

THE RUSSIAN VOLUNTEER FLEET.

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THE prominence into which the ships of the Russian Volunteer Fleet have been brought during the present war between Russia and Japan seems to make this a suitable time to bring the Fleet, and more especially the faster portion of it, to the notice of this Institution.

CONSTITUTION AND OBJECTS OF THE RUSSIAN VOLUNTEER FLEET ASSOCIATION.

The Volunteer Fleet was originally founded as a material expression of the wish of the more wealthy Russians, especially those of Moscow, to assist their Government, then at war with Turkey, by providing vessels which would be of use as transports and auxiliary cruisers, and be self-supporting as liners in time of peace. Encouraged by the heir-apparent who subsequently became Czar Alexander III., committees were formed in all the chief cities with an administrative committee in Moscow, and their formation was followed by the purchase, in 1877-8, of four vessels belonging to the North German Lloyd Company, which were re-named the *Rossia*, *Petersburg*, *Moskva*, and *Nijni-Novgorod*, and were used at the conclusion of the Russo-Turkish war to bring troops back to the Russian Black Sea ports. On the conclusion of peace in the summer of 1878 preparations were made to open a line to the Far East, and these four vessels sailed for their first voyage in the autumn of that year, and during the next ten years six other vessels were purchased.

The early career of the Volunteer Fleet as a trading organisation was not such as to encourage its founders, and there was considerable conflict of opinion as to whether it should be continued as a separate institution or transferred to the Russian Steam Navigation Company. The former course was decided on, and ten years after its foundation the whole organisation was transferred to the control of the Ministry of Marine, a definite policy of building inaugurated, and its constitution and objects clearly defined as being for the maintenance of a cargo, passenger, and postal service between Odessa and the East, and the general development of national commerce, all the operations of the Fleet being on a commercial basis.

The funds of the Volunteer Fleet as now constituted consist of:—

- (1) The assets of the original company.
- (2) Donations.
- (3) Profits of commercial operations ; and
- (4) Subsidies from the Government.

The vessels of the Volunteer Fleet have to make not less than eighteen trips annually between Odessa or Petersburg and Vladivostock, calling nine times out and nine times home at both Port Arthur and Shanghai. A number of compulsory voyages are fixed annually for carrying convicts to the Island of Saghalien, calling at the ports of Alexandrovsk and Korsakovsk. A scheme of sailings with rates for cargo and passengers is drawn up every year by the Committee, and approved by the Ministers of Marine, Finance, War, Interior, and Ways and Communications. These rates hold good for the ensuing season, and are subject to a rebate of 20 per cent. to passengers travelling on Government service. A special tariff is arranged for rank and file, peasants, emigrants, convicts and their families, who accompany them voluntarily, and also for any Government cargo. 30 cwt. of mails and postal parcels are carried free by each vessel in specially constructed compartments, above which weight freight is paid. Couriers and special messengers travel free, except for the cost of their food.

The Fleet takes precedence over all other steamship companies in the carrying of troops, military and naval stores, &c., but has, however, the right to refuse this service if the ship is already appointed for the service of some other Government department, or if the cargo to be despatched by the War or Naval department is not ready at the time of sailing. The Minister of Marine has the right to hand over the vessels of the Volunteer Fleet temporarily for the use of the Naval or War departments, on conditions to be agreed between these Ministers and the Imperial Control.

The demand for subsidies is submitted for decision in the usual course to the Council of State, and, if approved, the amount allowed is paid by the Government for a definite period of time, depending on the conditions under and in which the Fleet is at the time, and are payable at the beginning of each year, subject to any deductions for the non-fulfilment of the previous year's sailings.

The obligations of the Volunteer Fleet are—to build or acquire ocean-going steamships corresponding to its aims, and the necessary offices, workshops, quays, warehouses, and other adjuncts for its business.

The ships, offices, and agents of the Volunteer Fleet are free from the Imperial Commercial Tax.

The commanders, officers, engineers, and doctors on the ships of the Volunteer Fleet are taken from the Active Navy List from amongst the retired naval officers or from any Russian subjects trained for the Naval service. The commanders, as also the heads of offices and agents, are approved by the Minister of Marine on the recommendation of the President of the Committee, who himself appoints the remaining officers. Naval officers receive no remuneration from the Government, but their time on the Volunteer Fleet service counts in regard to their pension, and they may retain their post after the expiration of the time limit for Navy service.

The Committee, to whose administration the Volunteer Fleet is entrusted, meets at least once a week, and is directly subordinate to the Minister of Marine. It consists of a President, who is appointed from among the admirals on the active list, having no

other appointment or occupation, by Imperial command, on the recommendation of the Minister of Marine, two members from the Ministry of Marine, one member from the Ministry of Finance, one member from the War Office, and a representative of the Imperial Control, who has not, however, the right of veto. The Inspector, or, as he would be termed in England, the general manager, is recognised as a consulting member of the Committee. A representative of the Ministry of the Interior with the right of veto attends the meetings when matters affecting this department are under consideration.

Reserve and Insurance Funds are established, the former being obtained by an annual charge on the trading profits equal to 5 per cent. on the first cost of the ships and real estate of the Association, and the latter by a similar charge of 3 per cent. on the present value of the ships. The first charge ceases when the ships are written down to 5 per cent. of their total original cost, and the latter when the Insurance Fund reaches and does not fall below one-third of it.

Provision is made whereby the Inspector, Committee, and staff benefit by the prosperity of the Association.

The funds, transactions, and accounts are under the supervision and inspection of the Imperial Control, and subject to special rules drawn up by it with the approval of the Minister of Marine.

SHIPS OF THE RUSSIAN VOLUNTEER FLEET ASSOCIATION.

In considering the ships of the Russian Volunteer Fleet it is only proposed to deal with vessels specially designed for its service, and these may be divided into three classes:—

- (1) Vessels for special service in the East.
- (2) Low-speed vessels for oversea service.
- (3) High-speed vessels for oversea service.

