

The Twentieth Century

Prophecy has its allurements even in the domain of applied mechanics; and having reviewed progress during the past two centuries in naval architecture, as embodied in sailing ships, merchant steamers, warships, and yachts, there is a temptation to speculate on the prospects of the future. The possibilities of the steam turbine, for manufacturing which the Scotts are laying down a special plant; the potentialities of the producer-gas engine as applied to the propulsion of ships; and even the solution of the problems which stand in the way of the application of the universally-desired oil turbine, are all topics which would prove interesting, even although no conclusion could be arrived at. It is enough, however, to say here, that each is having careful consideration by the firm.

The historian is not, however, concerned with the future, and the only justification for the title given above is the intention here to briefly review the state of marine construction, as represented at the beginning of this new century by typical vessels built or being built by the Scotts. It is difficult, where so many ships of distinctive design and equipment have been constructed, to select a few representative types. Amongst the countries which have had new ships in recent years are France, Russia, Italy, Denmark, Holland, Portugal, Greece, India, the Straits Settlements, China, Australia, New Zealand, Brazil and other South American Republics, and the United States of America. This list of foreign clientele, however, is being diminished, owing to the influence of subsidies paid by foreign Governments to ship owners or shipbuilders.

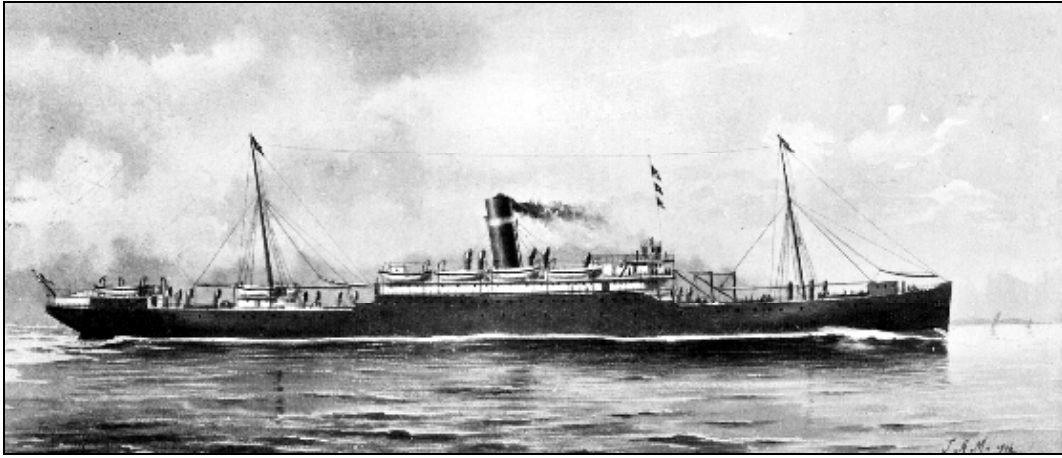
Taking account only of large vessels built during the past fifty years, there are one hundred and five of Scotts' steamers now trading in China seas, twenty-six in the Indian Ocean, ten on the North Atlantic, nine in the South African seas, thirty in South American waters, eighteen in the Colonial service, and ninety-seven on the European coast; while in home waters there are many more.

One of the gratifying features in connection with the commercial relationship of the Scotts, too, is the continuance of confidence over a long period of years of several of our large steamship companies. This is, perhaps, the best indication of the satisfactory character of the work done. The Holt Line have had built for them within forty years, by the Scotts, forty-eight vessels of 148,353 tons. The China Navigation Company has had a greater number of ships, namely, sixty-four, but as the size is smaller the total tonnage is less, namely, 115,600 tons. An important Continental firm has had twenty-one vessels; while for a Portuguese Company five large vessels were built, and for the French Trans-Atlantic Company eleven fast liners. Other cases might be mentioned, but these suffice.

As regards fast, steamers the recent warships built and described in a previous chapter may be accepted as typical in so far as the problems of marine engineering are concerned. In each of these cases the design of the machinery has been prepared by the firm, and the difficulties were more complicated than in the case of merchant work. Moreover, it must be remembered, that the maritime predominance of Britain is due as much to that enormous fleet of moderate-speed intermediate and cargo ships, which maintain exceptionally long voyages with regularity and economy, as to the fast ships engaged on comparatively short routes. Of the nine thousand odd British ships included in Lloyds' Register, less than 2j per cent, have a speed of over 16 knots: a fact which in itself proves that economy, rather than speed, is the primary consideration.

From Lloyds' Register we classify, according to speed, the numbers of British and Foreign, and of Oversea and Channel, Steamers, of over 16 knots.

