REPORT

ON THE TRIALS OF THE

FOTTINGER TRANSFORMER TWIN SCREW TURBINE STEAMER.

"KONIGIN LUISE"

(Hamburg American Line, Channel Service.)

BY

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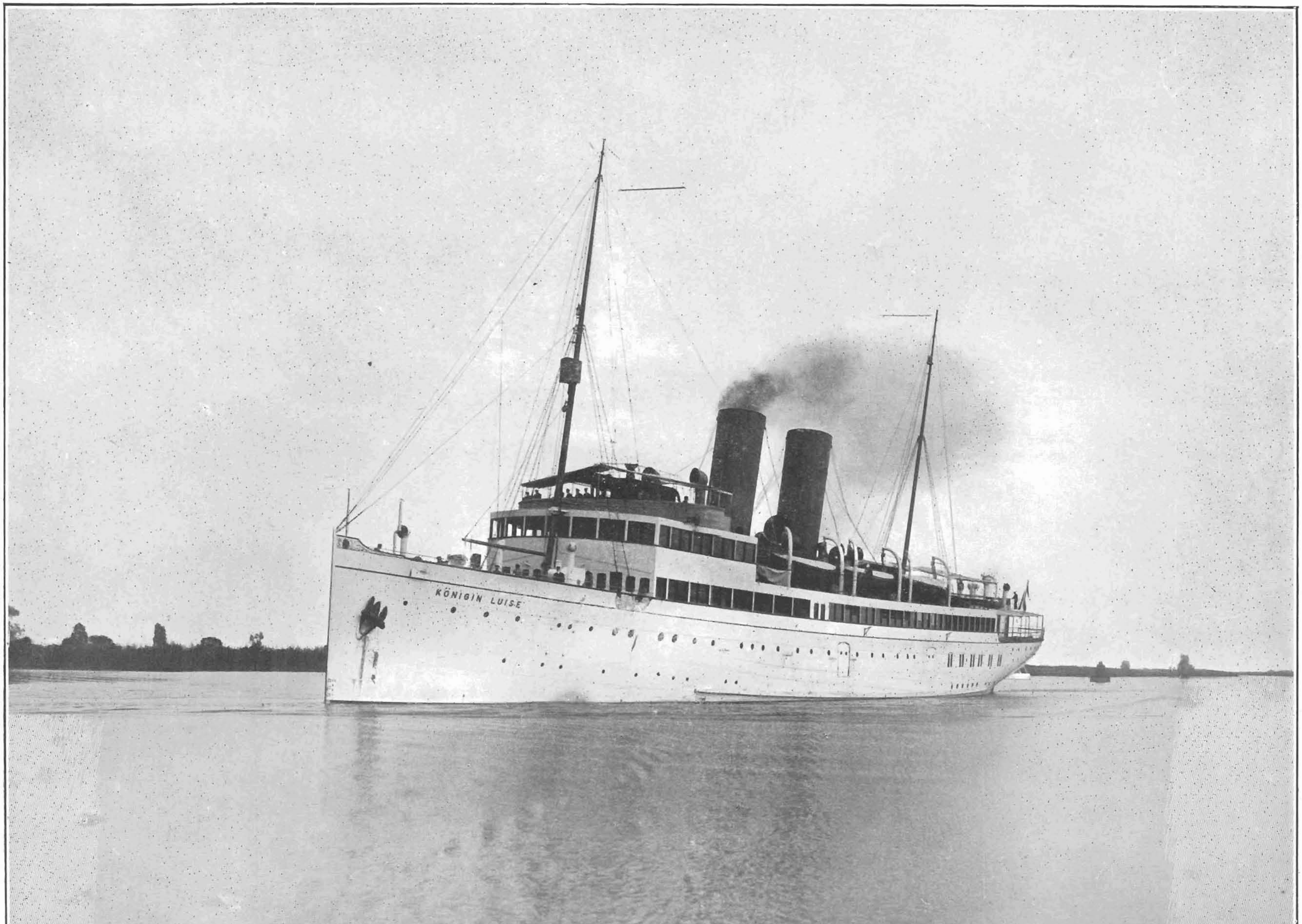

T.S.S. "KONIGIN LUISE."

J. H. BILES & CO.

Broadway Chambers, Westminster,
London, S.W.

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STEAM TRIALS OF THE FOTTINGER TRANSFORMER

IN THE

TWIN SCREW TURBINE CHANNEL STEAMER "KONIGIN LUISE."

