave enterprise. Unfortunately, his brother John Scott III forestalled him by announcing that he also wished to withdraw from Scott, Sinclair and Co. After prolonged and somewhat frosty negotiations in 1851 Charles had his way, leaving Scott Sinclair in brother John's hands, and embarked on what was clearly an extremely risky venture. He built his new yard on what is now called a green field site at Cartsdyke on the verge of his sister's Garvel Park estate, equipping the yard with the latest metal working machinery. The new Scott and Co. launched their first iron ship from the new yard, the paddle steamer 'Gourock' on 18th February 1852. So after being partners in the various family concerns for a lifetime the brothers went their separate ways. John Scott III was sixty six years of age and Charles was fifty seven years of age. Ten years later in 1861 Scott and Sons had gone into bankruptcy and Scott and Co. were flourishing.

The ready availability of male heirs was a feature of the Scott family history. At this time the eldest sons of both John and Charles Scott were in the business. They were both called John Scott after their illustrious grandfather, John Scott II. To distinguish them, John Scott III's son was called John Scott, jr and Charles C. Scott's son was called John Scott, yst (later John Scott IV). John Scott jr disappeared from the scene after the failure of Scott and Sons in 1861. John Scott IV on the other hand exhibited all the characteristics typical of his grandfather. He clearly must have been very influential in his father's decision to start up on his own. A great proponent of iron ships and steam power, he was quickly given his head to run the new Cartsdyke iron shipyard. In his subsequent career he went on to make Scott and Co. into a shipbuilding and marine engineering organisation of international repute.

In the decade which followed, John Scott III appeared to have undergone a belated conversion. He extensively re-equipped Scott Sinclair and Co. installing new power plant and a new turning shop with a wide range of modern machine tools. He also built a new iron shipyard to the west of the West Burn shipyard but as is clearly seen in Table 2/1 he built very few iron ships and by 1855 he offered to sell his iron shipyard to Greenock Harbour Trust for harbour development. He ceased building iron ships in 1857, reverting to building wooden sailing ships. By 1859 he was forced to put the re-equipped Scott, Sinclair and Co. up for sale and it was re-acquired by Charles Scott and his son John Scott IV and renamed the Greenock Foundry Co.

Finally, in 1861 Scott and Sons went into bankruptcy bringing to an end 150 years of shipbuilding and ship repairing at West Burn by the Scott family. However, the Scott flag still flew over Greenock. Scott and Co. under John Scott IV had by this time secured a truly international reputation and had undertaken many contracts for foreign owners with such exotic names as the Neptune Steam Navigation Co. of the Volga, the Steam Navigation Co. of the Two Sicilies, Valery Frères et Fils, the St. Petersburgh and Riga Steam Navigation Co. He also built for the French and Spanish Navies and for high class British liner companies such as P. & O., British India, Lamport and Holt, Rathbone Bros. and of course Alfred Holt.

Chapter 2 described the contrasting progress made by the Scott family enterprises during the years following the death of John Scott II, culminating in the failure of Scott and Sons in 1861 and the foundation and immediate success of Scott & Co. under the leadership of the young John Scott IV. Chapter 3 addresses the developments in marine engineering particularly on the Clyde during the same period, in which John Scott IV also played a prominent part and which so influenced the future shape of the British shipbuilding and shipping industries ultimately leading to world domination in these fields.

When John Scott IV came on the scene in the early 1850s the major problem controlling progress in this field remained the very high fuel consumption still being encountered, stemming from the low efficiency of the power plant which resulted in frequent bunkering and limited the use of steamships to coastal voyages or channel crossings. The low efficiency of the marine steam power plant was a function of the low boiler pressure which was in turn a reflection on the quality of the materials available. Another serious problem the early marine boilers posed was the accumulation of scale internally stemming from the use of sea water boiler feed and which necessitated frequently discharging or 'blowing down' of the denser boiler water and replenishing with sea water - a serious heat loss. Over the years improved materials and stiffening of the boiler shell led to higher pressures which made the scaling problem worse and ultimately led to the adoption of fresh water boiler feed. This required the elimination of (sea water cooled) jet condensers and their replacement by surface condensers in which the cooling (sea) water was kept separate from the fresh water condensate. This eliminated the heat loss from the blow down procedure which was no longer required. The Scott, Sinclair machinery on S.S. 'India' was one of the earliest installations to have this feature.

Paddle propulsion was in universal use until the 1840s after which the screw propeller took over. It bred a variety of marine engines designed to cope with the low revolutions of the paddle wheels and also the constraints of the location of the paddle wheel shaft in the engine room and most of them died out with the disappearance of the paddles which were unpopular with the Royal and Merchant navies alike. The Navy saw the paddle boxes as being vulnerable and limiting the number of guns available for broadside fire. Merchant shipowners did not like paddles because their machinery occupied the most valuable space in the ship and they also presented additional surface to the force of wind and waves. Scott, Sinclair and Co. were very active in the 1850s in the design of new types of marine engines and they patented a number of ingenious designs which were extremely economical in space for both paddle and propeller driven applications. They also, in 1854, patented a range of propellers including two, three and four bladed designs.

John Scott IV, who was a time served engineer, with his vision of the world's oceans being patrolled by large and powerful steamships was conscious of the huge international market waiting to be tapped provided the bunker/cargo space ratio on steamers could be modified. At that time in the mid 1850s there was little enthusiasm among shipowners for experimentation. So John Scott IV, in a fashion which was to become typical of him when he had a point to make, decided to build a ship to his own account and fitted it with advanced machinery - watertube boilers and compound expansion engines. He reasoned that the potential of a high expansion ratio available from a high boiler pressure could not be exploited unless compound expansion was introduced. So, in 1857 the 'Thetis' was built and on trial produced, as was intended, a quite remarkably low fuel consumption which left no doubt as to the advantage of high boiler pressure.

The following year saw the first somewhat fortuitous meeting of John Scott IV and Alfred Holt, another enthusiast for steam navigation being applied to the long haul ocean routes, and so what was to become a historic relationship was born. After building four small ships for Holt's initial shipping line which traded to the West Indies, John Scott IV undertook to design, build and engine the famous trio 'Agamemnon' 'Ajax' and 'Achilles' for the first regular steamship service to the Far East. All three ships were delivered in 1866 and their subsequent success owed much to their remarkable compound expansion machinery and had far reaching consequences for shipping and shipbuilding world wide.

The period 1860-1914 saw British shipping and shipbuilding became world leaders in their respective fields. It is very clear from Fig. 8/1 which shows the gross tonnage built annually by Scotts' during the one hundred years under review that the second half century saw remarkable almost exponential growth compared with the first half century reflecting the development of larger, more powerful steamers as the sailing ship finally departed the scene. In 1861 Scott and Co. had just completed their first ten years trading very successfully building iron steamers and they had acquired a distinguished clientele containing many foreign shipowners, many of them engaged in the French coastal and North African trades. They had also built for the French Navy and their reputation was high in influential circles.

During that year, the French government, which had been concerned for many years at the domination of the transatlantic mail, passenger and cargo services by British and American liner companies decided to authorise a number of subsidised transatlantic services. The routes to New York, and to Central America and the West Indies were awarded to the Compagnie Générale Transatlantique, Paris. An international competition to build eight transatlantic liners for these services was won by Scott and Co. with three ships being built in Greenock and the remaining five being built in a new modern shipyard on a 'green field' site at St-Nazaire in France. The contract also called for Scotts to design the shipyard, build and equip all the workshops and the building berths before building the ships. Scott and Co. were also responsible for recruiting and training a local workforce in a variety of shipyard trades. It was altogether a most remarkable project and John Scott IV must have had his doubts before taking it on but in fact all the difficult tasks were achieved. The eight ships were successfully delivered by the Cartsdyke and St-Nazaire yards. John Scott had even built houses to protect his workforce from the local landlords and provided works canteens! Alas, what was in so many respects a triumph turned out to be a financial failure.

There were a number of reasons for the failure in December 1866 of Scott et Cie in St-Nazaire and Scott and Sons in Greenock, including early delays in procuring iron plates and sections of acceptable quality for both the Greenock and St-Nazaire ships and an unexpected shipbuilding boom on the Clyde in 1862-3 which resulted in many of his skilled ironworkers being poached by other Clyde shipbuilders offering higher wage rates. Part payment for the ships was made in the form of preference shares in C.G.T. which Scott was unable to cash in time of need because of difficulties C.G.T. were having with the Bourse. In his final exchange of letters with M. Leonce Goyetche, of C.G.T. John Scott IV made it clear that he believed he had been betrayed by C.G.T. and in particular, by the Péreire brothers.

Shattering as the whole experience must have been, John Scott with the help of friends was able by February 1867 to have a Deed of Arrangement passed at Greenock Sheriff Court which allowed Scott and Co. to resume trading. It was indeed fortunate for Scott and Co. that the Greenock Harbour Trust, under pressure to provide more docks and a graving dock in a final bid to retain the Glasgow trade, paid Charles C. Scott I the sum of £80,000 for a substantial part of the Garvel Park estate which he had inherited from his late sister, Mrs. Margaret Sinclair in 1859 and had been a shrewd investment by John Scott III in 1832.

In early 1868 John Scott IV took his younger brother, Robert Sinclair Scott into partnership, a most productive association which lasted for thirty five years during which 'Bob' Scott had responsibility for all production matters at the family shipyards and engine works. At this time also there were the first signs of revival in the shipping market. The revival was sustained for seven years during which the constituents of what was to become a unique triumvirate in shipping and shipbuilding were being assembled.

The process is described in Chapter 5, beginning in 1858 with the first business contact between John Scott, shipbuilder, and Alfred Holt, shipowner. Their shared enthusiasm for steam navigation led to a close personal friendship which culminated in Alfred Holt being John Scott's best man at his wedding in 1864. The second phase of the coming together took place in 1866 when John

Swire, a Liverpool textile merchant, visited Shanghai to establish an office there to handle his export business. His new firm Butterfield and Swire, opened for business on January 1st, 1867 with John Scott's younger brother, James Henry Scott as manager. Young Scott, trained as a banker, had been introduced to John Swire by Alfred Holt who had also offered him a free passage to Shanghai on the Scott built S.S. 'Achilles' making her maiden voyage to the far east. The third significant event occurred in 1874 when John Swire, visiting Liverpool, accompanied by James Henry Scott by then a partner was told by him that his brother John Scott IV had in Greenock three steamers, left on his hands by the original owners and which were going cheap. On his original visit to Shanghai in 1866 John Swire had accepted the agency there for Alfred Holt's new Ocean Steam Ship Co. and in the years which followed he sensed considerable potential in the China coastal trade. He tried to interest Alfred Holt who did not share his enthusiasm, so John Swire in 1872 formed the China Navigation Co. with the intention of trading on the Yangtse. After discussions with John Scott IV they formed a joint company which took over two of the Greenock steamers for trading on the China coast. The new company was named the Coast Boats Ownery and was immediately successful and extremely profitable, so much so that Scott and Co. received a whole series of orders for more China coasters and other steamers which lasted into the early years of the next century. During this time the orders from Swire's China Navigation Co. were matched by a similar flow of orders from Holt's Ocean Steam Ship Co. The remarkable cooperation between Scott, Swire and Holt was of mutual benefit to all parties and the ability of such strong characters to work together over such a long period is a great tribute to them.

It was not unusual during the period under discussion for there to be strong links between shipbuilders and certain shipowners. The connections were sometimes financial and in other cases were born of satisfactory service having been provided over a long period of years. In the case of Scotts and Alfred Holt the links were particularly strong due to the common interest in technical efficiency. John Swire, on the other hand, not being a technical person trusted John Scott to provide him with sound ships and reliable machinery capable of coping with the hostile conditions encountered at times in the Yangtse river and on the China coast. Over the years Scotts developed high quality standards of design and manufacture which applied only to Holt and Swire ships and were much in excess of those laid down by the classification societies. Such was Holt's faith in the quality of Scotts products that in 1874 he decided that in future he would carry his own insurance - a compliment indeed. There were of course other benefits from such a close association. Having ample resources, both Holt and Swire were able to place orders for new ships during recessions. Such orders helped Scott to keep his skilled workforce occupied at such times. In busy periods Holt and Swire were given priority in allocation of berths. Another great boon to the Scotts was the practice of John Swire in ordering six ships at a time. Holt occasionally ordered four ships at a time. Scotts also undertook to analyse voyage data for both Holt and Swire ships, a free service which they continued to offer to all their customers until well into the twentieth century.

John Swire died in 1898 aged seventy one years and was succeeded by James Henry Scott who remained senior partner until his death in 1912. During his tenure the firm's holdings and turnover doubled. Before his death, his son

Colin C. Scott who was serving in the far east was appointed a partner and in later years he became chairman of Scotts. In 1900 John Swire and Son put in hand the design and construction of what became Taikoo Dockyard, Hong Kong and John Scott IV was appointed technical adviser. The project comprising a dry dock, slipway, building berths and an engine works - a facility which in the years ahead was to provide employment for many of Scotts production and technical staff.

Alfred Holt took little part in the affairs of the Ocean Steam Ship Co. after 1898 and was succeeded by three young members of the Holt family. Notwithstanding the departure from the scene of these two remarkable men the orders for new ships for Ocean Steam and the China Navigation Co. continued to arrive in Greenock.

The assessment of the Scott-Holt-Swire connection and the analysis provided in Chapter 5 and the associated Tables 5/6-7-8 make very clear how reliant Scott and Co. were on the Holt and Swire orders as a substantial base load for their production programme. However, it is equally clear that John Scott did not make much profit from the Holt ships, whereas the Swire contracts were very profitable. Unlike John Swire, Holt did on occasion take tenders from other shipbuilders who in their *ignorance* of the Holt standards quoted a very competitive price which the Scotts had to meet with a consequent reduction in their profit margin.

Chapter 6 is a comprehensive review of developments in marine engineering over a period of fifty years following the success in 1866 of the compound expansion machinery installed in the 'Agamemnon' trio. The source of much of the data concerned and the subsequent analysis thereof was the collected technical records of Scotts including their records of over five hundred ships sea trials.

Bearing in mind the progressive approach of John Scott to machinery design the chapter could be regarded as the story of the development of marine engineering during the most significant period in the history of the industry. Much of the data is incorporated in the individual ship records which form Volume Two of the thesis. The analysis of the design criteria and the trends which emerge are portrayed in graphical form with comments covering a wide range of topics, elements of boiler design, methods of waste heat recovery, increase in expansion ratio, decrease in fuel consumption horsepower, ship's speed and others.

The invention and development of the corrugated boiler furnace by Samuel Fox, financed over some years by John Scott, was another element of his on-going search for higher thermal efficiency and triggered the introduction of the triple expansion engine. A significant event in the late 1880's was the start of a long series of orders received by Scotts engine works, the Greenock Foundry Co. for the manufacture and installation of propelling machinery for naval vessels built in the Royal Dockyards which was to lead to their being placed on the Admiralty list of tenders for the building of capital ships.

The original naval orders were for machinery for two sloops but they were followed by others for the cruiser, H.M.S. 'Hercules' and for two battleships, H.M.S. 'Barfleur' and H.M.S. 'Centurion' in all of which the boilers were of the Scotch cylindrical type. At this time the Admiralty were intending to replace Scotch boilers by watertube boilers in their new ships, having established after trials that these were much better suited to naval service conditions.

It was very typical of John Scott, at odds with the classification societies over their practice of limiting the working pressure of Scotch boilers to one half of the test pressure, (whereas the Admiralty allowed boilers to be worked up to within 90 p.s.i. of their test pressure) that he decided to build at his own expense a duplicate of a naval boiler being installed by Scotts in the sloop 'Sparrow' and test it to destruction. His progressive tests reached a pressure of 620 p.s.i, 4.5 times the working pressure without failure and in a paper describing the tests, which he gave to the Institution of Naval Architects in 1889 he argued that there was surely justification for a reduction in the minimum scantlings of marine boiler shells to the scale adopted by the Admiralty, a view which was strongly endorsed by the meeting.

In 1896 Scotts received an order to build and instal propelling machinery for the battleship H.M.S. 'Canopus' including Belleville type watertube boilers, the first fitted in a British battleship.

A number of British boiler manufacturers with vested interests in retaining the Scotch boiler in naval service led the opposition to watertube boilers in general and the Belleville design in particular, and so the 'Battle of the Boilers' began. The outcome is discussed in detail in Chapter 6 but resulted in the Belleville boiler being banned (many thought most unfairly) and a recommendation that the Yarrow design be adopted for the lighter, faster naval craft and the Babcock and Wilcox design be fitted on the larger warships. It will be noted from Table 6/1 that the boilers for all machinery built and installed by Scotts in large naval cruisers and battleships thereafter were almost all of the Babcock design, the exception being those for the cruiser 'Defence' which were of the Yarrow design. In the light of these developments and the continued demand in parallel from other clients for

Scotch boilers, Scotts substantially re-equipped their boiler shop in 1890 with powerful new plate bending, flanging and riveting machines. For the new watertube boiler orders they built a new shop in the early 1900s laid out on a production line basis capable of handling 50,000 boiler tubes per year.

Table 6/1 shows the dramatic growth in size, power and speed of the capital ships of the Royal Navy built in the Royal Dockyard and engined by Scotts. Their performance on these contracts over many years finally won them a place on the elite Admiralty List of firms qualified to tender for the larger naval ships and in December 1901 Scotts were awarded a contract to build the armoured cruiser H.M.S. 'Argyll' with watertube boilers and four cylinder triple expansion engines.

There were similar major developments in propelling machinery. The steady growth in world trade led to a demand for larger and more powerful ships, and with increasing boiler pressure making larger expansion ratios possible, the triple expansion engine was introduced. Scotts first 'triples' were fitted in 1886 in the famous 'Changsha' class of luxurious cargo/passenger liners employed by Swires on their China/Australia service of which John Swire was justly proud, and in 1888 they replaced Alfred Holt's beloved single crank compound tandem engine. These were also installed in the larger machinery contracts undertaken by the Scotts for Royal Dockyard built warships and the new H.M.S. 'Argyll'. In fact, the triple expansion engine became standard equipment in the world's merchant navies and remained popular into the twentieth century and through two world wars. Early in the new century, with higher boiler pressures available, the quadruple expansion engine appeared but had a mixed reception. Scotts built only eight engines of this type mainly for passenger liners - potential owners had to balance the marginal economic advantage against the cost of an additional cylinder.

The sensation created by the arrival on the scene of Charles Parsons experimental steam turbine driven craft 'Turbinia' had its initial impact on naval engineering design and Scotts immediately obtained a licence for the manufacture of Parsons reaction type marine turbines in June 1905 and they received an order in March 1908 for the steam turbine machinery to be installed in the 'Dreadnought' battleship H.M.S. 'St. Vincent' building in Portsmouth Dockyard, followed in May 1909 and March 1910 by contracts to build (and engine) further 'Dreadnoughts', H.M.S. 'Colossus' and H.M.S. 'Ajax', all fitted with quadruple screw machinery including watertube boilers and steam turbines.

As the manufacturing techniques for steam turbines were completely different from those employed on reciprocating engines, Scotts immediately invested heavily in new facilities, a new turbine shop and large new machine tools.

The use of steam turbines to drive ships propellers efficiently posed a problem. For high efficiency, turbines should rotate at high speed whereas propellers required modest r.p.m. Direct drive turbines involved an unsatisfactory compromise and by 1916 single reduction gearing was being installed on naval machinery built by the Scotts. However, as early as 1913 Scotts had the distinction of delivering the first transatlantic passenger liner in which geared steam turbines had been installed the S.S. 'Transylvania' for the Cunard Line. Originally specified by the owners to have twin screw quadruple expansion machinery, the Scotts design team produced a remarkable alternative, described in Chapter 6, which produced a smaller engine room, higher ship's speed and significant reductions in coal, oil and stores and machinery weight compared with the specified installation.

Post war c.1920 as turbine machinery became popular with merchant ship owners it became necessary to introduce double reduction gearing into merchant turbine installations. Many builders encountered problems with the gearing in service but Chapter 6 describes how Scotts devised and patented a method of overcoming the problem.

Another example of the service provided to owners by Scotts, also described in Chapter 6, was the technical investigation into the relative merits of reciprocating and turbine machinery and also of single and twin screws carried out on selected ships of each type in the Ocean Steam Ship Co. fleet with the cooperation of the owners. Chapter 6 includes notes updating these included in Chapter 3 on steam condensers and transmission including propellers. There is also a section on the demise of the sailing ship which clearly illustrates Scotts leading role in penetrating the market with steamers in the second half of the nineteenth century.

A number of elements contributed to the success of Scott and Co. during the period of fifty years covered in the Chapter 6 review. Firstly, there was the brave and timely decision made by Charles C. Scott I to risk all and become a shipbuilder in his own right and build iron steamships. Secondly, the crusade mounted by his son John Scott IV in pursuit of improved thermal efficiency of steamships led to the liaison with Alfred Holt which produced the famous Agamemnon trio and freed the steamship to challenge the supremacy of sailing ship in the long haul trades on the world's oceans. Thirdly, the fortuitous consequences of the appointment of James Henry Scott to John Swire's staff in Shanghai, led to the Swire connection which proved very profitable for both the Scotts and their employees in providing ships and engineers to serve on the rivers and coasts of China. Fourthly, the entrepreneurial skill of John Scott IV and his zeal in seeking further improvement in thermal efficiency of the marine power plant which produced the corrugated boiler furnace which was significant in the emergence of the triple expansion engine and was also very profitable. Fifthly, it became almost a matter of honour for John Scott IV that the name of Scott and Co. should be on the Admiralty List of firms qualified to build the largest naval vessels and his many years engaged in providing propelling machinery for Royal Dockyard built warships ultimately led to him achieving his objective when Scott & Co. received orders to build the armoured cruiser 'Argyll', delivered 1905, and the battleships H.M.S. 'Colossus' and H.M.S. 'Ajax' delivered 1911 and 1912, the former being the first Dreadnought built on the Clyde. Sixthly the foresight shown by the Scott brothers in 1883 in securing, as an investment for the future, the former large shipyard of Robert Steele and Co. located at Cartsburn, half a mile from the Cartsdyke yard and which later became the Scotts naval yard and without which the story of the Scotts in later years might have been very different. Finally, at the beginning of the century, iron shipbuilding having been replaced by steel shipbuilding and ships, both merchant and naval, having become larger and more powerful, the Scott brothers decided to commit very large resources to complete modernisation of both their shipyards and their engine works.

The entire programme involved the creation of ten building berths in the to yards, ranging in length up to 700 ft. A new fitting out basin was created in the former Steele wood yard served by a 120 ton crane. In addition to extensive material handling and storage facilities, new workshops containing new and more powerful machine tools were built for both the steelwork and outfitting trades. The latter included a furniture factory of 50,000 square feet floor area. In the engine works the emphasis was on providing new workshops for the outfitting trades to cope with the huge increase anticipated in outfitting load. Well equipped and fully staffed chemical and physical laboratories were built for materials testing and for the conduct of experiments in respect of new ideas and theories. The cost of carrying out the entire programme over the period 1900 to 1912 was £500,000.

John Scott IV and Robert Sinclair Scott, sole partners in Scott and Co. and the Greenock Foundry Co. decided in 1899 to convert both partnerships into a limited company. So, Scotts' Shipbuilding and Engineering Co., Ltd., was incorporated under the Companies Act 1862-1898 with John Scott as Chairman and the merging of Scott and Co. and the Greenock Foundry Co. into the new company began - a lengthy process. Sadly John Scott IV C.B. died in May 1903, and he was succeeded by his brother, Robert Sinclair Scott and in April 1904 the new Articles of Association were confirmed. Robert Sinclair Scott died suddenly in February 1905 and within two years the working partnership of almost forty years had gone. The brothers had secured the long sought after large naval contract and had witnessed the keel laying of H.M.S. 'Argyll' but neither survived to see her join the fleet.

The new chairman, Charles C. Scott II, John Scott IV's eldest son had been actively involved in the business for almost twenty years in accordance with family tradition. He and his younger brother, Robert Lyons Scott, appointed deputy chairman at the same time were already directors of the company. The formation of the new private limited company by John Scott IV and Robert Sinclair Scott was only one of a number of initiatives taken by them designed to equip the family firm for the challenges of the next century. They had already set in train the complete modernisation of the shipyards and engine works, an expensive exercise but which displayed their confidence in the future of the firm.

Their traditional dependence on orders from Holt and Swire was being modified by their involvement in the expanding naval market and the growth of the passenger liner trade. Their early experience in building H.M.S. 'Argyll' had already exposed the need for greatly enhanced outfitting facilities. The complex and diverse nature of the 'Argyll' contract led to the appointment of professional managers who as board members were able to suggest and implement changes to the company organisation based on their observations of that contract. The implementation of all the changes viewed to be necessary fell to the engineering director, James Brown, a man of wide experience at home and abroad, and who was to become a joint managing director of the company in 1912. He introduced a new line and staff management structure designed to cope with the likely shape of future production programmes but before discussing it reference must be made to further initiatives taken by Scotts in 1909 and 1912.

During this period the Scotts negotiated licence agreements with Fiat, Italy for the construction of naval submarines of the Laurenti type and for the manufacture of Fiat marine diesel engines, moves which were to lead to Scotts involvement in submarine building and refitting for the world's navies over a period of seventy years and which gained them on international reputation for the quality of their products in this specialist field. In this context James Brown's task was a formidable one. He had to implement changes at a time when the company order book embraced a great variety of ship types each embracing new developments. To help him he set up a company graduate training programme, a very progressive move in the industry at that time. He firstly strengthened the technical departments, linking their 'servicing' activities with those of the production departments. He also introduced production planning and control systems to replace the previous arrangements which had coped for decades with a continuous flow of Holt and Swire ships and engines but which could not hope to handle the extremely diverse range of products likely to be met with in future. The young graduates he employed in setting in train all of his new company procedures gained a remarkable range of experience and responsibility during this time and many in later years occupied senior positions inside and outside the company and in the leading shipping companies and classification societies.

The diversity of the actual order book which built up is very clearly illustrated in Fig. 7/1 which shows that in the years 1911 to 1913 Scotts delivered or had commenced two battleships, five passenger liners, eight Holt cargo liners, six general cargo ships, one depot ship, two submarines, one tanker, and three lighters, i.e. twenty eight ships in eight ship categories for five different owners. There can be no doubt that Scotts success in coping with this programme, particularly the superposition of the Dreadnought and passenger liner contracts, proved that the modernised establishments were able to cope adequately. The Scotts construction times for the two Dreadnought battleships were particularly note worthy.

The first world war began very quietly for Scotts'. By the end of 1914 many men had been called to the Colours, mainly Reservists or Territorials. The firm was completing submarines S.'2'. and S.'3'. and H.M.S. 'Swordfish', the first Royal Navy submarine to be propelled by steam turbines. The first wartime orders were for destroyers, submarines and a mortar but before they were started the firm was dealt a sad blow with the death of the chairman, Charles C. Scott II at the early age of forty eight years. Her was succeeded by his brother, Robert Lyons Scott with James Brown, the other joint managing director as deputy. There were two other important events in 1915.

Firstly, the company were advised that as from 12th July 1915, Scotts were to be a Controlled Firm. This effectively banned merchant shipbuilding at Scotts for the duration of the war. Then in November Alfred Holt and Co. made an oral agreement with Scotts' chairman R.L. Scott effectively requisitioning two berths in Scotts Cartsdyke yard for a period of five years after the war, presumably on the assumption that the war would soon end - a gross presumption!

By 1916 the shipping lost by 'U' boat attack and by mines had reached serious proportions and Scotts order book reflected the emphasis on dealing with the 'U' boat menace consisting mainly of light cruisers, destroyers and submarines. However, by virtue of the yard location, a great deal of ship repair was undertaken during the war. In all some one hundred and ninety ships were docked or repaired including a battleship, six cruisers, fifty destroyers, twenty mine sweepers, thirteen submarines, etc., The tables in Chapter 7 give a clear picture of the performance of Scotts and other Clyde shipbuilders during the war. Financially, Scotts came out of the war very well, being clear of all bank borrowings by 1917 and at the end of 1919 had reserves and retained profits of £528,373.