Speed.	British.	Foreign.	Oversea.	Channel.
Over 20 knots	42	26	17	51
19 to 20 knots	23	11	7	27
18 to 19 knots	38	14	15	37
17 to 18 knots	53	49	67	35
16 to 17 knots	70	56	77	49
	226	156	183	199



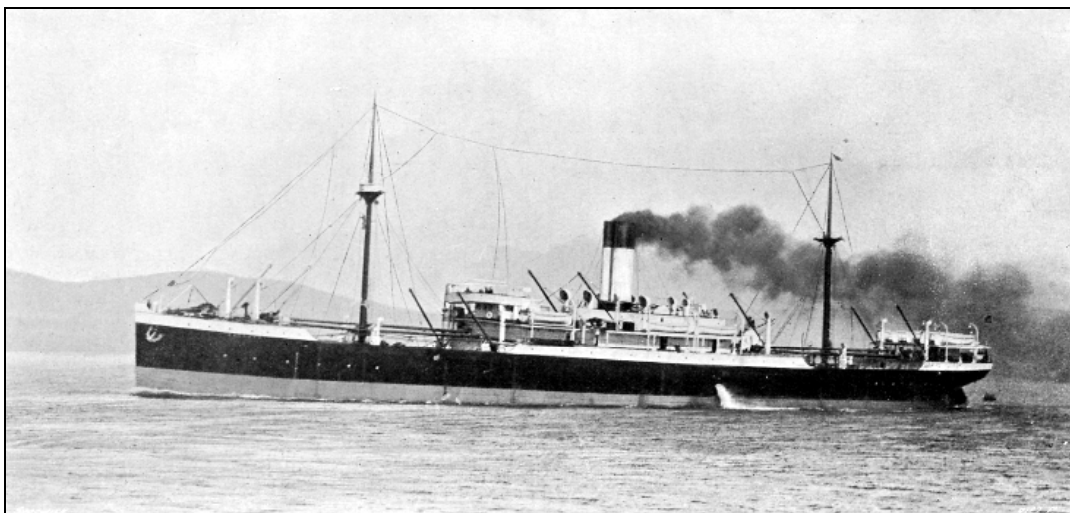
The Donaldson Liner CASSANDRA

The new Donaldson liner, now being constructed by the firm, may be accepted as representative of one of the most useful types of steamer in the British fleet. An illustration of this vessel is given above. While primarily intended for the Atlantic passenger trade, she is of such moderate dimensions as to suit almost any service, having a length of 455 ft. between perpendiculars, a breadth of 53 ft., and a depth, moulded, of 32 ft.; the draught will not be more than 26 ft. with a displacement of 13,500 tons. While designed to carry 8000 tons of deadweight cargo in the four holds, the vessel has accommodation for a large number of passengers, who are afforded more room than on the larger and faster liners, with the same luxury and comfort. This latter fact accounts in large measure for the growing preference of a great proportion of the travelling public for the intermediate ship.

The machinery has been designed with the view of attaining the highest economy. For driving the twin screws there are two separate three - cylinder triple - expansion engines, which are to indicate together 5500 horse-power when running at the moderate piston speed of 680 ft. per minute. The cylinders are respectively 26 in., 42 in., and 70 in. in diameter, the stroke being 48 in. There is a very complete installation of auxiliary machinery. In all, there are fifty-seven steam cylinders in the ship, each having its special function.

Steam for all of these is supplied at a pressure of 180 lb. per square inch, by two double-ended boilers 20 ft. long, and two single-ended boilers 11 ft. 6 in. long, the diameter in all cases being 15 ft. 9 in. The total heating surface is about 15,000 square feet, and the grate area 435 square feet. In the design and construction of the engines and boilers every consideration has been given to strength in order to ensure reliability.

In dealing with the development of the steamship we had occasion to refer to the Holt liners, which inaugurated the first regular steamship service to the Far East, via the Cape of Good Hope. That was in 1865, and since then a long series of most successful steamships has been constructed by the Scotts for the China trade of the Ocean Steamship Company. As representative of the modern ship for this service we take four vessels just completed, three of them taking the names of the pioneer ships of the line—the Achilles, Agamemnon, and Ajax, while the fourth is named Deucalion; one of these is illustrated below.



The Holt Liner ACHILLES of 1900

Throughout the forty years that have elapsed since the first vessels were built, each successive steamer of the forty-eight built by the Scotts has marked an increase in size, and an improvement in economy. In the former respect the advance is not perhaps so striking as in some other trades; but it must always be remembered that a ship which is to steam for 12,000 or 13,000 miles without many opportunities of coaling cannot be of high speed; otherwise the bunker capacity would be so great as to seriously reduce the available cargo space; while the running expenses would be so heavy as to materially decrease the utility of the vessel as an aid to the development of commerce. There is ever the happy mean, which has here been realised with characteristic prudence and enterprise.

