quantitative measurements. This, however, is not the case, since probably the chief use of such tests is a qualitative examination of the wave motion created by the hull, particularly in relationship to the position in which the engines and propellers are proposed to be placed.

The physical problems presented by the aero engine are for the most part not peculiar to aeronautics, but are part of the general study of the internal combustion engine. The use of this type of prime mover for aircraft does, however, present special problems owing to the urgent demand for 'reliability' on one hand and lightness on the other. Moreover, there is always the tenuity of the air at altitude to be reckoned with.

As a matter of fact, the aero engine has improved enormously in recent years—not so much perhaps as the result of scientific study as by sheer hard efficient work on the part of the engineering staffs of the engine-builders. As witness to this remarkable success, I would specially mention the performance of the Napier water-cooled engine on the flight to South America, the excellent behaviour of the air-cooled Jaguar engine on Mr. Cobham's flight to South Africa and back, and by no means least, the remarkable achievement of an air-cooled Jupiter engine in flying 25,000 miles without any overhaul.

Need for lightness of construction brings in quite other considerations. For high output, high efficiency is necessary, and this calls for increased compression pressures and a consequent liability to the troubles induced by detonation. The study of detonation and the means of avoiding it are fitting studies for physicists. Equally fitting are the investigations necessary to ascertain whether the output of the engine in relation to its weight can be increased by what is known as supercharging, and if so, how far in that direction it is expedient to go. All the while it has to be borne in mind that the engine must not only be capable of operating in a normal atmosphere such as that in which most internal-combustion engines work, but also in conditions in which the pressure may be only one-third of that at sea level and in which the atmospheric temperature may be no less than 50° Centigrade below zero.

This sensitivity of the engine to atmospheric pressure has led naturally to attempts to create an artificial atmosphere of increased density in the engine intake. A scheme of this sort was indeed mooted by Sir Dugald Clerk more than twenty years ago, and was called by him 'super-compression.' It is now known as 'supercharging' when the effort is to maintain an intake pressure at all altitudes equal to that at ground level, or 'boosting' when the effort is to increase the intake pressure by a constant fraction at all heights. These developments present an infinitude of problems most of which are now beginning to be seriously tackled—their close relationship to detonation is a complicating phenomenon. There are such great possibilities in this direction that a material decrease in weight per horse-power at altitude may confidently be looked for in the not distant future.

We live in a wonderful age. Just as in the thirteenth century the splendour of life must have seemed most to surround the work of the architect, or in the fifteenth century that of the painter, so it appears to me in the present age does it crown the labour and achievement of the physicist.

Iron in Antiquity.[1]

By Dr. J. NEWTON FRIEND.

IT would be difficult to find a subject of greater interest than the study of iron in antiquity. Man's first acquaintance with the metal undoubtedly dates back, in certain districts, to the Stone Age. At that time meteoric iron would be much more common than now, and primitive man would soon observe that the metal was more malleable than ordinary stone, and could be cold worked, by repeated hammering, into simple shapes for ornament or for personal use. Probably this was the origin of the metal beads, the oxidised remains of which have been found in predynastic tombs in Egypt, dating back to about 4000 B.C. But it was not until man had progressed slowly upwards through ages of unremitting toil that he learned of the connexion between metallic iron and certain of the stones around him, and succeeded in reducing the metal from its ores.

Iron appears to have been manufactured in the Near East at a fairly early date. The Hittites were beginning to use iron weapons for military purposes about 1300 B.C., and Rameses II., King of Egypt, is known to have applied to the Hittite king for a supply of the metal. Whether he obtained it or not is unknown, but a mutilated letter has been found, possibly addressed to Rameses II., in which the Hittite king states that he is sending an iron dagger, and promises to forward a supply of iron.