Another important development, which took place during 1917 and which must be recorded, was a further agreement between Scotts and Alfred Holt and Co. whereby Alfred Holt and Co. acquired one third of the ordinary shares in the company which were registered in the name of the Ocean Steam Ship Co. and the China Mutual Steam Navigation Co. subsidiaries of the parent company. As a result H.B. Wortley joined Scotts' board on 1st July 1917 to represent Holt's interest and Cedric Sinclair Scott also joined the board on that day to represent the interests of the executors of the late Robert Sinclair Scott. Mr. Wortley died in February 1919 and his place on the Scotts' board was taken by Mr.Lawrence Holt. The Holt shareholding in Scotts' was held until 1953 when it was transferred to the Taikoo Dockyard and Engineering Co. Ltd. a subsidiary of John Swire and Sons Ltd.

Finally, it was appropriate that Scotts most significant contribution to the war effort during the conflict as described in Chapter 7 lay in the fields of research and development, mainly concerning submarines, but also covering a wide range of topics in the field of thermodynamics. The activities of the Scotts' design teams at that time would have given John Scott IV great satisfaction. The Admiralty were pleased with Scotts approach to the construction of the earlier 'S' class boats and in 1913 they awarded to Scotts the contract to build the first steam turbine driven submarine for the Royal Navy, H.M.S. 'Swordfish', an experimental vessel built as a type ship for the later 'K' class fleet submarines. Scotts were responsible for the design of the hull, machinery and all supporting systems which provided their design staffs with the opportunity for much original thinking and wonderful experience. Their invention of the 'telemotor' hydraulic system which allowed key personnel to operate all vital systems from the submarine control room irrespective as to where the control devices were located in the boat. The telemotor system was subsequently adopted for use in all later submarines up to the present day. Another of the design team's inventions took care of the problems associated with the very unusual power plant on 'Swordfish' in particular shutting down the boiler, housing the funnel inboard and closing the apertures with watertight hatches in a 'crash dive' situation!!

Another of the design staff's contributions to improving the operational efficiency of submarines was the invention in 1916 of what looks remarkably like the World War Two German 'Snorkel' device which allowed battery charging in an awash or partially submerged condition. This system was patented by Scotts who offered it to the Admiralty who did not take it up.

Scotts collaborated in 1916-7 with G. & J. Weir, Glasgow in the development of their closed feed system designed to prevent corrosion in boilers stemming from dissolved oxygen in boiler feed water and also to improve the fuel economy by increasing the temperature of the feed water entering the boiler. The Admiralty agreed that the system should be tried out on H.M.S. 'Strenuous' a destroyer then building at Scotts. Trials at sea subsequently showed a saving of 3 tons of oil fuel over the four hours trial compared with sister vessels fitted with the old system. Another example of the diversity of research work undertaken by the Scott Research and Development team was their work on silencing propulsion noise made by naval ships under way using the screening effect of air bubbles.

Finally, with an eye to post war developments Scotts, who recognised that the low fuel consumption of the marine oil engine would result post war in a demand for slow speed engines of this type began negotiations in 1916 with the Engine Development Co. who held the patent rights for a new combined heavy oil and steam engine and by the end of the war drawings of a single cylinder experimental engine were ready. The subsequent post war development work on what became the Scott-Still engine, financed entirely by Scotts' is now history. The Scott-Still engine utilising waste heat recovery produced the lowest specific fuel consumption recorded up to that date and for many years thereafter and it was to that project that the research and development team turned their attention in the post war years. The experimental single cylinder engine was on trial in late 1920.

The end of the war in November 1918 was followed by a long period of confusion in all the warship building yards with berths being occupied by half built ships no longer required. Scotts were better placed than most yards through their links with Holt and Swire. In fact sixteen out of the twenty one ships built immediately post war were for the China Navigation Co. and the Ocean Steam Ship Co; the remaining five being high class passenger liners for the Cunard and Donaldson lines and the Compania Sud Americana de Vapores, of Valparaiso - all very profitable contracts.

So, in 1920, Scotts', still a private family firm, with its modernised shipyards and engine works was once again supplying their high quality products to the world.

POSTSCRIPT.

Scotts' continued to trade in the inter war years building quality ships but around 1930 their product mix took on a decidedly naval look as can be seen from Table 8/1 which shows the outcomes of all contracts undertaken in the period 1921-69.

By the outbreak of the second world war Scotts was effectively a naval establishment and of course during the war was totally committed to naval ships. The post war period up to about the late 1950s saw plenty of merchant work around but thereafter the combined effect of the Japanese invasion of the European shipping market together with the introduction of containerisation hit the shipbuilding industry hard. Fortunately, Scotts submarine expertise had secured many contracts from the Royal, Royal Australian and Chilean Navies and this, coupled with a series of naval contracts for surface vessels including fleet replenishment ships and a number of highly sophisticated research ships, kept the yard in full employment. As a result of government pressure Scotts and Lithgows of Port Glasgow were merged in 1969. The Scott Lithgow combine was incorporated in the nationalised British Shipbuilders in 1977. It was subsequently privatised and passed into the control of Trafalgar House in 1984 and effectively ceased trading in 1993, bringing to an end two hundred and eighty two years of Scotts' in shipbuilding in the Greenock area.

Table 8/1

SCOTTS' S&E CO.LTD — 1921 -69.
MAIN CONTRACT OUTCOMES.

SHIP CATEGORY	No of SHIPS	TOTAL PRICE £'000	% of TOTAL	NET PROFIT £	NET PROFIT % by CATEGORY	NET PROFIT % of TOTAL
SWIRE China Navigation Co.	20	7,856,873	5·6	530,218	6·8	5·9
HOLT Ocean Steamship Co.	38	19,235,183	13·7	826,642	4·3	9·2
Other merchant ships	62	56,796,517	40·4	2,592,124	4·6	28·8
Naval Vessels Second World War	64	23,666,603	16·8	2,737,000	11·6	30·4
Naval Vessels Post W.W.2.	13	32,906,195	23·5	2,303,727	7·0	25·7
TOTALS	197	140,461,371	100	8,989,711	-	100.

Compiled from Vol. II - Scotts' Ship List.

Machinery for all powered vessels covered in Tables nos. 5/7 & 8/1 was made and/or installed by Scotts' and the financial contribution arising therefrom is included therein.

The significant income which accrued from Scotts' involvement in other activities, ship owning, ship and machinery repairs is not available, the information being incomplete.

Fig: 8/1

Compiled from data in Volume II - Scotts Ship List.

APPENDICES.

APPENDICES.

Chapter One.

Chapter Two.

Chapter Four.

APPENDIX 1/1.
WILLIAM SCOTT II (1756-c.1840).

William Scott joined his brother John around 1777 in the family business, and the two partners spent the next twenty years extending and consolidating their facilities, and at the same time increasing the range of ships built by them.

In 1797, William moved to Barnstaple. The reasons for this move are not known, but may have been due to Scotts links with timber merchants in the area, since he remained a partner in the business. This view is supported by the fact that in 1799 William married Elizabeth, daughter of James Mullins, timber merchant of Barnstaple. By that time he obviously thought his prospects as a merchant in that area were good, because in 1802 he left the family business, and began operating as a shipowner and ship broker, no doubt drawing on his experience in Greenock in these areas.[31] Contrary to the references to him in Scotts volume 'Two Centuries of Shipbuilding' he did not build any ships at this time.[32]

In 1810 William Scott moved to Bristol, and on 17th November of that year he was admitted as a Burgess on payment of a 'fine' of 40 guineas.[33] He continued to correspond on the best of terms with his brothers, John and Christopher, and was kept fully informed of the Saint John, New Brunswick operations referred to elsewhere. Indeed his business affairs were almost a mirror image of those of his brother John at Greenock, and they bought and sold timber from one another.

During his spell at Barnstaple two ships were built for him there. After his move to Bristol (and sometimes in partnership with brothers John and Christopher) he purchased and operated a number of superannuated West Indiamen on the British North American timber and emigrant trades. It was not until 1824 that he began shipbuilding in Bristol, at East Wapping. He built in all about fourteen vessels, ranging from small steamboats, sloops, to full rigged ships.[34]

Shipbuilding timber used by the Bristol builders came from the Forest of Dean, the oak being of the highest quality.[35] John Scott visited the area frequently to select timber for his shipbuilding operations at Greenock. After the Napoleonic Wars, when the West India market was in decline, and competition from Continental countries following reciprocal trade treaties was growing, there were a number of bankruptcies in the decade commencing 1829 amongst the older Bristol shipowners including William and Christopher Scott in 1830 and 1831.[36]

A list of the ships which William Scott owned, and some of the ships built by him is appended.[37] His shipyard was taken over by William Paterson, who built the famous ship 'Great Western' there in 1837.

His son, James Mullins Scott (1803-1850) was long remembered in Greenock as a benefactor. He was a pioneer of the Penny Savings Bank in Greenock, and was the founder of the Artisans' Club, an experiment in social science far ahead of its time, totally financed by James Scott, but which proved a failure "due to the extreme apathy to public undertakings generally."[38]

William Scott II died c.1840.

(Continuing Appendix 1/1)

Table 1/5

SHIPS OWNED BY WILLIAM SCOTT.

of Barnstaple and Bristol.

Year	Type of Vessel	Ships Name	Built	Tonnage	Other Owners
1804-16	Brig	Joan	1804	154	J. Thomson, Bristol. A. M^cGowan, A. Law, Greenock.
1804-19	Ship	Flora	1794	403	Sold 1819 to Christopher Scott, St Andrew N.B.
1810-21	Barque	Wilson	1782	328	Jointly owned with Christopher Scott.
1810-11	Ship	Maria	1805	428	
1810-18	Ship	Simon Taylor	1784	347	
1813-13	Ship	Caledonian	1811	353	
1811-14	Barque	William		207	
1811-22	Ship	Martha Brae	1785	457	
1815-18	Ship	Betsey	1800	267	Part-owner
1816-30	Barque	Charlotte	1797	285	
1818	Brig	Minerva	1809	168	
1819-22	Snow	William	1819	175	Part-owner
1820-25	Snow	Asia	1820	181	
1822-28	Snow	Africa	1822	202	
1828-30	Ship	Venus	1786	388	
1828-30	Ship	Bernard	1813	468	

Information provided by Grahame Farr in a letter to Rev. T. Willis on 8th May 1970, and drawn from Mr. Farr's book - West Country Passenger Steamers (1956) published by Tilling, London.

(Continuing Appendix 1/1)

List includes:

(1) Ships Scott used in his timber trade,

(2) Ships he built or bought speculatively, used for a voyage or two and sold,

(3) Ships which were brought to him in a damaged condition which he refitted for sale.

Table 1/6

SHIPS BUILT BY WILLIAM SCOTT AT BRISTOL.

Ships Name	Built	Rig	Tonnage	Remarks
Lord Beresford	1824	Schooner	81/117	Paddle steamer. Cost £7,443.
Isabella	1825	Ship	340	
Dryade	1825	Ship	266	
Camel	1825	Sloop	59/65	
Wye	1826	Schooner	60	Paddle Steamer.
Avon	1826	Barque	243	
Worcester	1827	Schooner	41	Paddle Steamer.
Somerset	1827	Brigantine	81/96	
Julia	1827	Ship	403	
Lady Fitzherbert	1828	Ship	386	John Scott II had 20 out of 64 shares.
Eclipse	1828	Sloop	30	Paddle steamer.
Francis Smith	1828	Ship	581	
Britannia	1829	Ship	411	
Nautilus	1831	Schooner	50	Paddle steamer.

Information provided by Grahame Farr in a letter to Rev. T. Willis on 8th May 1970, and drawn from Mr. Farr's book - West Country Passenger Steamers (1956) published by Tilling, London.

APPENDIX 1/2.

Letters from John Scott II to Christopher Scott (Saint John) N.B.

See Scotts Archives - ref. GD319/11/1/1.

Greenock.
23 March, 1799.

Dear Brother,

We hope by this time you have got a good offing, and you are now past the principal risque of the enemy's cruisers, the wind has been mostly S.E., S. & S.W. since you left us with fair weather and moderate - we got the whole of the insurance done at 7 guineas in Hull, Glasgow and here. This you'll receive per Captain Rusk who we believe is now clear to sail in the Hunter - The William is all discharged and her cargo sold at public sale, it all went off well. We are afraid we will not be able to get any anchors to go by her as we have been enquiring in every place and cant find any of 10 - 12 cwt nor can they be got made. We have been paying off the Glasgow goods on discount and mean to do the whole of next week.

As you will be the first vessel out, we imagine, from this country (this season) we hope you'll get to a ready market with the goods and that you'll sell to good account what you have no use for.

Since the fire, sailcloth has become so much in demand that it's risen in price and cannot be got as much as wanted. We suppose there was 20 suits of sails destroyed - ropes we believe will rise also - you'll observe we paid the smith two months advance and a monthly note also you'll be careful to advise in case of him or any of the rest leaving you - as to the Brigts crew the Master will advise of them. You'll give Captain McPherson and Mr. Morgan whatever they want, always advising me when they come home what the whole may be.

In the event you find you cannot employ the money you will have from the sale of goods to good purpose, you may remit us Bills as it need not lie idle, but we hope you'll be able to make some purchases which will yield handsomely. -

We find the William is to be sheathed with copper and that she will not sail before the first, or middle of May. It was fortunate we thought of the brigt or we would have been entirely disappointed this Spring. - the America and Ruby we believe have not left Liverpool yet. We have wrote to Whitehaven for anchors, we hope we will have them in time, but as that cannot be depended upon you must be on the look out to secure whatever you can that will answer, even if we should run the risque of a double stock.

There is a small parcel of 7 fine shirts come for Mr. Morgan which will be forwarded by the William. - we wish him to give his professional advice to any of ? ? & Co's ships building provided it is not out of his way from our work and we would wish you to keep on the best terms with their connections as we may be of service to one another.

(Continuing Appendix 1/2)
Letter from John Scott to Christopher Scott St. John N.B.
23rd March, 1799.

The new ship 'Albion's bottom has turned out quite rotten as far as the elm runs. Take care to buy none that have been very long on the stocks as Birch and Elm are much the same in nature and are sure to decay standing wet and dry, the Albion must have been rotten on the stocks. The fire is burning yet among the ruins - all the walls will have to come down - There is nothing remarkable happened since you went away - war seems to be again begun on the continent between the French and the Austrians and a strong Fleet is now in Brest supposed intended for Ireland. We imagine we will be kept in continual alarm all this summer. As we send you a few newspapers by Captain Lusk you'll there find the public news more particular.

John Scott.

Letter from John Scott to Christopher Scott - (Saint John N.B.)

25th May, 1799.

Dear Brother,

The William being now clear, we enclose invoices of goods shipt on board of her amounting to £931-15-1 Stg. We hope they will get safely out and in good time. The shoes from Paton is much the same in quality as Mr. Alstons, Mr. ? 's is much better as they are made for home sale and are much dearer.

We know coarse shoes must sell well and readily as they are so few gone out this year - the tinwork is the remainder of the first order and we think better assorted than what you had.

We returned the bale of Bedding of Mr. Greig's and have sent the 3 boxes which are paid for - We have not got so many brushes from Colquoun as we wished but believe they will do.

You had better reserve the cabin stores for the vessels that may be coming out as there is less reason for them in the summer season. We have succeeded better than expected in getting anchors and have sent six, which with what you have will fix you to a certainty. The cables are part of the Leith Navy Store sale and we think they are very good and may be distributed with a new one to each vessel.

The coil of shroud stuff is what was brought from Archangel.

We thought you might be short of spunyarn and have sent some more - ropes and sailcloth have both up in price -

We expect soon to hear of you from the 'Countess of Chatham', how you have succeeded and what articles you will need more - timber of all sorts continues very high - staves no better than what you sold for £20 the other day. - Any kind will sell. - some Quebec timber (oak) sold for 4/10d per foot. - pine timbers we daresay would bring 2/6d. per foot - all hardwood will sell fast and at great prices. Vessels still continue in demand and freights are higher than ever.

(Continuing Appendix 1/2)
Letter from John Scott to Christopher Scott - (Saint John N.B.)
25th May, 1799.

We have got in the ship from Canna - she appears a great ship and appears to have suffered little damage - she goes into dock in a few days - when she is done we think she may be a serviceable ship. We find we charged the freight from 'Countess' too low as Hunter & Robertson charge 2/- per foot for measurable and 4/- per foot for iron and anchors and 5/- per foot for cables or rigging unmeasurable. You'll observe the spunyarn was got from Robert Lindsay - it was to have been twice laid but when the ship was ready he had it not and we were obliged to take part new - He made it into more coils than was entered and we had to put two into one - there are 13 double coils and two single ones - we have given you a specification of the weights for your government - we wrote per last packet. As the ship sails near about the going of the next we will not write by it. There has been but little news this while only the Brest fleet of 23 sail of the line is at sea - their destination is not known nor have our fleet been able to fall in with them - we refer you to some newspapers sent per Captain Hunter. We expect you'll write by every opportunity and that you'll be particular in what you want out - sailors are very scarce and we hope you'll be able to manage without any more assistance from this even if their wages are high - deals and staves are in great demand and we think will be loaded at less expense than timber. If they can be kept dry the better for them and the vessel too. As we have got a large cargo of Norway spars you need not send any unless it is small ones from steering sail booms downwards to mop shafts. Masts we do not think will be needed either - staves of any sort will sell well and readily no matter what kind of wood as long as they are clean - there has been many captures lately - the Charlestown 'Mary' - the 'Mary' for Providence - the 'Good Intent' for Quebec and the 'Good Intent' and 'Margaret' for Providence. Some sailed before you and some since - however we hope you got clear. In the event that any accident may have prevented you getting out we have written to Mr. Black by this ship to open your letters and sell the goods on board the William as it would not do to allow them to lay over. There will be more people after new ships and Captain Hunter goes out on this ship - however you have already secured all you can get - built or building - we beg you to write us often and particular as to what you have done or intend doing.

If you can buy the half or any part of John Malcolm's ship and take chance of voyage do it - even at an advance.

Dear Brother,
Yours sincerely,

(Continuing Appendix 1/2)
Letter from John Scott to Christopher Scott (Saint. John N.B).

12th Sept., 1799.

Dear Brother,

We have received all your letters up to 7th July per the 'Countess of Chatham and America'. The 'Countess' arrived safe after a passage of forty days..

She is sailed again for Cork and Barnstaple - the cargo is all sold directly on landing, the Birch at 4/- ft, and much in demand. It will fall much short of the invoice measure at least 8 tons. In future you must look better after the country measure as they certainty do not measure fair. The 'Countess of Chatham' is quite too small for crossing the Atlantic Ocean. We have shipped on board the Minerva Capt. Potter on the joint account goods to the amount of five hundred and fifty pounds which we hope will arrive safe and turn out suitable for you, likewise John Scott (not family) as master, and Malcolm Forrest for mate, and as many seamen as we can pick up - they are very scarce, and we cannot condescend on the number as they have not signed the articles for the voyage. We will fill up with liberty to you to send the ship to any of the British Colonies in the West Indies, and from there to Britain or direct from Saint John to Britain. We approve of your sending the ship to Jamaica providing you can furnish a proper cargo in time this season which we understand from different people that has been in that trade must consist of boards and as little ranging timber as possible. Fish of any kind seldom answer, and more risk of perishing. Boards are always wanted for sugar ? and house building, and never out of season for a ready sale. We leave this voyage entirely to yourself to give the necessary directions, but take care that the ship will leave from New Brunswick before the winter sets in either for the West Indies or home -I think the West Indies will be the most profitable providing you can accomplish it as the ship would fall in for the early crop, and would have a good chance of a freight for this place or Liverpool which would answer last. If you send her to Kingston give the consignment to Mr. Ryburn there, J. Scott is acquainted with him, and I am sure he will pay proper attention to our interest. We have had much trouble to get a master to go out to New Brunswick as that description of people are very scarce. We hope that J. Scott will do well, and you'll give him every assistance in your power. We hope that Captain J. Patterson will be nearly ready to leave Saint John by this time. If she arrives safe there is no fear of the cargo, and if we choose the ship will sell well. Cordage and sailcloth has got up very much. Cordage is now at 60/- and 64/- per ? This will make new shipping come very high as we had no vessel of our own going out this fall we did not ship any beer, or a number of the different articles you wanted, but chiefly confined the shipment to the new ships use you may be building.

We could not get a pound more of rope from all the manufacturers here the demand is so great. Hunter, Robertson and Co., has kept them busy all summer. There is an order in council for stopping the exportation of copper and copper bolts.

I am afraid we cannot get any sent you for the new ships. We have a parcel of bolts and spikes by us. I will try if I can get them put on board the

Letter from John Scott to Christopher Scott (Saint John, N.B.)
12th Sept., 1799.

'Minerva' before she sails.

You must be very attentive that the carpenters do not drive the one half of the spikes in the new ships bottoms that they generally do in New Brunswick. It's a very bad custom, and the sooner it is stopped the better. Masts begin to be scarcer here, a dozen or twenty properly sorted from 17 to 20 inch would do very well, spars we have plenty, only about the sizes of steering sail booms is always wanted, 3 inch fir deals clean and good and Birch timber will pay the best. Staves will do well of all kinds, and make good stowage, some 2.1/2 & 3 inch long deck plank, about 10 inch broad, and of the right kind.

If for quarter deck they might be sawn 9 inches at the one end and 6 to 7 inches at the other as the tree goes would suit very well ourselves - We hope the 'William' is arrived safe as we have heard nothing of her, and that the goods in her will suit you. New ships will be much in demand, and we suppose everybody will be engaged to build where a new ship can be built. We are very sorry for the misfortune that Mr. Morgan met with. We hope that he has long since recovered - he certainly had a narrow escape for his life. We hope you and he live on good terms and that he is useful to you. How does Mr. Ewing, and Mr. Taggart behave, and the blacksmith? Write us particularly in your next. - We have enclosed a bundle of newspapers to which we refer you for the public news, by which you'll observe that Admiral Duncan and General Abercrombie have made an attack on Holland, and got possession of the 'Texel' and 'Helder Fort' with all the Dutch fleet without any bloodshed. The combined fleet of France and Spain is at present in Brest harbour blockaded by Lord Piedport. There has been a strong French privateer in the North Channel from this summer, and captured a great many vessels from the Clyde and Liverpool, and has alarmed the Underwriters, and of course raised the premiums of insurance.

Yours etc.,

Letter from John Scott to Christopher Scott, (Saint. John, N.B).

14 September, 1799.

Dear Brother,

We wrote you on the 12th Sept and expected at that time the ship would sail next day. We have since got from Mr. Laird a great addition to the cordage which will suit you completely, and enable you to fit out several vessels in the spring or even in this fall yet. You may find people that have been disappointed in getting out their rigging, and may sell the hulls rather than let things lie over the season, and you will avail yourself accordingly of such a supply as we have sent, and we trust will make the most of it. - We have likewise sent you a parcel of copper bolts, and a cask of copper spikes (6 inch) about 5 cwts. There is not as many

Letter from John Scott to Christopher Scott (Saint John, N.B.)
14th Sept., 1799.

bolts as will be required for a ship of 300 tons, but you might manage them so that a few strong bolts here and there amongst them in the floors before the skeleton went on we think would do no harm.

Only you must plug up the hole at the loose end on the underside of the keel, and let no iron heads appear. We are suggesting this as a makeshift in case you could not find copper bolts enough to bolt the ship. We will properly send you more copper bolts in the Spring. You have 5 cwt of spikes which is double the quantity we would use here -----. If you go on to build a copper fastened ship, we think you might make her from 350 to 400 tons providing the timber will suit. We dare say a number of shallops for West Indies druggers would turn out very well to send when finished to different islands for sale with suitable cargoes. Mr. Morgan is well acquainted with the kind suitable - from 50 to 60 tons sloop rigged is a good size.

We suppose that before this reaches you that you are going on in building one or more ships of 300 tons. You informed us some of a smaller size will sell very well. We think it's very profitable in the Spring that we will send out a vessel of our own to New Brunswick. There is a very disagreeable thing has happened. Just now we have agreed nine seamen, Captain and mate, to go in the Minerva as passengers. It seems we have given our seamen 5/- per month more than Hunter Robertson & Co., Our John Scott has been busy all day in getting the cordage and other things to the ship and Mr. Robertson called at the yard and left notice that as we had given our men more wages than theirs that from none of them should go out in their ship. There the matter rests, and we do not know whether or not we will be allowed to send them.

It will be a very serious matter for us if we do not get them out to you. I am just going to wait again on Hunter Robertson to know if they still persist in not letting them go. It's 8 o'clock on Saturday night, and I will let you know on my return to finish this letter.

They say the Captain and mate can go. I will however, send them aboard tonight if possible. If the wind promises from the eastward the ship may sail early in the morning.

Letter from John Scott to Christopher Scott (Saint. John N.B).

2nd November, 1799.

Dear Brother,

We are favoured with yours of August and September, and by Capt. Cowan we learn you are well. We find you have got your hands full at present, but we hope Capt. Scott in the Minerva with his crew of 9 men have got out before this time which would give you a relief. Capt. Patterson is not arrived yet, but we look for him daily, and we hope one or two of the others will follow soon. If you find

(Continuing Appendix 1/2)
Letter from John Scott to Christopher Scott (Saint John N.B.)
2nd November, 1799.

you cannot manage the ship this season there is no help for it, but we think if you could get her sent to Jamaica with a good captain and steady crew she would yield well. All your bills drawn before the 18th are come home, and mostly paid, we hope you'll be as sparing as possible in drawing more until we are able to turn some of the vessels and cargoes into money. We are sorry to observe the dullness of the sale of goods in general, but as you have not been very particular with what things you have sold or have not sold we cannot be a judge.

We have taken note of what was wrong with the 'Countess', but you say not a word of what was the William, we hope you will be more particular in your future letters, and give us every information you think you would wish yourself providing you were here. We expect that you'll send us as accurate a list as you can of what you will want for the two ships you have engaged for the next season, and the progress they are in.

As vessels are not in such demand now we don't want you to build any more ships until you hear from us. West Indian produce continues dull, and there has been a number of failures of late, indeed no kind of article is so brisk as last year but it may go better. The Liberty's birch is all sold at 4/- foot and we daresay a small cargo or two may sell as high, Ashes are not in demand.

The Lord Duncan sold for £3,600 lately, and the Hunter for £3,000 - we hope you have our vessels well masted and well rigged, as that seems a fault they often fail in at Saint John.

The expedition to Holland has proved unsuccessful and government are obliged to withdraw our troops. No other public news, only two Spanish frigates taken with a great deal of treasure.

Letter from John Scott to Christopher Scott, (Saint, John N.B).

25th November, 1799.

Dear Brother,

We wrote you on the 2nd and 9th per packet mentioning the great alteration which had taken place in trade here. Such stagnation in everything that we did not think it prudent to extend our speculation in ships until an appearance of times bettering. Trade is still no brisker, and we think you should keep off building if possible if you have not contracted before. We have since heard of the arrival of the 'Minerva' and we hope with the assistance of Captain Scott and the men sent with him you'll be greatly relieved, and will get the 'Catherine' despatched.

We also hope the carpenters got well on with the ship, and by this time you can form an idea whether you'll get her off this season or no.

The Carleton is all discharged, but nobody having offered for her we have taken a freight of sugars to Dublin, and we expect her to sell there. If not we will employ her some way or another. Capt. Patterson continues on her, and seems

(Continuing Appendix 1/2)
Letter from John Scott to Christopher Scott. (Saint John. N.B.)
25th Novr., 1799.

to do perfectly well. She is very small for her tonnage, and although she is tolerably well finished externally, yet she appears to be a poor thing, and sloped? up for the occasion without any attention to clearing the stuff of sapwood which always should be done and especially in a wood country. We will be very happy if we can get what you say she has cost, her cargo is to be sold on Wednesday 27th, we expect it will bring about one thousand pounds. We wish there had been more staves and hardwood. The birch you sent is very bad stuff and all squared.