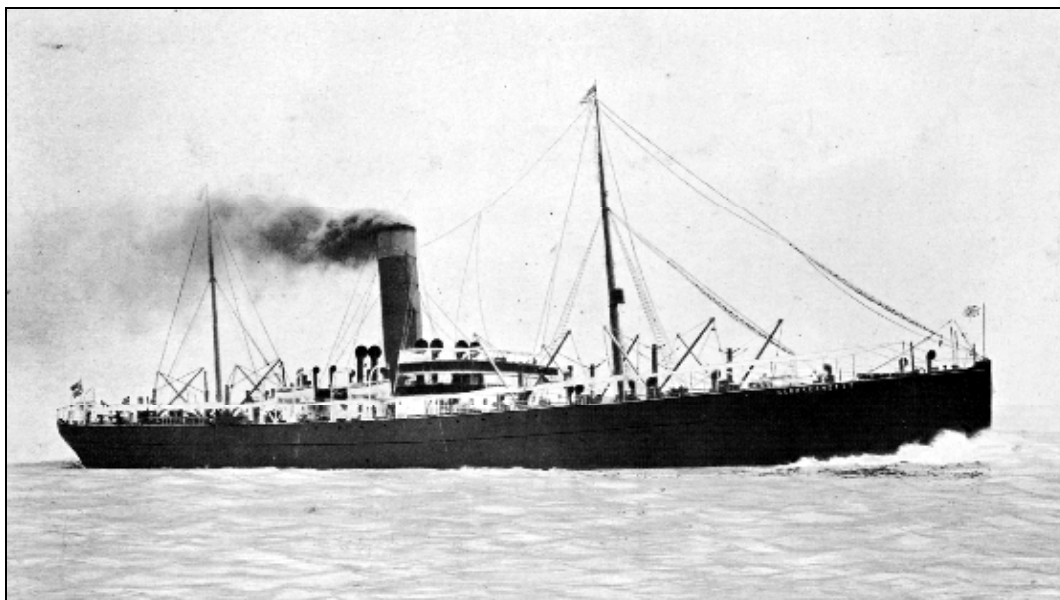
The forty years' progress in the case of the Holt liners has brought about an increase of 50 per cent, in the dimensions of the ship, the later Scotts' vessels being 441 ft. between perpendiculars, 52 ft. 6 in. in breadth, and 35 ft. in depth moulded, with a gross register of 7043 tons. In respect of deadweight capacity, however, there has been considerable development, due to the adoption of mild steel having permitted a reduction in the weight of boilers and engines, and in the scantlings of the hull. The new vessels, with a draught of 26 ft. 6 in., carry 8750 tons of deadweight cargo—two and a-half times the weight carried by the earliest Holt liners.

In forty years the steam pressure in the Holt liners has increased from 60 lb. to 180 lb.; and the piston speed from 400 ft. to 720 ft. per minute. The heating surface in the boilers has decreased from 6 square feet to 3 square feet per unit of power; and the condenser surface from 1,83 square feet to 1.3 square feet per unit of power. On the other hand, each square foot of grate gives now 14 horsepower, as compared with 6.6 horse-power formerly.

As a result of increased steam pressures and greater efficiency of propulsion, it may be taken that, notwithstanding the increase in dimensions and capacity of the ship, and the consequent advance in engine power, the coal required for a voyage half way round the world has been reduced to one half that of 1865.

Another notable feature in the economy of the ship is that twenty-five derricks have been fitted for dealing rapidly with the cargo, and one of these has a lifting capacity of 35 tons, to take such heavy units of cargo as locomotive boilers and tenders. In addition, there are eighteen steam winches. The reduction in the time spent in port, because of the facilities thus provided, is another element in the economy of the modern ship.

The largest oil steamer yet constructed, the Narragansett, was completed by the Scotts in 1903. This vessel, built for the Anglo-American Oil Company, carries in her sixteen separate compartments, 10,500 tons of oil, at a speed of 11 knots, for a fuel consumption of 4.9 lb. of coal per 100 tons of cargo per mile. This result is deduced from steaming, in ordinary service, over nearly 24,000 miles, and is consequently as reliable as it is interesting.



