CAPT. J. W. TROUP

Wallace Shipbuilding & Dry Dock Co.

LTD.

NORTH VANCOUVER, B. C.

CANADA.

SPECIFICATION

FOR THE CONSTRUCTION OF

MACHINERY

FOR

C.P.R. PASSENGER STEAMER

VESSEL No. 108.

DIMENSIONS

Length O.A. .....

" *B.P.* .....

Beam Mld .....

Depth Mld .....

Date OCTOBER 12 1920

WALLACE SHIPBUILDING & DRY DOCK CO. LTD.

N. Vancouver, B. C.

Canada.

S P E C I F I C A T I O N F O R

the construction of

Machinery

for a

Single Screw Passenger Steamer.

Princess Louise

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MAIN ENGINES

1. GENERAL DESCRIPTION. The vessel to be driven by one set of direct-acting triple expansion surface condensing engines having four inverted cylinders. The engines are to be balanced on the Yarrow, Schlick and Tweedy system.

The boilers to be four in number, single ended, designed to work with assisted draught on the closed stokehold system, and constructed for a working pressure of 180 pounds per square inch. They are to be capable of maintaining a good average of 16-1/2 knots on service.

2. CYLINDERS. The engines to have one high pressure cylinder, one intermediate, and two low pressure cylinders. The high pressure cylinder to be 28 inches diameter, the intermediate pressure cylinder to be 43 inches, each low pressure cylinder to be 50 inches diameter, and the length of stroke of each to be 3 feet 3 inches. The cylinders are to be cast separately of hard close-grained cast iron and to be good sound castings. They are each to be fitted with a separate liner of extra hard close-grained cast iron secured to the cylinder by screw bolts at the bottom, the top being fitted as an expansion joint, caulked with long fibre Italian asbestos cord and covered by a wrot. iron ring 1/2 inch thick, machined and secured by 1/2 inch wrot. iron pins. The space between each cylinder and its liner to be not less than 5/8 inch and the low pressure spaces to be fitted as steam jackets with the necessary reducing valves and drain traps. The bottom of the cylinders to be strongly ribbed. Drain cocks and pipes to be fitted to the bottoms of the cylinders and valve casings for returning the water to the condensers. The cylinder drains to be led to the condenser direct and the valve casing drains through water traps of approved make to the condenser. The gear for opening the cylinder drain

cocks to be led to the starting platform and to have index plates. Auxiliary starting valves to be fitted to the I. P. receiver with connection from main steam pipe and hand gear to the starting platform. The starting platform to be on the starboard side of the ship; The stuffing boxes for all the main engine piston rods and valve spindles to be packed with U. S. or other approved metallic packing. Escape valves with spiral springs enclosed in domes to be fitted on each end of each cylinder and to each receiver. Suitable cocks and copper pipes not less than 1-1/2 inches diameter also gear having ample bearing surfaces bushed with gunmetal to be fitted to each engine for taking diagrams from both ends of each cylinder. The indicator cocks on the cylinders to be of approved design. All the cylinders and casings to be lagged with No. 1 quality fossil meal or 85% magnesia composition and afterwards covered with thin burnished steel sheets secured to iron grounds by round headed brass screws.

3. CYLINDERS PORTS AND STEAM PIPES. The areas of the steam ports of the cylinders, the port openings and the steam and exhaust pipe connections to be such that when the engines are developing their full power the mean velocities of the steam shall not be more than as follows:-

Main steam pipes	100	feet per second
H..P. cylinder, port opening	95	" " "
I. P. " " "	150	" " "
L. P. cylinder, port opening	220	feet per second
H. P. " ports and exhaust passages	80	" " "
I. P. " " "	110	" " "
L. P. " " "	130	" " "
Eduction pipes between H.P. and I. P. cylinder	120	" " "
Eduction pipe between I.P. and L. P. cylinders	150	" " "

Eduction pipe between L. P.
cylinders and the condenser .. 100 feet per second

4. CYLINDER COVERS. The cylinder covers to be cast iron, of open section, strongly ribbed. The tops to be covered with non-donducting material and chequered malleable iron plates, and the necessary eye bolts for lifting them.

5. PISTON AND SLIDE VALVES. The H. P. and I. P. cylinders to have each a piston valve of cast iron fitted with Lockwood and Carlisle packing rings. The L. P. cylinders to have each a double ported slide valve working on a separate slide face made of hard close-grained cast iron secured to the cylinders with cheese-headed bronze pins. A relief frame to be fitted to each L. P. valve and lubricated same as "Princess Adelaide" and fitted with white metal buttons. All valves to be so arranged that they can be easily withdrawn. The valve covers to have oil cocks. A balance cylinder to be fitted to the I. P. and each L. P. valve. Drawings of the balance cylinders to be submitted to the Owners for their approval. The liners for the piston valve casings to be of extra hard close-grained cast iron securely fastened to the cylinders.

6. PISTONS. To be of the best mild cast steel of conical form or of cast iron to suit the balancing and each fitted with a junk ring of cast iron. All pistons to be fitted with hard close-grained cast iron packing rings of Lockwood & Carlisle's make. The junk rings to be secured by collar studs of mild steel screwed into the bodies of the pistons. Guards, formed of brass washers, to be under the nuts and split pins to be fitted above the nuts.

7. PISTON RODS. To be of the best forged mild steel with solid shoulders below the pistons and malleable iron nuts for securing the rods to the pistons and the crossheads. The H. P. and I. P.

rods to be interchangeable and the forward L. P. to be interchangeable with the after L. P. The rods to be ground after being turned to secure perfect parallelism.

8. CONNECTING RODS. To be of the best forged mild steel, and of not less than 6 feet 6 inches in length between the centres. To have double bearings at the top and having bushes of gunmetal lined with white metal of approved mixture, 1/2 inch thick, and caps of forged mild steel. The crank pin bearings are to have gunmetal bushes lined with whitemetal of approved mixture 1/2 inch thick, and caps of forged mild steel. All the bolts for securing the caps are to be forged mild steel.