The necessity for high revolutions in the turbine and low revolutions in the propeller, in order to obtain the maximum efficiency of both, causes the selection of some system of reduction of revolutions by a transformer to be a problem requiring immediate solution in a large number of cases of new ship designs.

The mechanical gearing of the Parson's type has been successfully tried for ranges of speed of ship in which a directly coupled turbine is wasteful. The ratio of reduction in the cargo steamer "Vespasian" was 19·9:1; with a service speed of 10 knots. In the cargo steamer "Cairnross" the ratio was 26:1; with a speed of 10 knots. In the cross channel steamer "Normannia" the ratios were 6·4:1 and 4·45:1 in the h.p. and l.p. respectively, or a mean ratio of 5·4:1 and a service speed of 18 to 19 knots.

The Fottinger hydraulic transformer is principally suitable for the last mentioned type, *i.e.*, where the shaft-horse-power required is large in proportion to the displacement, as in Cross-Channel Steamers; Destroyers and Light Cruisers; or equally in the case of vessels of large tonnage of 18 knots and over, *e.g.*, Atlantic Liners, fast Mail Steamers, Armoured Cruisers, and Battleships.

In the Channel Steamer "Konigin Luise" the Fottinger hydraulic transformer was adopted. Its reduction ratio is 4:1 at full power. This, however, is not the economical limit of ratio. Several Fottinger Transformers of large power are at present under construction with ratios of 5:1 and of 6:1.

The results of the Fottinger system as applied in the "Konigin Luise" are given herewith, in order to enable an idea to be formed of the gain in efficiency which has been obtained by the hydraulic transformer as compared with a directly coupled turbine installation; a comparison is also made with a similar type of mechanically geared ship.

The "Konigin Luise" is of the following dimensions :—

Length B.P.	275 ft.
Breadth (moulded)	38·62 ft.
Depth to Promenade Deck	23·45 ft.
Draught loaded	9·75 ft.
Displacement	1,800 tons.

She has three boilers of the Yarrow water tube type, fitted with uptake superheaters and Howden's hot air forced draught. The amount of superheat is, however, small, being about 70°F. The superheating surface is 3,000 sq. ft. The working pressure of the boilers is 240 lbs. per sq. inch.

The total boiler heating surface is	12,220 sq. ft.
„ grate „ „	258·1 sq. ft.
H.S./S.H.P. =	2.44 sq. ft.
S.H.P./G.S. =	19·3 sq. ft.