The largest oil-carrying steamer afloat, the NARRAGANSETT

The Narragansett, which is illustrated above, has a length between perpendiculars of 512 ft. and overall of 531 ft.; the beam is 63 ft. 3 in., and the depth, moulded, 42 ft. The deadweight carrying capacity on a draught of 27 ft. is 12,000 tons. The engines are of the triple-expansion type. Interest in the machinery is associated principally with that fitted for the pumping of the oil cargo. There are two pump-rooms, one located conveniently for the oil in the eight compartments forward of the machinery space; the other in a corresponding situation for the same number of

tanks abaft the propelling engines. The 10,500 tons of cargo can be loaded or discharged in less than twelve hours. While primarily for the Atlantic trade, the vessel was designed to undertake, if required, the much longer voyage of the Eastern service.

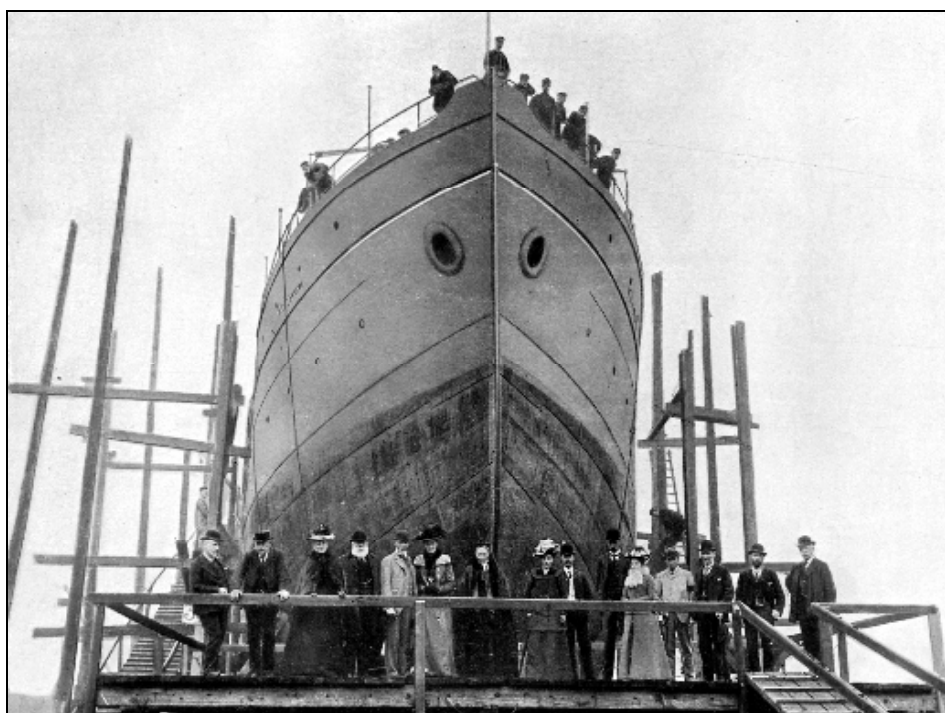
Because of the uniformly good results with ordinary coal, we give the details as received from the superintending engineer of the owners;—

TABLE VII.—RECORDS OP COAL CONSUMPTION OF STEAMSHIP “NARRAGANSETT”

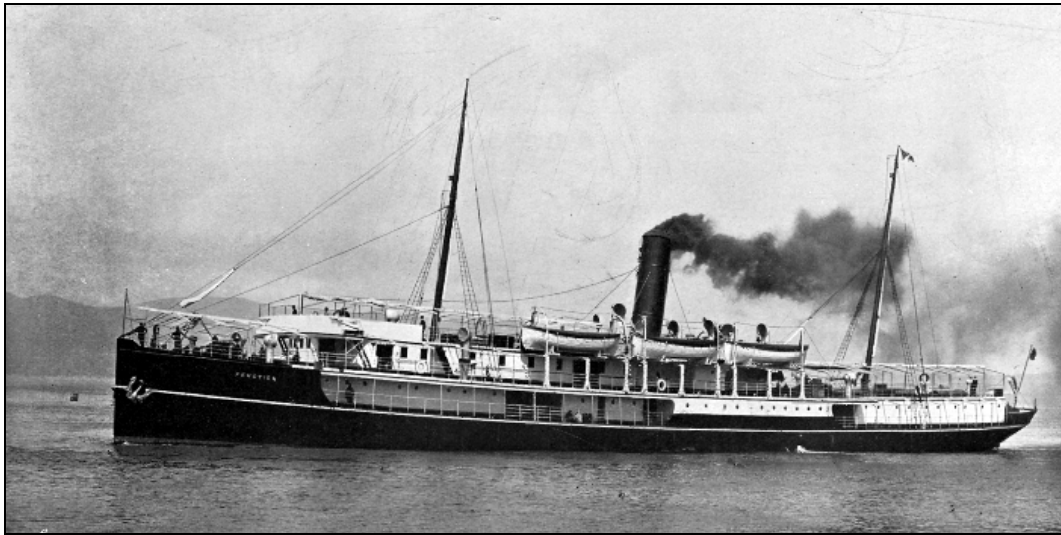
	lb.	tons	tons	miles	tons	knots	I.H.P.
15	1.60	918	822	3,447	10,298	10.85	3,713
	1.58						3,900
16	1.59	923	834	3,403	10,289	10.80	3,951
	1.64						3,775
	1.63						3,668
17	1.50	924	836	3,469	10,499	10.40	3,949
	1.53						3,796
18	1.50	847	775	3,441	10,563	11.10	3,937
	1.50						3,720
19	1.44	837	760	3,423	10,570	10.85	3,909
	1.43						3,813
20	1.50	780	707	3,312	10,641	11.50	4,107
	1.32						3,817
21	1.56	846	766	3,330	10,651	10.60	3,909
	1.44						3,870
	1.46						3,746
Totals		6075	5500	23,825	73,511		
Averages	1.51	868	786	3,404	10,501	10.87	3,848