9. CROSSHEADS AND GUIDES. The crossheads to be of hard forged steel each secured to its piston rod with a malleable iron nut. The crosshead pins to be flattened at the sides for the greater part of their length. The guide shoes to be of cast steel of the double guide pattern working in cast iron guides bolted to the cast iron columns and are to be faced with white metal of approved mixture on both the ahead and the astern surfaces. The white metal to be cast into machined and tinned recesses in the shoes. The guide shoes to be so arranged that they may be easily withdrawn and lined up for wear.

10. VALVE SPINDLES. To be of forged mild steel ground after being turned to ensure perfect parallelism and fitted with adjustable guides below the stuffing boxes.

11. VALVE GEAR. The valves to be worked by means of double eccentrics and link motion of the Stephenson type, and having gunmetal slides made adjustable. The eccentric rods, the reversing links, the link blocks and the drag links to be of forged mild steel, the pins for the eccentric rods being forged solid with the links. The larger part of the eccentric sheaves to be of cast iron and the smaller part of forged steel. The eccentric

rods to have "T" ends and to be separate from the straps, the ahead rods being in line with the valve spindles. The reversing levers to be of cast steel and made with a slot and screw and fitted with a crosshead to which the drag links are to be attached; the point of cut-off to be marked on each. All the working parts of the valve gear to be bushed with gunmetal except the straps which are to be lined with white metal of approved mixture and made adjustable for wear. The lubricating arrangements to be complete, with syphon lubricators fitted throughout and galvanized sheet iron troughs underneath the eccentrics. The valve gear to be made as far as possible interchangeable. The reversing shaft to be in two pieces united by a flange coupling and bolts, and supported in brackets having adjustable bushes of gunmetal.

12. REVERSING ENGINE. A steam driven reversing engine of ample power with gear of the all round type to be fitted, with steam connection to the main steam pipes and exhausting to the condenser. The engine to be capable of being worked in either direction by means of a change valve, and gear to be fitted to admit of the reversing links being held in any position, and to have an index marked "ahead" and"astern". The reversing worms to be machine cut and the worm wheels machine moulded.

13. COLUMNS. The cylinders are to be supported on both sides by four cast iron columns of box section to receive the guides. The columns to be secured to the cylinders and soleplates by a sufficient number of turned bolts, not less than four at each end of each column being carefully fitted. The cast iron columns are to have separate guide plates and to be arranged for water to circulate behind the ahead and astern guide faces, and also front columns may be used as oil tanks, the necessary cocks and gauging apparatus being fitted.

14. SOLEPLATE. To be of cast iron and of box section, with six (6)

bearings for the crank shaft. The bearings to be exceptionally long to reduce the wear to a minimum, and to have bushes of special strong cast iron lined with white-metal of approved mixture, not less than 1/2 inch thick. The lower bushes to be made so that they can be taken out without removing the crank shaft. The covers of main bearings to be of steel, each with a hand hole and each to be held down by two forged steel bolts, so fitted that they can be easily removed. The oil boxes to be of cast brass tinned inside. The holding-down bolts to be screwed through the tank top with nut, grommet and iron washer below, the upper ends of these bolts being fitted with double nuts.
A cast iron chock to be fitted at each holding-down bolt and teak wedges fitted in between the chocks.

15. CRANK SHAFT. The crank shaft to be made in two sections united by flanged couplings and bolts, each section to have two built cranks. The crank shaft to be of Siemens-Martin mild ingot steel hydraulic forged by first class makers. The strength of the shaft to be not less than 5 per cent, in excess of B. C. requirements. The angles between the cranks are to be in accordance with the requirements of the Yarrow, Schlick and Tweedy balancing system.
A crank shaft gauge to be supplied for #1 and #6 bearing.

16. TUNNEL SHAFTING. The tunnel shafts to be of the same quality and make of steel as the crank shaft, each of the same length and smooth turned all over. The strength of the shafts to be not less than 5 per cent, in excess of B. C. requirements. Each shaft will be supported on cast iron pillow blocks and will have couplings of the same dimensions as those of the crank shaft and bored to the same template. The holes are to be widened and accurately fitted with tapered bolts, not less than six in number to each coupling.

A. trailing collar of ample surface to be arranged.

at the forward side of the aftermost tunnel block.

17. PILLOW BLOCKS. The tunnel pillow blocks to be of cast iron lined with white metal of approved mixture; the covers to be hollow and fitted with separate oil cups, Save-alls to be fitted to the ends of each block and an external and internal water service to each block is to be provided. The aftermost block to be adapted to take the drag of the propeller when the tunnel shaft is disconnected.

18. THRUST SHAFT. The thrust shaft to be of the same quality and make of steel as the crank shafts.

The diameter of the shaft at the bottom of the collars to be the same as the crank shaft and the couplings also to be of the same dimensions as those of the crank shaft. A bearing to be fitted close to the end of the thrust block and fitted with an external and internal water service.

19. THRUST BLOCK. The thrust block to be of cast iron with adjustable rings of the horse shoe type of cast iron faced with white metal of approved mixture, not less than 1/2 inch thick. The face of thrust rings to be machined and carefully tinned before the white-metal is cast in. The lower part of each block to be adapted to hold water and oil, and the rings fitted with water circulation. The block to be inside the engine room and to be firmly bolted to the engine seat. The thrust to be taken by forged steel rods, each screwed with a fine thread, and having gunmetal lock nuts. Ample surface to be provided on the shoes.

20. PROPELLER SHAFT. The propeller shaft to be of the same quality and make of steel as the crank shaft. The strength of the shaft to be not less than 5 per cent, in excess of B. C.

requirements. The shaft to be covered with a gun-metal liner the whole length of the stern tube and the liner to be tested with water to 50 lbs. per square inch if required before being pressed on the shaft. The liner is to be fitted in one continuous length and the shaft is to be tinned at the forward end of the liner with a thick coating of tin, tapering from the end of liner for a length of 6 inches along the shaft. The couplings to be of the same dimensions as those of the crank shaft.

21. COUPLING BOLTS. Each coupling to have 6 bolts of forged mild steel with nuts of wrot. iron. The taper of the bolts through the couplings to 3/8 inch diameter per foot.

