that there has been a forward movement occurring, ever since 1916 with certainty, and probably from 1914. From further observations of the higher portions known as the Glacier du Géant, and of its tributaries, the Glaciers de Leschaux and Talèfre, it is shown that there has been a very considerable increase in the bulk of the glacier, an augmentation of thickness having been observed ever since 1913.

The Glacier des Bossons, the central glacier of Mont Blanc itself, offers the most interesting results, for owing to the snout being so readily accessible by the exceptional advance of the glacier on to the very meadows of the valley of Chamonix, it has been found possible since March 1917 to obtain monthly records of progress. They show that the glacier does not advance *en bloc*, but with a waddling motion, sometimes one side, sometimes the other, and sometimes the middle of the front, moving most during the month, like a heavy man walking in such a manner as to advance each shoulder alternately. Moreover, in summer the left of the front moved, on the whole, the more rapidly, and in spring and winter the right; the former is due to greater melting of the ice on the side showing least motion, and the latter to the form of the glacier bed, the line of maximum movement of a sinuous glacier being, as is well known, on the convex side of the central line of the glacier, that is, nearer to the concave border. Since the year 1910 the annual march of this glacier has varied from 33 metres during the first year (July 1910–July 1911) to 51 metres in 1917, from which it slowed down to 23 metres in 1920. The advance was greatest in spring, then next in summer, then in winter, and slowest in autumn. The mean values for the four years 1917–1920 were 11 metres in spring, 5·2 metres in summer, 5·1 metres in winter, and 1·7 metres in autumn. In spring there is extra pressure from above, owing to accretions from the névé of the higher snowfields, undiminished by melting, as the spring sun has first to melt the fresh winter snow. But in summer the movement is diminished by real fusion and thereby loss of solid ice, combined with reduced pressure from above, the weight of the winter snow having been removed by melting.

The Glacier de Bionnassay has been advancing since the year 1916 with certainty, and probably since 1914. The last measurements had been in 1913, and between then and 1916 the front of the glacier had advanced 30 metres. It continued at this rate more or less steadily down to the report period 1920.

Thus it is clear that the glaciers of the French Savoy side of the chain of Mont Blanc have all advanced, the amount being accentuated in the cases of the steeper glaciers, Le Tour, Argentière, and Les Bossons. In the more slowly moving cases, the Mer de Glace and the Trélatête glacier, the increase has been chiefly one of bulk and of thickness.

The glaciers of the Tarantaise, and other Savoy Alps, which are much influenced by the Lombardian winds of the valley of the Po, have either advanced to a less amount than those of Mont Blanc, or have retrogressed. The latter, for example, has been the case with the Glacier de la Vache (Source de l'Isère).

Special reference should be made to the particularly interesting determinations of the thickness of certain glaciers. The late M. Joseph Vallot obtained results on the Mer de Glace, at widely different positions in its course, which varied from one hundred to two hundred metres of solid ice; and he came to the conclusion that the latter figure represents the maximum depth. This estimate is almost exactly confirmed by these later measurements and estimations by the Department des Eaux et Forêts, the opinion being that, if not quite accurate, it errs on the low side.

The observations conclude with some remarkable estimates of the volume of additional ice represented by the advance of these glaciers. The Glacier du Tour has increased per annum between 1911 and 1920 by the amount of eight and a half million cubic metres. The glacier of Argentière has increased in volume by one to three million cubic metres per annum of solid ice; and the Mer de Glace has shown a similar amount of swelling, until in 1920 the exceptional heat caused a slight net loss. The Bossons glacier has enlarged by amounts varying from one-sixth to one-half million cubic metres a year. The glaciers of Bionnassay and Trélatête have gained in volume of solid ice between 1912 and 1920 more than five million and seventeen million cubic metres, corresponding to an increase of thickness of the glaciers of seventeen and six metres respectively.

The French Department des Eaux et Forêts is to be most sincerely congratulated on this magnificent piece of accurate work. It is to be hoped that the observations have been carried on beyond the year 1920 in an equally satisfactory manner, and that they will be continued. It would appear that this is being done, for the writer has several times come on the officers of the department at work during his recent summer visits to the Savoy mountains, both Mont Blanc and the Tarantaise Alps, including one paid this last summer, and has had personal experience of the admirable way in which the measurements are being carried out.

A. E. H. TUTTON.

Obituary.

SIR PHILIP WATTS, K.C.B., F.R.S.

SIR PHILIP WATTS, who died on March 15, was born in May 1846, being thus nearly eighty years of age when he died. He was educated at the Dockyard School at Portsmouth and the Royal School of Naval Architecture, South Kensington, completing his education in 1870. Until 1885 he spent most of his time at the Admiralty on the Naval Constructor's staff, which afterwards became the Royal Corps of Naval Constructors.

During this time Sir Philip was engaged in the design work of the office which then produced such original designs as the *Inflexible* with 24 in. of armour and four 16-in. 80-ton guns; the *Iris and Mercury*, the first all-steel ship and the fastest then produced; the *Polyphemus*, an armoured ram which was almost submerged; and many other original designs. He assisted Mr. Wm. Froude in the classic observations on the behaviour of the battleship *Devastation*, one of the first of the mastless turret ships in H.M. Navy. He took a leading part in the investigations of the *Inflexible* Committee, which was created as the result of doubts expressed as to the fighting and seaworthy qualities of that ship. He designed the rolling chambers of the *Inflexible*, and went to sea in her to observe the effects of the chambers on rolling.