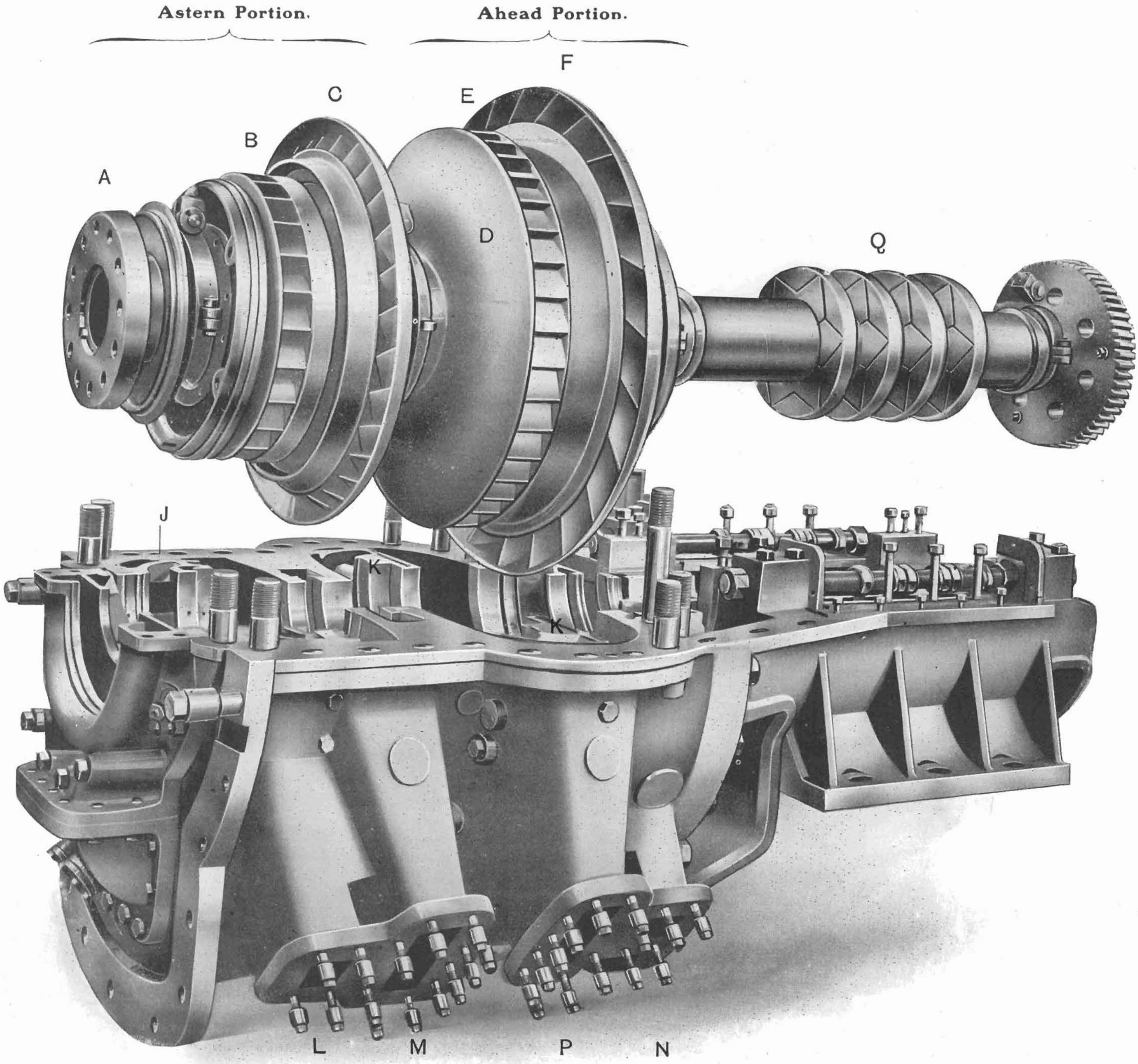
There are two independent turbine sets, each designed to give 3,000 b.h.p. at 1,800 r.p.m. They are fitted, one on the port and the other on the starboard side of the ship. These turbines are in hydraulic connection with the port and starboard propeller shafting through the Fottinger transformers.

ADVANTAGES.

The principal advantage of this system of transmission is that the astern turbine is dispensed with, and consequently there is a considerable reduction in the losses due to an astern turbine, and there is a saving of weight and space. Further, the main turbine can be run at a speed which is practically constant, and is in one direction only, so that during manœuvring there is no sudden change of temperature in the steam. In a reversing turbine, which must usually be not much hotter than the condenser, the inflow of boiler steam has a tendency to cause damage. Steam, with a considerable amount of superheat can be used, without fear of damage to the turbines when the Fottinger Transformer is used. Also, great rapidity of reversing is obtained by this system, and freedom from noise.

STEAM TURBINES.—The turbines in the "Konigin Luise" are of the combined impulse and reaction type, the impulse part being aft of the reaction. Steam nozzles, arranged in three groups of twelve each are fitted. Under normal working conditions, two groups only are in use, but for extra power a third group controlled by a separate stop valve can be used. The nozzles are arranged circumferentially on the aft end of the casing at a radius from the centre line of the shaft of about 2 ft. 6 in.

In the impulse part of the steam turbine there is one Curtis wheel having two rows of buckets. There are seven expansion stages in the reaction part. The exhaust is led to the condenser from the low pressure end of the turbine through a large exhaust bend On the forward end of the turbine shaft a centrifugal governor is mounted which operates a small piston valve in a valve chest, connected by means of a system of piping to a



STARBOARD ASTERN AND AHEAD TRANSFORMER AND THRUST BLOCK ("KONIGIN LUISE.")

Overall Length, 10 feet. | **Maximum Diameter Outside Casing 4 feet 2 inches.** | **Weight, 7 tons.**

A Turbine Coupling.

B Astern Primary Wheel.

C Astern Secondary Wheel.

* **D** Position of Ahead Primary Wheel.

* NOTE.— This wheel cannot be seen on illustration as it is concentric with and revolves inside No. 1 ahead secondary Wheel **E**.

E No. 1 Ahead Secondary Wheel.

F No. 2 Ahead Secondary Wheel.