You must send better or it will fall in price very much. Turpentine and tar was not worth sending. The ashes will do pretty well, but would have done better had they been put in new casks like the New York ones. The planks and boards fall greatly short of the measure they charged at least 10 more than what they can possible measure. You should make your bargain so as to have everything measured by a sworn surveyor, and pay half the expense. The country people will cheat in spite of you. One thing in the 'Carleton's' favour is that we have saved her insurance, asked so high that we would not give it, and there was nothing in her or cargo. We wish the 'Kingston' may be equally fortunate. We think she should be near at hand now. The staves from the States are better, and bring more price so that you should lay hold of them wherever you can get them. They will sell whilst the others will not.

If you have contracted, and the ships are to go on, be careful that good wood is put in, and the plank well cleared of sapwood especially the decks and upper works.

New Brunswick ships have got a bad name, and we believe with much reason they are entitled to it.

If we are to have any, let us have good ones. When you have time you will advise us in good time what you want sent out, and that Mr. Cruickshanks is continuing to aid you. On account of the small charges at loading or landing, deals pay as well as anything.

The spars are cut too short they should have been 9 or 10 feet longer.

Yours,

Letter from John Scott to Christopher Scott (Saint. John N.B.).

17th March, 1800.

Dear Brother,

We wrote you per the last three packets, but the weather has been so bad they only sailed lately, and probably you may receive this as soon. The last we had from you was per Kingston. The Govr. Carleton, Capt Lusk, arrived 1st March after a passage of 40 days. By her we had a letter from Mr. Cruickshanks, and Capt. Scott, but none from you.

(Continuing Appendix 1/2)
Letter from John Scott to Christopher Scott (Saint John N.B.)
17th March 1800.

This rather surprised us, and indeed we have heard so very seldom from you that we are mostly obliged to others for information we have got concerning your proceedings.

The easterly winds having prevailed so much this winter made it very bad for vessels getting in. Almost ever since the 'Carleton's arrival they have been easterly. The Kingston was 82 days, and we suppose the 'Catherine' will not be much better as there is no word of her yet. It has been very unfortunate that she should have been detained so long as the one half of bills are now home accepted, and Capt Lusk bringing such a quantity of Birch has quite overstocked the market, and we fear the 'Catherine' and her cargo will not be very saleable for some time. You should not have drawn the bills for the 'Catherine's cost until you had the vessel fully delivered over to you. We also find it an advantage that you draw in small sums, as large bills generally find there way here sooner. We enclose accounts of the sales of the Kingston and her cargo. She suffered so much in her rigging and sails that we were glad to get quit of her, and she was so shallow that she was a mere bottom of a vessel. We also send you Invoice of and Bill of Lading for iron and copper per Britannia which with the seamen and carpenters is all we could with propriety send, until we heard more particularly from you. Mr. Simpson, the mate will deliver you the ships papers, and you have enclosed the Carpenters agreements. We still wish the John to go to Jamaica. If you can get her off in time, and with the carpenters sent you'll be able to expedite the sheathing and finishing should that not be done when they arrive we imagine Kingston will be the best place to send her, and boards and singles with a few long masts for schooners and spars will do best.

Any other articles are precarious. We beg you attend to the Boards being free of splits, that they be mostly pine, and proper thickness and measure, as they are apt to shrink in Kingston if there is not proper attention paid at receiving and delivering them. We think it will be best to consign her to a respectable house and for that purpose we will write Messrs. Crooks & Ryburn, Kingston, and you can introduce Capt. McKellar to them. Mr. Ryburn the former is dead, he loaded Capt. Malcolm's ship home to Port Glasgow, she made about £3,100 freight home, and must have made a good voyage, though if she had been earlier she would have done better. We hope you'll be able to despatch the John earlier, and prevent the risk of her being thrown on her homeward voyage. There is a possibility she may sell to good advantage at Kingston, and we will limit them to a sum which if they can get to sell off hand, and remit us good bills, if not procure freight home. We hope Capt. McKellar will prove an active man and push on the outfit with despatch at Saint John and attend to the business of ship and cargo in Jamaica. We have said nothing to him about selling her, and we suppose you better say nothing of it either.

If you send the ship to Jamaica take a set of Bills of Lading with a specification on the back of the sizes of the masts and spars if there are any on board. The number and total feet of the boards is all that is wanted of them, you may send us a note of the cost of the ship, and cargo for insuring them. We find

(Continuing Appendix 1/2)
Letter from John Scott to Christopher Scott (Saint John N.B.)
17th March 1800.

an inconvenience at selling any of the vessels as your name is in the Register. We should have a mandate form you empowering us to sell before the purchaser can procure a new register.

You'll therefore mind to send it the first letter you write.

The stove, pans, and other things you did not get per William, you must look for at Saint John. Captain Hunter was discharged before your letter came, and the owners know nothing about it. We have sent out the carpenters in the hopes that you'll get the two new ships finished early as we find the inconvenience of being late. There are three journeymen, two of our oldest apprentices, the journeymen have monthly rates, and the apprentices are paid up till their indentures are out. We hope they will all keep by you, and do their work faithfully. They will assist to crew one of the ships home, and you must write to us in time whether we are to send more seamen or that you'll take a chance on picking up what you require in Saint John. For our own part we think that after paying passage money and the risk of their running away, it is better to give high wages at Saint John.

We observe the rudder irons on all New Brunswick vessels are very clumsy, and the tails far too long. There is no use for any but the lower one to be long or above 12 to 18 inches from the neck. Be particular in having the sapwood taken off all the outside plank especially the upper works, quick works, and decks where there is plenty of wood. It's so cheap, and its a shame to see an inch or two of sap in edges. It will never stand caulking, and always in a few months let in. Upper decks to be planed and payed with turpentine. Decks to be oiled and well carlined. If you can, put stringers below the beams. The copper formerly sent was rather scant especially the bolts. We think this will allow you to fasten the keelson, and its no matter though the breast hooks stand till later as the iron can be taken out any time. Copper is now not allowed to be exported, and of course must be smuggled out, which will increase the value. We are not so much afraid of the times as we were, and we think vessels will be in demand again.

Every material has risen in price in this country. If you find yourself much behind, and cannot get both ships done in the time you would wish, you may sell one if you can get a decent profit, the purchaser paying that over and above the cost, taking her with whatever berthing she may be liable to.

We hope you'll send us a particular note of what you wish sent out in time to prevent disappointment.

This we only mention as a hint in case purchasers should be plenty, and you find enough to do with one. In the event you part with one, you'll keep the one you think the best ship for yourself, and put all the strength to her you can in order to have her finished as early as possible.

'Carleton's birch is very fine, we hope what you get will be equally fine as that will be the only chance of its selling.

<u>**(Continuing Appendix 1/2)**</u>
<u>**Letter from John Scott to Christopher Scott (Saint John N.B.)**</u>
<u>**17th March, 1800**</u>.

Good deals will readily go off, and lathwood with a few yellow pine masts. Dollars cannot be got here at any price but should the scarcity of specie still continue we may probably send a few hundred guineas in the fall. You must just do the best you can and keep off drawing as much as you can and try to reduce the business to a small compass before you leave Saint John in the event you come home this winter, and keep everything as snug as possible.

We very much approve of your getting Mr. Cruickshank's assistance, and hope he will continue to be of assistance to you.

The 'Carleton' is gone up the Baltic on our account.

We observe a crab which Captain Lusk has got in his ship which must be very handy for loading, and discharging timber. We hope you'll finish off the John well, and paint her properly as it will make a great difference in case of sale. In the event the John to goes to Jamaica you must instruct Capt. McKellar to take the passage most likely to keep him clear of the enemy and call at Morant Bay, and wait there till he hears from Kingston as that will save his men, and she may sell at any of these places, and from thence he can command all the ports but in Morant Bay to be the best place. We have sent some stuff for points and gaskets to be made up by the sailors on passage.

<u>**Letter from John Scott to Capt. Donald McTaggart (Brig. 'Carleton')**</u>

11th April, 1800.

Sir,

The weather has got in now mild, and we hope the navigation is open, and that you'll be at Dantzick (Danzig) by the time this reaches you, as we find there will be a great demand for vessels to carry grain to this country, and as you will be among the first up we mentioned to Messrs. McLean that if they could get a good freight to any good port to your liking in the North of England or East Scotland say not less than £500 or upwards and 2/3 port changes, and a quick dispatch at loading, or unloading we had no objections you to take it as there would be time enough for plank afterwards, but if that cannot be got at once, you'll load plank for us as ordered by us formerly, and you need not mind buying the wheat, or pease, only a few bags of the latter for family use. In case she will take more plank than our order you may just take your choice of what you think will answer best, always preferring thick plank - we would as soon the brig be discharged at Grangemouth as here, so that if the wind answers, you'll go there as you'll carry the convoy further. Be sure to write us often, and let us know what you intend doing. We hope that your crew are all behaving well and that we'll see you soon.

Yours,

(Continuing Appendix 1/2)
Letter from John Scott to Christopher Scott (Saint John N.B.)

12th April, 1800.

Dear Brother,

Since writing the annexe we expected to have sent this per Mr. Lawson, but he taking a ramble, the brig sailed, and he and the others lost the opportunity, such a one they will not find again soon. We believe they are going in the Liberty but cannot say for certain as we never see them, not having shown the least inclination to work. When they first arrived, we advanced Lawson 5 guineas without knowing you had paid him before which with 5 guineas we lent Hall we are afraid will be lost as Hall is at Liverpool, and unable to pay it. They are a bad set of people, and you must be on your guard in future.

The birch per Catherine has turned out pretty well but there is a deal of beech among it, which is not so valuable. What was taken in at Digby seems to be better squared than what was got at Mouse River, and we see the reason of the short measure is in not taking the bark off the corners as it makes from half an inch to one inch difference in the girth. If you can get Barlow to engage for a ship from 250 to 300 tons we wish to do it, and put the copper bolts in her. She may be finished in fall 1801, and we would rather give him more price than want her, but if he will not do it, you need not be in a hurry engaging with another. We think vessels will still be on demand, and that this cheque may be of service. We hope Capt. McKellar and the men will get out, and that you'll get the John sent to Jamaica in good time. If not, that you'll get her here soon. There has been several people looking at 'Catherine', but we have not sold her yet. The only objection is the draught of water, and the cables being rather small. We believe it will be as well to sell the old cables if you can get a decent price. We will send out the courses, and topsails of the two ships made as we think it will be a saving and make them to the dimensions of the Pomona yards which you have and we think will be large enough.

We will send every other thing we think you will want for the ships per the Liberty, and also a Captain two mates, and a boatswain. With them we think you'll be able to fit the rigging, and we think the fall will be time enough to send out what more will be wanted, but we think getting them on the spot, although the wages is high, is better than running the risque of sending them from here. We beg you will be very particular in the measure, either what is sent to Jamaica or here as we certainly have been much imposed upon. It will be as well not to send any more staves than what is wanted to stow the cargo. They are rather plentiful, and likely to be so.

Yours,

(Continuing Appendix 1/2)
Letter from John Scott to Christopher Scott, (Saint. John N.B).

23rd July, 1800

Dear Brother,

We wrote you on 17th June by way of Boston since which we have not had any from you. We are very vexed that you have determined on sending the Marie here as she would have got a load at Jamaica to a certainty but we hope you have yet altered your mind, and sent her there after you had conversed with Capt. McKellar. We are afraid we will not have another such chance again. Should it come peace the freights will certainly be down. When Capt. Scott's ship is ready which we hope will be soon, if he and the materials have got out you'll send her at all events to Jamaica, and provide for the other to go that way too. We imagine you'll get plenty of men to go that way at Saint John, at least both Mr. Cruikshanks and Mr. Robson found no difficulty.

4th August, 1800.

Dear Brother,

We have this received yours, a duplicate of yours 15th May, and yours of the 1st June via Liverpool by which we find you had finally decided the ship Marie should come here. This we are very sorry about, however there is now no help for it and we must just make the most of her cargo when she arrives which we think might be by this time if you got her off by the time mentioned, but we suppose you have not got her so soon off.

From the letters we have all along wrote the greatest part of which we think you must have got, you'll observe its our opinion that it will be best to send the two ships to Jamaica, and give up all thoughts of building more as we see its attended by so much trouble, and explain, and we are afraid will be a heavy handful. You'll therefore prepare accordingly, and endeavour to get them away in good time. It must certainly make a great difference to have them finished while the weather is good provided you can get a handy thing done in time to follow the ships. We don't know what to think you mean by copper fastening her as you say you sold all the copper to McPagan at 2/4d. per ? which we think low enough, and we can't think he has any shipped from London this year as it is prohibited, and we got ours away secretly. We approve of you building a shallop. At any rate if you go on with her it is already too late to give you any directions about her dimensions but her height should be 8.1/2 or 9 feet clear, and she should be sheathed either with wood or copper, the latter we suppose you'll not get, and we are afraid it will be out of our power sending it to you as it seems the R & S Co., will not be having any ships going out this year.

(Continuing Appendix 1/2)
Letter from John Scott to Christopher Scott, (Saint John N.B.)
4th August, 1800.

You have everything out now that we could think of, and that you mentioned. Just make the best shift you can to fit ships with what you have. We hope the men are keeping by you though you are by no means either particular about them or the progress they are making on the ships.

These are points we are always anxious to know, and you should be particular about. We note you had called the ship Marian in place of Marie as the first is the ? name, but it can't be altered now as it is our wish that both ships should go to Jamaica. You'll let them take the same cargoes, and proceed to the same place we directed you to send the John, but as you'll take charge of the last one yourself, you'll do as circumstances point out -

We don't approve of arming as it is getting out of use now, and is very expensive. Insurance will be done much the same, and we will take care to do them in time.

Be sure to give us the longest limits for sailing as formerly the time of sailing has been so much delayed that we have had no chance of saving insurance.

We hope you'll take care to have the ships well sheathed, and that you'll keep clear of disputes with the carpenters as much as possible. We are rather alarmed at what you say about ? but hope it's made to your satisfaction.

Consider the value of time and give way to everything to gain that. There is much talk of peace, but we doubt if it will take place soon.

Yours,

APPENDIX 1/3.

The Voyage of 'Fleece' to Bremen.

Letters from John Scott to Captain Samuel Pincher of Scotts ship 'Fleece'

See Scotts Archives - ref.GD319/11/1/1.

17th October, 1798.

Sir,

In consequence of our having become the owners of the Brig. 'Fleece' under your command we hereby direct you to proceed with her to Bremen, and there deliver the cargo as per the Bills of Lading in the most expeditious way you can, and should you be able to get a freight to Hull or any betwixt that and Leith, providing it be no great detention, and worth while, in that case you may purchase a Bill on London with what you can spare after keeping as much as will clear you. However, if you do not get a freight from Bremen which you think proper to accept, you'll then lay out what more you have in crooked timber and come right here with it. You'll take care that it is sound, and fresh, and measured. The price used to be from 12d. to 14d. per cubic foot, the crookeder, and the more knees the better. The size may be from 6 inches to 12 or 14 inches girth.

You'll write us on your arrival, and when you have looked about how you mean to do, be sure you advise us frequently.

It is of great consequence your getting there to join the convoy as you cannot leave the country without one, and it's uncertain when the next may be appointed.

You must be sensible as the vessel is small. Without dispatch and frugality she will do no good, and we beg you particularly to attend to it. At the same time keep the vessel in good order, and keep the people employed in harbour - we hope you will make a short and pleasant voyage and that we will soon have the pleasure to see you again.

p.s.

When you are ready to leave Bremen, and a convoy to sail soon, take it. If there is no appearance of convoy you must run it if you are allowed - in case of loss or capture, be sure to enter a regular protest, and forward it to us by first opportunity, and in any case of misfortune do everything for the best as you would have done before.

Letter from John Scott to Captain Samuel Pincher of vessel 'Fleece'

3rd November,1798.

Sir,

We have not heard from you these some days. We heard from Mr. Wilson of Leith that you have agreed a man by the run of £10. We hope it is out and home, or else it will be high, and that you'll be able to save some pilotage by having him on board. We have a parcel of oak plank at Leith that Mr. Wilson has freighted to bring here. As your crew will be entirely idle, we wish you to give

(Continuing Appendix 1/3)
Letter from John Scott to Captain Samuel Pincher of vessel 'Fleece'
3rd November, 1798

all the assistance in getting and looking after them till shipped that you can render with your crew while there yourself. We once thought that we might not get a vessel to bring them till you were back, and in case you come back in ballast you should stop in Leith roads and enquire of Mr. Wilson, but as this vessel has been got, you need not stop, but come right through.

As the season is getting late we are very anxious about your getting away, and we hope you will take care to push so as you may not winter - we hope you get through the (Kiel) canal without damage, and that you'll have everything in a state of readiness as soon as the signal for convoy is made. We will be glad to hear from you before you sail.

Yours,

Letter from John Scott to Captain Samuel Pincher of vessel 'Fleece'

- 14th November, 1798.

Sir,

By a letter from Mr. Wilson we find you have not sailed, and you have applied to him for money. We have ordered him to give you five guineas as we hope that will do as you'll soon be from Leith. It is unfortunate that you were late for the last convoy as the detention will perfectly eat up the freight. We hope you'll be as frugal as possible, and use dispatch in getting back.

We cannot get vessels to take these planks from Leith here, and if you come direct here we mean you to bring them, and you must stop at Leith for that purpose even should up have timber you can bring a parcel of long ones on deck. On the otherside is a letter to Rover's father who if you can find you can deliver to, he may probably get you timber or butter for his son's debt, probably give you a Bill, but if you cannot get a cargo without risque of wintering wait for nothing, but return in ballast.

Extract from letter, John Scott to his Leith agent, Peter Wilson on

15th December, 1798.

---"We have heard nothing from the 'Fleece' and we are rather uneasy about her. We will thank you to enquire about her at Leith."

(Continuing Appendix 1/3)
Extract of letter, John Scott to his Leith agent, Peter Wilson
on 21st Decr., 1798.

21st December, 1798.

"We are anxious to know what you have done with the planks, and the arrival of the 'Fleece' to take them at Leith. If she does not arrive we will want to know the exact quantity of each thickness and length."

Letter from John Scott to Peter Wilson, Leith (extract)

12th January, 1799.

"Sir,

We are going to have a large sale of Black Birch on 23rd inst., which we wish to make public in Edinburgh for which purpose you'll insert notice of sale, once in each of the Advertiser and Mercury. Birch is getting greatly in use in place of Mahogany. - You might get a hundred handbills printed, and circulated among the joiners, and cabinet makers. - There is a George Robinson in Edinburgh who is agent for the Banffshire Fencibles. They wanted a vessel of ours to carry some recruits to Barnstaple, but we have heard nothing of it since the first, - please enquire if they still want them sent there and let us know as we can give them a vessel immediately."

Letter from John Scott to Captain Samuel Pincher of Scotts ship 'Fleece'

25th January, 1799.

Sir,

We have just heard the misfortune you have met with in being driven into Norway. We hope you have managed matters as frugally as possible, and at the same time have taken the proper steps for recovering the loss. We have written to Mr. Garrison at Bremen who will deliver this letter to you to assist you in settling matters as the winter is mostly past, and the voyage is as long as it can be we are thinking of loading the Brig home with timber, staves (barrel), and butter, providing you can get a freight as we mentioned before, and we will write Mr. Garrison to that purpose. In the meantime we hope you'll use all dispatch in getting the cargo discharged, and make the voyage as short as possible.

Yours,

(Continuing Appendix 1/3)
Extract from letter from John Scott to Peter Wilson, Leith.

27th March, 1799.

"Sir,

There is no more word of the 'Fleece' which we think is surprising, but as there is none from the other vessels we have no reason to think that any fresh accident has happened to her. She will make a bad voyage."

Extract from letter from John Scott to Peter Wilson, Leith.

10th April, 1799.

"We have no further news of the 'Fleece'"

Letter from John Scott to Captain Samuel Pincher of the Scotts ship 'Fleece'.

26th April, 1799.

Sir,

It was only yesterday we heard of your being clear to leave Tharsund, but that another impediment had come in the way to prevent it, which was privateers of the Enemy.

We likewise received a letter from Mr. Lund with a Bill drawn by you for £154 - 9 - 2d. We are much surprised at the expense you have incurred, but as you have not been particular in stating your loss we can say nothing about it at this time, only as things have happened we had better never seen the vessel - we hope you are by this time at Bremen, and that you have carried the necessary documents with you to settle the average. We have wrote to Messrs. Garrison to assist you in it, and to load the vessel home on our account providing the articles we want do not exceed the price limited. - If they do you'll take in ballast and proceed here immediately leaving Messrs. Garrison to settle the freight rather than lose the first convoy, and you'll stop the vessel at Leith, and there write us, and inform Mr. Wilson of your arrival. We hope you'll consider the bad ruinous voyage the vessel has made, and that you'll exert yourself in getting home. We have now lost six months complete use of the vessel besides all the expense she has incurred, and if she had been home she could have been continuously employed as freights are very brisk. We daresay if you had been in Bremen earlier you would have got freight for Leith here or Ireland through the Canal. - If you find nothing can be got you'll come directly in ballast as soon as your tobacco is out, and your presence is no longer necessary for settling the average.

Write us as often as you can.

Letter from John Scott to Peter Wilson, Leith.

4th July, 1799.

Sir,

We received a letter from Mr. McLean of Danzig informing us that the 'Fleece' had got a cargo of wheat from thence for the Firth. She left Danzig on the 13th June.

We have no letter from Pincher but as we soon expect him you may deter shipping any of the oak plank by the 'Trader'.

Yours,

Letter from John Scott to Robert Brown, jr, Glasgow.

3rd August, 1799.

Sir,

The brig 'Fleece' Captain Pincher now discharging wheat at Port Dundas, belongs to us. We have a letter from Mr. W. Gibson of Edinburgh informing us that he had sent the Bill of Lading, and a Bill for £25 accepted by us, and Capt. Pincher's receipt for £30 last advanced him in part of freight, and that you were to settle the balance when the cargo was all delivered. We request the favour of you not to pay Captain Pincher any of the balance until you inform us of it.

At the same time please let us know when the vessel is expected to be all discharged, and one of us will come up and be present at the settlement. We will esteem it a particular favour if you will write us without advising Captain Pincher. We will give our reasons for this when we meet.

Yours,

p.s. We hope you have not advanced him any cash already.

Letter from John Scott to Captain Samuel Pincher of Scotts ship 'Fleece'

4th August, 1799.

Sir,

I arrived here this afternoon, and have not received the letter you said you would put in the Post Office yesterday.

It is very extraordinary that your letters do not find their way to us. You certainly do not address them right. I will expect to hear from you on Monday how the discharge goes on, and when I may expect the vessel will be at Greenock. I beg that you will be expeditious as possible as we urgently require the ship.

(Continuing Appendix 1/3)
Letter from John Scott to Robert Brown, jr. Glasgow.

10th August, 1799.

Sir,

We now have the brig 'Fleece' in our charge, and wish to express our thanks for all your civilities. Please send us a statement of the cash advanced to Captain Pincher, and the balance of freight in your hands which we will draw for at your pleasure.

We hope to get a settlement with Captain Pincher soon.

We believe he is rather disappointed he did not get all the freights from you!!

Yours

APPENDIX 2/1.
CONSTRUCTION OF THE BARQUE 'CULDEE' - 1839.

John Scott III's Journals of Proceedings for the period 1837 to 1841 contain a day by day record of events in the shipyard embracing new construction and ship repair contracts.

By using the ships dimensions it has been possible to prepare a preliminary design for the barque 'Culdee' built in 1839 (See Fig. 2/15).

By using extracts from the Journal, it has also been possible to reconstruct the production programme for the barque 'Culdee' from keel laying on 13th June 1839 until the launch on 11th December 1839 (See Fig. 2/16).

The notes which follow describe in more detail the various operations involved in the construction of 'Culdee'.

EARLY PRIORITIES.

Agreement to proceed with the construction of 'Culdee' having been reached with her prospective owners, Messrs. George Muir, John Stewart and John Campbell, Greenock merchants, on the basis of Scotts tender specification, rigging plan and the accompanying half model, (See Fig. 2/17) the shipyard immediately put in hand a number of activities in parallel, in accordance with their normal practice.

Firstly, the middle of the three building berths at West Burn having been allocated to this contract, the berth squad cleared the berth and assembled sufficient keel blocks on the berth to accommodate the entire length of the ship's keel. The keel blocks were accurately aligned and set at a declivity of about 3/4 inch per foot.

The drawing office would have allocated from the timber pond stock list those fully seasoned logs required for the contract. These would be mustered by the timber pond squad and floated round to the yard.

Orders for the replenishment of the timber pond stock would follow as a matter of course.

The drawing office would issue detailed drawings of the keel, keelson, stem and stern post to the shipwrights through the mould loft, together with the approved half model of the vessel. (See Fig. 2/18)

The mould loft would draw full scale details on their scrieve boards of the bow and stern elements of the ship and provide templates or patterns to the sawyers for these elements.

(Continuing Appendix 2/1).
Construction of the Barque 'Culdee' 1839.

HALF MODEL.

The role of the half model in the overall production process was very important and a clear understanding of its use requires some detailed comments.

The shipyard employed a model maker, a highly skilled craftsman, to make a scale model of each proposed new ship using guidance drawings prepared by the design office. The scale was usually 1/4 inch = one foot.

Since a ship is symmetrical about its fore and aft centre line, port and starboard, only a half model was required.

The model maker first manufactured to scale a rectangular prism embracing the dimensions of half the vessel.

The prism was made from a number of identical, rectangular, finely finished wooden boards, each one inch thick, clamped together as shown in (Fig. 2/17) (clamping bolts are omitted for the sake of clarity.) The ship's lines plan prepared by the design office provided the model maker with the proposed profile, the outline of the maximum half breadth and the sheer of the main deck, all of which he transferred to the model. He circumscribed the model with the frame stations.

Using his craftsman's skill, chisels and sandpaper he carefully transformed the block into a three dimensional portrayal of the required form of the ship.

When they received the completed half model the mould loft shipwrights separated the layers and by scaling up the dimensions taken from the model at each frame station, they were able to draw on their scrieve boards (large scale drawing boards) full scale profiles of each frame, from which in turn they were able to manufacture templates or patterns which were handed to the frame squad for use in making the frames.

So as a result of these priority actions the main elements of the skeleton of 'Culdee' were in production, and in all areas the remarkable skill (and stamina) of the sawyers were fully employed.

BUILD PROGRAMME.

The build programme for 'Culdee', included as Fig. 2/16 and the notes and Figs 2/18 - 22 which follow below were derived from John Scott's 1837-41 diary and from the 'Evolution of the Sailing Ship' by Greenhill and Manning. (1988) published by Batsford, London.

KEEL.

For a ship of 'Culdee's dimensions the keel would be of 18" square cross section and it was made up of two lengths with a scarf joint. Each length was derived from a selected elm log which the sawyers mounted over the sawpit for squaring and preparation of the scarf joint.

(Continuing Appendix 2/1).
Construction of the Barque 'Culdee' 1839.

Thereafter on June 12th 1839 the two lengths were clamped together at the joint and augers were used to drill holes for the joint bolts. The bitumen coated bolts had a slight interference fit in the bolt holes and were driven home by sledge hammers, the remote ends being clenched over. (See Fig. 2/18).

The keel was temporarily dogged to the keel blocks to prevent distortion due to the effects of changing climate conditions.

The keel for 'Culdee' was laid on 13th June, 1839.

STEM AND STERN POST.

A transition piece was inserted between the forward end of the keel and the bottom of the stem, and was scarf jointed to both.

The stem was erected on 15th June, 1839 and the stern post was socketed into the aft end of the keel and bolted thereto on 20th June, 1839.

Both stem and stern post were shored up in position and the brackets between them and the keel, (known as deadwood) were fitted and bolted in position. (See Fig. 2/18)

THE RABBET.

A continuous groove (or rabbet) was cut on both sides of the keel and stem and stern post, into which lodged the square edge of the planking at the keel and the plank end terminating at the stem and stern post.