I.—VESSELS FOR SPECIAL SERVICE IN THE FAR EAST.

The principal vessel under this heading is the *Habarovsk* (see Table I., page 74, first division), built for the Arctic service as a postal, store, and relief ship, principally in the Sea of Okhotsk. She is a twin-screw vessel 250 ft. long, 36 ft. beam, and 21 ft. depth, of exceptionally strong construction to work among ice, and fitted with accommodation for first, second, and third-class passengers. The more exposed parts of the accommodation are insulated, and steam heating and steam cooking apparatus are fitted on an extensive scale. The *Siberiak* and *Diomed* are two powerful tugs constructed internally and externally so as to serve as icebreakers, and fitted with fire and salvage pumps.

II.—LOW-SPEED VESSELS FOR OVERSEA SERVICE.

These vessels, which are shown on Table I., second division, in order of date, are principally distinguished from the third group by the difference in speed and the plainer style of the first-class accommodation, which in their case was fitted in the poop instead of in bridge houses and 'tween decks amidships. They are all twin-screw

vessels of about 12 knots speed, having cylindrical boilers and Howden's system of forced draught. Of this group the *Yaroslavl* calls for particular notice, as she was specially built for the transport of the worst class of convicts from Europe to Saghalien, and for this purpose groups of beds in the different 'tween decks are enclosed in cages, with passages all round between them and the ship's side to serve as sentinel walks, &c. This arrangement makes it possible to control the number of convicts on deck, so that it never becomes larger than the guards deem expedient. Only male convicts are carried in this vessel, any members of their families deciding to go into exile with them being carried in the other vessels. Special means are fitted in the convicts' quarters for dealing with insubordination on a large scale, and dark cells are constructed in each compartment.

The *Tambov* is of the same dimensions and power as the *Yaroslavl*, except that she is fitted for carrying troops or emigrants instead of convicts, and has more saloon accommodation. She was built and equipped ready for sea by Messrs. Denny in less than six months, which, in spite of the advantage of duplication, was an excellent performance.

The *Vladimir*, *Voronej*, *Kieff*, and *Ekaterinoslavl* were four sister vessels, which were built with a view of increasing the earning power of the Fleet. Being of lower power and fuller form, their carrying capacity is much larger, and their consumption much lower than the high-speed vessels. They preserve, however, the characteristic appearance of the ships of the Volunteer Fleet. Their dimensions are 453 ft. 6 in. over all, 419 ft. between perpendiculars, 49 ft. 6 in. beam, and 32 ft. depth moulded. Fitted with twin-screw machinery of about 3,000 I.H.P., they are able to steam 12 knots on voyage with a consumption of 40½ tons per day loaded. The boilers are of the single-ended cylindrical type, working with Howden's system of forced draught. The upper and lower 'tween decks are fitted with portable iron beds for troops or emigrants, and accommodation for officers or first-class passengers is fitted in the poop. The ships' officers and engineers are berthed in the bridge amidships, and the crew and firemen in the forecastle forward. Generally speaking, the arrangements and fittings of these, in other respects, are similar to those of the higher speed vessels, except that no guns or magazines are arranged for, and that arrangements are made whereby the holds and lower 'tween decks also may be fitted for carrying troops on short voyages in the Black Sea, if necessary, thus increasing their numbers from 1,020 to 2,660 of all grades.

III.—HIGH-SPEED VESSELS FOR OVERSEA SERVICE.

This group, which is shown in the third division of Table I. (page 74), consists—in order of age—of the *Orel*, *Saratov*, *Petersburg* (now *Dnieper*), *Kherson* (now *Lena*), *Moskva* (now *Angara*), and the *Smolensk* (now *Rian*), and as it embraces the vessels which have in the highest degree those features which constitute the ideals sought after by those whose aim it was to develop the Fleet to its highest degree of usefulness, it will be considered in greater detail. The intention in 1889, when the *Orel* was ordered, was to build ten vessels of high speed which would fulfil all the requirements of the higher

class of troopship and auxiliary cruiser, and yet be able to trade as mail and passenger steamers when not required for that purpose. As might be expected, it was found that these vessels could not be run profitably, and, foreseeing that the opening of the Trans-Siberian Railway would rob the Fleet of much of its more profitable passenger and trooping business, the Committee decided that four of the ten ships should be built as intermediates, these vessels being the last four of the previous group.

The *Orel* was originally a flush-decked vessel of the spar-deck class, but in 1897 she had a poop, bridge and forecastle added, thus converting her to the type adopted in the later vessels. Her dimensions are 445 ft. over all, and 415 ft. between perpendiculars, 48 ft. breadth, and 35 ft. depth moulded. She has twin-screw machinery 34 in., 54 in., and 85 in., by 51 in. stroke, and four double-ended cylindrical boilers 18 ft. long by 15 ft. diameter by 160 lbs. pressure, with a heating surface of 17,200 sq. ft. She has a hold capacity of 99,800 cub. ft., and a total cargo capacity of 218,300 cub. ft. On a draught of 24 ft. she carries 3,550 tons deadweight, and has a speed of 19 knots. She is fitted throughout for troops, of which she carries 1,380 of all grades, and a crew of 113 all told. The saloon accommodation is fitted in the upper 'tween decks amidships. The *Orel* is now attached to Admiral Rodjestvensky's squadron as a hospital ship, having been converted for this purpose at La Seyne, by the Forges et Chantiers de la Méditerranée, the funds being subscribed in France, partly by the French Red Cross Society. It is claimed that she is the most completely equipped hospital ship that has yet been commissioned, and has specially built operating-rooms, binding and dressing-rooms, surgeries, laboratories, sterilising-room, steam disinfecting-room, Röntgen Ray department, &c. (Plate XVIII.).

The *Kostroma* has also been converted for the same purpose, and is attached to Admiral Nebogatov's squadron.