22. STERN TUBE. The stern tube to be of cast iron secured to the stern frame at the aft end by a large nut of malleable iron and to the bulkhead at the forward end by a strong flange. It is to be turned and carefully fitted to stern frame at the aft end and to the bulkhead at the forward end. To have a stuffing box and gland and a lantern ring at forward end, the gland to be bushed with gun-metal and to have rolled bronze studs with gun-metal nuts, two studs being left long. A bearing bush of gunmetal to be fitted at each end of the tube and lined with lignum vitae, fitted edge to edge and kept in place by gunmetal key strips. The lower one third to be end wood. The stern tube to have an 1-1/2 inch copper pipe and brass cock to draw off water at the lantern ring.

23. PROPELLER. The propeller to be right handed, of the built type, with the boss of cast steel, and four movable blades of Parson's of Thore's manganese bronze, secured with studs of forged mild steel and bronze nuts of the same material as the blades. The boss to be secured to shaft by a feather extending the whole length of the boss, and by a malleable iron nut at the after end, the thread on

the shaft for the nut being cut to opposite hand to that of the propeller when going ahead. The diameter, pitch and surface of the blades to be arranged to suit the vessel. The holes in the flanges of the blades to be made oval so that the pitch may be varied at least 2 feet.

The forward end of the boss to be recessed and fitted with india-rubber ring to enable the end of the shaft liner being made watertight where it enters the boss and a cast iron cone to be fitted over the nut at the after end of boss. Zinc protectors to be fitted to the stern frame, rudder post and plating as may be required.

24. TURNING GEAR. An independent engine of ample power, and having reversing gear, for turning the main engines by steam and with gear for turning by hand to be fitted. Steam connection to engine to be taken from the auxiliary steam pipes, and exhaust led to the auxiliary exhaust system. The turning wheels on the engines to be made in halves, both worm wheels to be machine-moulded, and the worm to be machine-cut. The gear to be so arranged as to be readily connected or disconnected.

ENGINEROOM AUXILIARIES.

25. CONDENSER. The condenser to be circular, having the shell formed of steel plates with solid wrought iron ring riveted and caulked on each end to form the flange. A manhole door is to be fitted on top and a sludge door on the bottom of the shell. The condenser doors to be of cast iron with hand hole doors in each. The tubes to be of solid drawn brass, No. 18 L. S. G. thick tinned inside and outside and packed at each end with cord packing and secured by checked screwed glands, and so arranged that they can be easily withdrawn and packed at each end. The tube plates to be of rolled brass not less than 1-1/8 inch thick. The supporting plates to be of cast iron 3/4 inch thick, with

1.25 square feet of Cooling surface per I. H. P.

All internal fittings to be of brass.

A cock for supplying soda to be fitted on top of the condenser, a drain cock as low down as possible, and shield plates to be fitted underneath the exhaust inlet.

The total condensing surface in the condenser to be not less than 5625 square feet.

The condenser to be water tested in the presence of the Company's Inspector to 20 lbs, per square inch after being tubed.

26. AIR PUMP. An independent dual air pump, of Weir's make, 12 inches diameter of cylinder, 22 inches diameter of pump, and 15 inches stroke, to be fitted in the engine room to work in connection with the condenser. The pump rods to be of hard rolled bronze and the pump liner, valve seats, and buckets, to be of gunmetal with metallic valves. A manhole to be fitted in each pump chamber. This pump to draw from the condenser and to discharge to the float tank.

27. CIRCULATING PUMP. The condenser to be fitted with an independent centrifugal pump of Paul's or other approved make, worked by a single cylinder engine, the impeller to be of gun-metal and the spindles of manganese bronze.

The diameter of the suction and discharge pipes to be not less than 14 inches.

The pump is to be arranged to draw from the bilge through a non-return valve fitted on the suction pipe.

The sea valves for the circulating pump and the ballast pump are to be fitted with a steam valve and pipe, to clear the valves of ice or mud, the other sea valves to have similar fittings where required, and all sea suction chests to have brass gratings.

28. FEED PUMPS. One pair of Weir's independent feed pumps to be

supplied and fitted in the engine room. Each pump to be not less than 10 inches diameter, with steam cylinder 13-1/2 inches diameter, and the stroke 21 inches, and each capable of supplying the boilers with the main engines, working at full power without excessive pump speed and to be regulated with automatic control gear fitted in a float tank.

These pumps are to have cast iron water ends, gun-metal lined, with cast iron valve chests and brass valves. They are to be arranged to draw from the condenser, the float tank and the reserve feed water tanks, and to discharge through or past the feed heater to the boilers by either the main or the auxiliary line of feed pipes. An air vessel to be fitted to these pumps. The feed pipes to be placed in an easily accessible position, if practicable elsewhere, not underneath the passages.

29. FEED FILTER. A feed water filter to be fitted in the engine room, with the necessary valves to admit of the feed water being passed through the filter or direct to the boilers. The filter to be approved make and the connections arranged to permit of the filter being overhauled while the main engines are at work.

30. FEED WATER HEATERS. One of Weir's Multiflow surface feed water heaters to be fitted in the engine room, taking steam from the auxiliary exhaust system, and of sufficient size to raise the temperature of all the feed water passing to the boilers to at least 220 degrees Fahrenheit. The heater to be fitted with steam, drain, and by pass valves and constructed in accordance with the requirements of the Board of Trade.

31. BILGE AND SANITARY PUMPS. Two direct double-acting duplex bilge and sanitary pumps each having cylinders 6 inches diameter pumps 6 inches diameter by 6 inches stroke, and of approved make, to be fitted in the engine room. The pumps and valve boxes of cast iron, and the valves of gun-metal and the rods of hard rolled bronze. The necessary stop valves to be

Fitted to enable either pump to be shut off and examined while the other is at work.

These pumps are to draw from the sea and from the main bilge system, in connection with which will be fitted the distributing bilge boxes which are to be placed above the floor plates and fitted with strainers and from these boxes suction pipes, terminating in rose boxes will be led to the engine room, the boiler room and the various holds. A stop valve to be fitted to each bilge pipe where attached to the main bilge boxes. The straight lengths of bilge and sanitary pipes to be of cast iron, the bends of the suction pipes being of lead and of the discharge pipes, of copper. A separate sea suction valve to be fitted for the sanitary pumps and for the general service pump.