FRAMES.

The frames, the ribs of the ship's skeleton, were very labour intensive, and were fitted in pairs at each frame station along the length of the keel. For 'Culdee' there would have been 56 pairs of frames at 22 inch pitch. Fig. 2/19 shows the construction of a typical pair of frames, each single frame comprising a number of separate sections, known as floors, futtocks and top pieces.

The joints of each frame were staggered radially from those on its mating frame.

The paired frames were finally bolted together, the floors solidly, the futtocks and top pieces kept slightly apart by chocks to provide for air circulation.

'Culdee's' frames were assembled at the berth in early June and hoisted into place over the period 22nd June through to 3rd August 1839.

(Continuing Appendix 2/1).
Construction of the Barque 'Culdee' 1839.

CANT FRAMES.

At the extreme ends of the ship where there was much change of form, square frames were not practical and cant frames were used, set square to the local run of the planking. The work was completed on 15th July 1839.

KEELSON.

When all frames were erected on the berth, temporarily braced at their top pieces, the keelson was placed on top of the frame floors in two lengths, and hand augers drilled holes through the keelson into the floors and through to the keel for the securing bolts compressing the frames against the keel.

DUBBING.

In order that planking, when applied, lay face to face against the frames before being secured, it was necessary to bevel or dub the outside face of the frame to the correct angle (See Fig. 2/20).

Some dubbing was done at the frame manufacturing stage using data obtained from the half model but a number of long softwood battens were temporarily fitted at various heights from the keel up to the sheer strake to allow the dubbers to get ahead of the planking squad.

Final dubbing began on August 12th, 1839.

BEAM SHELVES.

The installation of the beam shelves running from stem to stern, port and starboard, and involving a number of scarfed joints further braced the entire structure and allowed fitting of the deck beams which in 'Culdee's case were cambered five inches in 23 feet.

After the deck beams were fitted, lodging knees and beam knees were fitted between and below the beams to give further bracing to the deck supports. Work was completed by the end of August, 1839.

PLANKING.

This was another labour intensive operation which required careful planning.

Each strake of planking from bow to stern had to be continuous (although it could be made up of several sections) and because the girth around the ship varied (being greatest at midships) then clearly the width of the strake also had to vary.

The number of planks was determined by dividing the half midships girth by the width of planking chosen.

The run of the planking was determined by running a batten from the top of the sternpost along the hull near the turn of the bilge at midships and forward to the stem at a point comparable to the top of the stern post, the batten being at all times flat on the hull.

The planking squad then fitted three strakes, two at the top, the sheer strake and the one immediately below it, and the third at the bottom, the garboard strake.

The line of the remaining strakes was obtained by dividing the unplanked dimension at each frame by the number of strakes still to be planked and marking the frames accordingly. Where there was a risk of damage by contact or grounding e.g. at the sheer strake or the turn of bilge, extra thick planking was used.

Each strake was clamped in place prior to drilling and treenailing (pinning), and in way of the forward and aft ends where the hull form changed from convex to concave there was a need to use the stove house to condition the planking in these areas, to make it soft, pliable and capable of being clamped properly. (See Fig. 2/21)

DRILLING AND TREENAILING.

In tackling a strake of planking the planking squad, using augers, firstly drilled holes at each butt, (three holes in each side of the butt) into which spikes were driven. They then drilled two larger holes, one in way of each frame into which treenails were driven.

The treenails (hardwood seasoned dowel pins) were then wedged and cut flush with the planking.

The planking operation occupied the period from mid August until late October 1839.

CAULKING.

Planking of the main and quarter decks having been completed late September 1839, caulking of these decks began in early October conjointly with caulking of the hull planking, and the operations was completed by the end of October, 1839.

All deck and hull planking before installation had been bevelled to create a narrow V - shaped recess between adjacent planks. The caulking was carried out as a team effort. Four layers of tar soaked hemp known as oakum were hammered into the recesses, each successive layer having greater density of material, the final layer being 1/4 inch below the surface of the planking and hot tar was poured into the remaining space, surplus tar being scraped off when hardened. (See Fig. 2/22)

SHEATHING.

It was the mark of a superior ship if the underwater portion of the hull was sheathed with copper, and the Scotts always tried to persuade their prospective owners to invest in this protection.

Wood sheathing on top of hair felt was a cheaper alternative but Scotts recommended the use of hair felt next to the heavily tarred ships underwater surfaces, covered with wood which in turn was sheathed with copper sheeting.

The technique was designed to protect the ship's planking from the ravages of the ship - worm so destructive to the vessel's planking in tropical seas, and to keep the planking dry and sound.

On 'Culdee' the operation was commenced on November 12th and completed on December 2nd 1839.

PREPARATION FOR LAUNCH.

The preceding notes, of necessity much abbreviated, are intended to illustrate how the hull structure of a wooden sailing ship was put together in 1839, and the items listed and programmed on the bar chart (Fig 2/16) were clearly John Scott III's idea of the significant events.

The outfitting work inside the ship, the lining of the cargo holds, the installation of the cargo hatches, the accommodation, the installation of the deck winches etc., was progressed in parallel with the hull construction.

Preparation for the launch, the erection of the standing and sliding ways, began on November 23rd 1839 and 'Culdee' was successfully launched on December 11th,1839 at 2.30 p.m.

FITTING OUT.

After launch 'Culdee' was towed round to the West Harbour for completion, primarily the stepping of the masts and installation of rigging. Thereafter, having been stored, she embarked on her maiden voyage to Bombay on 6th February 1840.

Fig. 2/15 Reconstruction of Preliminary Design.
Barque 'Culdee'.

Fig 2/16 - Realised from Scotts' Shipyard Diary - 1837-40.
Scott's Archives Ref. GD 319/26/1/1.

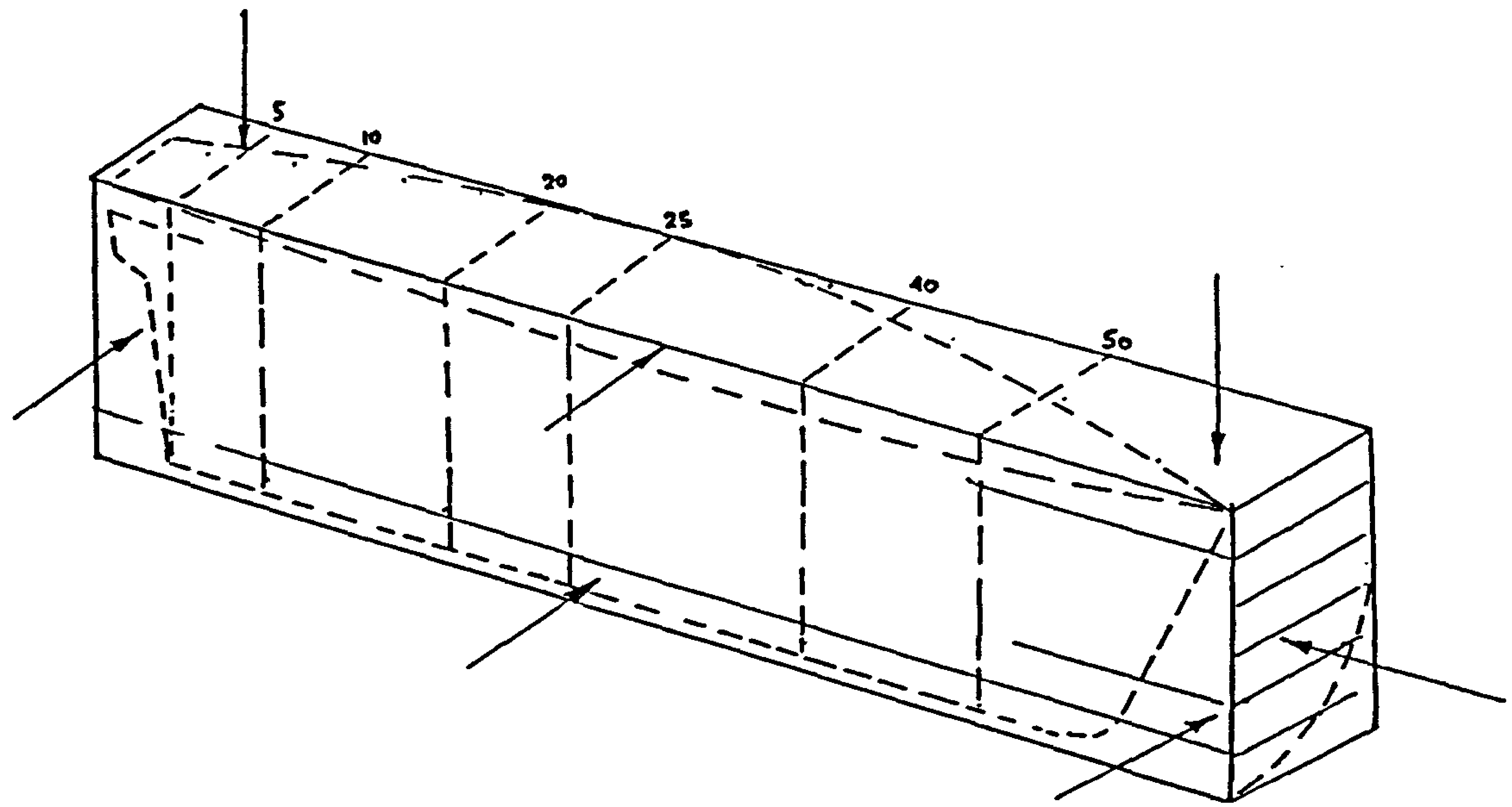
Barque 'CULDEE'
Berth Construction Programme - May/December 1839.

EVENT	MAY	JUNE				JULY				AUGUST				SEPTEMBER				OCTOBER				NOVEMBER				DEC.	
	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
moulds given out.	x																										
dressing frames.	x																										
dressing/joining frames.	x																										
slip cleared & frames hauled over.			x																								
keel scarfed and keel blocks laid			x																								
Keel laid. After deadwood fitted.			x																								
Stem raised, fitting ford. deadweight.			x																								
Stern frame raised.				x																							
Frames being hoisted.				x																							
Ford. keelson fitted and bolted.					x																						
After frames raised.						x																					
After keelson fitted and bolted.							x																				
Chocking & trimming timbers of fore body.								x																			
Raising after cants.									x																		
All hands temporarily transferred to repair work.									x																		
Some hands sent to fore body.										x																	
Dubbing & making ready to plank bottom.										x																	
Planking bottom.												x															
Sacramental Fast												x															
First black strake on.														x													
Planking top sides.															x												
Fastening stringers & clamps on upper deck.																x											
Getting in beams of lower hold.																		x									
Caulking main deck.																		x									
Laying quarter deck.																			x								
Fitting covering boards & bolting stringers.																			x								
Caulking quarter deck & putting on tween deck ceiling.																				x							
Putting on rails.																				x							
Bowsprit sawn.																				x							
Ceiling lower hold.																				x							
Caulking three strakes under bends. All ceilings on.																					x						
Rails all fastened.																					x						
Putting round bulwarks & caulking down.																						x					
Garboard strakes put on.																						x					
Caulking flat & finishing deck & inboard work.																						x					
Putting on sheathing.																							x				
. . . .																								x			
Laying launch & finishing deck & inboard work.																										x	
Bottom sheathed.																											x
Finished inside work.																											x
Launch - 2.30. p.m.																											x

Barque CULDEE
Owner - Muir, Greenock
Reg. Tonnage - 387
Length — 110·6 ft
Beam — 23·1 ft.
Depth of Hold — 17·7 ft
Launched — 11th December 1839
Registered — 5th February 1840

Fig: 2/16

The model, embracing the overall dimensions of the ship, was created from six layers of yellow pine, each one inch thick, to a scale of 1/4" = one foot, all bound together by bolts (omitted for the sake of clarity). Surplus material as shown by grey areas was removed by carving on three axes as indicated by arrows. The top layer was then removed and the requisite sheer applied. The final form of the bow and stern areas was then created by carving using chisels and templates for a number of frame stations in these areas provided by the design office. Any apparent discontinuities in the ship's lines were eliminated in the final smoothing and polishing.



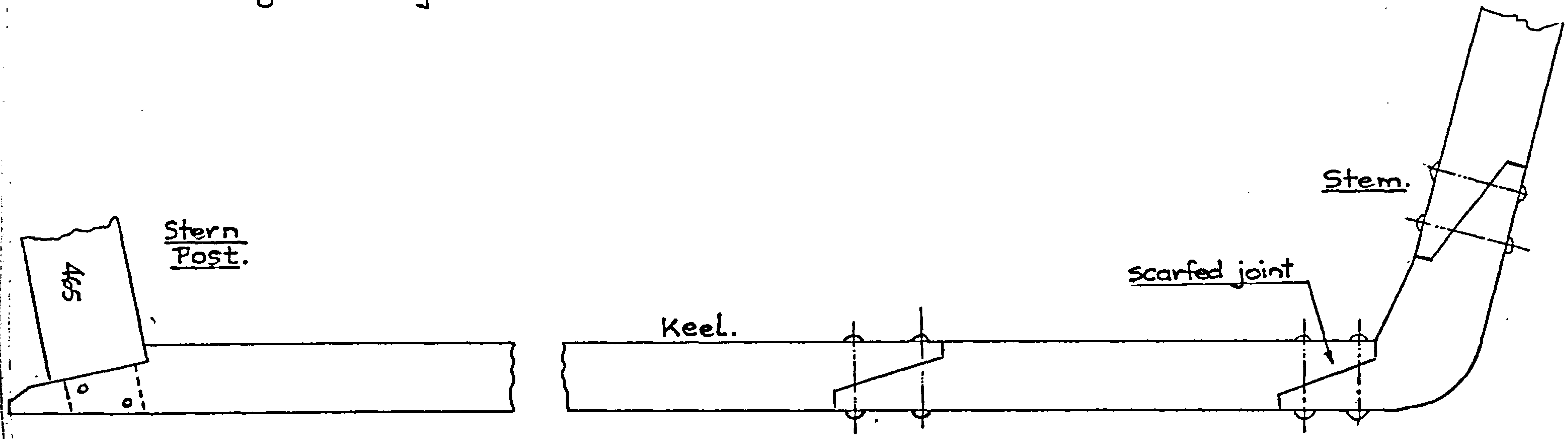
Manufacture of 'Culdee' Design Half Model.

J.F. Rodd
1992

Fig. 2/17.

Fig. 2/18

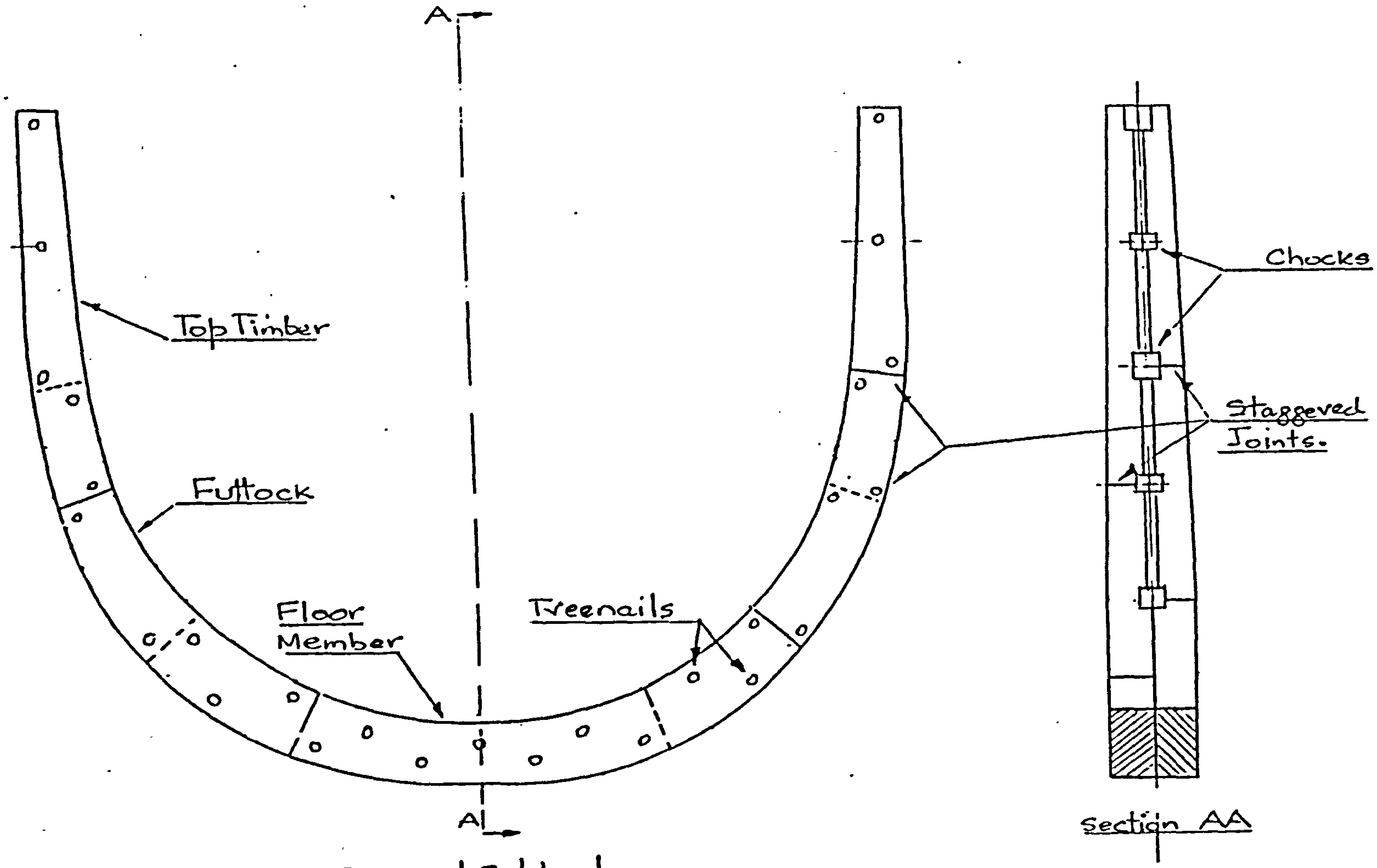
For large structural members such as keel, keelson and items adjoining them it was not always possible to obtain sufficiently large timbers to allow of one-piece construction.
Accordingly such members were made by joining two lengths of timber using scarfed joints.



KEEL, STEM and STERN POST ASSEMBLY
incorporating three scarfed joints and a socket joint.

I. F. Robb
1992

Each frame comprised five elements — a floor, two futtocks and two top timbers. The floors were solidly bolted together but the futtocks and top timbers were chocked apart to provide air circulation. Thereafter the pair of frames were treenailed together.



Barque 'Culdee.'
Typical Double Frame Assembly

J.F. Riddo
1992

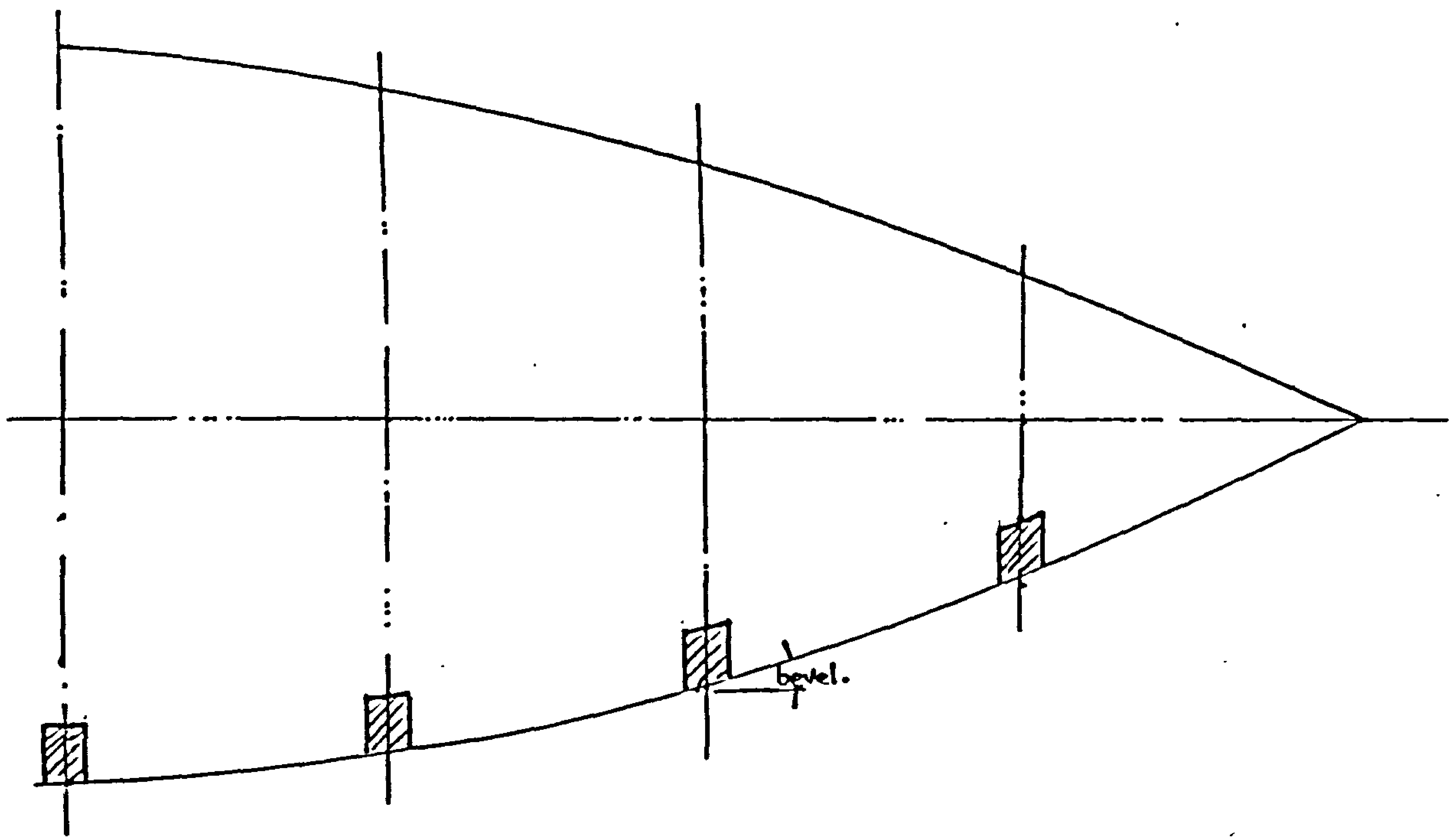
Fig. 2/19

DUBBING (or BEVELLING) OF SHIPS FRAMES.

To ensure that ship's planking would lie flat on the frames, bevelling or dubbing the contact faces of most frames was necessary. Some of this highly skilled work was done at an early stage of frame manufacture, using data obtained from the full scale ships lines drawn in the mould loft.
The amount of dubbing necessary was greatest at the extreme ends of the ship. In way of the parallel mid body it was not necessary.

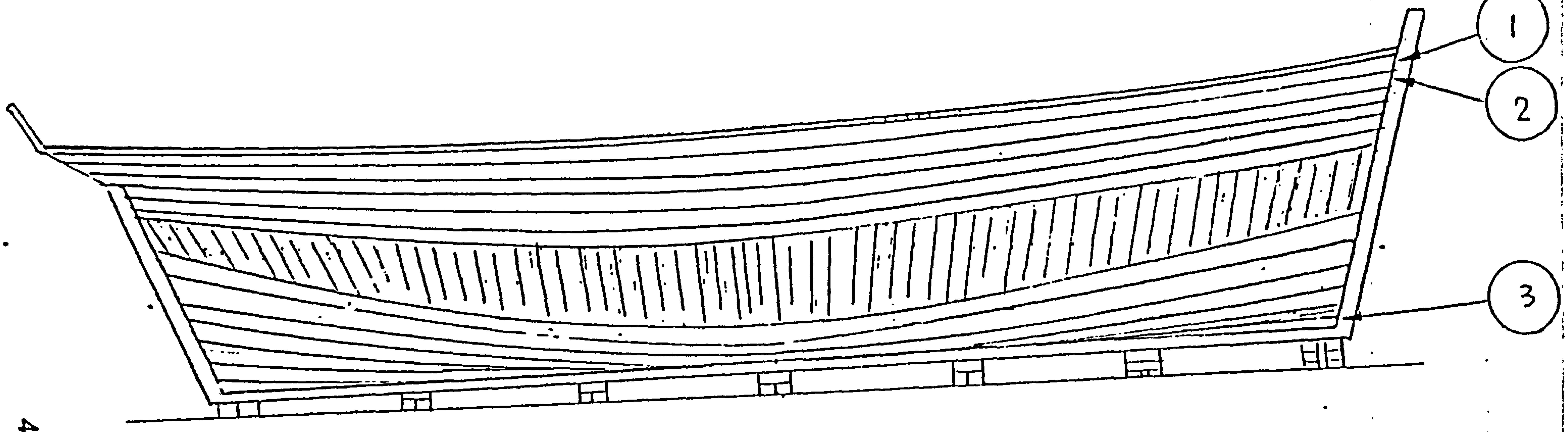
Barque 'Culdee'

Indication of dubbing required at forward end.



I.Y. Robb

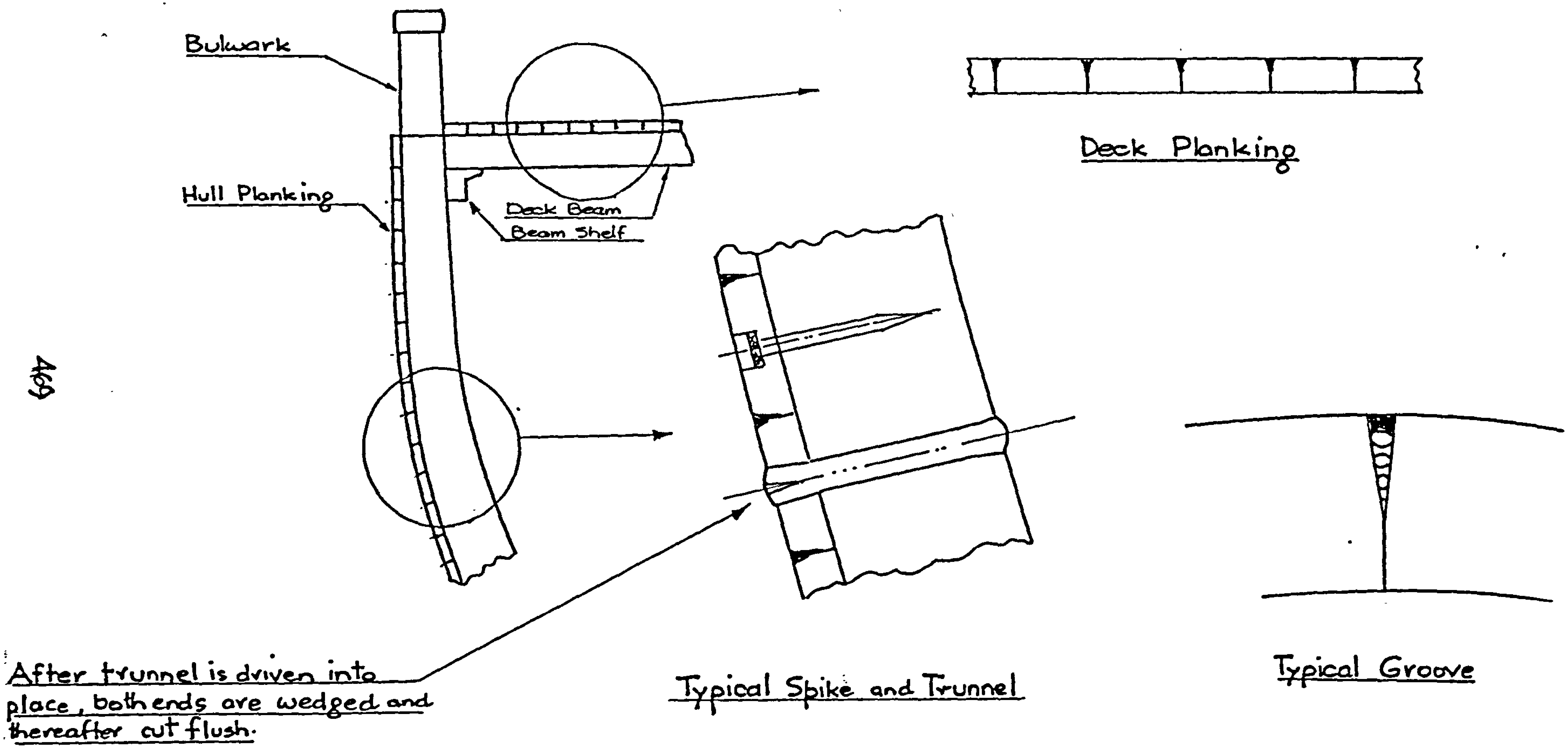
Fig. 2/20



Planking Scheme

① Sheer Strakes.
② Strakes below ①.
③ Garboard Strakes.
④ Planks thereafter fitted, down from top and up from bottom, the frames at each frame station being marked up with the location of the remaining planking.