The *Saratov* is 461 ft. all over, 425 ft. between perpendiculars, 50 ft. beam, and 35 ft. depth moulded. She has twin-screw machinery with cylinders 34 in., 54 in., and 85 in., by 51 in. stroke, and has five double-ended cylindrical boilers 18 ft. long by 13 ft. 3 in. diameter, and two single-ended boilers 9 ft. 4 in. long by 13 ft. 3 in. diameter, all of 160 lbs. pressure, with a total heating surface of 18,470 sq. ft. On a draught of 24 ft. she carries 4,030 tons deadweight, and has a speed of 18½ knots. She carries 1,515 troops of all grades and a crew of 129 all told.

The *Petersburg* is 461 ft. over all, 425 ft. between perpendiculars, 52 ft. beam, and 35 ft. depth moulded. She has twin-screw machinery with cylinders 34 in., 54 in., and 85 in., by 51 in. stroke, and five double-ended cylindrical boilers 18 ft. long by 13 ft. 10½ in. diameter, and two single-ended boilers 9 ft. 4 in. by 13 ft. 10½ in., all working at a pressure of 160 lbs., with a total of 24,050 sq. ft. of heating surface. She has a hold capacity of 233,000 cub. ft., and on a draught of 24 ft. she carries 4,390 tons deadweight, and has a speed of 19 knots. She carries 1,568 troops of all grades, and a crew of 138 all told.

These three vessels are all fitted with cylindrical boilers, whereas the *Kherson*, *Moskva*, and *Smolensk* are fitted with water-tube boilers of the Belleville type, the last one having economisers.

The *Kherson* is 492 ft. over all, and 455 ft. between perpendiculars by 54 ft. by 37 ft. 3 in. depth moulded. She has twin-screw machinery with cylinders 36 in., 57 in., and 92 in., by 54 in. stroke, and 24 Belleville boilers, working at 250 lbs. pressure. She has a hold capacity of 112,900 cub. ft., and a total cargo capacity of 243,500 cub. ft. On 24 ft. draught she carries 4,415 tons deadweight, and has a speed of $19\frac{1}{2}$ knots. She carries 1,600 troops of all grades, and a crew of 164 all told.

The *Moskva* is 507 ft. over all, and 470 ft. between perpendiculars by 58 ft. by 37 ft. depth moulded. She has twin-screw machinery with cylinders $36\frac{1}{2}$ in., 61 in., and 103 in., by 54 in. stroke, and 30 Belleville water-tube boilers, with a heating surface of 41,605 sq. ft., and has a speed of 20.16 knots.

The *Smolensk* is 507 ft. over all, and 470 ft. between perpendiculars by 58 ft. by 37 ft. depth moulded. She is fitted with twin-screw machinery, having cylinders 26 in., 44 in., and 75 in., by 48 in. stroke, four of each size, and 24 Belleville boilers with economisers, having a total heating surface of 42,565 sq. ft. She has a hold capacity of 125,500 cub. ft., and a total cargo capacity of 266,800 cub. ft., and on 24 ft. draught she carries 5,000 tons deadweight, and has a speed of 20.1 knots. She carries 1,643 troops of all grades, and a crew of 174 all told.

Apart from the points of difference shown in the Table attached, or already named, between these six vessels, and that existing in the machinery, which will be referred to later, they are so similar in type that a description of the *Smolensk*, which is the most recent, may be taken as applying to them all. The *Smolensk*, the general arrangement and appearance of which is shown on Plates XVI. and XVII., is a two-masted schooner-rigged vessel, with yards on the foremast (which have since been removed), three funnels, and a clipper stem and a short bowsprit. She has a long forecastle, bridge, with bridge house at its forward end, and a short poop. The bridge deck, which extends from side to side over the bridge and bridge house, is covered all fore and aft by a boat deck, over the forward end of which a large navigating bridge is constructed. The sleeping accommodation for the first-class passengers is in the upper 'tween decks, abreast of and forward of the machinery casing. These rooms vary in size up to 15 ft. 6 in. by 10 ft. 6 in., no upper berths being fitted, and the larger rooms are arranged so that the berths may be folded away, in order that they may be utilised as sitting-rooms. The dining saloon is on the upper deck, and communicates, by a pantry, on each side with the galley, which is situated at a convenient distance abaft it. The music-room stands on the bridge above, with a large opening in its centre, giving light to the dining saloon below from the skylight overhead. The smoke-room is on the bridge, further aft. The officers and engineers are berthed on the bridge on either side, the crew and petty officers in the forecastle, and firemen in the 'tween decks, near the machinery casing. The poop is fitted up with two large hospitals, dispensary, operating-room, and quarters for an assistant surgeon and two sisters of mercy.

A special feature of the first-class accommodation in some of these vessels is that, when the service on which the vessel is engaged requires it, the forward end of the dining saloon can be divided off and arranged with four of the largest state-rooms,

and the music saloon, with which it communicates by an independent stairway, to form a private and very complete suite of apartments. The saloon accommodation, as a whole, though on a smaller scale, is similar in style to that of the leading Atlantic liners.

Both 'tween decks all fore and aft are fitted up for troops or emigrants, a large apartment being set apart for non-commissioned officers or third-class passengers. Apart from the saloon galley which serves the ship's officers and the saloon, there is one galley for the crew amidships and one forward and one aft capable of cooking with comfort for 50 per cent. more troops than the vessel is fitted up for, and in addition a bakery is provided which can produce two tons of bread per day. A steam laundry with washing, wringing, and ironing plant, and a drying room, is fitted amidships, as well as a large disinfecting plant. The system of ventilation is by Stewart's thermo-tanks, of which seven are fitted and worked in conjunction with electric fans and air trunks led to every part of the vessel, the capacity being such that the whole of the air can be replaced by warm fresh air three and a half times an hour in the emigrants' quarters, and five times an hour in the state-rooms and saloons. A refrigerating engine with freezing and chilling rooms, and an iced water fountain is fitted. The electric light plant is in triplicate, each plant being capable of lighting the vessel. The distilling plant has a capacity of 16,000 gallons per day, equal to $8\frac{3}{4}$ gallons of water for every man on board.