33. FRESH WATER PUMP. A duplex pump of approved make to be fitted in the engine room having steam cylinders 4-1/4 inches dia., pumps 4 inches diameter and the stroke 5 inches. The pump and valve box to be of cast iron; the rods of hard rolled bronze and the valves of gun-metal. The connections to be as may be required for ship's purposes. An air vessel to be fitted to this pump.

34. GENERAL SERVICE PUMP. One direct double acting duplex pump of approved make to be fitted in the engine room for general service, with cylinders 9-1/2 inches diameter, pump 6 inches diameter, and 10 inches stroke, the pump and valve boxes of cast iron and valves of gun-metal and the rods of hard rolled bronze. The connections to be so arranged that the pump may draw from the boilers, hotwells, sea, ballast tanks, fresh water tanks and discharge to the boilers, overboard, to deck for fire and wash deck purposes and to the hose connection in the engine room. An air vessel to be fitted to this pump.

35. ASH EJECTOR PUMP. One direct double duplex pump interchangeable with the general service pump to be fitted, for supplying the water to See's ash ejector if required having cylinders 9-1/2 inches diameter, pumps 6 inches diameter and 10 inches stroke or of equivalent capacity. The pumps, valve boxes of cast iron, valves to be of gun-metal and the rods of hard rolled manganese bronze. An air vessel to be fitted on the discharge outlet of the pump. This pump to be arranged to draw from the sea and to discharge to the ash ejector and into the deck fire service pipe.

36. BALLAST PUMP. One direct double-acting duplex ballast pump having cylinders 6 inches diameter, pumps 7 inches diameter by 7 inches stroke, and of approved make to be fitted in the engine room. The pumps to be of cast iron the valves and valve seats of gunmetal, and the pump rods of hard rolled manganese bronze.

The pumps to be arranged to draw from the sea and Bilges, the ballast and peak tanks, and direct from the engine room bilge and to discharge overboard, to the condenser, and to the peak tanks. An air vessel to be fitted.

37. DISCHARGE VALVES. All waste water discharge pipes through the Ship's side to have valves arranged to open to internal pressure and placed well above the water line; lifting gear to be fitted. All to have valve seats of brass and valves chests of cast iron, and spindles of naval brass; the chests to have spigots passing through the ship's plates.

38. EQUILIBRIUM VALVES. An equilibrium stop valve to be fitted in the main steam pipe, close to the high pressure valve casing for regulating the speed of the main engines, with all necessary gear fitted for working from the starting platform. Separate throttle valve to be fitted between the equilibrium valve and valve casing with the necessary gear controlled by an Aspinall's governor.

39. ENGINE ROOM AND STOKEHOLD BILGE PIPES. To be of cast iron with stop valves at each bilge pump. All bilge suction cocks or valves, with cast iron chests, are to be arranged in convenient places above the floor plates in the engine and boiler rooms, and each valve to be fitted with a name-plate. All pipes to have flanges, and made in suitable lengths.

40. VALVE AND COCKS. Stop valves of 3 inches diameter and under to have the chests of gun-metal, and all stop valve spindles throughout the vessel to be of bronze. All cocks to be of the best gun-metal, and to have packed glands, with the exception of bilge cocks. The gland studs to be of naval brass and nuts to be of gun-metal. All stop valves with the exception of bilge valves to have outside screws and to be made to close with a right hand motion. All valve chests to be fitted with name plates.

41. BOLTS AND NUTS. All bolts, studs, screws, and nuts about engines and boilers to have Whitworth's threads. Nuts on cylinder covers, valve covers, and the glands throughout the engines to be shaped to standard sizes.

42. SPANNERS. A complete set of spanners, special and skeleton, where required, for all parts of engines, and a duplicate set for bolts under 1 inch diameter to be supplied. One large spanner to be supplied for the piston rod nuts, one for the propeller shaft nuts, and one for the stern tube nuts, also the necessary spanners for the boiler manhole doors. Racks for the spanners to be supplied. All special spanners to have the part of the engines they suit stamped thereon.

43. ENGINE ROOM LADDERS, PLATFORMS, ETC. These are to be suitably arranged for the engine room, so as to give convenient access to the various parts. All ladders to have double hand rails, polished; the ladder steps to be of cast iron and polished on the edges. The gratings round the cylinders and the middle platforms to have T. bars polished on top.

ENGINE ROOM LADDERS, PLATFORMS, ETC. Cont'd.

The lower platforms in the engine room to be of chequered malleable iron plates carried to tee bars and angle irons. All necessary sheet iron guards and shields to be fitted.

44. LIFTING GEAR ETC. An overhead beam with traveller is to be fitted in the engine room hatch over the cylinders, and to have the necessary screws for lifting the cylinder covers, pistons, and valves. Means to be provided for moving or securing the travellers.

The necessary shackles and slings to be provided for lifting the covers and bushes of main bearings, shafting thrust rings and the condenser doors, and special arrangements to be made throughout for easily overhauling the machinery.

All tunnel shaft couplings to be protected with a sheet iron guard, each having a sight hole.

45. GAUGES. The following steam gauges are to be fitted. Maker's name and sample gauge to be submitted for approval.

8 inch face
- 1 Pressure gauge for each boiler in its boiler room
- 1 Pressure gauge in the engine room.
- 1 Pressure gauge for the M. P. receiver.
- 1 Compound gauge for the L. P. -do-
- 1 Vacuum gauge for the condenser.

1 Pressure Gauge at each reducing valve.

All gauges for boiler pressure must be graded 360 lbs.

46. COUNTER ETC. A revolution counter of approved make, with the necessary gear, to be fitted, and placed near the starting platform. One eight-day clock, English make, in brass case, to be supplied and fitted in a convenient position in the engine room.

47. TELEGRAPH. A Chadburn's improved single screw telegraph, with reply, to communicate between the bridge, wheel house and the engine room, with illuminated dial on the transmitters, bridge, and wheel house, and two gongs of different tones -

TELEGRAPH Cont'd.

one for ahead and one for astern - in the engine room. To have also an automatic direction bell-tale from the engines to the bridge.