J Y Robb
1992



CAULKING & TREENAILING
Deck and Hull Planking

J F Robb
1992

APPENDIX 2/2.
CORRESPONDENCE BETWEEN LOWER CLYDE SHIPBUILDERS, OWNERS AND SHIPWRIGHTS SOCIETY.

May 8, 1833 From John Scott III to Robert Steele, Shipbuilder.

'We have just found your note on our desk. From the unsatisfactory meeting with the men at the Buck Head we have (on our part) come to the resolution not to interfere further with the Union as the members seem determined to follow their own way in forming rules and laws etc.,

It appears to us of necessity that their employers must just regulate their contracts or engagements in a way to avoid being trammelled by such combination'.

October 15, 1833 From John Scott III to Norman Yule, Aberdeen, (Owner).

Dear Mr Yule,

The disturbed state of all classes of workmen employed in the building of ships and the existing combination of unions, together with our other engagements in building ships, will prevent us undertaking yours in a shorter time than already named.

Diary Notes.

July 15 1839.

Sawyers making but little progress with their work from irregular attendance and generally ineffective workmen. This evil must be remedied.

Carpenters not working freely or heartily these some weeks past which must be attributed to the fatal effects of the Union system. viz:- To do as little as possible - and to prevent any thoroughbred operative who is not a member of the Union from working.

July 15, 1839

Work very much retarded by the irregular turning out of the sawyers - many pairs not turning out two days after the pay.

(Continuing Appendix 2/2).
Letters from John Scott III.

October 28, 1839 From John Scott III to Robert Duncan, Greenock, Shipbuilder.

'The case you describe in which some journeymen were brought to work from a distance is very flagrant, and if these men have been intimidated from working through the influence of the members of the Union or Society of Shipwrights then the matter calls for being followed up, unless the shipbuilders of the Clyde are determined to allow the Society or Union to control them under all circumstances in the unqualified employment of any class of workmen'.

March 16, 1847 Letter to Malcolm Sinclair - Preses - shipwrights of Greenock.

'We are in receipt of your letter of the 2nd stating that it had been unanimously agreed at a meeting of the shipwrights of Greenock held on 24th ult. to make application for an increase of 6d per day to the present rate of wages.

We have taken your application into due consideration and are of the opinion that the scale of wages of the shipwrights of this port is in fair proportion to the price of provisions and the near prospect of more moderate markets. Besides the continued depressed state of shipping interest will not admit of our paying a higher rate at this time.

We therefore trust the men will see it is not in our power to make them any further advances of wages'.

March 23,1847 From John Scott III to Robert Steele, Shipbuilder.

We have this morning your note, we are also in receipt of a letter form the Preses of the Shipwrights Society dated 20th inst. of the same nature, we presume, as the one sent to you and the other shipbuilders.

We are of opinion that no further good will result in corresponding longer through that channel. In the present aspect of matters it may be proper to call a meeting of the shipbuilders on an early day - Thursday or Friday - in order to decide on what course to adopt in reply to this second application from the men.

Although we cannot help think their rate of wages is quite high enough, in fact the present state of the shipping interest in this country will not permit of any increase, in the face of so near a prospect of an entire alteration in the Navigation Laws - which if carried in any degree into effect will at once depreciate ships and lower the price of labour. We venture to say that if the North American and Spring ships were fitted out there will be very little demands for the services of shipwrights in the Clyde for repairs for some months.

We think it unnecessary to consult with the shipbuilders of the upper parts of the Clyde as no doubt they will agree to any arrangement that may be fixed down here for interest of all'.

Yours etc.,

Letter from John Scott III to Robert Steele 23rd March 1847.

p.s. Mr. Simons has just called here, mentioning that Mr. Wood, you and himself would come here on Friday at 2 p.m. It will be perfectly suitable for us at the hour named when we shall be happy to see you.

August 19, 1847. Letter to Shipwrights Society.

'The master shipbuilders of Greenock and Port Glasgow at a meeting held here today and having taken into consideration the great fall which has taken place in the chief articles of food, the prospect of a plentiful harvest and still further decline which may naturally be expected to take place on all kinds of grain, were unanimously of the opinion that the ships carpenters wages should now be reduced to a rate of 3/10d. per day, and that the change should take place the ensuing week'.

APPENDIX 2/3.

Tender letter from John Scott III to the Hayle and Bristol Steam Packet Co., of Hayle, Cornwall. 1840.

We understand the above company have resolved on building a new vessel for their trade, of dimensions:-

length ---------150 feet
width ---------- 22 feet.
depth of hold - 12.5 feet.

We may remark that the breadth is rather little for the length and the depth might be 6 inches more.

We could form a very fine steamer that would carry 120 tons of general cargo and accommodate up to 50 cabin passengers exclusive of a good large fore cabin.

In order to give a large airy cabin the quarter deck would be raised three feet above the main deck and brought nearly 60 feet forward. The sponcings (sponsons) would be run about 3 or 4 feet on the paddle beams diminishing fore and aft.

Such a vessel we could construct with an elm keel and frames of English oak, planked with elm to turn of bilge; from that to wing wale, red pine and pitch pine; paint strake, English oak or African oak; paddle beams, African oak; hatchway beams, English or African oak; rest of beams, red pine and pitch pine; clamps and stringers, American, English or African oak; ceiling in flat and bilge, American oak; rest of ceiling, red pine and pitch pine; decks, yellow pine; coamings of hatchways, African teak. The usual deck and inboard work, pine bulwarks and hardwood nails; joiner work for cabins; painting - 3 coats - 2 clench built boats.

Masts and spars for a schooner, with dead eyes and eyebolts driven in hull, with figurehead and stern carving.

To be copper fastened to load line and decks copper nailed and dowelled. The paddle beams well secured with heavy iron knees and stays.

The whole work well fastened with copper and iron bolts and spikes and treenails, well caulked with good fresh oakum paid with pitch and finished and put out of hand in our usual substantial manner.

It would require about 6 or 7 months to build such a vessel as we have described and to fit the boiler and engine complete in working order about 6 weeks or two months more, and the lowest price fourteen pounds and ten shillings per ton payable as follows:-

one fourth - when contract is entered into.
one fourth - when in frame.
one fourth - when planked and beams in.

Tender letter from John Scott III to the Hayle and Bristol Steam Packet Co.,

one fourth - *when launched and builders certificate delivered.*

We have now on the stocks one of the large steamers building for the Royal Mail Co., ('Dee') for the West Indies Station which will be launched in a few months and, having other applications we hope to hear from you soon in order that we be prepared in making other arrangements for similar vessels wanted about the same time.

(Our engine works are greatly increased and extended with tools and powerful machinery since the Herald's engines were made).

Yours,

John Scott & Sons,

This tender letter did not produce a contract but is interesting for the details provided of the great variety of woods employed by shipbuilders at that time.

APPENDIX 2/4.

From John Scott III to Charles C. Scott - 13.12.1849.

Dear Charles,

After much deliberation I have come to the resolution of at once withdrawing from the business of Scott Sinclair and Co., after this date and I have also to inform you that I have this day done so publicly.

From John Scott III to Charles C. Scott. 3rd January, 1850.

Dear Charles,

Having now retired from the business of Scott, Sinclair & Co., it will be necessary that we meet to make arrangements for the completing of contract work now in hand, collecting debts, and other matters, and for this purpose I think we should meet on Saturday first at one o'clock in the Foundery, each bringing a mutual friend with him.

I consider this the best mode under existing circumstances of bringing our matters to a closing point.

10th May, 1850.

Dear Charles,

Since the receipt of your letter of the 4th, Mr. Lawrie has shown to me different methods of closing the partnership business of the Foundry which he also stated had been submitted to you.

I intimated many months since that it was my intention to retire from business. You then stated that could not be correctly done till the yearly balance on 31st May.

Is it your desire also to retire from the business, because if such is your fixed determination the works must of a necessity be brought to a sale and the proceeds applied to liquidate the debts.

But should you decide on continuing to carry on the works on my retiring at the Balance, the fixed property of concern, viz: houses, workshops, water power, tools and all such things must be valued by people skilled or conversant in matters of the like kind and so taken by the incoming partner or partners at such fair valuation.

That point can be as decided - then the contract for the Brisk machinery will fall to be valued and the required amount for its completion agreed on.

The collecting and realising of the debts and winding up the affairs will take some time but with steady perseverance it will also be accomplished.

Those are all the points that require consideration and I may state as you have done that I have no wish but to facilitate and bring to an equitable arrangement the affairs of the Foundry.

(Continuing Appendix 2/4).
Letters from Charles C. Scott to John Scott III 31st May, 1850.

From Charles C. Scott to John Scott III 31st May, 1850.

Dear John,

As you are aware that our partnership here expires today, 31st inst. it will be necessary that arrangements be immediately come to for having the concern of Scott Sinclair & Co. wound up and closed. This is the more indispensable as after today and without such arrangement being made, I do not see that the works can properly be kept any longer in operation as heretofore.

The payment of the men which I think should be tonight with respect to which Mr. McPherson called on you this forenoon is one of the arrangements demanding instant attention and of course I can give no orders to resume work tomorrow.

I await your reply.

From Charles C. Scott to John Scott III 1st June 1850.

Dear John,

In regard to a sale of the Works it appears to be the great object with you to see the obligations of Scott, Sinclair and Co., disposed of. Now in looking at our account you will find there is no great difficulty in the matter.

The following is a rough sketch as they stand of our debts and assets exclusive of small sums owing.

We owe the Western Bank about	*£27,000*
Mrs. Sinclair (their sister)	*£13,000*
	£40,000
and to meet the above obligations.	
The Scottish Central Railway owe us	*£ 5,832*
The Government	*£ 6,800*
Royal Mail shares	*£ 4,300*
Deficiency on your stock account	*£ 8,368*
	£25,000

If therefore these sums of £25,000 were received and paid into the concern the bank debt would be nearly extinguished. There would still remain the debt of £13,000 to Mrs. Sinclair, but in the event of my purchasing the works I have no doubt she will relieve you of any responsibility for my portion of what might be owing to her.

(Continuing Appendix 2/4).
Letter From Charles C. Scott to John Scott III 1st June, 1850.

If I became purchaser of the works, of course half the price would be placed to your credit with Scott, Sinclair and Co., and no conveyance of the subject in my favour would be required until the obligations of Scott Sinclair and Co., were discharged, so that the Works would remain in security for the payment of all these obligations.

Under these circumstances let me know the lowest price you will accept for your share of the Works and their appendages as described in my letter of 29th May and I will give you an immediate answer, and if we can agree on the price it will enable me to keep the Works in a going state and save us front that great sacrifice of property which otherwise I fear will be the same result.

In the foregoing statement I have kept out of view the minor account on which there will be a balance in our favour of about £5,000.

From Charles Scott to John Scott III. 30th December, 1850.

Dear John,

Twelve months have passed since you desired to terminate your interest in the Foundry, and still the business of Scott, Sinclair and Co., remains as much unadjusted as before.

Since that period serious loss has resulted and that solely owing to the unfortunate prohibitory position in which our business had to be conducted. To you having a large remunerative business to support you this state of matters may not be of much consequence but to me it is widely different not being so situated.

If an arrangement of the business is to be longer deferred it will not suit me to remain as Manager but it will be my imperative duty to direct my attention to another business for the support of my large family.

10th January, 1851 From John Scott to Charles C. Scott.

Dear Charles,

I was duly favoured with your letter of the 30th ult.

Passing over different topics to which you advert, I must say that it has surprised me your having so long deferred making any proposition for the resumption of work in the Foundry.

You know my determination to leave the business, but there is nothing to prevent your carrying it on for yourself.

I shall be glad to receive any proposal from you either for a lease or sale of the Works and purchase of the stock.

I need hardly add that my interest in both you shall have on terms very different from what I would concede to a stranger.

From Charles C. Scott to John Scott III   11th January, 1851.

Dear John,

In answer to your note of yesterday the warrant has not yet been received for the balance of the Greenock's machinery from the Government. With reference to Mr. Thomson's offer to proceed with me to Perth, I think that from the position in which we stood with that gentleman for so many years it would be very unpleasant to accompany him on such an errand. It is no doubt extremely desirable that we should receive our money from the Scottish Central but from what I heard from Mr.Johnston I am afraid that cannot take place until the Company obtain a bill from Parliament to raise money. But as the account is bearing interest similar to what we are paying the Western Bank there is no loss to us, but only the inconvenience to the bankers in being kept out of their money.

I shall be able to reply to your other letter in a few days.

Dear John,   *16th January, 1851.*

With reference to your letter of the 10th asking me to make an offer for the Works, I now beg to make you the following. I am willing to give to the present firm of Scott, Sinclair and Co., for the buildings, ground machinery, tools, stock in trade and workmens houses and all whatsoever belonging to them at this date the sum of eight thousand pounds stg subject to the conditions following with regard to the Contracts and work at present on hand. And to guard against this offer being rejected on the ground of our not agreeing as to the mode in which the above sum is to be paid as was the case when I made you an offer in May last, I would suggest that we leave the arrangement of this and any other affairs connected with the winding up of the present firm of Scott, Sinclair to our friends Mr. Craig and Mr. Dunlop with power to appoint an umpire in case of their differing.

The only works of importance now in hands are the Brisk's machinery and the Bombay boiler to which very little has been done.

I estimate that it will take £500 more that we are yet to receive from the Government to finish the machinery and boilers of the 'Brisk' and fit them on board the vessel.

In making the above offer I have taken this into account and should you accept it I shall take upon myself the responsibility of the contract, and if I pay for the material of the boilers, shall be entitled to receive the balance from the

Letter from Charles C.Scott to John Scott 16th January, 1851.

Government. With regard to the Bombay boiler we have received from the company £600 on account of the second boiler for which very little work has yet been done.

If you accept my offer I must be paid that sum by the present firm under deduction of what has already been paid for labour etc., I shall then pay for the materials and finish the work and receive the balance from Bombay.

Had our unfortunate agreement with the Shaws Water Company by which the purchaser of the Works must be bound to pay so large a sum annually not existed and had the history of this business for the last quarter of a century been different, I should have been induced to make you a much larger offer, but taking these circumstance into consideration I do not feel justified in hazarding a larger sum without any prospect of a certain return.

From John Scott III to Charles C. Scott. 24th January 1851.

Dear Charles,

The offer by you of £8,000 for the "Ground Buildings, Machinery, Tools, Stock in Trade and Workmen's Houses and all whatsoever belonging to them" appears to me to be much too little. The acceptance of such an offer would leave me with a considerable cash balance to provide for which would not be reasonable.

My proposal is that stock should be taken immediately and inventories of everything about the Works made up.

When these are completed we could get neutral parties to fix the values.

In this way both you and I will know what we are about. I need hardly add that my object is not to exact from you the extreme value, but if practicable to save myself from further advance.

The Shaws Water in place of a burden ought to be a most valuable appendage of the Works, and in my estimation the Buildings and Ground with the Waterpower would sell for a large sum even stripped of machinery and other property out of which alone double the sum you offer would be realised if brought to the Hammer.

I repeat, however, that this remark is not thrown out with a view to your being dealt with by me on such a footing.

From Charles C. Scott to John Scott III 25th January, 1851.

Dear John,

With reference to your letter of 24th inst., received this morning declining to accept my offer for the Foundry, Stock etc., and completion of the Contracts in hand, I must refer you to my letter in which I intimated to you that it was not *convenient for me to remain longer as Manager of the Foundry it being imperatively necessary that I should recommence business for the support of my family.*

We must therefore take immediate steps for the appointment of a proper person to superintend and finish the work we have in hand and wind up our concerns as next Saturday is the last day my arrangements will admit of my remaining here.

If you think it necessary to ascertain accurately for yourself the amount of stock we have in hand, you are of course quite at liberty to do so for your own satisfaction but I beg to say that a valuation by any other party will have no effect on my opinion of the value of the Works, and Stocks or influence me to make you a larger offer than I did on the 16th inst. when I said that the sum I named was the extreme limit to which prudence would permit me to advance.

From John Scott III to Charles C. Scott. Monday 27th January 1851.

Dear Charles,

I have received your letter of the 25th inst.,

On your own account I regret very much to perceive the determination to which you have come respecting the concerns of Messrs. Scott Sinclair and Co., but I still hope that you may see it to be for your own interest to adopt a different course.

For my part if your do throw upon me the whole burden of winding up the business by leaving the Foundry I must endeavour to undertake that burden.

I certainly think it necessary to know what value there is in the Foundry towards meeting its obligations. I shall therefore set about getting an account taken of the Stock with all dispatch.

In this I should be very glad if you will cooperate - you must be sensible however that my object is not to force you into buying at an unreasonable price but merely to ascertain what value may be in the property for which you have offered £8,000 stg. with a view to my guidance in a sale.

Dear Charles, *28th January 1851.*

I am favoured with your letter of this date you never asked me to make an offer for the Foundry and I never did so, understanding that you wished to buy not to sell. If you desire it however and engage either to buy or sell at the sum I may name, I shall name such sum immediately on Stock being taken.

In the meantime, I do not see any necessity for employing strangers to take stock, although it may be requisite afterwards to fix some of the price.

(Continuing Appendix 2/4).

Letter from John Scott III to Charles C. Scott Monday 27th January, 1851.

I do not advert to other topics alluded to by you, as this would be attended with no good so far as I can see.

From Charles C. Scott to John Scott III 28th January 1851.

Dear John,

In reply to your of 27th inst., I cannot help expressing my regret that while you rejected every offer I have made to you, you have refused to make any proposal to me and meanwhile our property is being daily depreciated.

It is not my desire to continue at this work but to resume a business which is more congenial in every respect to my habits and taste, unless compelled by circumstances to try what yet can be done with the Foundry.

If you wish to ascertain what value is in the Foundry towards meeting its obligations by all means do so, but I will be no party to the employment of valuators or any third party for I consider my own personal knowledge gained by experience, superior to any valuations which any strangers may put upon the property.

I will however give any personal explanations which you or the persons you may employ may ask, and meanwhile I will remain in charge, but you must yourself see that it is not only a waste of time but a serious loss to the Concern that its affairs should continue to be conducted in the way they have been for the last twelve months. The sooner, therefore you inform yourself and communicate to me your final resolution the better as my mind is made up.

Dear John, *29th January 1851.*

I am in receipt of your of the 28th inst., and I would point out that you are in error in stating that I never asked you to make an offer for the Foundry. I think you will be satisfied if you refer to my letters but particularly to that of the 4th April 1850 in which you will find I express myself as follows:- "I am willing to receive an offer from you of a price for the Works which you will either give or take to which I will return you an answer immediately." Now however that you agree to buy or sell at a sum to be named by you I accept this and hereby engage either to convey the works to you at the sum named in that offer, or to accept your offer you being bound to convey that Works to me at the sum stated in the offer.

As to taking stock you are aware that this was done so late as May last and it would therefore be a waste of time and money to take it again. I would therefore propose that the Inventory taken in May be examined by you and such alterations made therein as you require. This may be done quickly and as soon as you have satisfied yourself and then made your offer, I engage to give an early and definite answer.

(Continuing Appendix 2/4).
Letter from Charles C. Scott to John Scott 29th January, 1851.

Of course, I expect your offer will embrace all the obligations of the Company specified in my letter of 16th January to you and our unfortunate agreement with the Shaws Water Company.

From John Scott to Charles C. Scott. 20th February, 1851.

Dear Charles,

I hereby offer to pay you the sum of £6,000 stg. and to make over to you all my right and interest in the stock and property of Scott Sinclair and Co., on condition of your relieving me of the whole Debts and Obligations of that Company.

Or in your option I agree to buy or sell the Works, Machinery, Tools, Utensils and Stock in Trade of Scott Sinclair and Co., at Fourteen Thousand Pounds, £14,000 stg. - including in that sum the cost of finishing any work in progress, the price of which so far as not recovered shall be payable to me.-

This offer to be conditional upon the conversion by Mrs Sinclair of her claim against the company into a debt to be due by us to her individually each to the extent of one half the amount.

From Charles C. Scott to John Scott III 8th March, 1851.

Dear John,

Since you refuse to pay the men's wages which are due since the sale of the Works to you I must do so on your account, but you will distinctly understand that my doing so is in no way to be held as interfering with the concluded sale of the Works to you.

I have ceased to interfere with the men and my presence at the Works has been merely to look after the winding up of the affairs of the old concern.

From John Scott III to Charles C. Scott. 20th March 1851.

Dear Charles,

John has mentioned to me the purport of his conversation with you yesterday and that you had expressed a desire still to have Scott, Sinclair and Co's Works.

(Continuing Appendix 2/4).
Letter from John Scott III to Charles C. Scott 20th March 1851.

I should be very glad indeed to see them yours and again in active operation. But before I can reopen a negotiation it would be proper I think that you agreed to cancel my offer of £14,000.

I shall therefore be glad to receive a Buy or Sell offer from you.

If you entertain the proposal let me know as soon as possible that I may withdraw from the possession.

From Charles C. Scott to John Scott III   21st March 1851.

Dear John,

I have received your letter of yesterday's date. I have in answer to state that having accepted your offer of £14,000 (Fourteen Thousand pounds stg) for the Works, Machinery, Tools, Stock etc., of Scott, Sinclair and Co., contained in your letter of 20th February and having in consequence retired from the management and all further interference in the affairs of the Company. I cannot therefore now, as you desire cancel an agreement which was thus concluded and perfected between us.

I have also arranged with Mrs Sinclair for my portion of the debt due to her by Scott, Sinclair and Co.,

It is however proper for me to explain that there is an entire mistake in your letter in so far as you state I had expressed a desire to your son still to have the Works. John (Jr) must have completely misunderstood me if he left me with any such impression. He informed me that you were unwilling to take such a heavy burden on yourself and I said to him in answer that if you as the proprietor of the Works had any new proposal to make to me I might be disposed to take it into consideration.

From John Scott III to Charles C. Scott   21st March 1851.

Dear Charles,

I am favoured with your letter of this date.

From your explanation it would appear that John has misunderstood the purport of your observation which I regret.

Matters are therefore just where they were. Of course, I could not think of commencing a new negotiation with you on the footing you propose. But if you still have a desire for the Works I will either give or receive another Buy or Sell offer on your agreeing to my withdrawing the one in your hands.

(Continuing Appendix 2/4).

From Charles C. Scott to John Scott III   22nd March 1851.

Dear John,

I received your letter of yesterday's date and beg to have it clearly understood that the only terms on which I can cancel your agreement is when your make me such an offer as I can accept in its stead.

The buy and sell arrangement terminated with your purchase of the Works etc., and cannot be renewed.

As early a reply as possible to this is requested.

From John Scott III to Charles C. Scott   22nd March 1851.

Dear Charles,

I have just received your letter of this date.

In answer I have merely to refer you to my letter of yesterday which expresses the only footing on which I can agree again to negotiate. And I cannot refrain from adding that your proposal appears to me to be the reverse of what is reasonable or fair.

From Charles C. Scott to John Scott III   24th March 1851.

Dear John,

I have received your letter of the 22nd inst., and in reply I must deny that in my proposal of the 22nd there was anything unreasonable or unfair if you understand it in such a light you must have greatly misunderstood my meaning.

In reference to our conversation to-day regarding the appointment of someone to wind up the affairs of Scott, Sinclair and Co., I have no objection to your proposal of fixing upon Mr. McPherson provided a proper Deed of Agreement be previously entered into by us containing specific instructions for his guidance in doing so.

APPENDIX 4/1.
THE BROTHERS, EMIL AND ISAAC PÉREIRE.

Born at the beginning of the 19th century, the brothers came from a Portuguese Jewish family long established in Bordeaux. They had in their younger days been associated with the Saint-Simonien party which advocated changing society, eliminating competition, and the coming together of all people in the organised development of the world's resources.

Emil Péreire developed these ideas in the newspaper The National after 1830, and Isaac Péreire did likewise in his 'Lessons at the Atheneum' and in the 'Journal des Debats'.

Their first achievement, in 1837, had been the railway from Paris to St. Germain, after which they involved themselves in the construction of other lines in North, East and South-East France.

They knew the power of credit and used it to mobilise individual savings, relatively unproductive in isolation, but all powerful when invested in large industrial undertakings.

In 1852, in co-operation with a number of Parisian bankers they founded a merchant bank, the Crédit Mobilier.

It was their intention to finance a large numbers of businesses in France and abroad. These ultimately included railways, hotels, insurance companies, canals, warehouses, together with a number of foreign merchant banks.

At the end of 1854, the Péreires founded the Compagnie Générale Maritime. Later, in 1862, with the development of their interest in ocean mail services, the company was renamed Compagnie Générale Transatlantique, the story of which is closely linked to that of Scotts and is told in this chapter.

The Crédit Mobilier was far from popular. It was described in the Legislature as "this trunk with branches which only produced poisoned fruit."

Since 1852, Baron Rothschild and other bankers had been pursuing the Péreire brothers. It was not only a clash of personalities - the basis of the conflict was an irreconcilible antagonism to the Péreires' adherence to their Saint-Simonien principles.

The world economic crisis of 1866 damaged the majority of their enterprises and as a consequence the Crédit Mobilier, unable to cope with its debts, became bankrupt. The liquidator demanded their resignation which took place on 25th September, 1867. They were further assailed in the Legislature on 17th June 1868 and there was a request for a committee of enquiry to be set up to look into the management of the C.G.T. On 23rd June 1868, Emil Péreire advised the Legislature that he and his brother were resigning their directorships in the C.G.T.

In 1875 the Péreire organisation came to the rescue of the Compagnie Générale Transatlantique which they had founded and from which the brothers had resigned seven years before and was now in considerable financial trouble. Emil was dead but Isaac with his sons and nephews proposed changes in their amortisation and insurance procedures and recommended a company reorganisation and changes in the management.

M. Leonce Goyetche, who had been managing director during Scotts involvement with C.G.T. retired in 1875.

(APPENDIX 4/1 CONTINUED).

Whilst M. Goyetche was John Scott's principal contact with C.G.T. during the mail steamers contracts, it seems likely that the problems encountered by John Scott in endeavouring to cash the C.G.T. obligations (preference shares) he received in part payment for the ships, were the responsibility of the Péreire brothers.

APPENDIX 4/2.

CONTRACT GREENOCK SHIPS.

Between the undersigned.

La Compagnie Générale Transatlantique represented in terms of Article 35 of statutes and by virtue of a resolution of the Administrative Council of the 'Compagnie' dated 23rd October, 1861 by M M. Emile Péreire and Vincent Cibiel, directors, in residence at 15, Place Vendome, Paris.

on the one part.

and (1) M. M. Scott et Cie., shipbuilders at Greenock, Scotland and The Greenock Foundry Co. steam engine builders, also of Greenock, represented by M. John Scott, youngest, a director of these companies, residing for these purposes at 218 rue de Tivoli, Paris.

on the other part.