A large high-pressure auxiliary boiler of the cylindrical type is carried on deck in the machinery casing, with connection to the pumps and all auxiliary machinery.

The fresh water tanks are built between the tunnels, the method of building them between the outside of the tunnels and the shell of the ship adopted in some of the earlier vessels having been abandoned.

The boats, which are carried on the boat deck and on the poop as well as in the forward and after wells, include a number of semi-collapsible and steel lifeboats, a powerful steam towing launch, and six and eight ton surf boats for landing troops. Rapid handling of stores is ensured by the use of cranes and Temperley transporters forward and aft. Two steam and one hand steering gear of very large power are fitted, enabling the vessel to manœuvre with exceptional ease. Sixteen guns are carried, and ammunition hoists are arranged in convenient positions for the portable magazines, which can be dropped into the holds at short notice. The girder and column system of pillaring is adopted in order to facilitate this, flooding connections are provided for these magazines, and fire-extinguishing pipes are fitted to each compartment in the holds and 'tween decks.

The armament consists of 120 mm. and 75 mm. rapid-fire guns, and their disposition and angle of fire on two of the vessels is shown on Plate XIV., Fig. 5. The number of guns arranged for at the time of building was as follows:—

	120 mm.	75 mm.	47 mm.	37 mm.
<i>Smolensk</i>	8	8	...	...
<i>Moskva</i>	8	...	...	...
<i>Kherson</i>	7	...	...	...
<i>Petersburg</i> ...	7	...	6	8
<i>Saratov</i>	7	...	...	...

It is understood that the number of guns carried has been largely increased on some of the vessels ; for instance, the *Kherson* now carries eleven 120 mm. guns.

The ballast pumps are capable of ejecting 800 tons of water per hour, and 12 in. bilge pipes are fitted ; and, in case of emergency, by utilising the full pumping power of the vessel, the amount of water dealt with can be increased to 2,500 tons per hour. Ten watertight bulkheads extend to the upper deck, and the subdivision of the vessel is such that any two compartments may be open to the sea without the vessel necessarily foundering (see Fig. 1, Plate XIII.).

The main boilers are placed in three stokeholds of equal size, the coal bunkers being arranged at the sides as well as athwartships so as to afford a certain amount of protection. These stokeholds communicate by watertight doors, which can be closed instantaneously from the deck in some of the vessels, and which are so placed that their sills are 2 ft. 6 in. above the stokehold floor, that is, five feet above the inner bottom. The vessel is built to Lloyd's highest class with additions, has capacity for 1,000 tons of water ballast, and a permanent bunker capacity of 1,650 tons.

It will be seen from Table II. (page 76), which gives the total distance steamed and total coal consumed by all the ships of the Volunteer Fleet, that the average speed on the voyage of the high-speed vessels is 11 to 13½ knots per hour, corresponding to 1,650 to 4,050 I.H.P., as against 9,000 to 16,500 I.H.P. which these vessels are capable of developing and taking the powers corresponding to those speeds, the coal consumed works out at about 3 lbs. per indicated horse-power per hour. These results reached a climax in the later boats fitted with Belleville boilers, on which a heavy loss was incurred on each voyage. Two attempts were made in two of the earlier vessels to increase economy at reduced speeds ; in the first instance by fitting a fourth cylinder on the top of the high-pressure cylinder, and in the second by fitting an expansion valve in the high-pressure piston valve. Neither were considered to fully meet the requirements of the service, and it was therefore decided to fit in the *Smolensk* machinery of a type which was first worked out by the late Mr. F. T. Marshall (whose premature death occurred so recently) under the instructions and patents of Mr. Philip Watts and the late Mr. Magnus Sandison, and fitted with highly satisfactory results in a training ship named the *General Baquedano*, built at Elswick for the Chilian Navy, with a view of getting the maximum economy at cruising speeds. This arrangement, which formed the subject of a paper read before this Institution by Mr. Sandison, in April, 1900, consists (as will be seen by accompanying sketch and Fig. 7 in Plate XV.) of six cylinders working on each shaft, two being high pressure, two intermediate, and two low pressure, in two sets but on six cranks, and so arranged that a set of three on either shaft may be disconnected and the connecting and slide valve rods slung clear, the whole crank shaft being driven by the set in operation. This system enables a voyage at half power to be made with the same consumption per indicated horse-power as for full power without the shaft alignment troubles experienced in the *Sardegna* and other vessels where the same end was sought to be attained by fitting two separate engines to each shaft with an arrangement for disconnecting the forward set.

The results obtained on the consumption trials were as follows :—

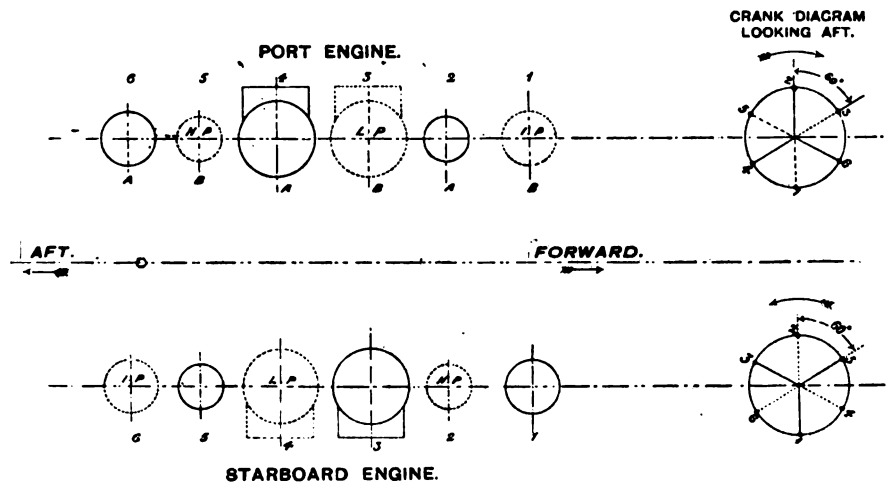
FULL SPEED.				TRADING SPEED.			
Power ...	...	...	15,900 I.H.P.	Power ...	...	...	4,055 I.H.P.
Speed ...	...	...	20½ knots	Speed ...	...	...	13½ knots
Tons of coal burnt ...	...	...	157 tons	Tons of coal burnt ...	...	...	30.75
Duration of trial ...	...	...	12 hours	Duration of trial ...	...	...	10 hours
Consumption in lbs. per I.H.P. per hour ...	...	...	1.741	Consumption in lbs. per I.H.P. per hour ...	...	...	1.698