J Fixed Astern Guide Wheel.

K Fixed Ahead Guide Wheel.

L Entry of water from Discharge Pump— astern portion.

M Exit of water — astern portion for manœuvring purposes.

N Entry of water from Discharge Pump— ahead portion.

P Exit of water — ahead portion for manœuvring purposes.

Q Thrust Block.

balanced piston valve which works the main throttle valve for regulating the admission of steam to the main turbine nozzles: the pressure for working this system is obtained from the main feed line. The object of this governor is to control the speed of the main turbine automatically when manœuvring. The throttle can also be worked from the starting platform by means of a handwheel and rod. The governor also operates the steam throttle valve on the water pressure or make-up pump for the transformer. The speed of this latter pump can also be controlled from the starting platform.

THE TRANSFORMER.

Ahead Section.—Keyed on to the after end of the primary or turbine shaft is the primary water wheel. Keyed on to the propeller shaft are two secondary stage wheels which are bolted together. The water from the primary wheel delivers up part of its energy to the vanes in the first secondary stage wheel. From here the water is led through stationary guide blades fixed in the casing, to the secondary stage wheel, where it delivers up the remainder of its energy, and it is then returned to the suction side of the primary water wheel, where it receives energy by acceleration from the primary shaft, and the operations above described are repeated. Some leakage takes place during the passage of the water at a high pressure. This leakage is made up as is described later.

The Astern Section is somewhat different. The primary water wheel is contained in a separate chamber forward of the ahead section and is keyed on the turbine shaft. This wheel discharges through blades which are fixed in the casing, and are set so as to reverse the direction of the flow into the secondary wheel. This wheel is bolted to the first secondary stage wheel of the ahead section, and through this is connected to the propeller shaft, which it drives in an astern direction. Owing to less power being required for going astern, sufficient energy can be extracted from the water in one stage, so that there is only one secondary stage wheel in the astern section of the transformer instead of two, as in the ahead. The astern power is about 70 per cent. of the ahead power.

It will be seen from the above that, when manœuvring, the main turbine can be kept running at a constant speed in one direction. This speed is controlled by means of the governor.

The Make-up Pump is of the centrifugal type, having its shaft vertical, and is driven by a small independent impulse steam turbine. The pump chamber is submerged in the tank which supplies water to the transformer. The pump discharges through the main manœuvring valve into either the ahead or astern portion of the transformer. Boiler feed water is used for the transformer, and is being constantly heated owing to the work done upon it in the transformer. In order to save this heat and put it back into the boiler, part of the water from the air pump discharge is admitted through a regulating valve to the transformer tank, and an equal amount is drawn off (by means of a branch in the discharge pipe which leads from the make-up pump to the transformer), and is led to the main feed pump suction tank.

There is an indicator above the engine room floor, which shews the water level in the transformer tank, so that it may be seen that the amount of water sent back to the boiler from the transformer is equal to the amount put into the tank.

The pressure of the discharge from the make-up pump is about 57 lbs. per sq. in., and the temperature is usually regulated to about 170°F. In addition to the gain due to saving this amount of heat for the boiler, it is also found that there is a considerable gain in the efficiency of the drive by using water at this high temperature, owing to the viscosity of the water being less than at lower temperatures.

The function of the make-up pump is to replace the water which leaks from the stages of the transformer: it also, when manœuvring, supplies water to the ahead or astern primary water wheel in the transformer. The discharge from the make-up pump is led to the transformer through the main manœuvring valves. These valves are placed horizontally, and are of the balanced piston type, worked by a hand lever from the starting platform. The ports in the valve chest are so arranged that when the primary ahead pump chamber is open to receive water, the primary astern chamber is open to the drain tank, and *vice versa.*

The ports in the valve chest and the ports in the valve are so arranged that both the ahead and astern chambers can be emptied simultaneously (which is what occurs when the manœuvring value is in its mid position and the secondary shaft is stopped), but it is impossible to fill both at the same time.

The ratio of reduction, *i.e.*, the ratio of the turbine revolutions to the propeller revolutions at which the set is designed to run in this ship, is 4:1. This ratio can be temporarily increased for manœuvring purposes by slowing-down the make-up pump, which causes the water wheel to cavitate. The make-up pressure is regulated according to the desired number of secondary revolutions. A thrust block is fitted aft of the transformer, which takes up any difference of thrust there may be between the propeller shaft and the secondary stage water wheels in the transformer. There is also a thrust bearing fitted on the forward end of the turbine shaft to take up the difference between the steam thrust in the turbine, and the water thrust in the primary water wheel of the transformer.