It has been agreed as follows:-

ARTICLE ONE

Mr. John Scott both in his personal name and those above undertakes v.a.v. Compagnie Générale Transatlantique (hereafter CGT) who accept, to build at Greenock, Scotland and to deliver afloat, complete finished, an iron mailboat fitted with a steam engine, in accordance with the price, clauses and conditions stipulated in the present agreement, and the associated specifications, inventory and plans attached.

(Continuing Appendix 4/2).

ARTICLE TWO

The steamship mentioned above will be delivered to the C.G.T. at Cherbourg after the machinery has been installed at Greenock to the satisfaction *of the C.G.T. and tried at sea in accordance with the Specification. All the outfit and accessories mentioned in the specification is also to be provided.*

ARTICLE THREE

The ship is to be completed finished and tried at sea not later than twenty six months after the date of the present contract and is to be brought to Cherbourg unless force majeure (See article 15) intervenes.

ARTICLE FOUR

In the event that the delivery of the ship is later than that stipulated at Cherbourg, C.G.T. would have the right from the due delivery date, without question or appeal, to an indemnity (penalty) of 1,000 francs per day late.

ARTICLE FIVE

The builders undertake to take responsibility for the balance of cost of food, repatriation of crew, oils, pilotage, and all expenses of that nature caused by the voyage to Cherbourg until after delivery of the ship is taken by the C.G.T. The amount of the costs fixed by the contract to be (over and above the cost of the ship) 32500 francs which will by paid by C.G.T. to the builders after delivery at Cherbourg. The maritime risks during the voyage from Greenock to Cherbourg are not included in the contract.

<u>(Continuing Appendix 4/2)</u>.

ARTICLE SIX

During the voyage from Greenock to Cherbourg, C.G.T. will be able to have on board a certain number of officers, engineers or other agents for whom the shipbuilder will provide food and lodging for the cost of which C.G.T. will reimburse them.

These agents will have the right to study the performance of the machinery and to visit, as convenient, various parts of the ship.

ARTICLE SEVEN

The builders will embark before the departure of the ship 1,000 tons of coal (Welsh) of first quality. Such coal as is not consumed on the voyage will be bought by C.G.T. at 25 francs per ton.

The cost of supplies, solid and liquid which have not been consumed during the voyage will also be reimbursed to the shipbuilder at cost price.

ARTICLE EIGHT

During the eight days which follow the arrival of the ship at Cherbourg C.G.T. will take delivery of the ship having checked the Inventory is complete and all the conditions and stipulations of the Specification have been met.

ARTICLE NINE

During the period of building up to and including the date of departure from Greenock the builders will take insurance against damage by fire to the ship and its outfit, materials in process of manufacture and the machinery, less the mount already paid by the C.G.T.

They must advise the insurance offices of all claims. The costs of these insurances will be to the account of the builder and be included in the fixed price of this agreement for the hull, outfit and machinery and its accessories.

ARTICLE TEN

C.G.T. undertakes to pay the builder for the price of the steam mailboat the sum of 2,286,000 francs or in Bank of France bonds and to hand over in part of the price 1280 obligations at the rate of 450 francs each issued by the C.G.T. in conformance with Article 21 of the statutes carrying interest at 5% annually and reimbursable at 500 Francs. A table of redemption will ultimately be set up.

In the fixed price of 2,286,000 francs and 1,280 obligations the complete hull will count for 1,582,250 francs in cash and 875 obligations and the propelling machinery for ———— . 703,750 francs in cash and 405 obligations.

ARTICLE ELEVEN

The payments, hereafter described, will be made in Paris at the head office of the C.G.T. and will be made in seven instalments for the ship and for the machinery in proportion in accordance with the following stages and conditions.

The C.G.T. will pay in cash and bonds for the ship:-

<u>(Continuing Appendix 4/2)</u>.

(1) One tenth when the keel is laid on the berth and when one quarter at least of the angle iron and plate for the entire framing of the ship is in the shipyard

(2) One tenth when at least half of the frames have been erected on the keel and when all the material for the frames is in the yard.

(3) One tenth, when the frames have all been erected on the berth.

(4) Two tenths when the lower decks, internal longitudinals, other than the keelsons have been fitted in place and when half of the shell plating has been riveted.

(5) Two tenths after the launch of the ship and when half at least of the outfit and equipment have been completed.

(6) Two tenths after the ship has left the port of Greenock to proceed to France.

(7) One tenth after the ship has been delivered to France and accepted by C.G.T. in the port of Cherbourg.

For the Propelling Machinery.

(1) One tenth when the cylinders have been cast, and when one quarter of boiler plate is delivered to the Works.

(2) One tenth when the cylinder covers and the pistons have been cast and machined and the baseplate pattern has been made and the rough forged piston rods are in the Works.

(3) One tenth when the bedplates and entablatures are cast and when the column forgings are in the works and when half the boiler shells has been erected.

(4) Two tenths when the bedplates, cylinders and entablatures have been erected in the works, and when all the furnaces and half of the boiler shells are riveted and when the shaft forgings are in the works.

(5) Two tenths when the engines have been entirely erected in the works, ready to be embarked and when the boilers are water tested.

(6) Two tenths when the ship has had its sea trials and is ready to leave Greenock for Cherbourg.

(7) One tenth after the expiry of the guarantee period in the specification covering the ship, outfit and machinery.

ARTICLE TWELVE

These various payments can be claimed after the C.G.T. representative surveying the work done has sent to the C.G.T. a certificate confirming the state of work on the ship or machinery concerned: and for the last instalment due at the end of the guarantee period, if during the machinery guarantee period the ship and its outfit have not given cause for any repairs due to bad manufacture or assembly or material used, it will be totally claimable.

In the event that repairs of that nature had been necessary during the guarantee period the cost will be deducted from the last payment without prejudice to the right of C.G.T. to claim against the builder should the cost of the repairs exceed the value of the instalment.

The cost of normal maintenance will be for the C.G.T. account during the guarantee period.

ARTICLE THIRTEEN

Unless by special request of the shipbuilder obligations will not form part of the first three payments for the ship or machinery. They will be paid out in proportion during the last four instalments which form seven tenths of the total price. It is to be understood that the builders will entrust to C.G.T. on the above obligations all interest which will emerge on the redemption day of the obligations.

ARTICLE FOURTEEN

Gradually as payments are made to the builder, the C.G.T. will eventually become the rightful owner of the completed portion of the ship.

ARTICLE FIFTEEN

In guarantee of the honest execution of the commitments contained in the present agreement, M. Scott in the name of himself and others undertakes to grant with minimum delay to the first request of C.G.T. a mortgage following the law of the country on all real estate and works in Scotland in the name of Greenock Foundry also all accessories and offices with no exceptions, Mr. Scott declaring that the said real estate is entailed by a mortgage in favour of the Clydesdale Bank of Glasgow for a sum of £14,000 sterling.

Mr. Scott undertakes to proceed and to agree at the first request to return to the C.G.T. the writ stopping the effects of the first above mentioned mortgage on condition that the repayment would be made by the said C.G.T. of the credit from the Clydesdale Bank in order that the mortgage taken out by the C.G.T. or by a person it has designated, be listed upon the real estate in question.

(Continuing Appendix 4/2).

ARTICLE SIXTEEN

The guarantee mortgage which the contracting parties will have thus conferred on the estate and works in Scotland by virtue of the Disposition above would be null and void if C.G.T. do not execute their commitments to Mr. Scott. This guarantee mortgage will lapse when the mailboat leaves the yard for France.

ARTICLE SEVENTEEN

Agreement on the interpretation of this agreement will be judged by the Seine Court of Justice firstly, and, on appeal, by the Court of Paris.

The Registration will be supported by all parties.

Made in triple engagement at Paris on 24th October, 1861.

Written Approval	*Written Approval*
Emil Péreire	*Scott & Co.,*

APPENDIX 4/3.

CONTRACT

PENHOET SHIPS

Between the Undersigned:-

The Compagnie Générale Transatlantique, represented in terms of Article 35 of the Statutes, and by virtue of a resolution of the Administrative Council dated 23rd October, 1861, by M.M. Emile Péreire and Vincent Cibiel of residence, 15 Place Vendome, Paris.

on one part

and M.M. Scott & Co., shipbuilders of Greenock, Scotland. for these purposes, in residence at rue de Tivoli, 218, Paris.

on the other part.

It has been agreed as follows:-

ARTICLE ONE

M.M. Scott & Co., have undertaken v.a.v. Compagnie Générale Transatlantique who accept, to build in France and to deliver complete in all respects ready for sea, five iron ships in accordance with price, clauses and conditions stipulated below and conforming with the Specifications, plans and inventories attached.

(Continuing Appendix 4/3).

ARTICLE TWO

The first ship to be launched, ready to receive its engines, no later than twenty three months from the approval date of this agreement by C.G.T. and completely finished ready for sea five months later.

The second ship to be launched and ready to receive its machinery three months after the first, that is to say twenty six months after approval date and finished five months later.

The third ship to be launched twenty eight months after the approval date and to be ready for sea five months later.

The fourth ship to be launched and completed three months after the third ship.

The fifth ship three months after the fourth.

ARTICLE THREE

In the case where the stipulated extensions for delay for delivery of the ships are exceeded the C.G.T. would have the right from the due date, without appeal, first of all to apply an indemnity of six hundred francs per day late and for each ship. This indemnity will be deducted from the price of the ships, and will not be claimable if the delay is not the reponsibility of the shipbuilder or the engine builder.

ARTICLE FOUR

The constructor will be responsible, at his cost, for insurance against fire during construction and up to the date of delivery with companies approved by

C.G.T. for the ships, their equipment and accessories, to a value at least that equal to the sum payable by C.G.T.

The constructor must produce the insurance policies on demand to the C.G.T.'s agents.

ARTICLE FIVE

C.G.T. agrees to pay to the constructors undersigned for the price of each completed ship the sum of one million seven hundred and ninety four thousand four hundred francs in cash or in Bank of France notes and the remainder to be 1008 obligations issued by the C.G.T. conforming to Article 21 of said statutes, carrying annual interest of 5% and reimbursable at 500 francs following the setting up of a sinking fund later on.

The above payments will be made at the C.G.T. headquarters in Paris, in stages, and as stated below:-

(1) One tenth when the keel of the ship has been laid on the berth and when at least one quarter of the angle iron and plate for the entire framing of the ship are in the shipyard.

(2) One tenth when at least half of the frames have been erected on the keel and when all the material, angle iron and plate for the frames is in the yard.

(3) One tenth, when the frames have been completely erected on the berth.

(4) Two tenths when the lower decks, internal longitudinals other than the keelsons have been fitted in place and when half of the shell plating has been riveted.

(5) Two tenths after the launch of the ship and when half at least of the fitting out has been completed.

(6) Two tenths after the first trial of the ship at sea and when the hull, its equipment and accessories are complete.

(7) One tenth when the ship has returned to France after having completed its maiden voyage, or three months after delivery of the ship to C.G.T.

By exception to the above stipulations the first two tenths of the first ship will be paid by the Company C.G.T. in the eight days which follow the approval of the contract.

ARTICLE SIX

These various payments will only be made after the C.G.T. agent overseeing the work has provided to C.G.T. a certificate recording and confirming the state of work on the ships and giving right to payment. In particular the final instalment for each ship is only to be payable at the expiry of the process. In the guarantee period it will be entirely claimable at that stage if during the period of *guarantee, the ship and its equipment have given no cause to withhold from manufacturing defects or of bad quality of materials employed.*

If repairs of that nature occur during the guarantee period the cost would be deducted from the last payment without prejudice to the right of C.G.T. to seek redress from the contractor.

In the case where the value of such repairs exceeds the amount of the last payment, the ordinary maintenance charges will be for C.G.T.'s account during the duration of the guarantee period.

ARTICLE SEVEN

Unless by special request of the contractor, the obligations will not participate in the first three tenths of the price of each ship: but they will be distributed proportionally on the last four payments which together make up the other seven tenths of the total price.

ARTICLE EIGHT

Gradually as successive payments are made by C.G.T. in accordance with Article 6 the C.G.T. will eventually become the rightful owner of the completed portion of each ship.

ARTICLE NINE

Where the constructor (shipbuilder) introduces into the construction of the hulls referred to below, iron, steel or other materials from abroad, they undertake at the request of C.G.T. to obtain excise bonds for the temporary admission of these materials and to surrender the said bonds to the C.G.T. which will solely profit resulting from their sale.

(Continuing Appendix 4/3).

The C.G.T. will make known in good time to the shipbuilders the amount of bonds it wishes to take responsibility for.

ARTICLE TEN

The C.G.T. reserves the right to enter into partnership with Scott & Co., to develop the shipyard which they have established in France, in the fashion and to the extent they will ultimately agree.

ARTICLE ELEVEN

The present agreement, binding on Scott & Co., will apply to C.G.T. after approval by their Administration Council. This approval to be reported to Scott & Co., within six weeks.

ARTICLE TWELVE

Any disagreements on the interpretation of this agreement will be judged by the Seine Court of Justice firstly, and on appeal by the Court of Paris.

The Registration will be supported by all parties.

Made in double original, Paris, 24th October 1861.

Written Approval	*Written Approval*
Emile Péreire	*Scott & Co.,*

By letters dated 6th and 21st 1861 and 6th January 1862 Scott & Co., have extended until 20th January 1862 the extension of time of the present bargain which expired 9th December 1861.

APPENDIX 4/4.

PENHOËT SHIPYARD

CONTRACT

relating to provision of ground for Penhoët shipyard, penalties for late delivery and C.G.T. options to participate in Scott et Cie operations there and to repossess shipyard on completion of the five ships to be built there.

Between the undersigned:-

The Compagnie Générale Transatlantique, represented in terms of Article 35 of the Statues and by virtue of a resolution of the Administrative Council dated 8th January 1862 by M.M. Emil Péreire and Matthieu Dollfus, President and Vice President of the Administrative Council, located at 15 Place Vendome, Paris.

on the one part.

and M.M. Scott and Co., shipbuilders, Greenock Scotland represented by M. John Scott, yst, located at present at 218 rue de Tivoli, Paris.

on the other part.

It has been agreed as follows:-

ARTICLE ONE

Compagnie Générale Transatlantique hereafter called C.G.T. undertakes to use good management and to take steps to obtain for a period of nine years, land situated at St. Nazaire near the future Penhoët dock which is to be secured, *made level and generally made suitable for workshops and building berths for ships*

ARTICLE TWO

The land, once appropriated in the name of C.G.T. will gradually thereafter be placed at the disposal of Messrs. Scott and Co., who will establish at their cost the workshops, machine tools etc., and the necessary plant and equipment for building five mail boat hulls and C.G.T. will be the sole landlord of the ground.

ARTICLE THREE

At the time of purchasing the tools, equipment and services for the new shipyard at St. Nazaire, C.G.T. will pay eight days after this date to Messrs. Barnett, Hoare & Co., or their representative two tenths of the purchase price of the first mail boat, being a sum of four hundred and fifty thousand francs which will only be paid to Scott and Co., after authorization from C.G.T. and as their expenditure justifies for the purchase of tools or for the cost of various equipments for the shipyard at St. Nazaire unless the progress of work on the first ship justifies the total payment.

ARTICLE FOUR

At the end of the construction of the five mail boats ordered on 24th October 1861, C.G.T. will have the option of recovering for its account and to buy from Messrs. Scott and Co., the tools, equipment and services, large and small, and the establishment at St. Nazaire existing on the ground at a fair price but it must be understood that the said price will be reduced by the sum of two hundred thousand francs and representing the depreciation of the establishment during the *course of the construction and any change in that figure will be discussed with Scott and Co.,*

C.G.T. must in the event of taking back the establishment be made aware of Messrs. Scott's intentions immediately after the launch of the third ship and provide in private the state of maintenance and current work.

ARTICLE FIVE

Article 10 of the 24th October 1861 agreement reserving the option to C.G.T. of going into partnership with Scott and Co., for the development of their business remains valid for a period six months from this date.

The form of that participation will be agreed later on but the proportion cannot exceed one third as a maximum for C.G.T. and the remuneration to which Scott and Co., would be entitled as managers and apart from the normal trading returns in proportion to their investment is fixed at ten per cent of the certified nett profits.

ARTICLE SIX

The mailboats ordered on 24th October 1861 should be launched and ready to receive their machinery in the following periods from the present date.

1st mailboat in the period of 19 months

2nd " " " " " 22 months

3rd " " " " " 15 "

4th " " " " " 28 "

5th " " " " " 30 "

The outfitting of each of the mailboats should be completed five months after launch.

ARTICLE - SEVEN

In the event of the ground necessary for the workshops needed to assemble the frames not being available to Scotts before 1st May next and the ground for the four berths not being built up and level by June 1st next for the first and the three others successively at two month intervals, the launchings of the ships would be delayed by the number of days corresponding to the delay in making the ground available.

ARTICLE EIGHT

In the event that the first three mailboats are not delivered in the time periods stipulated in Article 6 above C.G.T. would have the right, at the expiry of the period, to an indemnity of three hundred francs per day late and for each mailboat. That indemnity will be six hundred francs per day for the last two mailboats. The penalty will not be unreasonably be applied where the lateness is the fault of the machinery contractor.

ARTICLE NINE

It is agreed between the parties that after the launch of the ships the fitting out work will be carried out in the floating dock at St. Nazaire where the engineering contractor will instal the machinery.

<u>(Continuing Appendix 4/4)</u>.

ARTICLE TEN

The agreement of 24th October, 1861 takes precedence in all its clauses and is not derogated by this present agreement.

Made in triple original in Paris on 18th January, 1862.

Written Approved	*Written Approved*
Matthieu Dollfus	*Scott and Co.,*
Emil Péreire	

APPENDIX 4/5.

THOMAS STIRLING BEGBIE.

Thomas Stirling Begbie, merchant, shipowner, shipbroker, underwriter and consultant was well known in shipping circles during the period 1850-1900.

He acted as agent for both John Scott and Peter Denny and was also involved from time to time with Cairds and Hawthorn, Leslie.

His business dealings with John Scott resulted in an accumulation of 1,000 letters embracing the period 1855-1866 which were discovered in the clock tower at Scotts' Cartsburn Dockyard just before the tower was demolished in 1987.

They are now part of Scotts archives located at the University of Glasgow, reference GD319/11/1/12a.

Their twice weekly correspondence covered a wide range of subjects, including current enquiries for new ships, progress of new ships or conversions under construction, performance of his own ships in service and underwriting. He also acted as agent for a number of iron merchants and operated an employment agency for ships officers.

In reading the correspondence it is difficult at times to know who is client and who is agent!

He was at times scathing in his criticism of John Scott's conduct of his affairs. (not always justified). John Scott during the period of the 1860's was a very young man carrying great responsibility for his years. Begbie obviously had high regard for his ability, particularly in technical matters, but felt he should delegate more to others in the production field to ensure that the work progressed when John Scott was away on business.

They were nevertheless close friends and both Scott and Denny often visited the Begbie home at Blackheath when they were in London.

Begbie, when visiting Glasgow on business, stayed with his wife and daughters at Ardencaple Castle near Rhu which at the time under review was leased by a Mr. and Mrs Wiseman, closely related to the Begbies. He also visited Ardencaple for grouse shooting with M. Forquenot of C.G.T. as his guest.

His role in the C.G.T. contract was ambivalent, warning John Scott on June 9th, 1861 to abandon all thoughts of the French Yard scheme - "it appears to me that your affairs completely prevent the possibility of your being able to undertake such a weighty matter so far removed from your own yard. Is it not so? I could not engage myself as we proposed in this transaction with you, unless I saw my way clearly to your being relieved of much of the embarrassment which incapacitates you at present from administering your business with the calmness and tranquility of mind perfectly necessary to sustain a successful result quâ profit and credit."

However, on October 19, 1861 writing from Paris to John Scott's father, C.C. Scott in Scotland, Begbie wrote:-

"this contract should and I believe I may say <u>must</u> prove by far the finest thing in the shape of a contract ever taken by a shipbuilder. I need not assure you very sincerely I hope this will prove to be the case three years hence."

In fact, Begbie carried out the negotiations on the C.G.T. contract on behalf of Scott and Co., and was their agent during the entire contract.

It is easy with hindsight to criticise John Scott for embarking on such an enterprise but he certainly had no luck with the C.G.T. contracts. The unprecedented boom in shipbuilding order on the Clyde with its consequent labour shortage and high wages was accompanied by other delays arising from material supply difficulties due to the inability of the best British suppliers to meet the demanding specifications.

However, the inability to convert the C.G.T. bonds (given in part payment for the ships) into cash, after having been given assurances that this would not be a problem, and which was largely responsible for his failure in France, shows up the C.G.T. in a very bad light.

Begbie was helpful in acting together with Denny and Galbraith as guarantors of Scotts' composition at Greenock.

In spite of strenuous efforts to learn more about Thomas S. Begbie which continue, little has emerged of real assistance other than that he had some fleeting contact with Scotts in the 1870's. He died in November, 1899 from heart failure at the age of seventy eight.

APPENDIX 4/6

THE SHIPBUILDING YARD OF ST NAZAIRE.

(From the Daily Telegraph.)

Two years ago St Nazaire was an insignificant fishing village, with a population of about two thousand inhabitants. Very little accommodation was there for ships of any size, and the natural advantages of the place were entirely overlooked. But livelier times were in store for St Nazaire. The French Government at length saw to what use the broad bay lying between these two points might be put, and forthwith set about constructing a huge basin or floating dock which should extend over no less than twenty-five acres. This undertaking has been accomplished; but other tracks of land are being drained for similar purposes; and already two millions sterling have been voted towards this end.

And, as it appears from Monsieur Robert's (the overseer) revelations, the *proprietor* of these yards is not the French Emperor, nor the French Government, but a shrewd and long headed Scotchman. It has been *maintained* that the man in the moon must of necessity be a Scotchman; though, considering the fact of moonshine being an unprofitable investment, the suggestion is doubtful; but certainly no other than a Scotchman would have thought of pitching his tent and commencing business upon this remote and barbarous promontory, which everything necessary to his undertakings which cannot be manufactured by himself must be conveyed at considerable cost. Yet within these two years two ships of 2300 tons each have been built—one for the projected West India trade of the French Government, the other *for* the Parisian Transatlantic Company, which runs vessels between Havre and New York, and is meant to rival our Cunard line; while three equally large vessels are now in a forward state—no fewer than eighteen hundred workmen being employed thereon.

Inside the large enclosure in which these three lumbering sea-giants are rapidly approaching maturity, the scene is of the most animated description. Huge machines are everywhere at work, twisting, shaving, cutting, planing, and punching holes into sheets of solid iron as though they were mere pasteboard; while from the enormous skeleton vessels, sloping downward to the Loire, issue an incessant din and clamour of hammers. The workmen, of course, are French—taken for the most part direct from the customary agricultural labour of the country, and educated by a number of English workmen whom the proprietor, Mr Scott of Greenock, sent over when first he formed these yards. Having ingrafted upon the natives the cunning of their trade, the English workmen returned home, leaving only Monsieur Robert and the general manager of the works as representatives of the northern race. Monsieur Robert affirms the French natives to be excellent workmen, assiduous, energetic, and careful, while their labour is to be had at a somewhat cheaper rate than that of their English brethren. They are paid by piece work, and herein consists the chief difficulty of the management; *for* the regulation of the scale of prices must be made after experiment, and the Breton populace, in not a few instances, resort to somewhat cunning methods of obtaining high pay. For instance, if a workman is given a large amount of work, the scale for which has not been previously fixed, he works laggardly for the first day or two; then shows that unless this labour is paid at such and such a rate he will inevitably starve, and having the rate so settled, suddenly 'puts on a spurt,' turns out a splendid quantity of material within the fortnight and demands payment for the same at the stipulated scale. A less urbane 'foreman' than Monsieur Robert might run risk of assassination among these swarthy and violent tempered Bretons; but they seem to like the Scotchman exceedingly, and do his bidding as obediently as children, while they reply to his questions partly by wild gesticulation of hands, head, and shoulders.

Thoroughly to conserve the British character of the establishment, the machines used in the various processes have been obtained almost wholly from Johnstone—a village in the neighbourhood of Glasgow—and have been brought hither and fitted up at great expense. Very ingenious most of them are, and, being of quite recent erection, possess the very latest improvements. In drawing comparisons between English and French shipbuilding—as is sure to be done when those steamers, now being built on the Clyde for the French Emperor, are finished—it would be well to consider how far such comparisons are of value when we remember that the most fundamental portions of the work are in both cases executed by English machines. By all means let the French workman have his due meed of praise for such expertness and proficiency as he may display in manual labour; but in working a machine the result does not gauge the capabilities of the workman, but of the machinist.

As before hinted, this miniature colony is exceedingly self reliant. Owing to the difficulty and expense of procuring from a distance the many articles required for a ship's outfit, they are manufactured, as far as is possible, on the premises, even to the brass hinges for cabin doors and skylight windows. There is one portion of the works set apart for the galvanising of iron; another for the manufacture of bolts, rivets, and screws; joiners' shop for the building of small boats, making of doors, and so forth; painters' shops for the beautifying of the same; while the small republic even boasts an apothecary's shop and a resident doctor. The climate of the place is clear and healthy, and the sick list never very large.

What, then, are we to say of a shipbuilding yard which has for its proprietor a Scotchman which brings its machines from Scotland, its coals from Wales, its wood from Vancouver's Island, its mahogany from Brazil (through Glasgow), its fir from Canada, and so forth? Very evidently it is not of French growth. But, meanwhile, the reputation which it yields the little village is causing St Nazaire to spring up like a mushroom. Already there are 15,000 inhabitants in the place, and lodging-house keepers are amassing small fortunes.

APPENDIX 4/7.

LETTER DRAFTED BY JOHN SCOTT UNDATED BUT PROBABLY WRITTEN IN 1864 TO M. GOYETCHE.

Letter received, statement appended perused and is a heavy blow, produces a paralysing effect on you sometimes.

When this contract was entered on I did not expect to have such great delay in preparations to commence the works nor difficulty in procuring the iron which (of a quality and sizes superior to any hitherto adopted) entailed delay in its receipt and heavy loss to the makers of it.

At the period of entering into the contract the shipbuilding trade was, and had been for some time been in a very depressed condition with no immediate prospects of its speedy recovery.

Early in 1862 however, a considerable number of orders were received by shipbuilders and from that time up to the present time very large orders have been received at continually enhanced prices, (with large premiums for early delivery in many instances) which are required for the increased prices of materials and labour. The number of yards has been increased and the quality of tonnage produced last year was the largest ever known on the Clyde, while this year it will again be considerably in excess of 1863. The consequence of this great increase in the quantity of work has been to force up the price of labour enormously and has placed my firm, in common with all other builders, in a position of great difficulty with our men, a position which you can hardly make adequate provision for, as you cannot realise the consequence of increase of wages which induce diminished production per man per day and prevent any such strict control being kept as in ordinary times, for if strict control is attempted the men immediately cease work and at once obtain employment elsewhere at the very next place they apply for work, In addition to this spirit of insubordination individually, we have the greatest possible trouble caused by the Unions which in times like these absolutely enable the men to dictate to the masters the terms of engagement of their men. In our own case recently in obtaining extra carpenters we were compelled (to avoid the active withdrawal of our men from the yard) to obtain permission in writing from the Union to increase the number of our carpenters by importation from England which was granted under certain very onerous conditions and the increased wages which we were obliged to pay these new carpenters to induce them to leave their homes have now been followed by a rise of all carpenters wages to the same terms. This step was taken from the most determined efforts on our part to fulfil our engagements with you, to hasten delivery of your boats, and has brought down on me the ill will of all the masters on the Clyde as they all have had to raise their carpenters wages, while naturally all the other trades have also demanded and received an advance and it also clearly proves what we had believed to be the case, that to whatever we raise the wages the other builders will raise theirs

They will not, cannot part with a man, therefore we cannot withdraw their men from them, while we cannot obtain from the Union permission to import a large number of men from elsewhere - if we attempt to do so without their consent all of the carpenters are bound to leave our works by Union rule.

Is this not a fearful position to be placed with at such a time with the most honourable and feverish desire to evince our good faith towards you?