This result was borne out on the voyage from the Tyne to Odessa, during which a carefully measured consumption trial was run between Algiers and Constantinople, when the consumption for all purposes worked out at 1.73 lbs. per I.H.P. per hour, with a speed of 14¾ knots.

In practice it is advisable to use each set alternately for the voyage out and home.

SKETCH SHOWING ARRANGEMENT OF CYLINDERS IN SIX-CYLINDER ENGINE.

DOTTED LINES SHOW CYLINDERS USED AT CRUISING SPEED TRIAL.
CYLINDERS LETTERED ALIKE FORM ONE SET.



It is possible to make the change from half to full power at sea with comparatively small loss of distance covered, as will be seen from Fig. 2 (Plate XIII.), which shows the distance in miles covered by two vessels, one "B" fitted with the *Smolensk* type of machinery, and the other "A" with the ordinary type of machinery, during the first twelve hours of a voyage, assuming that both started at a cruising or trading speed of 14 knots with one boiler-room out of three under steam, and received orders at the end of the third hour to proceed at full speed.

In making this comparison it is assumed that water-tube boilers are fitted in both vessels, and that the time necessary for getting up steam on the unlighted boilers is three hours. If the vessels had equally started with steam on all boilers the distance steamed at the end of twelve hours would have been the same, seeing that in that case the six cylinders would obviously have been coupled up before starting. If both vessels had cylindrical boilers the difference at the end of twelve hours would be 58 knots, as shown by the dotted lines, seeing that, although there would be the same

falling off in speed in "A" as in the case of "B" during the four hours engaged in coupling up, the time taken to get up steam would be longer. It will be seen that the vessel "B" at the end of seven hours' steaming has lost 68 knots, and against this she has, apart from saving in the cost of fuel, a radius of action, at the cruising speed of 13 knots, of 4,700 knots per 1,000 tons of coal, as against a radius of action of 3,150 knots per 1,000 tons with the ordinary type of machinery. This represents, allowing for carrying coal in No. 3 hold, a radius of action of 12,600 knots as against 8,500. With coaling stations at definite points she would either have the advantage of carrying considerably more deadweight or of steaming at a higher speed owing to the saving in weight of bunkers.

Reference to Table II. (page 76) shows that each ton of cargo carried on the round voyage in the *Smolensk* requires 1.104 tons of fuel for its transport, as against 1.624 in a similar vessel with Belleville boilers and ordinary machinery, .462 tons in the slower vessels and 1.045 tons in the fast vessels with cylindrical boilers. It is, perhaps, hardly necessary to point out that as in trading only half the working parts of the six-cylinder machinery are in use, its life would be prolonged. The weight of the six-cylinder arrangement is practically the same as that of the three-cylinder arrangement, and owing to the valves being arranged on the face of the cylinders the length of the machinery space required is only about two frame spaces more than in the case of a ship with the three-cylinder arrangement: the relative lengths being 42 ft. 9 in. and 38 ft. 9 in.

When running at full power the balance of the engines was found to be practically perfect, and vibration, except immediately over the propellers, completely absent.

The boiler installation, which consists of twenty-four Belleville boilers fitted with economisers, has been found to work most satisfactorily, as was shown by the official report to the Russian Admiralty after the *Smolensk's* last cruise, which was "sixty-five days at sea—ready to sail to-morrow." That these boilers have proved so much superior to those of the *Kherson* (now *Lena*) is due to the Board of Trade having insisted on lap-welded iron tubes in the latter vessel, many of which have given out.

The boilers, which have 42,565 sq. ft. of heating surface and 1,333 sq. ft. of grate surface, would, without undue forcing, have enabled the engines to develop 18,000 I.H.P. at 105 revolutions—equal to 340 ft. piston speed, which, considering the comparative lightness of the reciprocating parts and their perfect balance, would have been maintained without difficulty. This power would, with suitable propellers, have increased the speed about a knot. In this connection it should be borne in mind that the propellers had to be designed so as to ensure obtaining economy of consumption at cruising speed as well as at full power, and that a maximum piston speed of 800 ft. per minute was a condition of the contract.

In view of the fineness necessary to obtain the required speed, the extent of the superstructures, and the weight of the deck fittings, considerable care had to be exercised in the design, so as to get a vessel which would have sufficient stability and yet be easy of propulsion. A satisfactory solution was, however, obtained, and the

metacentric height of the vessel in her equipped condition, with water in main boilers and bunkers empty, was 1.27 ft., the low centre of gravity of the six-cylinder engines helping this appreciably. Fig. 3 (Plate XIV.) shows the range and extent of the statical stability of the *Smolensk* under a sufficient number of conditions to enable the officers navigating her to draw their own deductions as to her safety in any condition of loading. Fig. 4 (Plate XIV.) shows the difference in height of the three-cylinder and the six-cylinder arrangements, which is of considerable importance in vessels designed to act as auxiliary cruisers.