THE EFFICIENCY OF THE TRANSFORMER.

The actual losses in the transformer may be classified as follows:—

1. Energy dissipated in fluid friction.
2. Heat lost by radiation.
3. Heat lost by conduction.
4. Friction of bearings, thrust, &c.

Of these the first is by far the greatest.

A very complete series of tests were carried out by the Vulcan Company on the starboard set before it was fitted in the ship.

The secondary horse power was measured by means of a water brake, and the friction and other losses in the transformer were obtained by measuring the amount and rise in temperature of the leakage water from the transformer. The mechanical equivalent of this amount of heat, plus the friction in the bearings, added to the secondary s.h.p., gives the primary horse power. Every precaution was taken to make the temperature and water calibrations as reliable as possible.

It was found that the efficiency of the transformer varied with the temperature of the water in the transformer. This is due to the difference in the viscosity of the water. The fluid friction diminished at the higher temperature.

With the transformer temperature (*i.e.*, the working temperature) at 170°F. and at 1,070 s.h.p. (40% of full load), the efficiency, including thrust block=88% from which it may be safely stated that at 2,700 s.h.p. the efficiency would be 89%.

TRIALS.

The vessel was tried at full power on the 24th and 26th September, 1913, in the presence of the representatives of the owners, the Hamburg American Line. The contract speed of 20 knots was obtained with a s.h.p. of 5,330 on 453 revolutions of propeller. The mean results, as taken by the Vulcan Company, are shewn in Table "B," where the results of this trial of the "Konigin Luise" are compared with the trial of the "Normannia," a geared turbine ship, and "Cæsarea," a direct driven turbine ship.

On October 17th, 1913, a further trial was made at which the writer was present, and the results of this trial are given in Table "A," and are detailed hereunder. During this trial the average shaft-horse-power was 4,550 or 16% lower power than the full Power Trials shewn in Table "B," and this difference is reflected in the water and coal consumption results.

PARTICULARS OF TRIAL ON OCTOBER 17th (TABLE "A.")

The vessel left the dock at Hamburg at 9.45 a.m., drawing 10 ft. 2 in. forward and 10 ft. 7 in. aft. The weather was calm and fine.

MANŒUVRING TRIALS.—At 1.20′. 44″ p.m., the telegraph was put full speed astern. At 1.22 the ship was absolutely stopped, time taken 1 minute 16 seconds, distance run not more than two lengths.

The revolutions before the telegraph was rung down was 430 starboard and 435 port, corresponding to about 19 knots.

The time to reverse the shaft was 8 seconds, and in another 16 seconds the propeller was running astern at 320 revolutions starboard and 310 port. These times were taken from the ringing of the telegraph to the moment when the propeller shaft stopped or reached its maximum revolutions astern.

This experiment was repeated at 1.31 p.m., the time taken to stop the ship being 1 minute, 10 seconds. The revolutions in this case were 430 starboard and 420 port, and the vessel stopped in about the same distance, namely, a little under two lengths. In this case the time to reverse the shaft was 4 seconds. It took 20 seconds more to bring the revolutions to 320 starboard and 310 port.

At 1.44′.16″ p.m., a third experiment was tried. The engines were running about 430 starboard and 410 port. The propellers were stopped in 3 seconds, and were not moved for some considerable number of seconds, when they were put to full speed astern, and in 4 seconds from the time the valve was opened they were running at 370 revolutions. In this case it took 1 minute 17 seconds to stop the ship, but the stopping was done in about a length and a half. It seems as if the immediate reversing of the engines on the stopping of the propellers is not so good as allowing them to go for some seconds without being reversed.

CONSUMPTION TRIALS.

The vessel then proceeded to sea and reached Heligoland at 4.55 p.m. On the way out, between No. 3 to No. 1 lightships, the mean speed over the ground was 20·15 knots. On the return journey, the speed over the same distance was 17·5. The average revolutions maintained throughout the whole of the run were port 420, starboard 416. The mean speed between these lightships was 18·82 knots, and the revolutions 418 port and 413 starboard. On the way back the revolutions were 423 port and 417 starboard.

