steam turbine. In the tests that have been quoted the useful output was determined by electrical means. Direct measure­ments of the useful mechanical power (the “ brake ” power) may, however, be obtained by applying a torsion dynamometer to the shaft. Devices are accordingly used in marine turbines for determining the horse-power from observations of the elastic twist in a portion of the propeller shaft as it revolves. In Denny & Johnson’s torsion meter two light gun-metal wheels are fixed on the shaft as far apart as is practicable, generally 15 or 20 ft., and their relative angular displacement is found by comparing the inductive effects produced on fixed coils by magnets which are carried on the wheels. In Hopkinson & Thring’s torsion meter a short length of shaft—a foot or so— suffices. A small mirror is carried by a collar fixed to the shaft, and a second collar fixed a little way along is geared to the mirror in such a way as to deflect the mirror to an extent pro­portional to the twist: the deflexion is read by means of a lamp and scale fixed alongside. As the shaft revolves the light re­flected from the mirror is momentarily seen at each revolution and its position along the scale is easily read. (J. A. E.)

**STEAMSHIP LINES.** The shipping company is the outcome of the development of the steamship. In former days, when the packet ship was the mode of conveyance, there were com­binations, such as the well-known Dramatic and Black Ball lines, but the ships which were run in them were not necessarily owned by those who organized the services. The advent of the steamship changed all that. It was in the year 1815 that the first steamship began to ply between the British ports of Liverpool and Glasgow. In 1826 the “ United Kingdom,” a “ leviathan steamship,” as she was considered at the time of her construction, was built for the London and Edinburgh trade, steamship facilities in the coasting trade being naturally of much greater relative importance in the days before railways. In the year 1823 the City of Dublin Steam Packet Company was inaugurated, though it was not incorporated till ten years later. The year 1824 saw the incorporation of the General Steam Navigation Company, which was intended not only to provide services in British waters, but also to develop trade with the continent. The St George Steam Navigation Company and the British & Irish Steam Packet Company soon followed. The former of these was crushed in the keen competition which ensued, but it did a great work in the development of ocean travelling. Isolated voyages by vessels fitted with steam engines had been made by the "Savannah ” from the United States in 1819, and by the first “ Royal William ” from Canada in 1833, and the desirability of seriously attacking the problem of ocean navigation was apparent to the minds of shipping men in the three great British ports of London, Liverpool and Bristol. Three companies were almost simultaneously organized: the British & American Steam Navigation Company, which made the Thames its headquarters; the Atlantic Steamship Company of Liverpool; and the Great Western Steamship Company of Bristol. Each company set to work to build a wooden paddle steamer in its own port. The first to be launched was the “ Great Western,” which took the water in the Avon on the 19th of July 1837. On the 14th of October following the “ Liverpool ” was launched by Messrs Humble, Milcrest & Co., in the port from which she was named, and in May 1838 the Thames- built “ British Queen ” was successfully floated. The “ Great Western ” was the first to be made ready for sea.

But the rival ports were determined not to be deterred by delays in getting delivery of theîr specially built ships. The London company chartered the “ Sirius,” a 700-ton steamship, from the St George Steam Packet Company, and despatched her from London on the 28th of March 1838. She was thus the first to put to sea. She eventually left Cork on the 4th of April, and reached New York on the 22nd, after a passage of 17 days. The “ Great Western ” did not leave Bristol till the 8th of April, but under the command of James Hoskeπ, R.N. (1798-1885) she reached New York only a few hours after the “ Sirius.” The Liverpool people, fired by the action of the other two ports, chartered the “ Royal William ” from the City of Dublin Steam Packet Company, and despatched her on the first steam voyage from the Mersey to Sandy Hook on the 5th of July in the same year. The “ Liverpool ” made her maiden voyage in the follow­ing October. But the "British Queen ” did not make her initial attempt till the 1st of July 1839. Trouble overtook all three of these early Atlantic lines, and they soon ceased to exist.

Perhaps the most serious factor against them was the success of Mr Samuel Cunard in obtaining the government contract for the conveyance of the mails from Liverpool to Halifax and Boston, with a very large subsidy. The Cunard Line was enabled, and indeed, by the terms of its contract, obliged, to run a regular service with a fleet of four steamships identical in size, power and accommodation. It thus offered conveyance at well-ascertained times and by vessels of known speed. The other companies, with their small fleets of isolated ships and their irregular departures, could not continue the competition. The Atlantic Steamship Company of Liverpool found that the port could not then maintain two steamship Unes, and the steamship “ Liverpool,” with another somewhat similar vessel which they had built, fell into the hands of the P. &O. Company. The Great Western Steamship Company proceeded to build the "Great Britain,” an iron screw steamship, which in every way was before her time, and were swamped by financial difficulties, their “ Great Western ” being sold to the West India Royal Mail Company, to whom she became a very useful servant. The it Great Britain ” (which was stranded in Dundrum Bay in September 1846, owing to her captain, Hosken, being misled by a faulty chart and mistaking the lights) eventually drifted into the Australian trade. The London company put-a second ship, the “ President,” on their station. She was lost with all hands, no authentic information as to her end ever being obtained. Her mysterious fate settled the fortunes of her owners, and the "British Queen ” was transferred to the Belgian flag. Steam navigation across the Atlantic was now an accom­plished fact. But all the three pioneers had been borne down by the difficulties which attend the carrying out of new departures, even when the general principles are sound.

Constant improvement has been the watchword of the ship-owner and the ship-builder, and every decade has seen the ships of its predecessor become obsolete. The mixed paddle and screw leviathan, the “ Great Eastern,” built in the late ’fifties, was so obviously before her time by some fifty years, and was so under-powered for her size, that she may be left out of our reckoning. Thus, to speak roughly, the ’fifties saw the iron screw replacing the wooden paddle steamer; the later ’sixties brought the compound engine, which effected so great an economy in fuel that the steamship, previously the conveyance of mails and passengers, began to compete with the sailing vessel in the carriage of cargo for long voyages; the ’seventies brought better accommodation for the passenger, with the midship saloon, improved state-rooms, and covered access to smoke- rooms and ladies’ cabins; the early ’eighties saw steel replacing iron as the material for ship-building, and before the close of that decade the introduction of the twin-screw rendered break­downs at sea more remote than they had previously been, at the same time giving increased safety in another direction, from the fact that the duplication of machinery facilitated further subdivision of hulls. Now the masts of the huge liners in vogue were no longer useful for their primary purposes, and degenerated first into derrick props and finally into mere signal poles, while the introduction of boat decks gave more shelter to the pro­menades of the passengers and removed the navigators from the distractions of the social side. The provision of train-to- boat facilities at Liverpool and Southampton in the ’nineties did away with the inconveniences of the tender and the cab. The introduction of the turbine engine at the beginning of the 20th century gave further subdivision of machinery and increase of economy, whereby greater speed became possible and comfort was increased by the reduction of vibration. At the same time the introduction of submarine bell signalling tends to diminish the risk of stranding and collision, whilst wireless telegraphy not only destroys the isolation of the sea but tends