With regard to the speeds of all the vessels, it should be noted that the speed named in each case is not that obtained on a measured-mile trial, but is the average speed attained on a 12 hours' continuous steaming trial in the case of the faster vessels, and of 24 and 48 hours' trials in the case of the slower vessels. The trials took place in the presence of a Commission representing the Russian Admiralty and the Russian Volunteer Fleet, the Naval Attaché of the Russian Embassy in London being also a member, and the observations of speed and consumption, as well as those of draught, fore and aft trim, hold capacity, capacity of ballast tanks, amount of water discharged per hour, and stability, each of which formed the subject of a guarantee, were carried out by a staff of twenty-one Inspectors, under whose supervision the hulls and machinery were built, and who were responsible to the Commission. They also tested and proved the satisfactory working of every fitting on board.

To summarise the development of the vessels of the Volunteer Fleet, this Association has now in the *Smolensk* obtained a type of troopship which, under the protection of her own guns, is capable of transporting 3,000 tons of stores and munitions of war and 1,650 troops 4,000 knots in nine days under such conditions of comfort as to land them in good health, without calling at any port on the way, and of landing them, subject to conditions of weather, on any beach promptly and without assistance. At cruising speed she could do the same thing from Odessa to Vladivostock.

What the future of the Volunteer Fleet will be, it is difficult to foretell. During the thirteen years preceding the present war it had, under the able management of General Linden, the present Inspector, prospered. Some of the vessels have been lost, and the *Kherson* and *Moskva* transferred to the Admiralty. The opening of the Siberian Railway having, as already stated, materially encroached on the more lucrative portion of the ocean trade makes it increasingly difficult to run the vessels, especially those of higher power, as liners. It may fairly be assumed, however, that the same forces that led to its establishment, and the same foresight and ability that has achieved its success, will ensure its continued existence.

As a matter of interest, particulars are given on Table I. of two vessels showing the probable direction of future development of both the high and the low-speed types in view of the increasing need of economy in working and first cost, the importance of capacity for tea cargoes, and the draught limit of Vladivostock Harbour.

TABLE I.

PARTICULARS OF VESSELS SPECIALLY DESIGNED AND BUILT

Name.	Builders.	Length.	Breadth.	Depth.	Under Deck Tonnage.	Gross Tonnage.	Engines.
(1) VESSELS FOR SPECIAL							
Habarovsk ...	Hawthorn, Leslie & Co.	Ft. In. 250 0	35 10	21 0	1,319	1,523	Twin. 18, 28, 46 × 30 in.
Diomed ...	" "	91 6	19 6	9 0	99	100	Single. 16½, 33 × 22 in.
Siberiak ...	" "	90 0	19 6	9 0	95	97	Single. 16½, 33 × 22 in.
(2) LOW-SPEED VESSELS							
Yaroslavl ...	W. Denny & Bros.	385 0	44 9	31 0	3,880	4,495	20, 33, 50 × 42 in.
Tambov ...	" "	385 0	44 9	31 0	3,880	4,441	20, 33, 50 × 42 in.
Kiev ...	J. Brown & Co.	419 0	49 6	32 0	4,811	5,566	21, 34, 52 × 45 in.
Voronej ...	W. Denny & Bros.	419 0	49 6	32 0	4,761	5,616	21, 34, 52 × 45 in.
Vladimir ...	" "	419 0	49 6	32 0	4,761	5,621	21, 34, 52 × 45 in.
Ekaterinoslavl	Hawthorn, Leslie & Co.	419 0	49 6	32 0	4,815	5,492	21, 34, 55 × 42 in.
Design ... (Shelter Dk.)	" "	471 0	60 0	34 11½	7,100	8,000	Twin-screw. 24, 40, 66 × 48 in.
(3) HIGH-SPEED VESSELS							
Orel ...	Hawthorn, Leslie & Co.	415 0	47 9½	35 0	4,470	4,528	Twin. 34, 54, 85 × 51 in.
Saratov ...	" "	425 0	49 9½	35 0	3,542	5,308	34, 54, 85 × 51 in.
Petersburg ...	" "	425 0	51 8	34 10	3,405	5,336	34, 54, 85 × 51 in.
Kherson ...	" "	455 0	54 0	37 3	5,787	6,438	36, 57, 92 × 54 in.
Moskva ...	J. Brown & Co.	470 0	58 0	37 0	6,388	7,267	36½, 61, 103 × 54 in.
Smolensk ...	Hawthorn, Leslie & Co.	470 0	58 0	37 0	4,783	7,270	Four of each. 26, 44, 75 × 48 in.
Design ... (Shelter Dk.)	" "	470 0	60 0	35 0	4,680	7,100	26½, 45, 77 × 48 in.

TABLE I.

FOR THE RUSSIAN VOLUNTEER FLEET ASSOCIATION.

Boilers.	Heating Surface.	I.H.P.	Speed on Trial.	Number of Crew.	Number of Passengers.	Bunker Capacity.	Cargo Capacity in cubic ft.	Water Ballast Capacity.	Dead-weight on 24 ft. Draught.	Number of Masts.	Number of Funnels.
SERVICE IN THE FAR EAST.											
3 S.E.	5,000	1,750	Knots. 12½	53	454	Tons. 190	79,700	Tons. 360	...	2	1
1 S.E.	1,150	...	10	7	...	...	...	...	...	1	1
1 S.E.	950	...	10	7	...	...	...	...	...	1	1
FOR OVERSEA SERVICE.											
4 S.E.	...	2,500	12·84	110	21, and 800 convicts.	706	255,530	666	5,220	2	1
4 S.E.	...	2,500	13·24	110	850	706	246,024	666	5,270	2	1
3 S.E.	8,118	3,000	13·0	115	970	843	309,820	907	6,080	2	1
3 S.E.	8,109	3,000	13·0	115	970	859	305,030	856	6,150	2	1
3 S.E.	8,109	3,000	13·0	115	970	869	305,240	856	6,126	2	1
3 S.E.	8,112	3,000	13	115	1,020	900	315,800	918	6,320	2	1
5 S.E.	13,400	5,500	13½	129	2,300	1,500	465,000	1,200	7,300	2	1
FOR OVERSEA SERVICE.											
4 D.E. & 2 S.E.	17,200	10,000	19¼	113	1,380	765	218,300	600	3,550	3	2
5 D.E. & 2 S.E.	18,470	9,500	18¾	129	1,515	820	240,800	670	4,030	3	2
5 D.E. & 2 S.E.	24,050	10,500	19	138	1,568	1,200	233,000	770	4,390	3	2
24 Belleville	35,350	13,500	19½	164	1,600	1,440	243,500	850	4,410	3	3
30 Belleville	41,605	17,500	20·16	170	1,630	1,440	270,000	900	4,750	3	3
24 Belleville	42,560	16,000	20·1	174	1,640	1,640	266,800	1,064	5,000	2	3
3 S.E. Cy- lindrical & 9 Yar- row large Tube	46,500	16,750	20	175	2,100	1,700	350,000	1,100	5,400	2	2

TABLE II.