The China Navigation Company of London, for whom the Scotts began building in 1875, have had in the thirty years sixty-four vessels, which have been an important factor not only in the development of trade in China, but also in the advancement of British interests in the Far East.

In an earlier Chapter we referred to the extent of the service conducted by these vessels, and also to the Company's continuous progressive spirit, which, for instance, induced them, on the suggestion of the Scotts, to adopt twin-screws. The launch of one of these ships is illustrated below, while the next picture, illustrates the Fengtien, which was built in 1905 in an exceptionally short period of time.



The launch of a China steamer.



The China Navigation Company's T.S.S. FENGTIEN

The contract was made in the closing week of 1904, the first keel-plate was laid on the 15th January, 1905, and the vessel was launched on the 20th April, and arrived in Shanghai on the 14th July - less than twenty-six weeks from the date when the building was commenced. This performance indicates not only the satisfactory character of the organisation, but also of the equipment of the shipyard and marine engineering works.

The Fengtien has a length between perpendiculars of 267 ft., a beam of 40 ft., and a depth, moulded, of 18 ft., with a deck-house having accommodation for thirty-three European first-class passengers ; while on the top of this house there is, as shown in the engraving, a promenade for passengers. The accommodation provided for first-class passengers is exceptionally satisfactory, both in respect of state-rooms and of public saloons. Fifty-six first-class Chinese passengers are also carried, as well as seventy steerage native passengers. In addition to this considerable source of revenue, the ship carries 1720 tons of deadweight cargo on a draught of 14 ft.

The Fengtien on her trial, when developing 2146 horsepower, attained a speed of 13.25 knots, which was considered highly satisfactory, in view of the unusual dimensions. The engines are of the triple-expansion, three-cylinder type, fitted with every accessory which experience has shown to ensure regularity of working, with the minimum of expense in respect of upkeep and working cost. Steam at 190-lb. pressure is supplied by two boilers, 15 ft. in diameter and 11 ft. 6 in. long, having 5184 square feet of heating surface, and 121 square feet of grate area.



Dining Saloon in a Mail Steamer

We have referred generally to the passenger accommodation in the ships built by the firm, and it may be interesting to refer here to the character of the work done and illustrated above. This view shows the dining-room of one of four Portuguese steamers. This room is designed in the Jacobean style. The walls are framed and panelled in solid walnut, and all the mouldings, cornices, architraves, pilasters, columns, pediments, and also the furniture, are beautifully carved. The floor is laid in mosaic tiles, in geometrical patterns, with Brussels carpet runners in the passage-ways. The ceiling is of yellow pine, moulded, ribbed, and broken up with carved panels, painted a flat white and relieved with gold. The dome skylight is in teak, with richly-carved beams and mouldings; and glazed with embossed plate glass, while the side windows are fitted with jalousie blinds, stout double-line teak shutters, and glass bull's-eyes in brass frames. The upholstery is in crimson Utrecht velvet, and seating accommodation is provided for sixty-eight saloon passengers.



