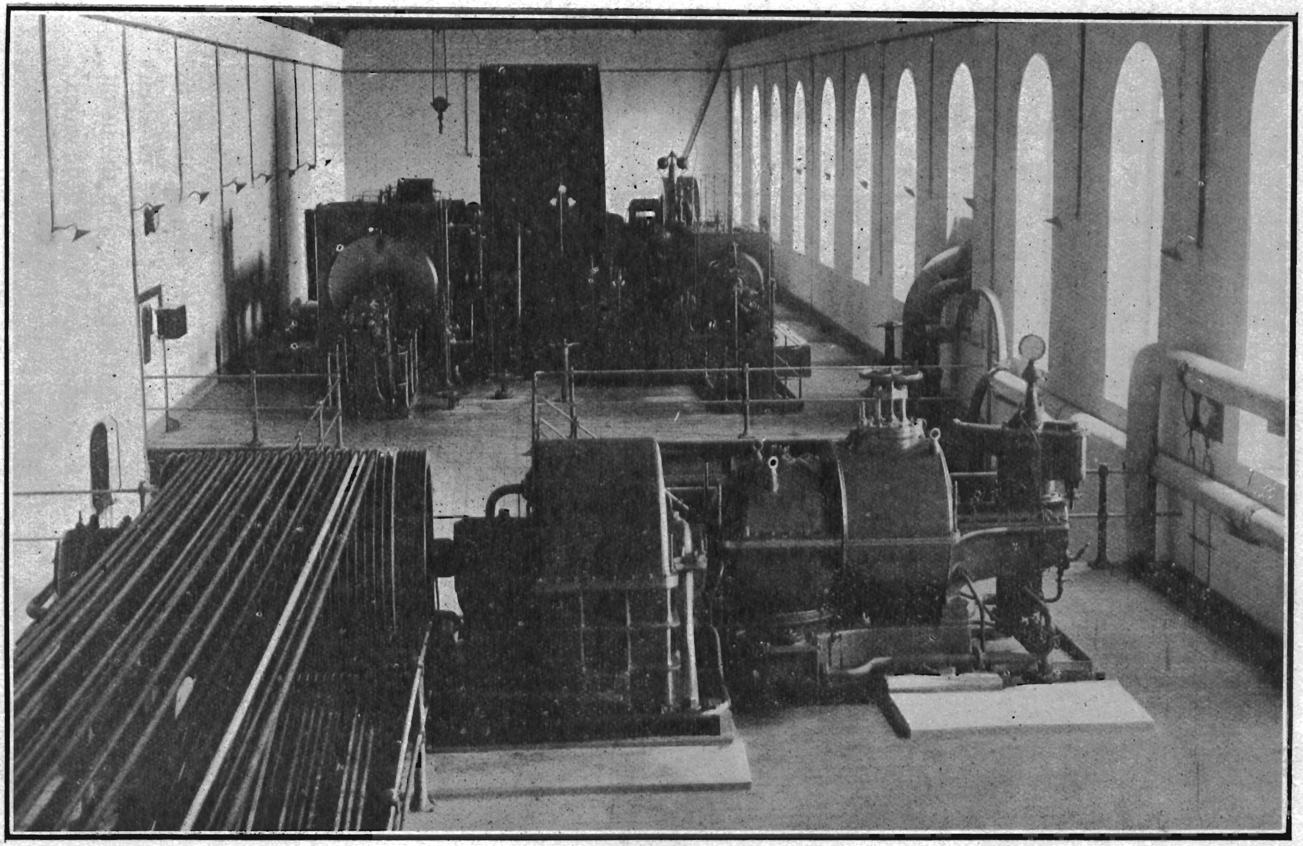

Fig. 6.

The steam and water conditions for the combined plant (Fig. 7) were as follows:—

S.V.P., 160lbs.;
Superheat, 50deg. at engine;
Circulating Water, 95deg. Fah.;
Vacuum at turbine, 27.5in., Bar. 30.0in.;

which conditions are not conducive to the best results.