Vessel.	Builders.	Date First Voyage Began.	Date Last Voyage Ended.
(1) LOST OR OBSOLETE SHIPS BOUGHT BY THE ORIGINAL RUSSIAN			
Rossia	Caird & Co., Greenock ...	August 1, 1878	November 13, 1894
Petersburg I....	„ „	August 1, 1878	March 17, 1893
Moskva I. ... ..	... ..	August 1, 1878	July 7, 1882
Moskva II.	J. Elder & Co.	March 14, 1884	September 19, 1895
Kostroma I.	Aitken & Mansel	January 28, 1883	May 16, 1887
Yaroslavl I. ... ..	... ..	September 9, 1880	March 1, 1882
Yaroslavl II.	Forges, etc., La Seyne ...	June 23, 1885	March 1, 1890
Nijni-Novgorod I. ...	Caird & Co.	September 1, 1878	January 1, 1891
Vladivostock	Lobnitz & Co.	February 16, 1880	June 4, 1893
(2) SHIPS BOUGHT BY BUT NOT DESIGNED FOR THE			
Kostroma	Hawthorn, Leslie & Co. ...	February 18, 1888	January 1, 1904
Nijni-Novgorod ...	Armstrong-Whitworth ...	February 12, 1891	January 1, 1904
Kazan	Wigham-Richardson & Co.	September 1, 1900	January 1, 1904
(3) SHIPS BUILT AND DESIGNED FOR THE RE-ORGANISED			
<i>(a) LOW SPEED.</i>			
Habarovsk	Hawthorn, Leslie & Co. ...	February 4, 1895	August 24, 1902
Yaroslavl	W. Denny & Bros... ..	January 1, 1893... ..	January 1, 1904
Tambov	„ „	June 12, 1893	January 1, 1904
Vladimir	„ „	August 19, 1895	January 1, 1904
Voronej	„ „	April 19, 1896	January 1, 1904
Ekaterinoslavl ...	Hawthorn, Leslie & Co. ...	June 20, 1896	January 1, 1904
Kiev	J. Brown & Co.	May 6, 1896	January 1, 1904
<i>(b) HIGH SPEED.</i>			
Orel	Hawthorn, Leslie & Co.	March 1, 1890	January 1, 1904
Saratov	„ „ „	December 17, 1891	January 1, 1904
Petersburg	„ „ „	June 1, 1894	January 1, 1904
Kherson	„ „ „	August 21, 1896	October 1, 1903
Moskva	J. Brown & Co.	October 5, 1898	September 1, 1903
Smolensk... ..	Hawthorn, Leslie & Co. ...	January 1, 1902	January 1, 1904

THE RUSSIAN VOLUNTEER FLEET.

TABLE II.

Type of Machinery.	Type of Boilers.	Total Miles Steamed.	Total Hours Under Way.	Mean Speed.	Coal.		
					Lighting Up and Keeping Steam.	Under Way.	Per Mile.
VOLUNTEER FLEET ASSOCIATION MORE THAN TWENTY YEARS AGO.							
Compound	... ..	509,224	49,193	10·35	Tons. 4,480	Tons. 78,220	Cwts. 3·072
"	... ..	494,625	48,115	10·28	4,800	85,160	3·444
... ..	... ..	101,123	9,694	10·43	1,815	19,818	3·920
Compound	... ..	410,457	38,161	10·75	6,070	74,340	3·622
"	... ..	135,272	14,308	9·45	1,960	17,780	2·630
... ..	... ..	16,055	1,710	9·38	267	2,113	2·632
Compound, 3 Cylinder	... ..	95,241	10,109	9·42	1,000	10,640	2·234
Compound	... ..	320,028	35,588	8·99	4,200	38,560	2·410
"	... ..	249,207	31,717	7·85	1,620	16,400	1·316
RE-ORGANISED RUSSIAN VOLUNTEER FLEET.							
Triple	Cylindrical.	588,964	55,932	10·53	4,170	77,280	2·624
"	"	463,192	50,879	9·10	2,980	47,480	2·050
Triple. Twin	"	133,586	11,504	11·61	1,160	23,030	3·448
RUSSIAN VOLUNTEER FLEET FOR OVERSEA SERVICE.							
Triple. Twin	Cylindrical.	143,628	15,819	9·08	2,280	15,130	2·106
"	"	457,137	44,440	10·29	5,210	75,990	3·324
"	"	430,886	42,782	10·07	4,290	68,250	3·168
"	"	340,511	34,357	9·91	3,530	60,710	3·576
"	"	320,519	31,578	10·15	2,890	55,150	3·442
"	"	311,596	29,652	10·51	2,410	47,940	3·078
"	"	313,905	29,264	10·73	2,550	52,850	3·368
"	"	409,329	36,335	11·27	7,760	78,950	3·858
"	"	461,862	39,844	11·59	5,760	101,590	4·40
"	"	351,049	29,993	11·70	4,560	80,760	4·601
"	Belleville.	231,625	19,424	11·92	6,370	80,340	6·937
"	"	107,290	9,752	11·00	2,270	45,840	8·546
Triple Six Cylinder.	"	4,197	307	13·65	81	1,219	5·809

DISCUSSION.