In addition to the difficulties which on this question of wages have gone so heavily against us from the first and which up to the present moment have been continuously with me, the nature and quality of the work I confess deceived me much. Both hull and engines have taken very much more time and have required very much more expenditure on their production than I had expected.

The profit I had naturally looked forward to as the reward of so much labour and much anxiety has not only been swept entirely away but the result leaves me an actual loss.

At the full contract price, without any penalties being exacted, the C.G.T. will have the steamers at an actual less sum of money than it has taken me to produce them, irrespective of the considerable sum I had to expend both in the yard and engine works to enable me energetically to carry out these contracts. In addition to my loss I find my financial estimate of receipts completely drained from the much greater time that it has taken me to build the steamers from my increasing difficulties with my men than I had calculated on originally.

APPENDIX 4/8.

BLOCKADE RUNNERS

IN THE

AMERICAN CIVIL WAR.

Coverage of the early 1860's period in this work is dominated by the French mail steamer contract and the Holt long haul ocean steamers, 'Agamemnon', 'Ajax' and 'Achilles'.

However, in common with other Clyde shipbuilders, Scotts became involved at this time in the building of fast paddle steamers specially designed to run the blockade of the Confederacy ports of the southern U.S. states by the Yankees.

As always, Thomas S. Begbie was deeply involved. He built two blockade runners in 1863 with Barclay, Curle and named them after his two daughters, 'Emma' and 'Gertrude'. They were fitted with Greenock Foundry engines.

He scoffed at the idea of the 1858 Scott built paddle steamer Flora being used for blockade running. In a letter to John Scott on 21st February 1863 he remarked - "Flora with old boilers won't do for blockade work - won't stand screwing down (safety) valves or resin pitched into the furnaces." In fact, the 'Flora' had a very good record, having run the blockade ten times between Bermuda and Wilmington between August 1863 and January 1864 when she was lost sixty miles from Bermuda on her way to Halifax for repairs.

The Scotts principal contribution to the blockade running fleet consisted of six identical vessels, 'Ivanhoe', 'Redgauntlet', 'Elsie', 'Talisman', 'Marmion' and 'Kenilworth' and all with Greenock Foundry engines.

At the time of negotiating these contracts John Scott was concerned that the prospective owners might desert the contracts. He pointed out to T.S. Begbie that their representative, a Mr. Lamb, was a Southerner and not a British subject and recommended having a deposit of some kind.

Particulars of these and all other known Scott - built ships are given in Vol. 2.

They had mixed success, 'Ivanhoe' was wrecked and 'Redgauntlet' and 'Elsie' captured all as a result of enemy action. 'Talisman' was wrecked en route to being repaired, and 'Marmion' and 'Kenilworth' both survived the Civil War. They were employed in taking war supplies into the southern ports of the U.S.A. and bringing out cargoes of cotton, the sale of which provided funds for the prosecution of the war.

In the course of rescuing the John Scott - Thomas S. Begbie letters (1855 - 1866) prior to the demolition of the Cartsburn Shipyard in 1987, the following letter from Captain Russell of the 'Marmion' to Thomas S. Begbie dated 17th December 1864 was discovered.

It paints a very dramatic picture of 'Marmion's' attempt to break the blockade and get into Charleston in spite of the efforts of the enemy to prevent him and clearly illustrates the hazardous nature of blockade running.

P.S. 'Marmion',
Nassau,

T.S. Begbie Esq., 17th December, 1864.

Dear Sir,

I beg to forward a report of my first attempt to get into Charleston.

I left Nassau on Saturday, Nov. 26 and at 11.30 p.m. on the 28th made Charleston bar and had passed seven of the outside blockading fleet but as we proceeded further inshore the water became very luminous which was the cause of our being first seen by a small vessel lying close into the beach.

He immediately commenced firing rockets over us and making other signals to the fleet and in less than two minutes we were surrounded by their ships, the nearest one opened fire on us with their musketry, the others trying to drive us onshore or to cut us off from getting to sea again. Finding myself in this predicament I could not see the shadow of a chance to save my ship and fully expected to have been forced to beach her or to surrender but being determined not to do either till the last, I tried to set my ship's head but they cut me off in all directions.

I then stopped my engines and let them come towards me which they did and as soon as they were nearly up to me I went full speed astern and passed between four of their ships. They all fired upon me but I am happy to say that none of their shots struck our ship and before they could get their ships heads around I was a sufficient distance from the breakers to set on a head again. By this manoeuvre I am happy to say we got our ships head offshore and only one ship in chase of us. The others had, I presume, to look after their own safety.

This vessel kept us in sight till 4 o'clock the next morning. At this time I was able to alter my course and by daylight I had got a good offing from the land and no ship in sight. At noon I stood in again for the bar, engines working slow and at 8 p.m. I was again at the entrance to Charleston bar, but unfortunately for us the weather was quite calm and we ran into a dense fog and although we were in an excellent position for going in, my pilot refused to take charge of the ship on account of the weather. At this moment we were so close to a ship that we could hear them giving orders but could not see her.

Finding it was impossible to get the pilot to take charge of my ship I determined to make the best of my way back to Nassau as my coals would not hold out to risk another night in case I might get chased off again. I then stood out again to sea and on the morning of 1st December we sighted to all appearance a large sailing ship. I immediately altered my course and in an hour altered the bearings of the stranger four points. At this time the wind freshened and it was then that he showed his intentions by setting a cloud of canvas and pointing his ships head directly for us. I then saw we were in for a hard chase and as he had the advantage of a strong four wind to cut me off from getting round I determined to run for the nearest land and fortunately we did so as he continued to chase me up till 4.p.m. At that time I ran between the Whale Rocks and Guano Cay and he did not give up the chase till he saw that I had run clear of the rocks and was in safety. At this time he was not more than two miles from us. After we had *anchored I went on shore and watched him till he was out of sight and at dusk we came out again to sea and at daylight arrived safe at Nassau.*

I trust in our next attempt we shall be more fortunate and that my endeavours to get into Charleston and my proceedings to save my ship will meet with your approval and be satisfactory to the directors. I must now beg to state that my ship and engines are in first rate condition and that it was her superior speed that saved us from adding another one to the number of the Yankee prize list. I am now ready for sea and await further instructions from Mr. Atkinson to proceed.

You will observe that my provision bills are rather heavy owing to my lying in Falmouth so long it interfered with my sea stock and everything in this part is fearfully dear but I am in hopes in a short time to make the returns of the ship satisfactory to all concerned in the interest of the 'Marmion' Captain Raison of the 'Kenilworth' I am sorry to say met with no better luck than myself on his first trip with her.

The 'Beatrice' Capt. Randle was driven on shore the night previous to my trying to get in, his ship was destroyed, but he with a portion of his crew escaped in a boat. He returned here in the P.S. 'Wild Rover' and has now got command of her.

I remain, Dear Sir,
Yr Obedient Servant,

W. Russell.

APPENDIX 5/1.
CHINA NAVIGATION COMPANY.

TRADE ROUTES

The map included as Fig. 5/8 is intended to supplement the text covering the association of Scotts' of Greenock with the development of the China coastal trade by the China Navigation Co.

The great preponderance of the Scott-built fleet was engaged in the beancake trade run from Newchwang to Swatow and while this could be described as coastal traffic, the trip extended to one thousand three hundred miles, and in monsoon weather and wide variations in the climate encountered, severely tested the ships involved..

On the map the various sections of the Yangtse River are shown, as are some of the later routes developed.

The various ports opened to foreign trade as a result of the Treaties of Nanking and Tientsin are shown thus:-

Canton - The original five ports opened in 1842-1844.

Tientsin - Nine additional ports opened in the 1860's.

A more comprehensive set of maps showing all of the China Navigation Co., trade routes in the Far East is included in the Scott Archives, ref. GD319/26/1/4.

APPENDIX 5/2.

DESIGN REQUIREMENTS FOR SHIPPING ON THE CHINA COAST.

From their first involvement with John Swire in 1873 up to the beginning of the First World War, Scotts built the lion's share of the China Navigation Co., fleet, some seventy two ships in all, mostly for 'beancaker' and general trading duties, with a few ships for the Yangtse.

The design of these ships reflected the early accumulation of operating experience (particularly on the beancake run) and the remarkable variety of hazards (natural and otherwise) encountered in the dangerous waters of China's coasts and rivers. Locale also had considerable influence on design - a Lower Yangtse River ship was completely different from a 'beancaker'.

THE BEANCAKERS.

The beancakers travelled from Newchwang, the principal port of Manchuria in North China to Swatow in South China with cargoes of large cartwheels of compressed soya bean residue, 30 inches in diameter and 3 inches thick, formed after the oil had been extracted and used as fertiliser for the production of sugar. They also carried soya beans and bean oil.[64]

The service was extremely profitable partially because of the availability of return cargoes of sugar.

The beancakers were good sea boats, graceful and yacht like, c 1,000 tons gross initially but over the years they grew in size, the later ships being in excess of 2,000 tons gross.

The early ships performed the round trip of 2,600 miles in around 25 days, the actual time taken depending on the season.

Going north against the north east monsoon could take a day or more longer, whilst going south with the monsoon at their backs they could achieve the remarkable speed of twelve knots or more. Fig. 5/8 gives an indication of the conditions encountered. In addition to these heavy weather stresses both ship and crew were also subjected to large variations in temperature, leaving Swatow with the temperature in the seventies and arriving six days later at Newchwang with the temperature in the thirties.

In the early days great navigational skill was required on the coast through unlisted and unchartered inshore passages, taking short cuts not only for a quick passage but also to gain shelter during the gale force winds of the monsoon in winter and protection from passing typhoons.

In later years the revenues of the Imperial Maritime Customs were used to provide much needed light buoys and beacons along the coast and by the start of the First World War one thousand eight hundred and twenty two lights, forty four light vessels and one hundred and seventy one buoys had been installed, making possible much safer and quicker passages since ships were then able to enter and leave most of the coast ports without regard to the availability of daylight.[65]

A further hazard less easily coped with was encountered when threading through Chinese fishing fleets on passage.

The Chinese tried to close on an approaching steamer on a converging course in an attempt to force the steamer, when taking avoiding action, to pass closely astern of the junk.

They believed that all of the bad 'joss' pursuing the junk would be cut off by the steamer's stem and pass into her!

This manoeuvre often resulted in the junk master swimming around minus junk as well as 'joss'![66]

Yet another hazard was the risk of being boarded by pirates, a regular occurrence on the Chinese coast which persisted into the 20s and 30s.

Scotts' had to provide all new China Navigation Co., ships with anti piracy protection. The ships officers were armed and Sikh guards were carried. The main protection however was to divide the deck structure with steel grilles so that the bridge and centre castle were separated from the fore and after decks usually crowded with Chinese deck passengers (including pirates in disguise!).
(See Fig. 5/9)

Steam lances were also provided to assist in repelling boarders. (All of these provisions were still being specified during the writer's involvement in providing China Navigation Co., with new tonnage after the Second World War).

They were simple ships, the beancakers, the only China Navigation Co., group of ships to retain affection. It is hard to imagine why this should be - perhaps it was a sort of bitter-sweet nostalgia. Beancakers figured prominently in first promotions and also as punishment ships.

As a punishment for drink, a popular and the only crime in those days, it was more a slippery slope to resignation than a cure. The life was indeed a lonely one.[67]

YANGTSE RIVER STEAMERS.

The Yangtse river covered a distance of 1,500 miles from the sea to Sui Fu, regarded as the limit of navigation.

It was conveniently divided into four areas: the Lower, Middle, Upper, and Top, each distinctly different in character.

Initially, only the prosperous Lower section was open to foreign trade but in 1885 the Middle river was opened, followed in time by regular sailings through the spectacular gorges to Chungking on the Upper river which was kept closed until it was proved that steamers could ascend the river so far.

The lengths of the various sections were Lower-600 miles, Middle 350 miles, Upper 380 miles and the Top 130 miles. (See Appendix 5/I and Fig. 5/8)

It is now generally recognised that the purchase in 1873 by John Swire of the Union Steam Navigation Co., at that time plying on the Lower River, marked the establishment of what became the Swire empire. Their early steamers provided a daily (except Sunday) service from Shanghai to Hankow calling at the treaty ports, Chinkiang, Nanking, Wuhu and Kiukiang.

In summer, ocean going ships of 28/30 feet draught could penetrate into the heart of China, but in winter only ships of 2,000 tons could proceed that far, there being a draught restriction of the order of 10 feet.

The earlier Lower River boats were paddle steamers based on those operating on North American inland waterways.

Scotts built four stately looking river steamers for service on the Yangtse. For the Lower River they built 'Ngan Kin' (1883-1933), 'Poyang', (1891-1934) and 'Tatung', (1891-1935), and for the Upper River they built 'Shasi', (1891-1931).

Fig. 5/10 which shows 'Ngan Kin' fitting out in the Victoria Harbour at Greenock, has just a hint of the Mississippi! The photograph is interesting in that it shows the large cargo port doors on the ships side which were a feature of all China Navigation Co., ships on the China Coast.

The cargo was loaded manually without the benefit of derricks or winches, a system known as walking the cargo into the ship or ashore, directly to or from the godowns (warehouses).

In the opinion of one old China Coaster, containerisation is only now matching the speed of loading cargo achieved regularly by this method on the China Coast all those years ago.[68]

The Middle River in comparison with the Lower River had comparatively little trade and was always a lonely stretch of river. For most of its length it meandered between steep banks of alluvial soil which were constantly eroding away and slowly changing the course of the river.

Navigation on the Middle River consisted mainly of following the steep eroding banks, crossing from side to side to reach them. Latterly ships marked out their own channel with bamboo poles which they retrieved after crossing over because the channel could shift again before the next ship arrived.[69]

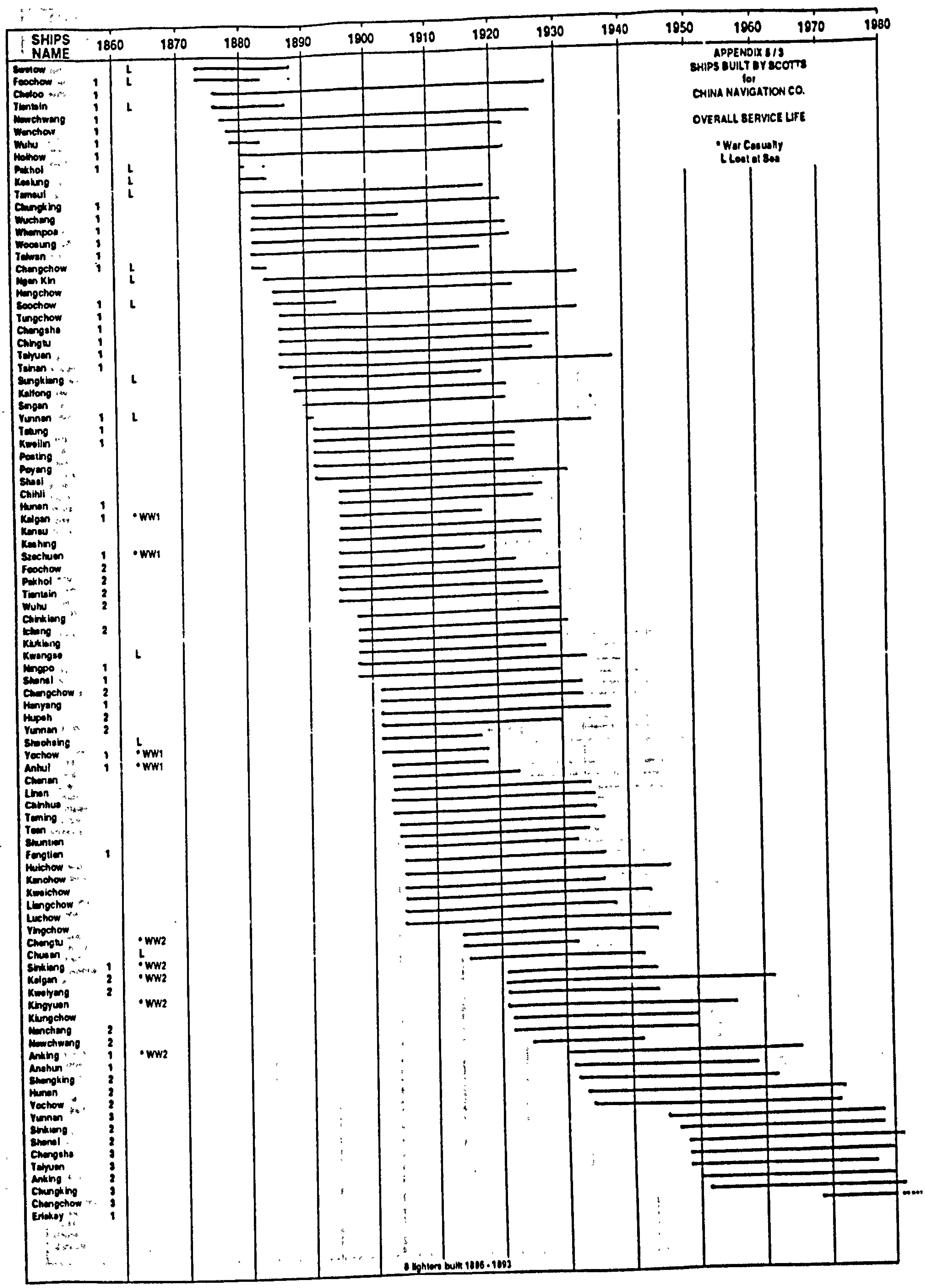
Groundings were rare on the Lower River but fairly frequent on the Middle River which presented Scotts with design problems in reconciling strength of structure with the necessary shallow draught.

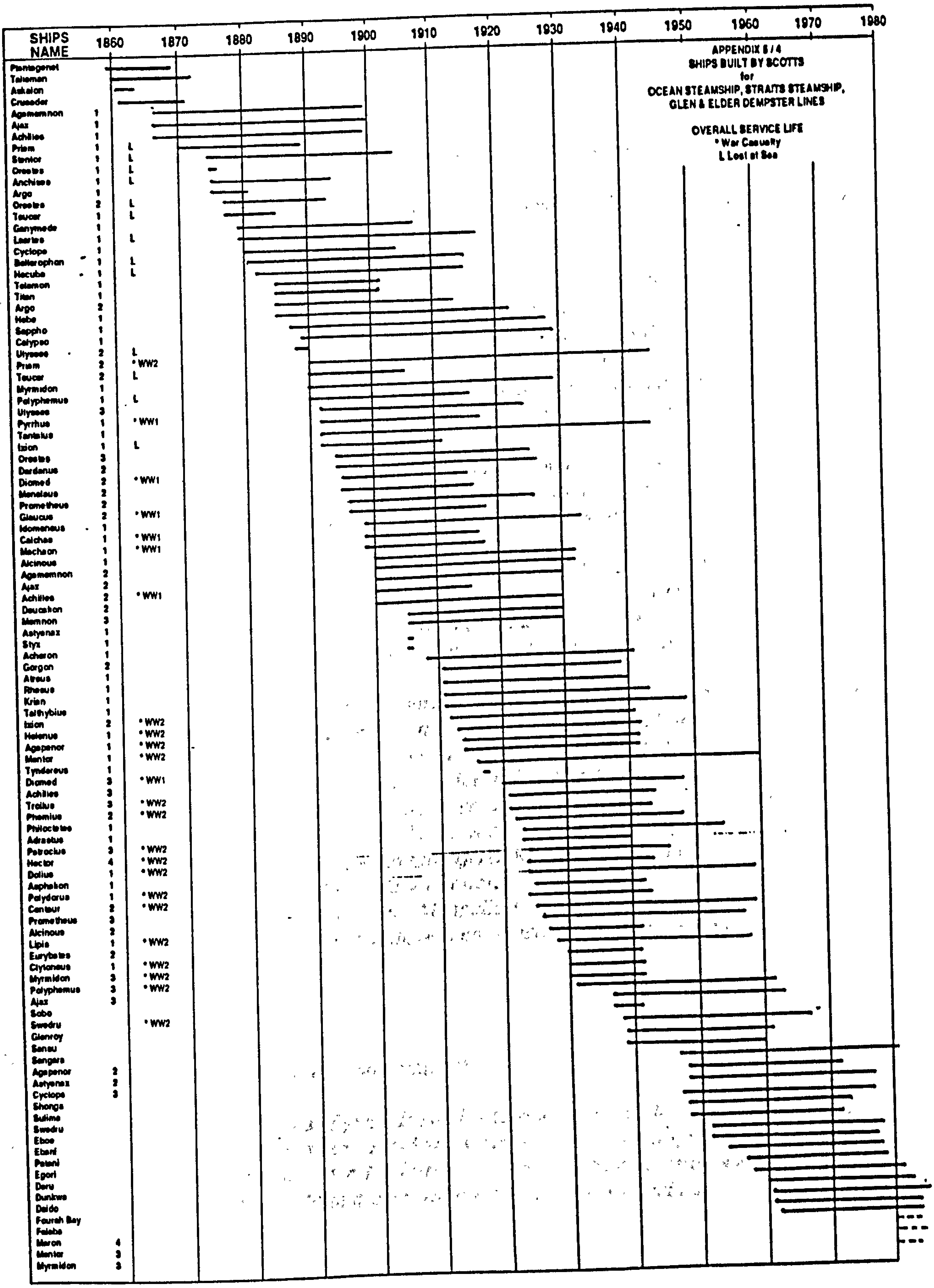
(Continuing Appendix 5/2)

All four of the Yangtse River ships built by Scotts were equipped with twin screws which greatly eased the navigational problems described above.

All Scott built ships for China Navigation Co., were designed for specific services, be it the beancake trade, the Lower, Middle or Upper Yangtse, the Tientsin express service, Australian passenger/cargo service or general coasting, in respect of tonnage, dimensions, accommodation, cargo handling arrangements, and type and power of machinery.

For all China Navigation Co., and Ocean Steamship Co., new construction contracts Scotts' applied enhanced scantlings and standards in excess of those laid down by the Classification Societies.


SHIPS NAME
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
APPENDIX 5/3
SHIPS BUILT BY SCOTTS
for
CHINA NAVIGATION CO.
OVERALL SERVICE LIFE
* War Casualty
L Lost at Sea
Swatow L
Foochow 1 L
Chefoo 1
Tientsin 1 L
Newchwang 1
Wenchow 1
Wuhu 1
Hoihow 1
Pakhoi 1 L
Kelung L
Tamsui L
Chungking 1
Wuchang 1
Whampoa 1
Woosung 1
Taiwan 1
Changchow 1 L
Ngan Kin L
Nangchow
Soochow 1 L
Tungchow 1
Changsha 1
Chingtu 1
Taiyuan 1
Tsinan 1
Sungkiang L
Kaifong
Singan
Yunnan 1 L
Tatung 1
Kweilin 1
Posting
Poyang
Shasi
Chihli
Hunan 1
Kalgan 1 * WW1
Kansu
Kashing
Szechuen 1 * WW1
Foochow 2
Pakhoi 2
Tientsin 2
Wuhu 2
Chinkiang
Ichang 2
Kiukiang
Kwangse L
Ningpo 1
Shensi 1
Changchow 2
Hanyang 1
Hupeh 2
Yunnan 2
Shaohsing L
Yochow 1 * WW1
Anhui 1 * WW1
Chenan
Linan
Chinhua
Taming
Tean
Shuntien
Fengtien 1
Huichow
Kanchow
Kweichow
Liangchow
Luchow
Yingchow
Chengtu * WW2
Chusan L
Sinkiang 1 * WW2
Kalgan 2 * WW2
Kweiyang 2
Kingyuen * WW2
Kiungchow
Nanchang 2
Newchwang 2
Anking 1 * WW2
Anshun 1
Shengking 2
Hunan 2
Yochow 2
Yunnan 3
Sinkiang 2
Shensi 2
Changsha 3
Taiyuan 3
Anking 2
Chungking 3
Changchow 3
Eriskay 1
8 lighters built 1886 - 1893


SHIPS NAME
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
APPENDIX 5 / 4
SHIPS BUILT BY SCOTTS
for
OCEAN STEAMSHIP, STRAITS STEAMSHIP,
GLEN & ELDER DEMPSTER LINES
OVERALL SERVICE LIFE
* War Casualty
L Lost at Sea
Plantagenet
Talisman
Askalon
Crusader
Agamemnon 1
Ajax 1
Achilles 1
Priam 1 L
Stentor 1 L
Orestes 1 L
Anchises 1 L
Argo 1
Orestes 2 L
Teucer 1 L
Ganymede 1
Laertes 1 L
Cyclops 1
Bellerophon 1 L
Hecuba 1 L
Telamon 1
Titan 1
Argo 2
Hebe 1
Sappho 1
Calypso 1
Ulysses 2 L
Priam 2 * WW2
Teucer 2 L
Myrmidon 1
Polyphemus 1 L
Ulysses 3
Pyrrhus 1 * WW1
Tantalus 1
Ixion 1 L
Orestes 3
Dardanus 2
Diomed 2 * WW1
Menelaus 2
Prometheus 2
Glaucus 2 * WW1
Idomeneus 1
Calchas 1 * WW1
Machaon 1 * WW1
Alcinous 1
Agamemnon 2
Ajax 2
Achilles 2 * WW1
Deucalion 2
Memnon 3
Astyanax 1
Styx 1
Acheron 1
Gorgon 2
Atreus 1
Rhesus 1
Krian 1
Talthybius 1
Ixion 2 * WW2
Helenus 1 * WW2
Agapenor 1 * WW2
Mentor 1 * WW2
Tyndareus 1
Diomed 3 * WW1
Achilles 3
Troilus 3 * WW2
Phemius 2 * WW2
Philoctetes 1
Adrastus 1
Patroclus 3 * WW2
Hector 4 * WW2
Dolius 1 * WW2
Asphalion 1
Polydorus 1 * WW2
Centaur 2 * WW2
Prometheus 3
Alcinous 2
Lipis 1 * WW2
Eurybates 2
Clytoneus 1 * WW2
Myrmidon 3 * WW2
Polyphemus 3 * WW2
Ajax 3
Sobo
Swedru * WW2
Glenroy
Sansu
Sangara
Agapenor 2
Astyanax 2
Cyclops 3
Shonga
Sulima
Swedru
Eboe
Ebani
Pateni
Egori
Dara
Dunkwa
Daido
Fourah Bay
Falaba
Maron 4
Mentor 3
Myrmidon 3

APPENDIX 6/1.

GD 319/11/1/14.

1868 Jan 9.

Letter from John Scott yst to T.S. Begbie (Scotts London Agent):

I have yours of yesterday handing me report of the Superintending Engineer at Bombay on the state of S.S. 'Columbian' (P. & O steamer re-engined and re-boilered by Scotts) on arrival at that port.

This document is equivalent to a report of the greatest carelessness on the part of the Chief Engineer in charge of that vessel as it means nothing more nor less than that the boilers have been allowed to become salted up or partially so. This conduct would have been atrocious on the part of the engineer had the vessel been fitted with common jet condensers but that it should have occurred with surface condensers is beyond all belief to us, and is as far as I know, an unheard of piece of negligence.

These boilers have more clear space round the tubes, between the tubes, over the furnaces and at the back of the firebox than any boilers in P. & O's service (at least that I am acquainted with) and the occurrence cannot be attributed in the remotest degree to their construction.

It appears to me that the Chief Engineer, relying on his surface condensers has not attended properly to surface blow off of the boilers, as before such a deposit as that described by Mr. Ritchie could have formed, the boilers must have been worked with water of more than the common density during a great part of the voyage.

It appears further that none of the boilers has been opened from the time of departure from Southampton till arrival at Bombay and that the Engineer has not availed himself of the means at his command of successively examining his boilers during the passage. It is evident that had this been done the threatened accumulation of salt would have been discovered and its action prevented, ere damage had been done to the plates. A single day, at intervals, in rotation would have sufficed and could not have interfered with the vessel's passage as the engines were no doubt worked at reduced power.

The carelessness in the 'Mongolia's' case (another P. & O ship-built by Scotts in 1865) was great but there is no comparison between it and that manifested in 'Columbian'.

1868 Jan 9

Letter to Begbie from John Scott, yst.