The telegraph pulleys, chains, etc. to be protected by wood casings.

48. VOICE PIPES, LOUD SPEAKING TELEPHONES, ETC. A loud speaking telephone with electric bells, to be fitted to communicate from bridge to engine room, and voice pipes of copper or brass, with electric bells to communicate from the engine room to the boiler room, also from bridge right aft.

49. PAINTING. The whole of the cast iron and the malleable iron, including the internal parts of cast iron work such as sole-plate castings, etc. where not machined, to have two coats of paint before being put on board the ship, and after the engines have been tried at moorings to have a finishing coat of varnish paint of an approved colour. The engine room to have two coats of paint and one of varnish, of colour as may be approved.

50. STORE ROOM AND WORKSHOP. To be fitted up where Owners may require, with shelves, lockers, drawers, etc. for Engineer's tools and small stores. Chubb's locks to be fitted to store rooms as may be required.

51. STORE TANKS. Tanks of galvanized iron as required, for oil tallow and waste, to be supplied and fitted in the engine room, store room. or as may be otherwise arranged. A daily supply tank of brass, in three compartments to be fitted in the engine room, with three lock cocks.

Cocks and pipes, with all the necessary fittings for filling the tanks from the main deck to be fitted.

52. PIPES. All small steam, exhaust, feed, drain and circulating water pipes to be of copper, with brass flanges; those of

5 inches diameter and under to be solid drawn. THE main steam pipes to be of iron, lap welded, and to have solid steel flanges secured by expanding the pipes into them; the necessary expansion joints to be fitted.

A separate system of auxiliary steam and exhaust pipes to be fitted in the engine room. Besides the separate connection to the boilers the auxiliary steam pipes to have a connection with main steam pipes, and where required the necessary reducing valves of approved make to be fitted. These steam pipes to be led forward and aft to supply the deck machinery, and stop valves to be fitted to both mains where they leave the machinery casings.

Thickness of pipes to be not less than as follows:-

Main steam pipes of iron, not less than 1/2 inch thick.

Circulating water pipes .. ..No. 8 S. W. G.

Waste steam pipes .. ..No.14 S. W. G.

Bottom blow-off pipes . .. . " 7 "

Surface " " . .. . " 8 "

Main and auxiliary feed pipes, auxiliary steam pipes, and winch steam pipes, to be not less than 5 per cent in excess of Board of Trade requirements.

Auxiliary exhaust pipes according to their bore, also 5 per cent, above Board of Trade requirements, and not less than .. .. .No. 14 S. W. G.

53. TESTING. The various parts of the machinery to be tested with water to the following pressures, per square inch, viz:

The H. P. steam cylinders, barrels, and piston valve chests with covers in place .. .. 250 lbs

The M. P. cylinders with covers, etc .. .. 120 "

The L. P. " " " .. .. 40 "

Main steam pipes of iron .. .. 540 "

Steam and feed pipes of copper, above 1-1/2 inch diameter .. .. 360 "

TESTING Cont'd.

Surface condenser tubes (at the works of the tube makers)	300 Lbs
Main steam stop valve chests	360 "
Boiler stop valve chests	360 "
Boilers	270 "

All tests are to be made in the presence of the Company's representative, and as required by the Board of Trade, and B. C. Register.

54. BOILERS, DESCRIPTION OF. To have four single-ended boilers fitted with Morison's suspension and withdrawable furnaces or other approved make. The boilers to be cylindrical and of mild steel and to be arranged so that any one may be used independently of the others. They are to be constructed in accordance with the requirements of Board of Trade and B. C. Register for a working pressure of 180 lbs per square inch, and arranged to work with assisted draught on the closed stokehold system. Ample boiler power to be providee for using American coal on service. The flat sides of the fire boxes to be strengthened with stays screwed into both plates, and fitted with nuts at ends, in fire boxes. The ends of the boilers to be stayed with round steel stays, having nuts inside and outside of the end plates. The tops of the fireboxes to be stayed with solid malleable steel bridge stays.

Each furnace to have a separate fire box, and each furnace to be truly cylindrical, and of uniform thickness.

The thickness of steel and other plates, arrangement of stays, and riveting to be as required by the Board of Trade and B. C. rules. All plates to be made by the Siemens-Martin process.

The boilers to be fired fore and aft and arranged to form one common stokehold. They are to be not less than 16 feet 0 inches mean diameter by 12 feet long. The furnaces are to be not less than 4 feet 1 inch mean internal diameter and a total grate surface in all the boilers to be not less than 330 square feet with 6 feet 9 inches furnace bars and the total heating surface not less than 12,000 square feet. The tubes to be of iron 3 inches diameter and 8 feet long between the tube plates; the thickness of the plain tubes to be No. 9 B. W. G. the stay tubes to be 1/4 and 5/16 inch thick, the combustion chambers to be not less than 3 feet in length. 11 inches clear space to be left between each group of tubes to give access for cleaning. A sufficient number

of manhole and mudhole doors, McNeil's patent or other approved make, to be fitted from the inside with flanged and faced stiffening rings, to give access to all parts of the boilers for the purpose of cleaning and repairing. ALL the rivet and other holes to be drilled and the longitudinal joints to have double butt straps, triple riveted. Ends and edges of plates to be planed, and to be caulked on each side of the joints. All plates to be annealed after local heating.

55. PROVING BOILERS. The boilers, when finished, to be proved with water to 270 lbs, per square inch, in the presence of the Company's Representative, the Board of Trade and B. C. Surveyors.

After being proved and made tight to the satisfaction of the Company's Representative, they are to be painted with red lead before they are taken from the Contractor's works.

56. FUNNEL AND UPTAKES. To have one funnel made double and well supported and having the air space not less than 9 inches wide. The outer funnel to be made of plates 3-1/4 lbs. per square foot and the inner funnel plates to be 6-3/4 lbs. per square foot. Shackles for shrouds and glands for waste steam pipes as may be required, also single sheave blocks for hoisting scaffold boards are to be supplied.