Drawing Room in the steam yacht FOROS

The other view above, illustrates the drawing-room of the steam yacht Foros, built for M. Kousenzoff, of Moscow. It is in the Elizabethan style. The walls are framed in solid East Indian satinwood, highly finished and French polished, with figured silk tapestry panels of a shade that harmonises and blends with the wood-work. Neat and delicate carving in low relief is introduced where most effective. The ceiling, of yellow pine, has square panels of Tynecastle tapestry, relieved with rich carving in cornices and beams. The room is lighted and ventilated by eight large round lights in the ship's side, each enclosed in a recess with a sliding screen of beautifully-stained and leaded glass. The large circular skylight in the centre of the room, finished to suit the ceiling, has large opening sashes, glazed with stained glass. The floor is laid with oak parquetry, with a Parisian mat in the centre. The room is heated by a slow-combustion grate with rich brass mounts, tiled hearth, fire-brasses and fender. The mantelpiece and overmantel, in satin wood, is a beautiful piece of work—carved and relieved with colonnades and pilasters. This room is fitted with a complete installation of electric bells and lights, with two graceful electric candelabra, one on each side of the fireplace. The stained glazing is illumined at nights by electric lights on the outside. The drawing-room is completely and artistically furnished with high mirrors, fitments, writing-tables, card and occasional tables, and with a variety of beautifully upholstered chairs and sofas. All the metal-work is of ormolu.

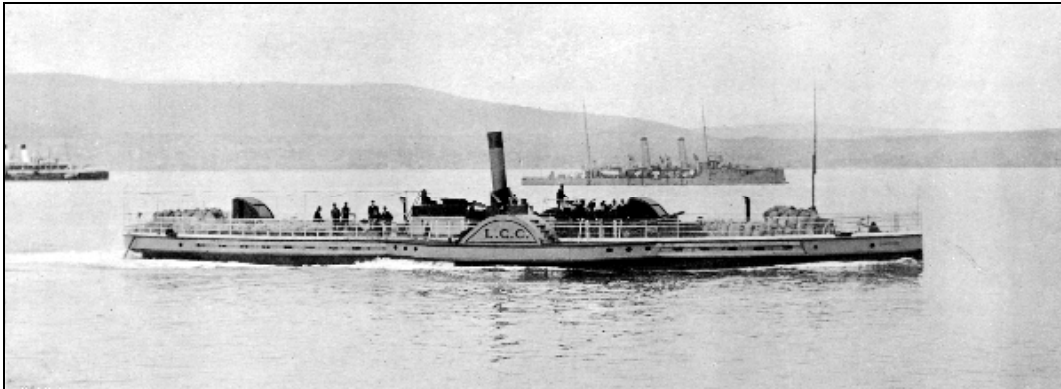
The British India Steam Navigation Company is another of the old clients of the Scotts. This Company, originally formed in 1856, under the title of the Calcutta and Burmah Steam Navigation Company, which was changed in 1862 to the title now known in all maritime countries, had its first steamship built by the Scotts, and it is therefore interesting to illustrate the one recently built at the same Works—the Bharata. This vessel is of the intermediate type, carrying a large number of British and native passengers, and nearly 4000 tons of cargo. The length between perpendiculars is 373 ft., the beam 45 ft., and the depth, moulded, 29 ft. 6 in. The cargo carried on a draught of 24 ft. is 3940 tons, and this is handled by eight hydraulic cranes, some of them of high power. The passenger accommodation, in the centre part of the ship, includes state rooms and saloons for forty-two first-class and thirty-six second-class European travellers, while in the 'tween decks a large number of native passengers are accommodated.

The machinery of the Bharata gives a speed of 16 knots, when the displacement is 5560 tons. The engines are of the triple - expansion type, and develop 6000 indicated horse-power. Five single-ended boilers supply steam at 180

lb. pressure. This vessel in service carries her cargo of about 4000 tons and her passengers at a speed of 16 knots, for a consumption of ordinary coal of about 50 tons per day.