"I have yours of yesterday and send you a separate letter about 'Columbian' which is most disgusting. I told you yesterday that I had a good report of her and I now enclose the letter I referred to, which is from Cairns one of her junior engineers who left from our drawing office to join 'Columbian'.

(Continuing Appendix 6/1).

I send this letter to you confidentially because if the Chief Supt. Engineer suspects any of his engineers writing to anyone about ship or machinery performance he is down upon them and consequently, I should not wish to have his name used. This letter is dated the day before Mr. Ritchie's report and apparently on the morning before the boilers had been opened.

From his letter you will see that the Chief Engineer, instead of working three boilers at a time, and having the fourth boiler open for its examination, periodically worked three furnaces of all boilers during the whole passage and apparently never opened any of them. You will observe in the Bombay report that one furnace in each boiler is undamaged, as of course, it would be, as it had no fire.

You say that the Chief Superintendent attributes the accident to the dry bottoms. If this is the cause, then God help Inman Line, Bremen, Hamburg and Cunard lines because they have now nothing else!! As I have already said these boilers have more room about them than any boat in the P. & O. fleet and there never was a finer set of boilers made. Mr. Ritchie himself saw them in our shops and admired their proportions.

The fact is, the Chief Engineers in the P. & O. service have become too fine gentlemen and have to put in an appearance too often in the Saloon with clean washed hands and dandy uniform. They require considerable wakening up. Were the boilers clean when they left Southampton? How is it that Holt's steamers manage to steam for nearly 80 days on end with boilers having one half the water spaces and circulating room of Columbian's and arrive after two such runs done in six months with hardly a pound of scale inside!

Two of them are in charge of men who are not mechanics but locomotive drivers and who keep their places in the engine room and attend to their work."

APPENDIX 6/2.

For over forty years John Scott IV and Robert Sinclair Scott together managed the affairs of the family shipbuilding and engineering business.

John Scott IV, in his day regarded generally as the doyen of Clyde shipbuilders, was senior partner of Scott and Co. wherein he concerned himself mainly with the technical aspects of the business. He was a founder member of the Institution of Naval Architects in 1860, becoming a member of Council in 1886 and was elected a Vice-President in 1903. He was a frequent contributor to discussions on papers related to marine engineering. His brother Robert, his junior by thirteen years had the responsibility of ensuring that their ships were built to the requisite standards of quality, on time and within estimated cost. He was much involved in the formation of employers organisations during the 1890s including the Association of Engineering Employers and the Engineering Employers Federation. As Vice President of the latter body he played a significant role during the national engineering dispute of 1897-8. He was the first president of the Clyde Shipbuilders Association in 1896-7.

Their photographs included here see (Fig. 6/44-5) tend to confirm their suitability for their respective roles. John Scott has a scholarly look reflecting his life long pursuit of improvements in all aspects of the steam power plant and the propulsive efficiency of his ships, whilst Robert Sinclair Scott comes across as a powerful man of action.

They were indeed very different personalities but in their family life and in their recreation they shared common interests. Firstly, the brothers married sisters, Anne and Frances Jane Spalding, daughters of Robert Spalding of Kingston, Jamaica.

John Scott's family consisted of four sons (two of whom died in their teens) and one daughter whilst Robert Sinclair Scott had two sons.

Both brothers shared an interest in the volunteer movement and in 1859 John raised two battalions of artillery volunteers. From 1862 to 1894 he was a lieutenant colonel in the Renfrewshire and Dunbarton artillery brigades.

He retired in 1894 from the movement and was made honorary colonel. He had been made C.B. in 1887 for his services to the volunteer movement. His brother Robert also served in the movement attaining the rank of major.

Together with their younger brother, Colin William Scott, a Glasgow shipbroker, they were keen yachtsmen, a tradition which began with their grandfather John Scott II in 1803, when he built the first notable Clyde racing yacht of which there is any record, for Colonel Campbell, an Argyllshire soldier. Thereafter he took up the sport and built a number of sailing yachts for private individuals and in 1833 he steered his yacht Hawk to victory at Dublin in a race for the Anglesey Cup at the age of 80!

The Scotts in the years that followed were prominent members of the Royal Northern and Royal Clyde Yacht Clubs and capitalising on their hobby they built a long series of luxurious steam yachts for distinguished British, American and other foreign owners. In all between 1876 and 1908 they built twenty four steam yachts including seven of progressively increasing size for themselves, all but one being named Greta after a stream which ran through the family estate, Hawkhill in Largs, Ayrshire. They became world famous for the quality of the workmanship displayed in the palatial public rooms and accommodation of their yachts. Typical owners included Count Florio, a Sicilian nobleman whose yacht 'Aegusa' built in 1896 was purchased by Sir Thomas Lipton and renamed 'Erin'. She was an excellent sea boat and Sir Thomas used her as tender for all the races in which his various challengers for the America's Cup, all named 'Shamrock', took part. (See Fig. 6/46 which shows 'Erin' together with the 'Tuscarora' built in 1897 for the Clarks of Paisley).

Earlier in 1891 Scotts built the 'Foros' for a Russian millionaire, M. Kousenzoff of Moscow and she later became 'Zarnitza' owned by the Russian Royal Family. 'Zarnitza' with H.R.H. Grand Duke Michael Alexandrovitch on board called at Greenock in 1902. The yacht was extensively refitted in 1906 by the Scotts' at Greenock. Two yachts built in 1900 and 1908 for American millionaires, the 'Margarita' and the 'Cassandra' owned by A.J. Drexel of Philadelphia and Roy A. Rainey of New York are shown in Fig. 6/47.

One final area in which John Scott and Robert Sinclair Scott shared a common interest was public affairs. Both brothers served on the Greenock Harbour Trust and John was chairman of the local marine board for twenty five years. He also stood unsuccessfully for Parliament as Conservative candidate on three occasions - in 1880, 1884 and 1885.

However, outside of shipbuilding and yachting their personal interests could not have been more different.

Robert Sinclair Scott was an enthusiastic agriculturist, a prominent stock raiser, a frequent exhibitor and prize winner at leading shows. He was also a successful horsebreeder.

Robert Sinclair Scott's role in the firm brought him into daily contact with the workforce all of whom held him in great esteem. There were some seven hundred mourners at his funeral including three hundred company employees who were conveyed to Largs from Greenock in the steamer Viceroy specially chartered for the purpose.

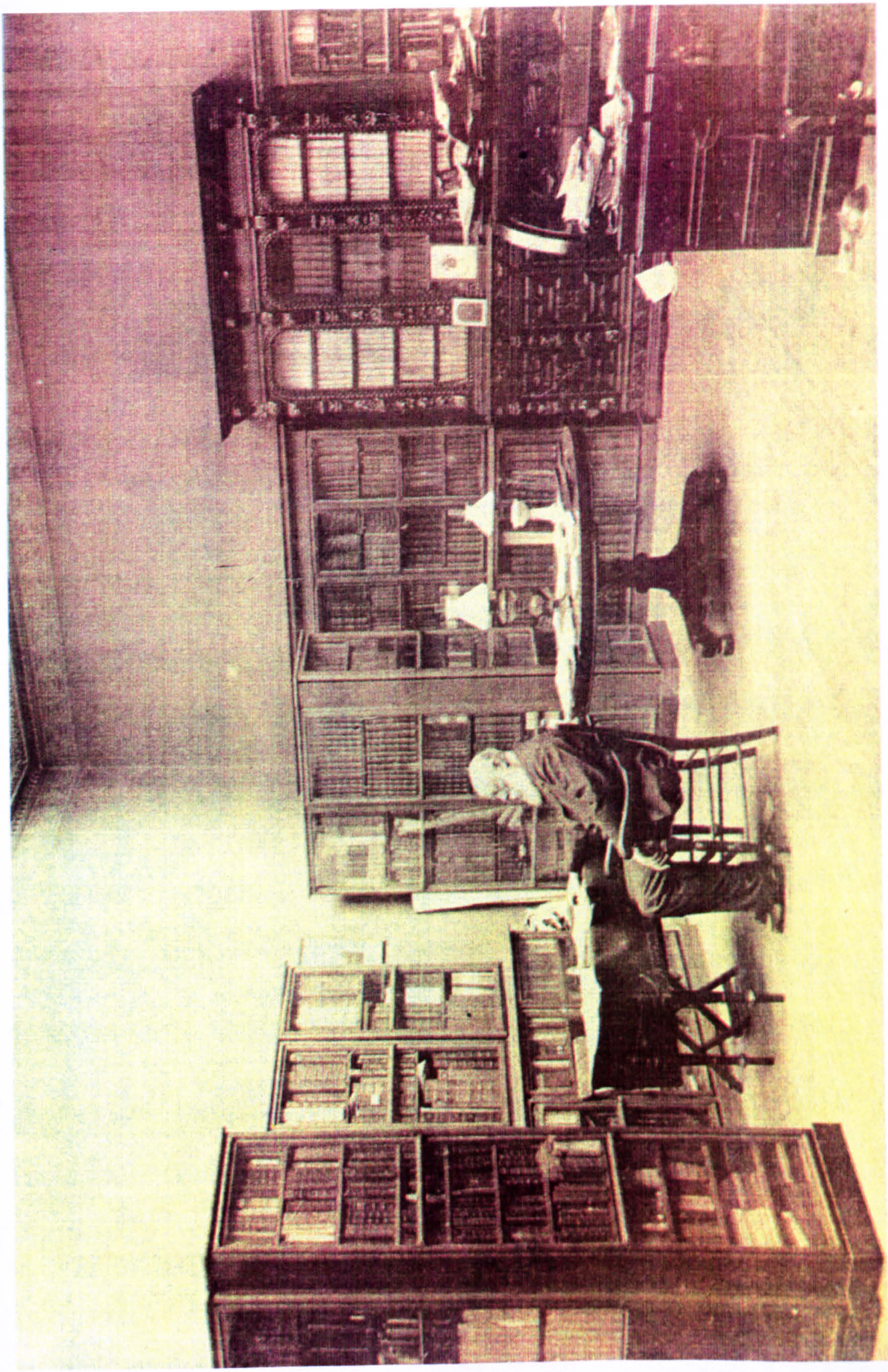
John Scott during the course of his active life collected an outstanding library of some 12,000 volumes which became famous as one of the finest private collections in Scotland. It had a wide scope and covered many different aspects, including a thorough representation of Scottish history down to 1745, with special emphasis on the Darien Scheme, the Union, and the Jacobite risings of 1715 and 1745. It included some 300 items on Mary, Queen of Scots and in 1896 John Scott compiled his 'Bibliography of Mary, Queen of Scots, 1544-1700' for the Edinburgh Bibliography Society. This was followed in 1890 by a 'Bibliography of Printed Documents and Books Relating to the Darien Company'. The collection contained many rare volumes including works by St. Augustine, the Venerable Bede and St. Thomas Aquinas (on vellum). It also contained several fine early manuscripts and many rare items on cartography and geography.

(Continuing Appendix 6/2).

Following John Scott's death in 1903 the collection was put up at auction by Sotheby's (27th March - 3rd April 1903). However, the sections of the collection specialising in shipbuilding and shipping were kept by the Scott family and after a period of some years during which the volumes were on loan to the Institution of Naval Architects they were formally presented to the Institution in 1930 by the then company chairman, the late R.L. Scott, and were placed in a separate room known as the Scott Library.

Mr. Scott was a Fellow of the Royal Society of Edinburgh and a Fellow of the Society of Antiquaries, Scotland.

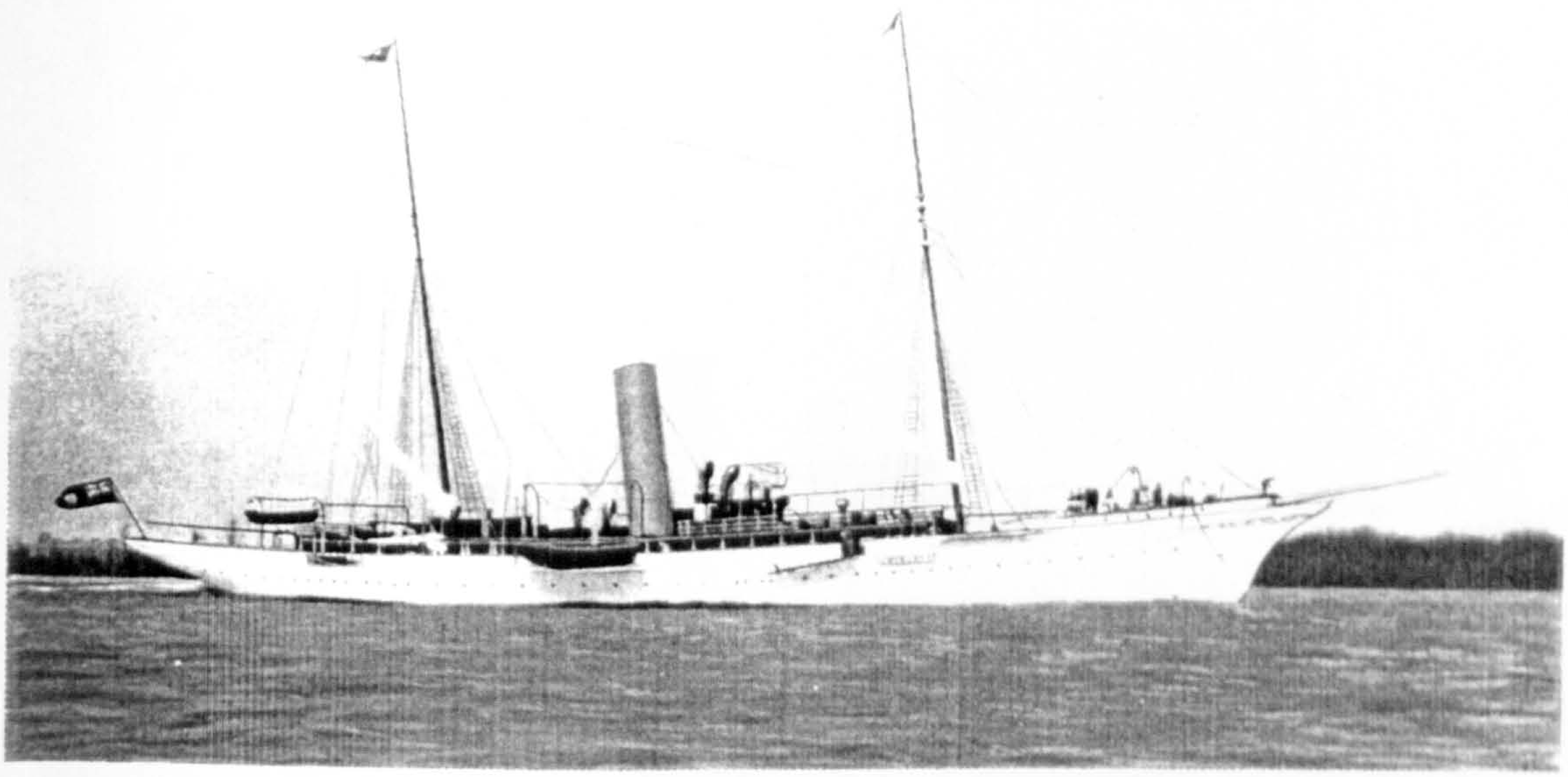
Fig 6/44



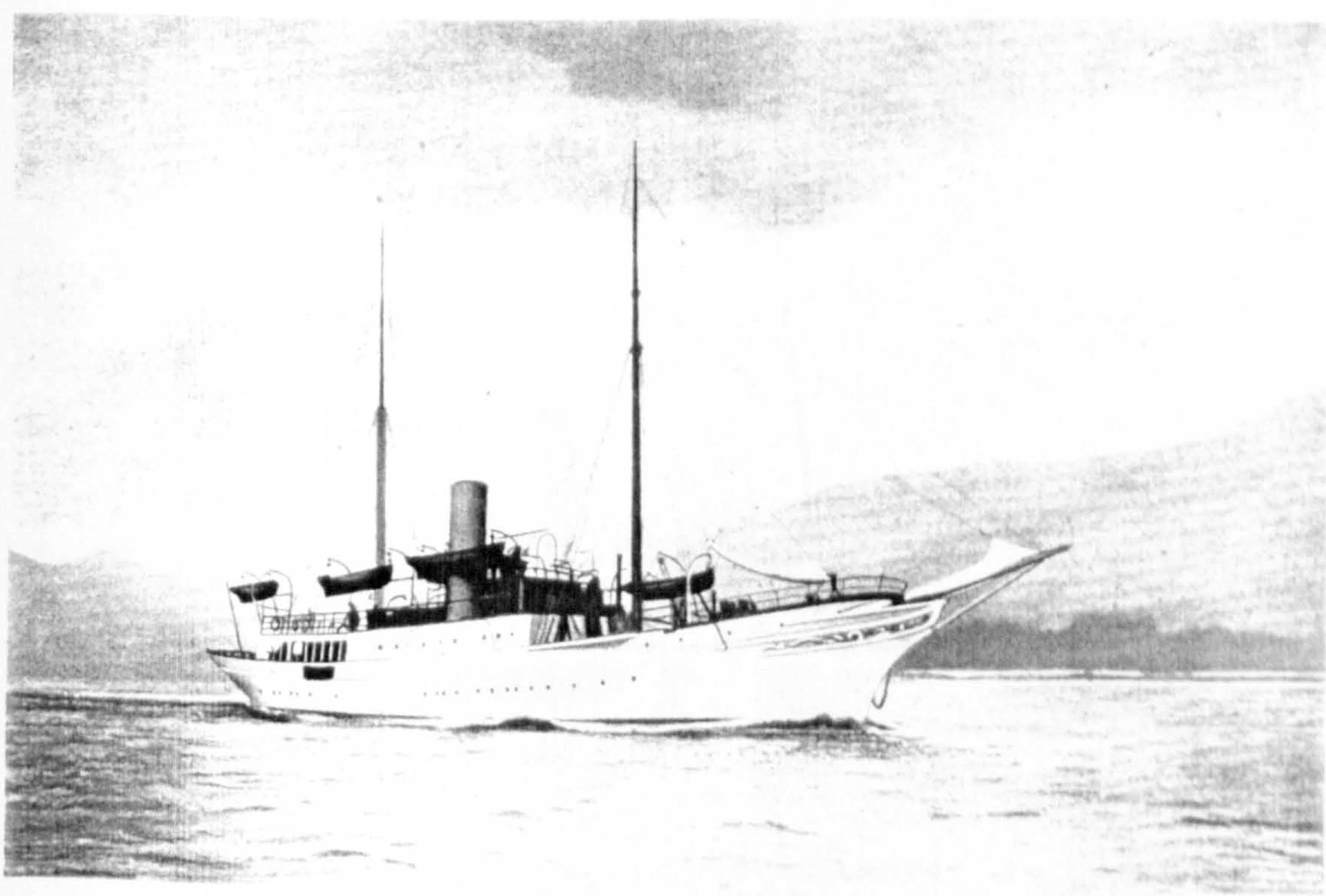
John Scott W.C.B
c. 1880.

Robert Sinclair Scott
c. 1895

Fig 6/46



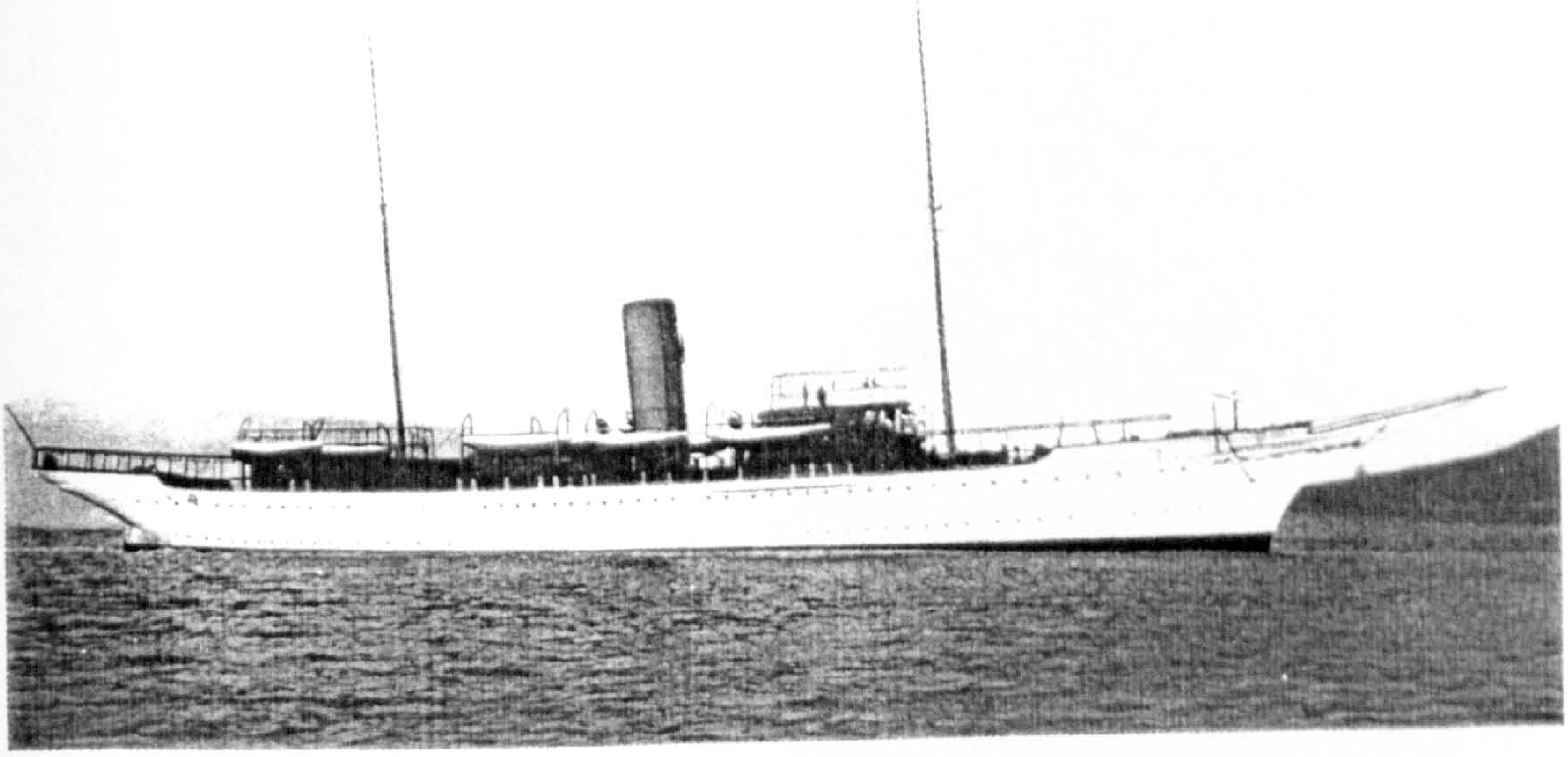
THE "ERIN" OWNED BY SIR THOMAS LIPTON, BART.—1896



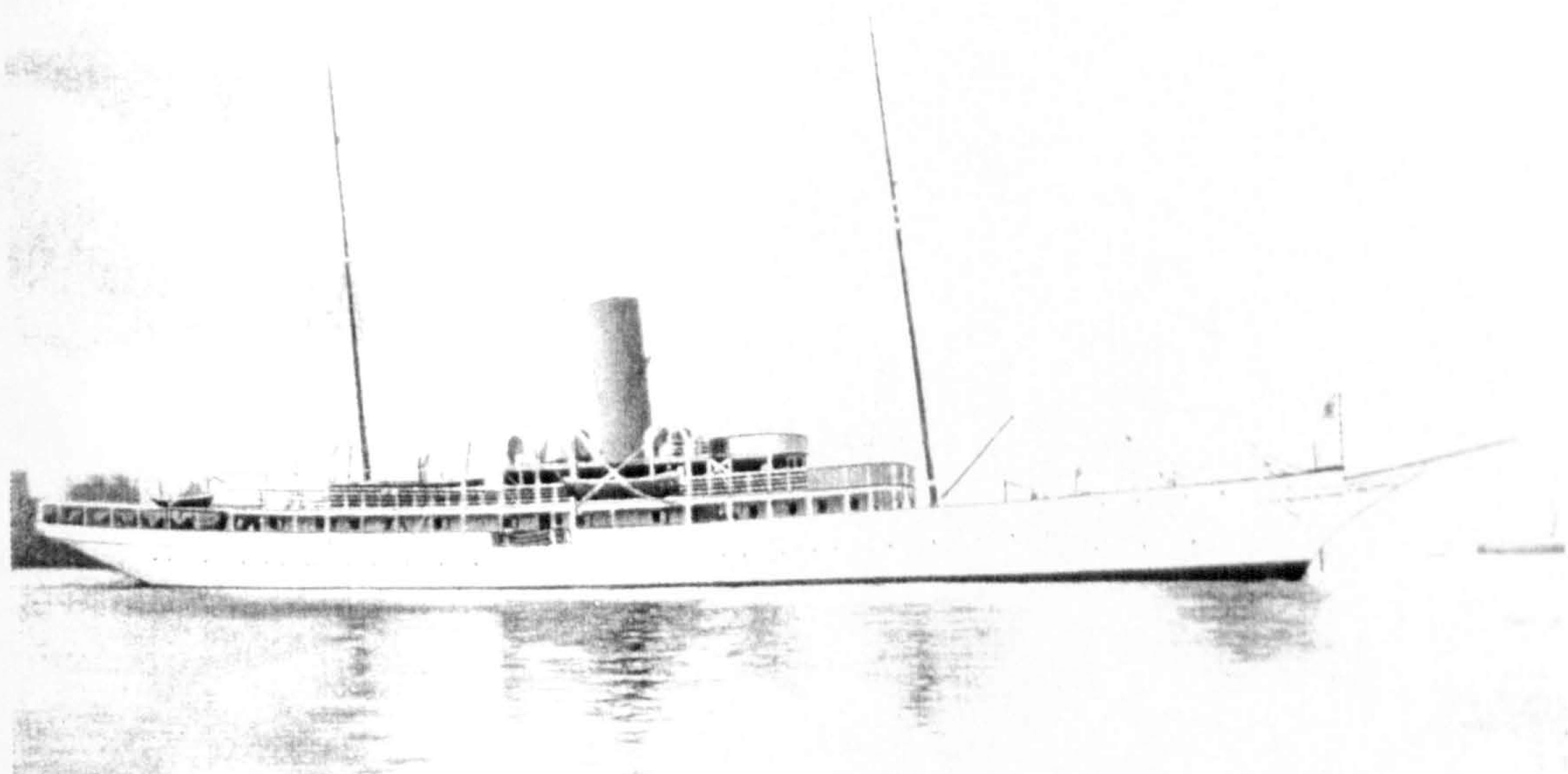
THE "TUSCARORA"—1897

From : Two Hundred & Fifty Years in Shipbuilding - 1961

Fig. 6/47



–THE STEAM YACHT "MARGARITA" 17·1 KNOTS—1900



–THE TWIN-SCREW YACHT "CASSANDRA" 15·6 KNOTS—1908

From: Scotts · Two Hundred and Fifty Years of Shipbuilding · 1961

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GD 319/1/1/3	-	1936-1947 Meetings.
GD 319/1/1/4	-	1947-1957 Meetings.
GD 319/1/1/5	-	1957-1976 Meetings.
GD 319/1/1/6	-	1966-1973 - Correspondence on Meetings.

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GD 319/13a/1	-	This volume includes steamers built 1852-1878
	-	and all sailing ships built 1853-1905.
GD 319/13a/2	-	Ships built - 1879-1892
GD 319/13a/3	-	Ships built - 1892-1929
GD 319/13a/4	-	Ships built - 1929-1988

Technical Particulars.

GD 319/26/2/20 - Ships built 1868-1908.

Technical Information concerning ships built by Scotts prior to 1852 included in the List was collected from a variety of sources, principally from Custom House records at Greenock, Glasgow, Leith, Aberdeen, Liverpool, Newcastle upon Tyne, Whitehaven and the Public Record Office, Kew.

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