Uptakes to be made of steel plates, and secured to the boilers by 2-3/4 inches by 2-3/4 inches by 3/8 inch angle bars; the inside casing plates to be not less than 6-3/4 lbs. per square foot, the outside casing plates to be not less than 3-1/4 lbs. per square foot and they are to be securely fastened to each other with thimbles and bolts.

Smoke boxes are to be constructed in the same manner as the uptakes, and are to have strong hinges and the necessary catches, hanging chains, etc. To be insulated as necessary with silicate cotton.

57. ZINC PLATES. Zinc plates as may be considered necessary are to be supplied and fitted to the boilers.

58. VENTILATORS FOR ENGINE ROOM AND STOKEHOLD. The necessary ventilators to be fitted to the engine room and stokehold, of large diameter; and to be of galvanized iron where exposed to the weather. The arrangements generally and the cowl heads to be of special design to suit the Company's requirements.

59. FANS. Two fans each about 66 inches diameter driven by enclosed force lubrication engines of Howden or Paul's or other approved make to be fitted complete and the air space between the uptakes and the hatch to be closed in so that a moderate pressure of air may be maintained in the stokehold if required. The fans to be designed to work at a reduced steam pressure but to be able also to withstand the full boiler pressure of 180 lbs. per square inch.

60. ASH HOIST. An ash hoist to be arranged for raising ashes from the stokehold. The engine to be of the latest vertical two-cylinder type with reversing lever and steam cut off combined, and to have all necessary pipes, cocks, valves, etc. complete.

61. BOILER STOP VALVES. Each boiler to have a main steam stop valve fitted to a steel saddle plate riveted on the boiler; the valve seats and valves to be of gunmetal. The glands and neck rings for spindles to be of gunmetal, and the spindles of rolled manganese bronze. Separate steam pipes and gunmetal valves to be fitted to boilers for the steering gear, and separate exhaust pipes led to the condenser and over the stern.

All valve chests, or cocks, where fitted to the boilers, to have a spigot passing through the boiler plate.

Internal iron pipes extending the whole length of the boilers to be fitted; they are to be connected to the main stop valves and to have transverse slits.

All boiler valves of 3 inches diameter and under to have chests of gunmetal.

62. SAFETY VALVES. Two spring loaded safety valves to the Board of Trade and B. C. requirements, to be fitted to each boiler. Easing gear to be attached to each set of valves so that the valves can be eased in the stokehold. Drain pipes to be fitted close to the waste steam pipe and led to the firemen's tank which is to be placed where convenient in the stokehold.

Waste steam pipe to be of copper, above boat deck casing polished and carried up aft side of funnel. The lower section within funnel hatch to be of iron.

63. BLOW-OFF AND SURFACE VALVES. A bottom blow-off valve of gunmetal to be fitted to each boiler, projecting beyond the boiler front a sufficient distance to allow the valve to be worked freely.

Cocks to be fitted on ship's side for the bottom blow-off from the boilers, and to be placed above the level of the stokehold floor. Each to have a spigot passing through the ship's side with a brass washer outside, and to be fastened with Naval bronze bolts. Cocks to be fitted with a safety guard.

A surface blow-off valve to be fitted on each boiler, and connected to the cocks on ship's side. Each boiler to have an internal surface blow-off pipe of iron, with a suitable collecting pan.

A plan of the blow-down system to be submitted.

64. FEED VALVES AND CHESTS. A feed valve chest of gunmetal with a check or non-return valve, to be fitted to each boiler and connected to the main feed pipes.

FEED VALVE AND CHESTS Cont'd.

Separate feed valve chests and valves, arranged as non-return valves, and pipes in connection with the auxiliary feed pipes, to be fitted to each boiler.

An internal pipe of wrought iron, for directing the feed water to be fitted to each boiler.

Arrangements to be made for completely isolating each boiler for repair.

65. WATER GAUGES. Two water gauges, and two test cocks, all asbestos packed, to be fitted on each boiler, cocks to be fitted on pipes where attached to the boilers. The water gauge standard to be of gun-metal.

66. SALINOMETER COCKS. A salinometer test cock of Dewrance's, Hopkinson's or other approved make to be fitted on each boiler, these cocks to be asbestos packed.

67. STOKEHOLD FLOORS ETC. To be of chequered malleable iron 5/16 inch thick with wood underneath not less than 1 inch thick, and supported on T bars. Guard plates to be fitted where necessary, to keep ashes and dirt from the bilges; the guard plates to be 1/4 inch thick and galvanized.

68. STOKEHOLD LADDERS, GRATINGS. ETC. All necessary gratings, ladders, and handrails to be fitted in the stokehold, to give access to the stop and safety valves and the gauge glass; also ladders and handrails from deck to stokeholds where necessary. The necessary racks and hooks in stokehold for firing tools to be fitted.

69. SEE'S ASH EJECTOR. A See's patent ash ejector, 6" size, to be supplied. The hopper to be installed in the stokehold, the discharge pipe and valve to be stowed as spare gear. The arrangement of the ejector and the pipes and connections to the ejector to be approved by the Patentee's representative before the work is put in hand. All necessary air vessels and escape valves to be fitted on the delivery pipes to the ejector nozzles.

70. ASH COCK. An ash cock, with screw nozzle for hose, to be fitted in the stokehold, with 1-1/2 inch copper pipe for supplying water for cooling ashes. The cock on the ship's side to be above the level of the stokehold floor, and to have a safety guard. A sufficient length of leather hose for the stokehold to be supplied.

71. BOILER SEATS. The boilers to be set in steel cradles of suitable construction built in the ship, and kept sufficiently high to allow for cleaning and repairing underneath; the cradles to be carried well up the sides of the boilers, and the boilers to be kept as high above the tanks as possible.

The boilers to be linked together and also to the ship's structure, at the tops to prevent athwartship movement.

72. COVERING OF BOILERS AND PIPES. The boilers to be covered with 85% magnesia composition, not less than 2-1/2 inches thick at any part, and with galvanized sheet iron 1/16th inch thick, to 12 inches below the centres of the wing furnaces; the lower ends of the sheets to be fastened to the angle bars fitted for carrying up the boiler covering; studholes in boiler shell plates for securing angle bars not to be deeper than 3/4 inch. The bottoms of the boilers to be painted with two coats Red lead.