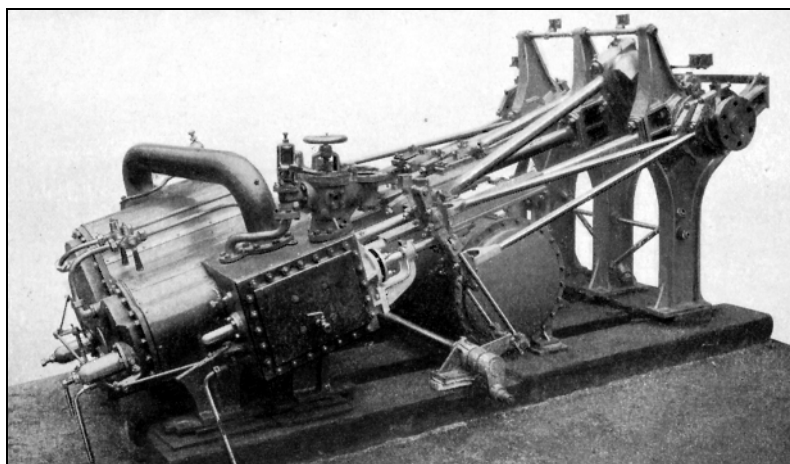
In our historical Chapters it has been clearly shown that the Scotts took a prominent part in the evolution of Channel steamers, and reference may be made to the latest vessels of this class now being built at the Company's works—two steamers for the old and successful firm of Gr. and J. Burns, Limited. These vessels, the dimensions of which are:—Length 233 ft., breadth 33 ft., depth 24 ft., are to have a speed of 13 knots. They are to be employed on the service between Glasgow and Manchester, and are fitted for steerage passengers, and also for conveying cattle, horses and sheep. The machinery consists of three-cylinder triple-expansion engines of 1750 indicated horsepower, having cylinders 23 in., 36 in., and 58 in. in diameter respectively, with a stroke of 42 in. The boilers, of which there are two in each ship, are 14 ft. in diameter and 12 ft. 6 in. in length, with a heating surface of 4000 square feet, and a grate area of 120 square feet. They work under natural draught at a pressure of 175 lb. per square inch.

We might continue almost indefinitely describing different types of ships, but will content ourselves with a reference to the fleet of Thames passenger steamers built in 1905 for the London County Council. Of the thirty vessels constructed for the Council, twenty had their boilers and engines from the Scotts' Works. Ten of the steamers, in which this machinery was fitted, were built on the Clyde by Messrs. Napier and Miller; six at Southampton, by Messrs. John I. Thornycroft and Company; and four at Greenwich, by Messrs. G. Rennie and Company. These vessels are 130 ft. long, and of very light draught—2 ft. 10 in. when loaded. An idea of their proportions is given by the engraving below, showing one of the Clyde-built vessels ready to steam from Greenock to London.



One of twenty Thames steamers engined by the Scotts

The engines for all of these vessels are of the compound, diagonal, surface-condensing type, the two cylinders being 16 in. and 31 in. in diameter, with a stroke of 3 ft.



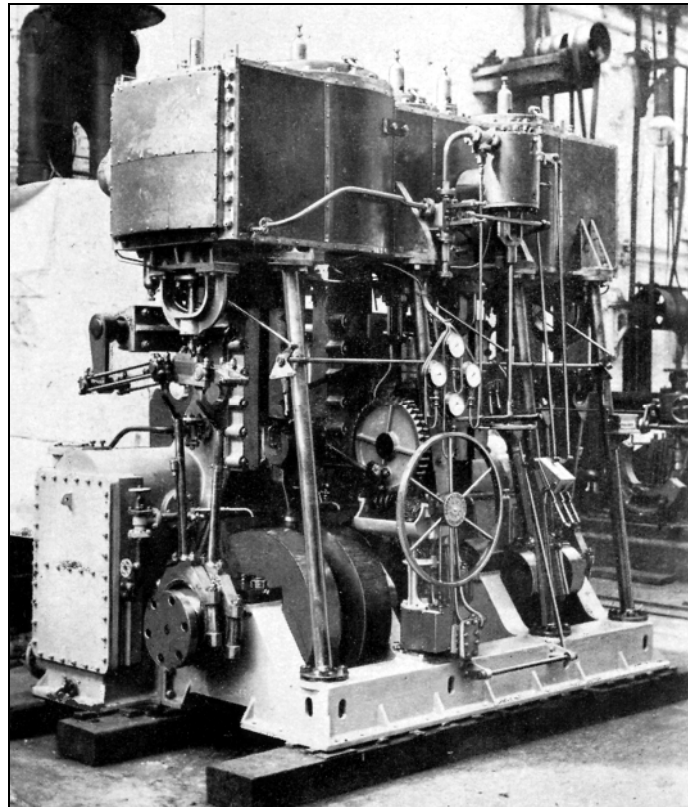
Engines of London County Council Steamers

One set of engines is illustrated above. They have forged steel guide columns, to bind the cylinders to the three entablature frames. The crank-shaft is a solid steel forging, 6f in. in diameter, coupled to the steel paddle-shafts by flexible couplings. The surface-condenser, cylindrical in form and constructed of light brass sheets, is placed below the guide bars close to the cylinders. The water-ends are of cast brass, arranged for double circulation of the water.

The air-pump, of the trunk type, is driven by bell-crank levers off the low-pressure connecting-rod. Two independent feed-pumps are driven off the same crosshead.