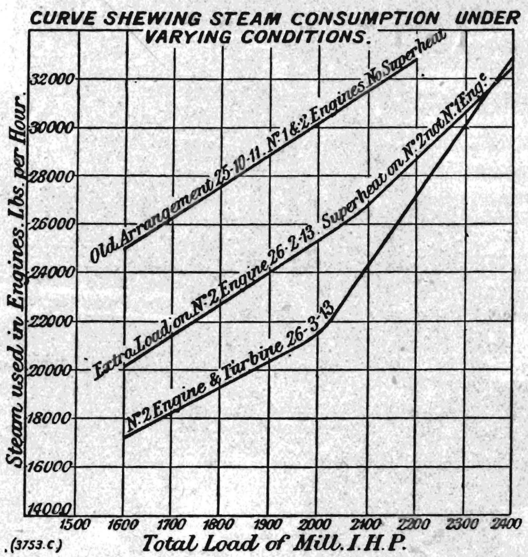

Fig. 7.

The steam used in the two plants amounts to 10.18lbs. per I.H.P. hour, and thus effects a saving of fully 15 per cent. compared to the best reciprocating engine practice.

Much larger sets are now running which confirm the opinion that the geared turbine is an ideal drive for such work, and it is proposed in future sets to couple direct to the spinning shaft, which is the heaviest drive in such mills, and drive the remaining shafts by ropes in the usual way, which will be much cheaper and more economical than driving by electric motors, and will give an equally good turning moment.

It has been found that a turbine plant working in conjunction with a reciprocating set, to a large extent, damps out the uneven moment of the engine.

As I have already stated, a mill equipped entirely with geared turbines procures a perfect turning moment, and which results in better work from that mill.

I might mention that the gear wheels of these plants have often been examined, but it has been impossible to discover the slightest sign of wear. The pinion teeth are polished, but the wheel teeth are not even marked enough to brighten themselves.

MARINE.

Finally, there is the geared marine turbine, the most important of all, and which, in the first instance, really accounted for the introduction of the geared principle.

As I have already stated, in 1897 Messrs. Parsons introduced helical reduction gearing in a launch. It was found that efficiency of this gear was remarkably good, although no special precautions were taken in the cutting of the single helical wheel.

No further practical work was done till 1909, when the Parsons Marine Co. and the American Westinghouse Co. were working on the problem. In this year the Parsons Marine Co. purchased the cargo steamer "Vespasian," equipped with triple expansion reciprocating engines. These engines were completely overhauled, preparatory to extensive coal consumption tests being carried out in actual service conditions by a special testing staff. After these tests had been completed the reciprocating engines were replaced by geared steam turbines, using the existing boilers, propeller, shafting, and thrust block (Fig 8).

After completion, the boat was again taken on many service trials, with the result that, compared with the reciprocating engine set, with the propeller revolving at

70 r.p.m. in each case, there was an increase of 20 per cent. in power, with 20 per cent. higher efficiency with the geared turbine.