All large steam pipes in boiler room and up to forward bulkhead of engine room to be covered with the same material as the boilers, and afterwards protected with galvanized sheet iron where necessary. Small steam pipes to be covered with sectional magnesia and canvas; exhaust pipes with hair felt and canvas. Large steam stop valves, tees, bends, etc., in engine room to be covered with same material as the boilers or with asbestos mattresses.

73. STEAM WHISTLE. One 8 inch bell whistle to be placed at an approved height in front of the funnel and to be worked from the bridge. To have a steam connection direct from each of the

boilers and if practicable from auxiliary steam pipe. THE steam pipe to have all necessary valves and special arrangements are to be provided for dfaining the whistle. A ladder to be fitted to the funnel to give access to the whistle.

74. OIL CUPS AND LUBRICATORS. Self-acting or other suitable lubricators to be fitted to the main bearings, crank pins, crossheads, and to all the moving parts of the machinery. All the cups and lubricators to be of cast brass and tinned inside.

75. WATER SERVICE. THe engines to be fitted with a water service arrangement, having galvanized iron pipes with copper branches for the main bearings, and crank pins, guides, thrust rings and tunnel blocks. Separate branches, fitted with cocks and union joints, to be provided for each main bearing and each side of each crank pin.

Tunnel blocks to have a branch at each bearing and branches to be provided to suit thrust rings.

Two 2" Hose Connections in Engine Room.

76. LAMPS. In addition to the electric light, all necessary oil lamps to be supplied and fitted by contractor in the engine and boiler rooms, and also in the tunnels. All the lamps to be of brass and to be suitable for burning mineral oil.

77. DRAWINGS. Two sets of prints mounted on cloth, of the main parts of the engines and boilers, including the pipe arrangement, to be supplied to the Owners.

78. GENERAL. The contractors are to fix the engines, shafting and boilers on board complete; fix all the usual eyebolts for lifting the several parts of the engines, and generally provide the whole of the fittings necessary for the proper

completion of the machinery, whether mentioned in this specification or not.

All royalties and charges for patents to be paid by the builders. It is to be distinctly understood that, where an option is given to supply various makes of auxiliary machinery or material, the selection rests with the Owners. Everything to be equal to that of the highest class.

79. TRIALS. The engines and boilers to be worked at moorings as long as may be necessary for making a thorough adjustment of the working parts, and afterwards to have the trials mentioned in Section 1 of specification, to prove to the entire satisfaction of the Owners or their representative the efficiency of the machinery. All the expense and risk of such trial trips, as regards the machinery, including cost of fuel, stores, and wages of the engine room staff, are to be defrayed by the Contractors. The engines to be opened up after trial, for examination and cleaning, and all defects, if any, to be made good.

80. GUARANTEE CLAUSE. The Contractors to guarantee the efficiency of the machinery in all particulars of design, material, and workmanship, and to make good or pay for the repair of all defects, if any, due to inferior materials or workmanship which may be observed within twelve months after the vessel is delivered; the amount to be paid for such repair and materials being limited to what same would cost if done or supplied in the Builder's yard.

81. OIL FUEL APPARATUS. The boilers to be arranged to burn oil fuel by a pressure atomization system of approved make.

The plant to consist of two pumps, each large enough for full power, to draw from the oil tanks and to discharge through the heaters to the furnaces.

The oil heating arrangement to consist of a battery

of three heaters, two of which to be of sufficient size to run the plant at full power.

The suctions from the tanks to be led as straight as possible with the usual suction strainers fitted.

The whole system to be installed in the latest approved manner.

No connection to be possible between the oil tanks and any other part of the ship.

A discharge connection, connected to both pumps, to be led up to main deck.

The oil tanks to be provided with steam heating coils, Drain from the heater to be led overboard.

81 a. SPARE GEAR

2 Propeller blades of bronze.
1 Piston rod for H. P. or M. P. cylinders, with nuts complete
1 " " " L. P. " " " "
1 Pair of bushes for H.P. or M.P. connecting rods, bottom end.
1 " " " " L.P. " " " "
1 " " " " H.P. or M.P. " " top "
1 " " " " L.P. " " " "
2 Pairs of bushes for eccentric rods, top end.
2 " " " " valve spindles.
1 Valve spindle, complete, to suit either H.P. or M.P.valves.
1 " " " to suit the L. P. valves.
2 Eccentric rods and straps complete (1 ahead and 1 astern)
100 Ferrules for tubes
50 Condenser tubes
Cord packing for tubes
1 Set of packing rings for each piston of main engines.
1 do. do. valve of main engines.
2 Bolts and nuts for main bearings.

SPARE GEAR COnt'd.

2 BOLts and nuts for H.P. or M.P. connecting rods, bottom end

2 Bolts " " " L.P. " " "

2 " " " " H.P. or M.P. " " top end.

2 " " " " L.P. " " " "

12 " " " " couplings to crank shafts.

1 Reamer for coupling bolts for main shafting.

8 Spiral springs for cylinder escape valves.

3 " " " safety valves of boilers.

1 " " "of each size and kind for other escape valves

24 Studs for junk rings for pistons, main engines.

100 Bolts and nuts of brass, turned, and assorted.

100 " " " iron " "

8 Studs and nuts for one propeller blade.

INDEPENDENT AIR PUMP.

1 Pump rod with nut

1 DELivery valve seat with guards.

1 Bucket with guards.

1 Set of valves (metallic) for one pump

CIRCULATING PUMP AND ENGINE.

1 Piston and rod with slipper, etc. complete.

1 Pair of bushes for connecting rod.

2 Bolts and nuts for -do-

2 Pairs of bushes for crank shaft.

1 Valve spindle.

1 Eccentric strap and rod.

1 Impeller with bronze spindle.

WEIR'S FEED PUMPS.

1 Set of suction and delivery valves and seats, of gunmetal for one pump.

1 Piston rod and pump rod complete.

1 Set of steam piston packing rings for each pump.

1 Set of pump piston -do- -do-

1 Shuttle valve and chest for weir's feed pumps.

BILGE AND SANITARY PUMPS.