The auxiliary machinery includes a circulating pump with auxiliary air-pump attached, a direct-acting feed and bilge pump, a fan and engine for the forced draught, and an electric engine and dynamo. Each steamer has one cylindrical steam boiler, 9 ft. in diameter by 9 ft. 3 in. long. The working steam pressure is 110 lb. The twenty sets of engines and boilers were completed in a remarkably short space of time.

These steamers were designed for a service speed of 12 statute miles per hour, and a trial speed of 13 miles per hour, or 11.285 knots. The best trial performances were attained by the FitzAilwin and the Turner, both built on the Clyde; they attained a speed of 14.1 miles per hour, or 12.25 knots, with the engines making 69.8 revolutions per minute, and indicating 360 horse-power. This is nearly 1 sea mile per hour more than was required by the contract.



Typical Propelling Engine

We illustrate above a typical set of triple-expansion engines. The practice in respect of the design of engines and boilers is necessarily very varied. From the designs for a small steam launch to those for a first-class cruiser or battleship there is a wide range, and all classes of work, with not a few of special interest, come between those extremes. In connection with the three-crank triple-expansion engine, now generally adopted for merchant work, an arrangement well favoured for sizes up to about 1000 indicated horsepower is that in which the high-pressure cylinder is in the centre with a piston valve, the intermediate-pressure cylinder being forward, and the low-pressure cylinder aft, each with a slide valve at the extreme ends. This has been found to give a handy arrangement of gear, and to be easily accessible. With twin-screw engines of this power it is customary, and has been found very convenient, to lead all the hand-gear for both engines to a pedestal placed midway between the engines and ahead of the forward cylinders.

A description of the types of engines built by the Scotts for the China Navigation Company during the past thirty years would be practically a history of the progress of marine engineering during that period. The customary sequence of cylinders has in the main been adhered to in the design of these engines—viz., high-pressure cylinder forward and low-pressure cylinder aft in the case of compound engines: the intermediate-pressure cylinder, in the case of triple-expansion machinery, is placed between the high- and low-pressure cylinders. Indeed, this latter is the arrangement invariably adopted by the firm in the design of all large-size ordinary cargo steamer engines. The valve gear is forward of its cylinder in each case. This has also been the design adopted in the case of recent high-class passenger and mail steamers with three cylinders, and in the case also of steamers for special trades.

Twin-screw engines present little deviation from the above, and such as there is mainly affects pipe connections. All engines of whatever type up to about 1000 indicated horse-power are usually arranged with forged columns in front. The condenser is ordinarily designed to form part of the engine structure, having the columns cast on, and supporting the cylinders; but not infrequently it is entirely separate from the main engines, and is carried either on the back of the columns, or fitted in the wing of the ship.

Of engines for the Navy nothing need be said beyond stating that they form quite a class by themselves, and all present the special features of design so characteristic of Admiralty work referred to in an earlier Chapter. The latest types of large-size engines for the Admiralty are being fitted with a system of forced lubrication to main bearings and crank-pins.

The Scotts' practice with respect to paddle engines has been no less varied than that in the case of screw machinery, ranging as it does from the ponderous side-lever engine of past years to the stern-wheel engine of the shallow-draught steamers of the present day. Oscillating and diagonal engines, both compound and triple-expansion, are also within the experience of the Company, the three-stage expansion being the type now usually adopted.

With respect to auxiliary machinery, the Scotts invariably fit a separate centrifugal pump for circulating the water through the condenser for all classes of engines, excepting only those for the ordinary tramp steamer. The air, bilge, and sanitary pumps are usually worked from the main engine by levers. The feed pumps are generally independent. Frequently, especially in yachts, all the pumps are entirely independent of the main engines. The Scotts in some cases make all auxiliary machinery for their own engines: such as centrifugal pumps, fans, feed-heaters, auxiliary condensers, duplex feed and ballast pumps, etc.

Many varieties and types of boilers have been made. The old practice of having two or three rings in the length of the shell in ordinary cylindrical boilers has long since given place to one plate in the length. The boiler ends are seldom made in more than two plates; up to diameters of 11 ft. only one plate is used. The number of riveted seams is thereby reduced to a minimum, and the liability of the boiler to leak is minimised. The Scotts also have a system of forced draught for supplying either cold or heated air to the furnaces, which is fitted largely to their ships, and gives every satisfaction. Large installations of Belleville and Yarrow water-tube boilers for working under forced draught have also been made and fitted in H.M. ships, but they need no description here. A large installation for burning oil fuel has recently been completed and applied by the firm to the Babcock and Wilcox water-tube, and the cylindrical, boilers of H.M.S. Argyll,