Professor J. H. BILES, LL.D. (Vice-President) : I am afraid, Sir, this paper is like the two previous ones in that it does not cultivate the gift of criticism. It is a very valuable contribution to the knowledge that is stored away in our Transactions, and it gives a great deal of very interesting information. Mr. Rowell, I think, deserves the thanks of this Institution, or at any rate of those members of it who are interested in the type of ship that is so fully illustrated and described in this paper. This work extends now over a great many years, during which time Mr. Rowell has been one of the principal workers for the Volunteer Fleet. The success of that Fleet from a technical point of view has been undoubted, I think, in every case. The interesting information that he has given us with reference to the arrangement of the six-cylinder engine is of value in showing how to make, in a comparatively simple way, an elastic steam reciprocating engine which shall have good economy over a wide range of speed. That has been one of the troubles of the reciprocating engine. It is one which is not commonly felt in the mercantile marine. It is only felt in special cases such as the Volunteer Fleet, but in the war navies this trouble is a real one. The method that has been adopted by Mr. Rowell's firm is a good one for effecting the purpose, and I think the description that Mr. Rowell has given will be of value to many of us. I do not know whether Mr. Rowell would care to give us the displacements of his ships. It does add to the technical interest from a naval architect's point of view if the displacement is given. No doubt from the shipowner's point of view, and that of those who run the ships, it is quite sufficient to know what coal a ship burns and how much weight she carries ; but for those who have to produce these results it is interesting to know a little more in detail what the form of the ship is.

The CHAIRMAN (Sir William White, K.C.B., LL.D., D.Sc., F.R.S., Vice-President) : The author of this paper will understand that the absence of discussion indicates no want of interest. The summary of information it contains of the history and organisation of this Volunteer Fleet is the best, so far as I know, that has yet been made available. The tribute rendered to General Linden, whom I have the honour of knowing, is fully justified by the work that officer has done over a long period of years in the development of this fleet, which has grown out of the desire, the very natural desire, of the Russian Admiralty to have the power of obtaining auxiliary cruisers in time of war. That power they did not possess apart from the creation of the Volunteer Fleet, because they did not have a large mercantile marine to draw upon. In some measure, no doubt, the creation of the Volunteer Fleet is a reply to the utilisation by other countries of the best available vessels in their mercantile marines. Those of us who have seen the vessels described by Mr. Rowell know that they have been built both to do the best they can in peace time in earning money, and to be of real service as cruisers in time of war. Many of the high speed vessels mentioned have actually been converted into recognised cruisers during the present war, and I think at least four vessels have been so treated, and are now with Admiral Rodjestvensky's Fleet. The *Smolensk*, of course, has made herself famous in other ways. Her name is likely to be remembered in England as the *Smolensk*, although we may not identify her under her new title. When I was in America the *Lena* arrived in San Francisco and was interned there, so we know where she is, but where some of the others are we do not know. The work done by Messrs. Hawthorn, Leslie & Co., in the creation of this Fleet, has been, from the technical side, of the greatest value. I was familiar with it when I was at the Admiralty, and I have continued to know of it since. At the suggestion of Messrs. Hawthorn, Leslie, the Russian authorities made not a few experiments in the construction of these vessels and their propelling apparatus, and these new departures were of great value outside the Volunteer Fleet. Water-tube boilers were adopted at a very early date and under serious conditions of service, and in the design of the machinery of the *Smolensk* the firm (although working on ideas originating with gentlemen outside their own firm) showed a readiness and resource which they have exhibited in many ways over a long period of years. It is our business as technical men to fulfil conditions laid down by those for whom we build ships. The conditions here were very special, and Professor Biles exactly expressed the truth when he said that from the technical side, whatever may be thought of the policy that was embodied in the construction of this Fleet, there

has been nothing but success. I only hope that the enterprise has in other ways proved as satisfactory to the builders. Gentlemen, you will wish me to express in your name to the author of this paper our best thanks for his contribution, and in your name I now convey them to Mr. Rowell.

Mr. HERBERT ROWELL (Member): Sir William White and Gentlemen, with regard to the question which Professor Biles put as to the displacement of these vessels, I may say that their co-efficient of fineness is practically '6, with the exception of the *Orel*. I am speaking of the higher speed vessels. In some cases it goes up nearly to '61, but it is nearly always '6. With regard to the other matter which Sir William White mentioned, I did not care to introduce it into my paper, but the present position or rather what was the position of these ships within the last two or three weeks, is as follows:—The *Kherson*, now the *Lena*, was attached to the Fleet as a cruiser, and is now lying at San Francisco disarmed. The *Moskva*, now the *Angara*, was also attached to the navy as a cruiser, and is supposed to have been lost at Port Arthur. The *Kazan*, now called the *Potosi*, is a hospital ship now at Port Arthur doing hospital service. The *Ekaterinoslav* was captured by the Japanese on February 6 of last year. The *Smolensk*, now called the *Rian*, and the *Petersburg*, now the *Dnieper*, are attached as auxiliary cruisers to Admiral Rodjestvensky's squadron. The *Orel* has been altered to a hospital ship and is on the same service. The *Kiev*, *Voronej*, *Vladimir*, *Tambov*, and the *Yaroslavl*, are all attached to Admiral Rodjestvensky's squadron as transports. The *Kostroma* has also been changed into a hospital ship, and she is with Admiral Nebogatov. The *Saratov* and the *Nijni-Novgorod* are still lying at Odessa. I wish to thank Sir William White, and you, gentlemen, for the patient way in which you have listened to my paper. I have felt that some of it was getting to be almost ancient history. At the same time, I was anxious that we should have in the records of this Institution as complete an account as possible both of the origin, the constitution, and the development of the Volunteer Fleet. That perhaps ran my paper to rather a greater length than I would have chosen. I thank you very much for the kind way in which you have received it.