1 Set of suction and delivery valves and seats for each pump.

1 Piston rod and pump rod, complete of each size.

1 Set of packing rings for one steam piston.

2 Packing rings for water piston for each pump.

FRESH WATER PUMP.

1 Set of suction and delivery valves and seats of gunmetal for each pump.

GENERAL SERVICE PUMP.

1 Set of suction and delivery valves and seats of gunmetal for each pump.

BALLAST PUMP.

1 Set of suction and delivery valves and seats of gunmetal for each pump.

ASH EJECTOR PUMP.

1 Suction valve and seat with spring, complete.

1 Discharge do. do. do.

BOILERS.

6 Feed check valves for boilers.

50 Plain tubes for boilers.

10 Stay tubes do.

6 Bolts for manhole doors.

1 Set of joints for the manhole doors of one boiler.

1 Sheet steel template for each size of boiler manhole door.

50 Gauge glass tubes for boilers.

50 Woodite rings for -do-

82. ENGINE ROOM FURNISHINGS.

2 Brass oil cans, one quart each.

4 Oil cans.

ENGINE ROOM FURNISHINGS Cont'd.

8 Oil feeders

2 " funnels.

1 Two gallon oil measure

1 One " "

1 HALF-gallon oil measure

2 Brass oil can drainers

1 " cock for oil barrels

1 " salinometer

1 Copper can for salinometer

1 Thermometer in copper case

Lamps for engine room as necessary

" " boiler gauge glasses as necessary

" " shaft tunnels as necessary.

1 Dark Lantern

1 Safety Lamp

6 Electric torches

4 Brass swabbing pots

2 Tanks for engine oil, 100 gallons capacity

1 Tank for cylinder oil, 40 " "

1 Tank for spern oil, 20 " "

2 Tanks for colza oil, 20 " "

1 Tank for tallow, 3 cwts. capacity

1 Tank for soap, 1 cwt. capacity

1 " " söda, 2 cwts. capacity

1 " " turpentine, 10 gallons capacity

1 Tank for boiled oil, 10 gallons capacity

1 Oil strainer of copper

1 Brass daily supply oil tank, in three compartments with a lock cock on each

1 Japanned tin box for sulphur

1 " " " " black lead.

1 " " " " emery cloth

1 " " " " lamp wick.

1 Brass syringe.

3 Log Slates

1 Copper kettle and stand.

NOTE:- All the furnishings to be of the best make and to approval.

83. ENGINE ROOM TOOLS.

1 Set of drills from 1/4 inch to 1-1/4 inch

2 Ratchet braces

2 Force "

1 Drilling post, fixed at vice bench

Gear for removing and replacing U. S. packing

2 Pairs of eye bolts, each 1/2 inch, 5/8 inch, 3/4 inch, 1 inch and 1-1/4 inch diameter

1 Tail vice, 90 lbs.

1 Vice bench with drawers.

1 Six inch hand vice.

1 Pair of copper vice grips

1 Pair of lead -do-

12 Steel wedges, assorted

12 files, assorted, with handles

4 Hand hammers

1 Copper hammer

6 Chipping chisels, assorted.

3 Beam grabs.

1 Face plate of approved size.

1 Pair of iron blocks, with brass sheaves and fall, each pair to lift three tons (three and three sheaves)

1 Pair of iron blocks, with brass sheaves and fall, each pair to lift 30 cwt. (three and ~~three~~ two sheaves)

1 Set patent differential blocks, to lift 2 tons through three feet.

2 Pairs crank pin chain blocks, each pair to lift 16 cwts. hook to pass through bolt holes.

ENGINE ROOM TOOLS Cont'd.

2 Snatch blocks, with sheaves, brass bushed.

4 Chain slings for cylinder covers, assorted.

4 Rope slings, assorted lengths and sizes.

12 Shackles, assorted.

2 Stretching screws.

1 Screw Jack to lift 5 tons.

2 Smiths' hand hammers.

3 Copper drifts.

6 Sheets of tinplate

1 Special steel box spanner for nuts of propeller blades.

2 Box spanners for junk ring screws.

6 Shifting spanners, 2 ten inches, 2 sixteen inches, and 2 twenty-two inches.

1 Set of valve sticks.

2 Crank shaft gauges

1 Sheet steel cone template for propeller boss and key seat.

2 Crowbars.

1 Grindstone and trough, 24 inches diameter, fitted where required.

4 Packing screws, assorted.

6 " sticks, "

6 File scrapers, with handles

4 Scrapers for brass with handles

1 14 inch bow saw, with 24 spare blades

1 Pair of tinsmiths' shears, 12 inches long

1 Pair of lamp scissors, 6 inches long

1 " ordinary " 8 do

1 set of condenser tubing tools, complete

2 Soldering irons - one large and one small

1 Arkansas oil stone, in case.

1 Mallet of wood.

2 pairs of pliers, 8 inches long

2 " purchase pliers

1 portable forge with fan blast

ENGINE ROOM TOOLS Cont'd.

2 Pairs smiths' tongs

3 Smiths' sets.

3 " creases

1 Poker for forge

1 Smiths' anvil, medium size

4 " cold chisels

4 " hot "

NOTE: All the engine room tools to be of the best make and to approval.

84. BOILER ROOM TOOLS.

2 Dudgeon's tube expanders, one for plain tubes and one for stay tubes.

2 Steel drifts.

2 Tube caulkers

3 caulking tools

1 Riveting hammer

1 Holding on "

2 cleaning rakes

4 Mud rakes

4 Valve scrapers, double-ended

18 Tube brushes

8 Brush handles (Tube)

8 Tube stopper rods, each with two cast iron washers

1 Steel coal barrow

2 Ash buckets.

NOTE: All the boiler room tools to be of the best make and to approval.

In the event of a decision being made during construction to change the vessel to a coal burner, the usual furnace fittings and firing tools will be supplied. The alteration in cost to be adjusted, taking into account the progress of the work.

It is understood that the vessel will be either an oil burner or a coal burner.

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