Experiments show that the progressive acceleration of the rhythm brings about the modifications represented in the following table. The acceleration of rhythm from sixty to eighty steps per minute has

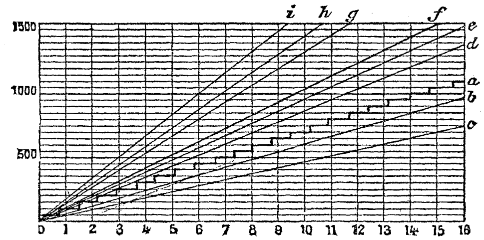

FIG. 4.

increased the length of the step, and decreased the time required to travel a certain distance; but, when we go above this, the opposite effect is produced. It is better to replace the numerical table by the diagram of fig. 5, which represents the variations in

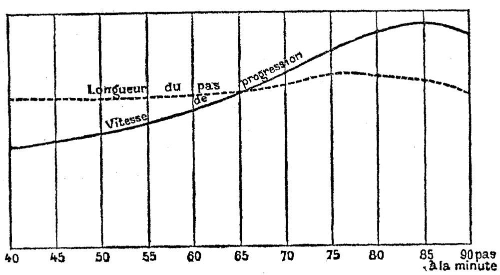

FIG. 5.

quickness of gait, and length of steps, as guided by the electric bell ringing at different rates.

Time of travelling over 1,542 metres.	Number of double steps to the minute.	Length of double steps.
20′ 30″	60	1.35 m.
18′ 40″	65	1.37 m.
16′ 27″	70	1.45 m.
14′ 58″	75	1.51 m.
13′ 52″	80	1.50 m.
13′ 3″	85	1.49 m.
14′ 1″	90	1.32 m.

NAVAL ARCHITECTURE IN ENGLAND.

FRANCIS ELGAR, professor of naval architecture at the University of Glasgow, devoted his inaugural address, on entering upon his duties in November, 1884, to a history of the science.

Until within comparatively few years but little attention has been paid to the study of naval architecture. Fifty years ago ninety-nine per cent of the British merchant-ships were under five hundred tons, and few measured more than a hundred and thirty feet. They were comparatively uniform; and, being built after an established plan, they were perfectly seaworthy when properly ballasted. In the case of war-ships the matter was more difficult; as it was necessary to get a type of ship which should be large, high out of water, and able to carry many large guns, without interfering with her sailing-qualities, or rendering her top-heavy.

In 1811 a school of naval architecture was started in England, and during twenty years it trained forty students. This was followed in 1848 by another at Portsmouth, and in 1864 by a third at South Kensington, which is now united with the Royal naval college at Greenwich. Some excellent designers have been graduated from these three schools.

Before the use of iron, ship-building required no elaborate calculations: it was simply a highly developed mechanical art. Ships were built of great relative depths in proportion to their breadth, and initial stability was deliberately sacrificed to reduce the tonnage measurement. Usually these ships would not stand up, when fully rigged and light, without ballast; and, judging from the proportions given to them, they must also have required ballast when laden with cargoes which were not composed of heavy dead-weight. What is now required of the ship-builder is to predict with great accuracy the weights of complicated iron and steel structures, with all their fittings and machinery; the weight of cargo that such structures will carry at sea; the stability they will possess in different conditions of loading, and the treatment necessary to insure a safe amount of stability being preserved upon all occasions; the amount of steam-power and the rate of coal-consumption required to maintain given speeds at sea; and very frequently the strength that is possessed by the hull to resist the straining-action of waves.

The reason that the English schools for this study have not been better attended, is that the courses are too technical in character, and the requirements too rigid, to attract any except advanced students. The idea of the newly established chair of naval architecture in the University of Glasgow is to teach in a less technical manner the new science, and to adapt the course to the requirements of the students. The policy will be first to fix what they already know, and then to go forward to a complete study. Special stress is to be laid upon long-continued and arduous practical training, combined with true science. The only way in which superiority in ship-building can be attained is by possessing a class of ship-builders who have gone through just such a training, and who by long study and work have acquired these theoretical and practical principles.

RECENT BRITISH LOCOMOTIVES.

ENGINES recently designed for the London, Brighton, and south-coast railway of Great Britain by Mr. Stroudley, were described by their designer at a recent meeting of the British institution of civil engineers. They were designed for freight-traffic, or as goods-engines.' The steam-cylinders were inside the frames. The forward wheels were coupled, instead of, as usual, the after-wheels; thus getting a set of small trailing-wheels, short outside coupling-rods, and a large boiler. The centre of gravity of the engine was purposely made high, as is the practice in this country in the construction of the wide-firebox engines of Mr. Wooten, for the purpose of making the engine move more easily at high speeds, and, as both these designers believe, making them safer; the rolling being less serious at exceptionally high speeds than in engines having a low centre of gravity. The action of the high centre of gravity in throwing the pressure mainly upon the outer rail, in rounding curves, was thought to be another advantage of appreciable value, permitting the inside wheels to slip more readily. Six wheels were used, without truck or 'bogie.'