Sir Philip was thus associated with most of the scientific development of naval architecture at the Admiralty between 1870 and 1885, at which date he began his independent career in charge of the design and construction of warships at Armstrong's works on the Tyne, in which position he remained until 1902, when he accepted the position of Director of Naval Construction at the Admiralty. His active career as warship designer extended for well over half a century, and during this time he was associated with a continuous increase in efficiency and battle power of the many ships for the design of which he was the responsible creator. His reputation stands unrivalled for the quantity and quality of his work. Of the warships which he designed and built when at Armstrongs, the cruisers were the fastest and best armed of their day, and the battleships were the most powerful. Nearly all the warship fighting done by the Japanese victorious fleet in 1894 and 1905 was done in Watts's ships.

When Sir Philip went to the Admiralty, two of the King Edward class of eight battleships had been commenced. He produced designs having much greater gun power, and not inferior in other respects, with the view of building a squadron of eight ships much more powerful than the King Edwards, but My Lords decided to complete the inferior ships. This was discouraging to the man who wanted to give our ships as much gun power as possible. On the appointment of Admiral Fisher as First Sea Lord, however, Sir Philip's chance came, and he had hard work to give Fisher all the guns he wanted. The all-big-gun ship was wanted. Its adoption was approved by the Committee on Warship Design appointed to consider the question, and the Director of Naval Construction produced the complete designs for the Dreadnought type approved by that Committee. Thus, by the energy of Fisher and the skill of Watts, was begun the series of Dreadnoughts and super-Dreadnoughts of which the Grand Fleet was largely composed—which, to adapt the phrase of Mahan, stood between the Germans and the conquest of the world. Watts could not have attained and maintained such a position without a very full knowledge of all that pertains to warships, not only the structure of the ship but also the principles underlying armour, gun and machinery production, and a full appreciation of the strategy and tactics of sea warfare and of the life and ambitions of the great sailors of his time.

Watts was one of the earliest graduates of that school of naval architecture which began in the 'sixties, developed in the 'seventies into the Royal Naval College at Greenwich, and has continued ever since to turn out men of high attainments to fill not only that able Corps of Naval Constructors (over which Sir Philip presided) but also the Royal Naval Engineers, who have so ably assisted in the enormous developments of marine engines which have taken place since the school was founded. Sir Philip, like his predecessors and successors, saw to it that this source of supply of naval constructors and engineers was fully maintained. He assisted in the creation of the professional chairs and the schools of naval architecture in Glasgow, Durham, and Liverpool, from which so many naval architects and marine engineers have graduated and have found scope for their abilities in the ship and engine works of Great Britain.

Sir Philip's great scientific attainments and his practical skill in applying his knowledge were recognised by the Royal Society, of which he was a fellow and vice-president, and by the universities which conferred on him LL.D. and D.Sc. degrees. It was, however, in the Institution of Naval Architects that his work was best known. He contributed many papers of high value and always took an active part on the Council of the Institution. He frequently presided at the council and general meetings, being for many years the senior vice-president. When at Armstrong's he was an enthusiastic territorial gunner and had the rank of Colonel. He was not a great talker in public or private, but all who had the privilege of his friendship will remember him as a generous and genial man with sound commonsense and wide scientific interests, which, combined with a gifted imagination and great courage, enabled him to carry through his important work successfully.

PROF. ERNST EHLERS.

PROF. ERNST EHLERS was born on November 11, 1835, in Lüneburg in the kingdom of Hanover, where his early education, carefully supervised by his father, who was a merchant, was received, and where the ancient buildings and historical surroundings doubtless had an influence on his sensitive mind. His training consisted of a good knowledge of classics, of history, mathematics, French, and chemistry, whilst his natural bent found a congenial field in faunistic works. He then (1857) proceeded southward to the University of Göttingen, where he energetically studied medicine and natural science, two subjects so intimately related, as all history shows, that the efforts of the late Scottish Universities Commission to separate them are vain. Amongst the professors there, none interested him more than W. Keferstein, R. Wagner, and Bödeker. There were comparatively few zoologists of the period who, like Ehlers, entered on their later studies with broad views and a thorough acquaintance with both vertebrate and invertebrate anatomy. It is true in his early days he had not the advantage of a life on the sea-coast and of familiarising himself with marine life from Protozoa to mammals, but he balanced this by his able researches on structure and by his skilful pencil, so that amongst the distinguished zoologists of the period he stands prominently forward.

Ehlers' abilities and natural bent were soon observed by Keferstein, who took the young naturalist with him to Naples and Messina, introducing him to the rich marine fauna there, the joint authors producing a memoir on the Siphonophores. In 1861 he received the degree of M.D. at Göttingen, his thesis being the "Anatomy of *Priapulus caudatus*," the material for which he had obtained from the well-known Japetus Steenstrup of Copenhagen. The same year he was appointed prosector to the Anatomical Institute of Göttingen, and two years later a private tutor in zoology and comparative anatomy.

His association with the leading zoologists of Germany and Austria led Ehlers to select the fine field for