During part of the run, from 5.0 to 5.15 p.m., the revolutions were 430 port and 425 starboard. The mean horse power, corresponding to the revolutions between the lightships out and home, was 4,480. On the high speed run, which was not done between these lightships, the s.h.p. was 4,810, and the revolutions 427½. The speed for this quarter of an hour was not measured, but it is estimated to be about 19.26 knots.

The water in which the vessel was running was shallow, so that the speed obtained is not a fair measure of the deep water speed. But as the trial was made to test the economical and manœuvring qualities of the vessel, extreme accuracy in speed is of minor importance.

The results are given in Table "A" from which it will be seen that the water consumption per shaft-horse-power is 12.46 lbs. for turbines and transformers (at 4,550 s.h.p.), as compared with results shown in Table "B" of 12 lbs. at full load trial (5,330 s.h.p.).

The equivalent measured coal was 1·38 lbs. per shaft-horse-power (4,550 s.h.p.) (including auxiliaries). The coal ("Westphalian steam") was sampled and tested at the University of Glasgow, and the ascertained calorific value = 12,220 B.T.U.

(NOTE.—The measured coal as given by the Vulcan Company in trial on 26th September (5,330 s.h.p.) was 1·31 lbs. per s.h.p. The calorific value of the coal given by the Vulcan Company on such trial = 13,500 B.T.U. It is, therefore, evident that very inferior coal was used for the trial on the 17th October.

The Vulcan Company had a large record party on board, and readings were taken simultaneously every two minutes for the following:—Main steam pressure, nozzle steam and temperature, primary and secondary revolutions, and torsionmeters: these readings were plotted to a base of time, and the means taken for every 15 minutes are given in Table "A."

At 5 p.m. the power was increased for 15 minutes: the average pressure at the nozzles was 181 lbs. per sq. in., and the mean s.h.p. was 4,810 at 427·5 mean revolutions a minute.

The pressure in the fan casing	was about	$3\frac{1}{2}$ in. water.
,, ,, ash pits	,,	$1\cdot\frac{7}{8}$ in. water.
,, ,, furnaces	,,	$\frac{3}{4}$ in. water.

The following auxiliary machinery was working—three fan engines, one dynamo, two air, feed and circulating pumps, sanitary pump and two make-up pumps.

The machinery worked very satisfactorily throughout the three hours, and there was practically no noise or vibration from the transformer when going ahead. Also, the results of the manœuvring trials shew that this form of transmission is very efficient for quick manœuvring.

At the conclusion of the three hours' trial the ship was stopped, in order to see whether the zero position of the torsionmeter indicator had moved from that observed before starting. It was found to have slightly altered, and the mean of the two readings was taken as the true zero, from which the s.h.p.'s have been determined. The ship then proceeded up the river and arrived at the Vulcan wharf at 11.35 p.m.

The measurement of the shaft-horse-power was taken by means of the Fottinger torsionmeter, which measures the angular twist over a certain length of the shaft. The instrument and shaft were carefully calibrated in the shop after the trial, and the assumed constant mutiplier for the twisting moment, and also the magnification ratios of the instrument, were found to be correct.

The steam consumption was measured by recording the steam pressures in the nozzle used. It is known that the amount of steam which passes a nozzle, depends on the size and shape of the nozzle, and the pressure and temperature of the steam. This amount can be estimated. But to have no doubt, the main turbine nozzles were taken from the ship after the trials, and the steam consumption was obtained by calibration of the nozzles.

The nozzles were fitted to the exhaust receiver of the condenser in the test house, and connected up to the power house boilers. The steam pressure and temperature were measured by the same gauges and thermometer as were used on the trial. The condensed steam was pumped by the air pump out of the condenser and discharged into a measuring tank. Each group of nozzles was tested at three different pressures, each for one-half hour. The results obtained confirmed the results of previous trials witnessed by the Hamburg Baupoliziebehorde.

COMPARISON OF "CÆSAREA," "NORMANNIA," & "KONIGIN LUISE."

Reference to Table "B" shews the principal results of the full load trial of the "Konigin Luise" taken on the 26th September, as compared with the published results for the mechanically geared "Normannia," and the direct driven turbine vessel "Cæsarea."