It was asserted that the cranked axle, and other parts of the machine, do not break if properly proportioned, although it was evidently felt that the axle is a source of danger in greater degree than when straight, as in outside-connected engines. The steam was given an admission varying from twelve to seventy-eight per cent, the engine running very smoothly, and with great economy, at high speeds, with the shorter cut-off. The compression is thus made advantageous in both ways. It was considered that compounding would not be of sufficient advantage to justify its adoption in such engines; although it might prove useful for heavy, slow-moving engines, working with little expansion the greater part of the time. The Westinghouse brake was fitted to all these engines, and gave thorough satisfaction. Its pump had been fitted with a water-connection, and it could thus be utilized as a boiler-feeder when on sidings. The boiler was made of Yorkshire iron, with joints butted, edges of sheets planed, holes drilled after bending the sheets, and all hand-riveted. The steam used amounted to about twenty-six pounds per horse-power per hour, on a road on which the average is thirty. One pound of coal conveyed one ton thirteen miles and a half, at the speed of 43.38 miles an hour. Heating the feed-water saved two pounds and a half per train-mile.

SEMI-CENTENNIAL OF THE LYCEUM OF NATURAL HISTORY AT WILLIAMS COLLEGE.

IT will be news to many, that a natural history society of college students has had an uninterrupted existence of fifty years at Williams college, in the little village of Williamstown, Mass. It is nevertheless true, and its semi-centennial was celebrated on April 24.

The exercises were opened by the president of the society, Mr. Henry B. Ward, with a short historical sketch. "Fifty years ago," said he, "on the 2d of April, eight students of Williams college formed a society for the study of natural history in its various departments. At first secret, under the name of Φ B Θ, within six months it adopted its present name. Professor Albert Hopkins, speaking twenty years later, said that it had sustained from the beginning a spirit of enterprise. The history of its early years remarkably verifies his assertion; for within a year from its formation it was large and active enough to send to Nova Scotia an expedition of twelve members and three professors. This expedition gave the lyceum a considerable reputation, and it was referred to by a French scientific journal as the first of the kind attempted in America. In the spring of 1840, only four years later, an expedition was sent through Berkshire county for study and collecting. By these two expeditions and individual effort, the collections well filled the society's rooms in East college. When that building was destroyed by fire, in 1841, the collections also perished. Contributions from all sides, and hard work by the members, soon restored them so well that the rooms in South college became too small; and in December, 1854 a circular was sent out, forcibly setting forth the needs of the lyceum, and asking for twenty-five hundred dollars to erect a building. This circular was brought to the notice of Mr. Nathan Jackson of New York, a relative of Col. Williams, and grand-uncle of the president of the lyceum at that time. He sent a check for the whole amount; and in a few months Jackson hall was completed. At commencement, Aug. 14, 1855, the lyceum was addressed in the forenoon by Prof. William B. Rogers, and in the afternoon held a public meeting in its new rooms in Jackson hall, to dedicate the building, and celebrate its twentieth anniversary. At this time Mr. Jackson sent a thousand dollars to make up the full cost of the building. In February, 1857, desiring to fill the cases in Jackson hall, the lyceum sent an expedition to Florida. Sixteen members, under the guidance of Professor Chadbourne, spent a month collecting on the Florida shores, with great success. The expenses were provided for by the liberality of Mr. Jackson and other friends of the society. In 1860 another expedition under the charge of Professor Chadbourne was arranged to Labrador and Greenland, a description of which has been recently published by Prof. A. S. Packard, a guest of the lyceum on that trip. In 1867 an expedition under the joint auspices of the lyceum and the college was sent to South America, under the charge of Professor James Orton, a former president of the lyceum. A small party proceeded from the northern coast by the courses of the Orinoco and Rio Negro to the Amazon: the main body crossed the Andes from the western coast, and descended the Amazon in canoes. In 1870 an expedition from both the lyceum and college spent four months collecting in Central America with great success. The expedition of 1877 to the northern Rocky Mountains was broken up by the death of Professor Tenney, its leader, just as it had started.

"Many have been the professors who have aided the lyceum in its work; but to Professor Albert Hopkins, Dr. Chadbourne, and Professor Tenney it owes a debt of gratitude which can never be computed."

Dr. W. K. Brooks, a former president, then addressed the lyceum on Life. He spoke of the age