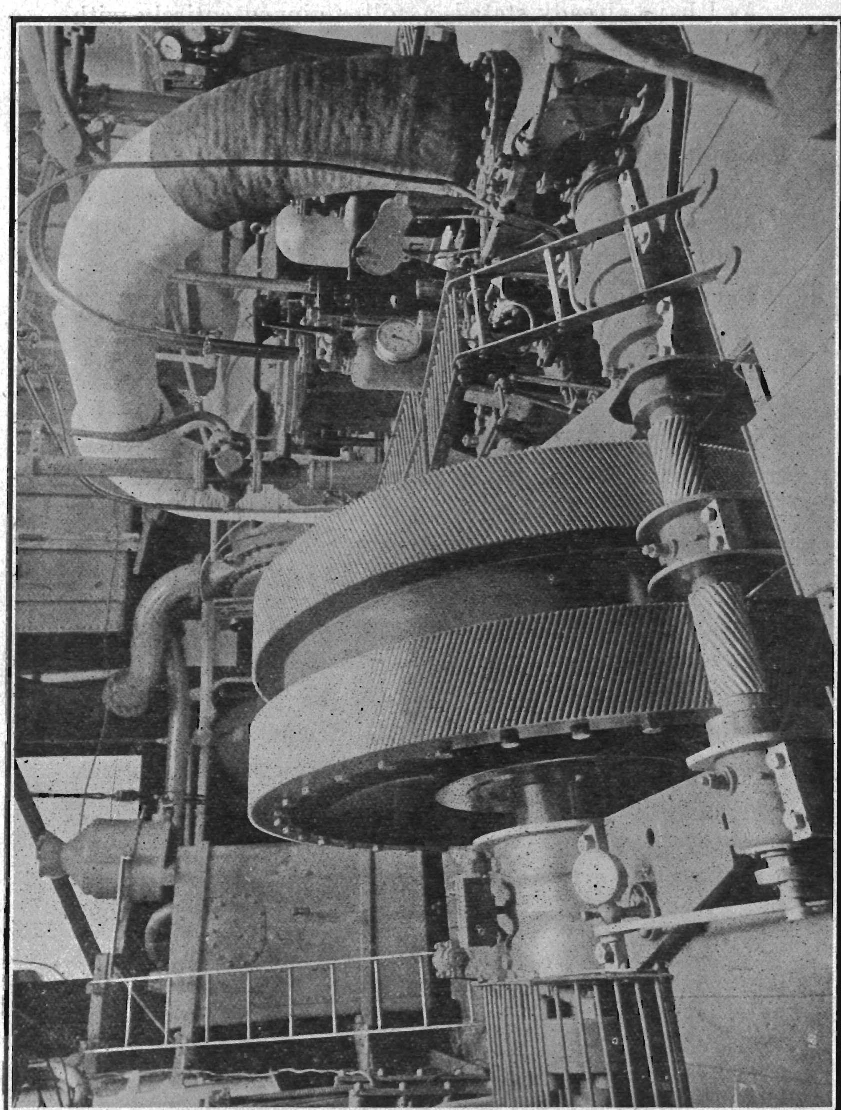

Fig. 8

No trouble was experienced with the new arrangement, and one of the many very marked advantages was the disappearance of racing in the heavy weather which the boat repeatedly experienced.

It must be remembered that in the case of the "Vespasian" the best steam conditions did not exist for the steam turbine; the boilers were old and the steam low in pressure and saturated; but the tests in other respects were truly comparative.

TABLE II.—SUMMARY OF 36-HOUR TRIAL.

	"Cainross" Geared Turbine.	"Cairngowan" Triple Expansion.
1. Revolutions per min. (mean of 36-hour)	61·76	61·68
2. Coal per day ..	27 8 tons	32·7 tons
3. I H.P.	—	1,790
4. S.H.P.	1·570	—
5. Ratio of S.H.P. "Cairnross" to I.H.P. of "Cairngowan"	87·7%	
6. Lbs. of coal per I.H.P. hr. all purposes	(equiv). 1 45 lbs.	1·704 lbs.
7. Lbs of coal per S.H.P hr. all purposes	1·65 lbs.	(equiv). 1·94 lbs.
8. Estimate of water consumption per hour all purposes	22,000 lbs.	27,200 lbs.
9. Estimate of water consumption per I H.P. hr. ..	(equiv). 12·3 lbs.	15·18 lbs.
10. Estimate of water consumption per S.H.P. hour ..	14 lbs.	(equiv). 17·3 lbs.
11. Hot well temperature ..	79° Fah.	104° Fah.
12. Feed temperature	203° Fah.	221° Fah.
13. Estimate lbs. of water per lb of coal (from feed temp) ..	8·5 lbs.	8·97 lbs.
14. Percentage of ash . ..	12·5%	9·36%
15. Pressure, steam pipe in engine room	158 lbs.	175 lbs.
16 Initial pres're, H.P. Turbine	138 lbs.	—
17. Vacuum	28·75″	26·8″
18. Circulating water inlet ..	50° Fah.	50° Fah.
19. ,, ,, outlet ..	70° Fah.	95° Fah.

The loss of power in transforming from the turbine speed of 1,400 to that of the propeller, amounted to 1½ per cent., the majority of this being absorbed in the bearings.

Next, Messrs. Cairns, Noble and Co. (Fig. 9) equipped two sister cargo ships, of 9,900 tons displacement—the "Cairngowan" and "Cairnross"—the former with reciprocating engines, the latter with geared turbines, and from simultaneous trials on a 36-hours' trip the saving in coal consumption in favour of the geared turbine boat was 15 per cent. (Fig. 10).