From these it will be seen that as far as the results have been taken there is practically no difference between the first named two vessels in the coal consumption per s.h.p. for all purposes. The steam consumption per s.h.p. for turbines and transformers only at the maximum s.h.p. obtained is 12 lbs. in the "Konigin Luise" (5,330 s.h.p.); which is the same as that obtained in the "Normannia" when running at 5,000 s.h.p.; as against 15·1 lbs. in the direct driven turbine steamer "Cæsarea" at 6,675 s.h.p.

(*Signed*) J. H. BILES.

TRIAL RESULTS A

T.S.S. “ K

OCTOB

BETWEEN CUXH

Time p.m.	Revolutions per minute. Primary. Port.	Primary. Starbd.	Secondary. Port.	Secondary. Starbd.	Torsion Meter Readings. Port.	Torsion Meter Readings. Starbd	Secondary. Twisting Moment. Port. (Foot-lbs.)	Secondary. Twisting Moment. Starbd. (Foot-lbs.)	Secondary. Shaft-Horse-Power. Port. (English units.)	Secondary. Shaft-Horse-Power. Starbd. (English units.)	Secondary. Shaft-Horse-Power. Total. (English units.)
4.0—4.15	1665	1715	418	413	87·5	52	29200	26850	2330	2110	4440
4.15—4.30	1680	1720	420	417	87·6	54 7	29250	28300	2345	2250	4595
4.30—4.45	1678	1720	420	416	87 2	54·5	29100	28100	2330	2220	4550
4.45—5.0	1672	1725	419	415	86 6	53·6	28900	28100	2310	2210	4520
5.0—5.15	1715	1750	430	425	91·5	55·4	30550	28600	2500	2310	4810
5.15—5.30	1680	1715	421	415	87·1	52·4	29000	27050	2330	2130	4460
5.30—5.45	1675	1725	421	417	88·0	53·5	29400	27650	2350	2200	4550
5.45—6.0	1677	1725	421	418	86·8	53·4	28950	27600	2320	2200	4520
6.0—6.15	1672	1720	423	417	87·0	53·0	29000	27350	2335	2170	4505
6.15—6.30	1675	1730	422	418	87·2	53·4	29100	27600	2335	2190	4525
6.30—6.45	1620	1730	413	408	89·5	55·5	29900	28650	2345	2230	4575
6.45—7.0	1680	1720	417	411	87 6	55·5	29250	28650	2320	2250	4570
Means for 3 hrs. 4.0—7.0	1680	1725	420	416	87·8	53·9	29300	27850	2346	2206	4550

COUNTER READINGS.

Time.	Port.	Starbd.
3.14 p.m.	1517560	2300350
7.18	1620030	2401620
4 hrs. 4 min.	102470	101270
Revs./min.	419·9	415·1

Total Coal burnt 18,96

ANALYSIS OF COA	
Moisture ...	2·7
Ash ...	9·4
Volatile ...	11 8
Sulphur ...	0·7

TABLE A.

AT 84 % OF FULL POWER.

ONIGIN LUISE,"

ER 17th, 1913,

IAVEN & HELIGOLAND.

Steam Pressure at Turbine Nozzles. (Gauge).		Temperature of Steam at Nozzles.	Vacuum Barometer 30·7″		Condensed Steam Main Turbines.			Water per S.H.P. per hour.			
Port.	Starbd.	°F.	Port.	Starbd.	Port.	Starbd.	Total.	Port.	Starbd.	Total.	
lbs./ins.²			Inches, Mercury.		lbs./hr.			lbs./S.H.P./hr.			
170	171	436	28·5	28·78	29250	27300	56550	12·54	12·94	12·74	
171	172	440·6	28·39	28·72	29400	27450	56850	12·53	12·21	12·37	
171	170·5	437	28·35	28·68	29500	27400	56900	12·66	12·34	12·5	
170·5	171	440	28·31	28.68	29400	27210	56610	12·71	12·32	12·52	
181	181	449	28·31	28·62	30810	28570	59380	12·33	12·36	12·35	
170·5	170·5	449·6	28·31	28·66	29180	27080	56260	12.51	12·7	12·61	
171	171 5	453	28·35	28·7	29250	27120	56370	12·44	12·33	12·39	
170	173	453·5	28·35	28·8	29080	27300	56380	12.53	12·41	12·47	
171	170·5	454	28·26	28·86	29250	26920	56170	12·52	12·41	12·46	
171·5	171	458	28·43	28·86	29250	27080	56330	12·52	12·36	12·44	
171	171·5	458	28·47	28·91	29150	27100	56250	12.43	12·3	12·3	
170	171	451	28·47	28·9	29080	27080	56160	12.54	12·06	12.3	
171·5	172	448·3	28·38	28·76	29380	27300	56680	12·52	12·4	12·46	Means 3 hrs
		72° Superheat									

lbs. = **6,321 lbs./hr.**

= **1·38 lbs./S.H.P./hr.**

Make-up Pump 3800 revs./min.

Pressure 57 lbs./ins.² Temp. 118 °F.

Circulating Pumps 180 revs./min.

Air Pumps, 48 double strokes/min.

L.**	
%	Calorific Value G. Wright Thompson Calorimeter = 12,220 B.T.U.
1	
5	
0%	

TABLE B.

COMPARATIVE TABLE OF FULL POWER TRIALS.

	" CÆSAREA " (Turbine direct driven)	" NORMANNIA " (Mechanical Gear).	" KONIGIN LUISE " (Hydraulic Gear).
Date of Trial.	January, 1911.	23rd February, 1912.	26th September, 1913.
Length B.P.	284 ft.	290 ft.	275 ft.
Breadth Moulded	39 ft.	36 ft.	38 ft. 7 ins.
Depth	23 ft. 10 in.	23′ 6″	23 ft. 6 ins.
Draught (trial)	12 ft.	12′ 3″	9 ft. 9½ ins.
Displacement at D	1990	1864	1800
Propeller diameter	5 ft. 6 in.	8′	6 ft. 6¾ ins.
,, pitch	5 ft. 6 in.	7′ 6″	5 ft. 7 ins.
,, area (projected) ...		17′ 7″ sq. ft.	18.1 sq. ft.
,, area (developed) ...		20.4 sq. ft.	20 sq. ft.
S.H.P.	6670	4980	5330
Revs. per minute	500	310.25	453.32
Speed—knots	20	19.68	20.05
No. of Shafts	3	2	2
BOILERS—type	2 D.E. 23·0 × 16·3	1 D.E. & S.E. cylindrical M.M.	3 Yarrow W.T.
Working pressure	160 lbs. per sq. in.	160 lbs. pr. sq. in	240 lbs. per sq. inch.
Draught	Close Stokehold.	Closed Stokehold 0.5″	Howden hot air, 2.3″ water.
Superheat	None	None.	70°F
Heating Surface	12,985 sq. ft.	10,221 sq. ft.	12,222 square ft.
Grate Surface	338 sq. ft.	303 sq. ft.	258 square ft.
H.S/S.H.P	1.94 sq. ft.	2.05 sq. ft.	2.29 square ft.
S.H.P/G.S.	19.8	16.4	20.6
H.S/G.S.	38.5	33.7	47.7
TURBINES—type	Parson's re-action. 1 H.P. on centre shaft and 2 L.P.'s on wing shafts.	Parson's reaction 1 H.P. & combined L.P. and astern on each shaft.	1 Curtis Vulcan combined impulse and reaction on each shaft.
Receiver pressure	145 lbs. per sq. inch	145 lbs. pr. sq. inch.	176 lbs. per sq. in.
Vacuum	28.3″	28.25″—28.1″	28.27″—28.31″
Feed temperature	190° F.	190° F	198° F.
Revs. per minute	500	1990 H.P. 1365 L.P.	1827
Reduction ratio	Direct drive.	5.4:1	4.03 : 1
Weight—Turbines and Gearings	——	77 tons	42 tons
***STEAM**—per S.H.P. per hr. turbines and reduction gear, but excluding auxiliaries ...	(1) 15. 1 lbs. per hour. (estimated)	(2) 12.2 lbs. per hour. (estimated)	(3) 12 lbs. per hour. (actual)
COAL consumption, all purposes lbs. per hour	At 6670 S.H.P. = 10472 lbs.	At 4980 S.H.P. = 6720 lbs.	At 5330 S.H.P. = 7050 lbs.
COAL per S.H.P/hr. all purposes	1.72	1.34	1.31 †
Duration of trial	6 hours.	6 hours.	3 hours.

					Estimate for Auxiliaries.
* Note.—(1)	Actual steam per s.h.p. including auxiliaries	—	17·1	—	2·0
(2)	,, ,, ,, ,, ,,	—	14·0	—	1·8
(3)	,, ,, ,, excluding ,,	—	12·0	—	1·6

† Calorific value = 13,500 B.T.U.