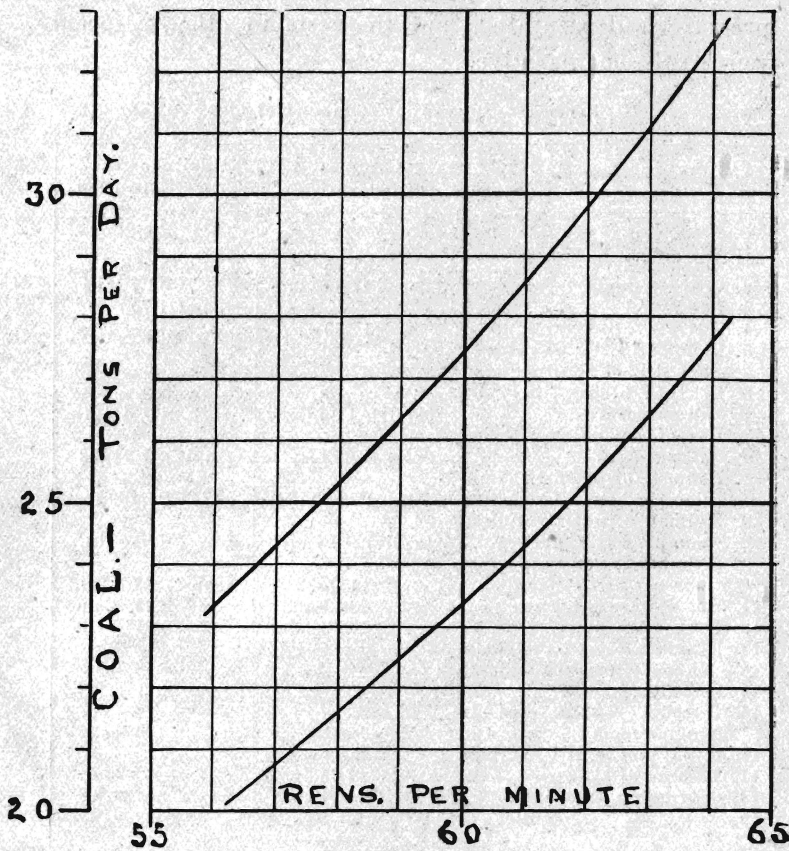

Fig. 10.

ESTIMATED PERFORMANCE IN FINE WEATHER.

S.S. "Cairngowan" .. .. upper curve

S.S. "Cairnross" .. .. lower curve

Trim of ships and evaporation as on 36 hour trial.

Note—60 revs. per min. corresponds (approx.) to 10 knots.

The next important step was taken by Professor Biles in 1911, in advising the L. and S.W. Railway to install this type of turbine for their new Channel steamers "Normania" and "Hantonia."

A year previously this company had taken delivery of two sister boats equipped with direct coupled turbines, the sea speed required being about 19 knots, which speed, from the point of view of coal consumption, is bordering on the territory of the reciprocating engine, on account of the difficulty in efficient propeller design.

The two new boats required were of similar size to those equipped with triple screw, direct coupled turbines; but it was estimated by Professor Biles that the steam consumption of the twin-screw geared sets would be 12½lbs. per shaft h.p. against 15.7lbs. for the direct coupled turbines.

In the case of the geared boats "Normania" and "Hantonia," Professor Biles was able to make a reduction in the boiler power (owing to the lower steam consumption of the geared turbine), so that one double and one single-ended boiler could be adopted instead of two double-enders. As a result of this he was able to decrease the beam of the geared boats by three feet, with the resultant superior lines of the "Normania" and her sister ship. This resulted in a considerable saving in weight of hull and boilers, and the necessary driving power for the boat.

The weight carried in the trials of the "Normania" was the same as for the direct coupled boat, with the result that the total coal consumption for the six hours' trial on the "Normania" was 18 tons at 19.7 knots, against the direct coupled "Cæsarea" of 29 tons for 20 knots—a saving in favour of the two-propeller geared boat of 40 per cent.

Professor Biles credits the improvement of the hull with about 20 per cent. of this amount, leaving about 20 per cent. to the credit of the geared turbine and efficient slow-speed propellers.

The triple propellers of the direct coupled "Cæsarea" revolved at 500 revolutions, whereas the twin-propellers of the geared "Normania" and sister ship revolved at about 300.

Professor Biles, in his paper before the Institute of Naval Architects in 1912, on the subject of these two-geared steamers, states, in comparing the two direct coupled turbine boats with the geared sister ships, as follows:—

"To effect the object of reducing consumption without reducing the advantages of speed and accommodation to the travelling public, which had been secured in the last two steamers, did not appear at first sight to be an easy problem, because these vessels were very efficiently propelled."

When it is remembered that the direct coupled turbine steamers to which he refers were found superior by about 6 per cent. to 10 per cent. to two practically similar ships built at the same time with reciprocating engines, the immense improvement of the geared-turbine over-reciprocating engines and direct coupled turbine steamers becomes even more apparent.

Needless to say, such savings as Professor Biles so clearly demonstrated with sister ships had a very marked effect upon Naval Architects and ship owners generally, and the progress of the marine geared turbine since then has been really remarkable.

Weight and space occupied by propelling machinery, all-important items in marine work, and especially in war vessels, have been greatly decreased by the introduction of the geared turbine.

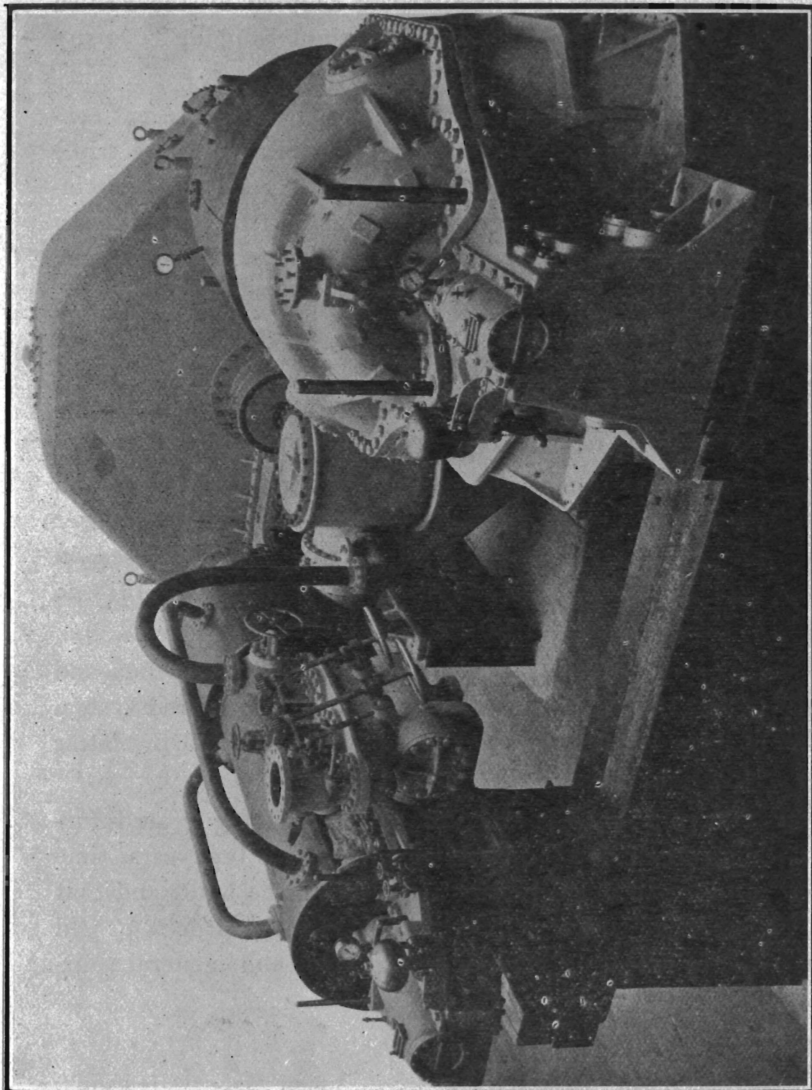

Fig. 11.

There are many important advantages over and above the question of steam consumption, decreased weights, etc., in the geared type, but time will not allow me to enter into the question to-night; sufficient is it to say that the system is being largely adopted by the British Navy, and by almost every important shipping company in the world.

An example which interests us locally is the recent conversion of the Union Company's "Maheno" from a triple screw, triple turbine, direct coupled steamer to the twin-screw, four turbine-geared steamer. This enterprising company was the first to adopt turbines in Australasia, and has again the honour with the geared turbine.

In 1910 the British Navy first partially adopted the system for two destroyers. Since the successful trials of these destroyers, 65 war vessels, with complete or partial gearing, are in service or are being built (Fig. 11).

The total number of geared turbine vessels, war and mercantile, amount to over 90, and in 1910 the total power of geared turbines was 15,000 h.p. This increased in 1911 to 32,500 h.p., in 1912 to 118,000 h.p., in 1913 to 435,000 h.p., and in 1914 it has reached 634,000 h.p.

Large steamers are now being built for the Union and Orient Companies, both of which have the geared system of propulsion, the former being 12,000 h.p. and the latter 14,000 h.p. boats.

So reliable, efficient, and quiet are these geared turbines that it is not rash to state that in a few years' time no direct coupled turbine steamer will be built, and that the system will very largely take the place at present held by reciprocating engines for marine and general purposes.