The Philistines are believed to have introduced the general use of iron into Palestine, although the metal was known many years prior to that. It is clear from references in the Old Testament (see 1 Sam. xiii. 19-22) that the Philistines retained the monopoly of working iron, with the result that at first there was no smith in Israel, and the only Hebrew persons possessing iron swords were Saul and Jonathan. In other words, the Philistines had already entered upon their iron age when the Israelites were still in their bronze age. By the time that David ascended the throne, however, the use of iron was becoming more general. Nevertheless, it is interesting to note that no iron tool was allowed to be used in the construction of Solomon's temple at Jerusalem. The employment of iron would have been offensive to God, who had in previous years spoken against the use of metal, and had ordered (Ex. xx. 25) any altars erected to Him to be made of unhewn stone. In view of this the following tradition is interesting. Whilst the present writer was in Jerusalem last year, his dragoman informed him of a curious belief prevalent amongst the Jews to the effect that if the crevices in the ancient wall at the famous Wailing Place are completely filled with

[1] Substance of a lecture delivered at the Royal Institution on June 3.

iron nails, Jerusalem will once again be restored to the Jews.

The Greeks and the Cretans would appear to have been the first European peoples to use iron. Homer, who lived about 880 B.C., was very familiar with the metal. The Homeric age, however, as depicted in the "Iliad" and "Odyssey," is several centuries earlier; the Phaeaceans referred to in the latter work are believed to have been the Minoans of Crete, famous for their sea power—the Britons of the Mediterranean. The Homeric period was transitional between the Bronze and the Iron Ages. Iron was listed amongst the treasures of the wealthy, but was in general use only in the peaceful pursuits of agriculture. Probably the metal lacked homogeneity and could not be relied upon in such thin strips as would be necessary for swords, owing to its tendency to bend or snap. The Vikings 2000 years later were familiar with this difficulty, as is evident from the Icelandic sagas. One frequently reads that the swords would not "bite," and occasionally we are told that the sword bent so seriously that the warrior often had to straighten it under his foot! This surely was giving his opponent too much of an advantage.

The Romans about 2000 years ago were skilled metallurgists. Virgil in his "Aeneid," written about 40 B.C., describes a smithy in full work, and refers to the steel hissing as it is quenched in water, showing that the art of tempering was practised. Pliny some years later showed a wide knowledge of the ores of iron and of the working of the metal. He appears also to record, in what is otherwise an obscure passage, the accidental production of cast iron. For this product, however, there was at the time no practical use, as the Roman furnaces were incapable of dealing with it. The tendency of iron to rust was regarded by Pliny as Nature's punishment on the metal which, owing to its use in warfare, "brings the greatest dangers upon perishable mortality." Occasionally, as now, the rusting of iron was turned to good account. A very clever metallurgical conception was attributed by Pliny to Aristonidas, who, wishing to express in a statue at Rhodes the "fury of Athamus subsiding into repentance after he had thrown his son Learchus from the rock, blended copper and iron, in order that the blush of shame might be more exactly expressed by the rust of the iron making its appearance through the shining substance of the copper."

Iron was regarded as symbolical of Mars, the god of war, and the alchemists represented it by the symbol ♂, which is usually supposed to be derived from the shield and spear of that god. The popular idea that iron is a useful remedy and invigorates the constitution owes its origin largely to this connexion with the virile god, who was supposed to transmit his strength to his dedicatee. Ancient legend has it that King Iphiclus of Phylacea about 1380 B.C. was very anxious to beget children, and was successfully treated by the shepherd Melampus, who dosed him with iron rust in wine—the earliest *vinum ferri* of the pharmacist on record!

Iron was known to the Britons long before the advent of Julius Cæsar. The Romans greatly extended its use in Britain, and numerous objects of iron are continually being unearthed on the sites of various ancient Roman stations. One of the most interesting of these is an iron ring, probably the remains of a ferrule, found last year at Uriconium. It appears to have been made by bending a strip of iron into a circle and soldering the ends together with some copper alloy. This is the first recorded example of such work.

Cast iron was known in Sussex by 1350 A.D. and soon became quite a familiar commodity. It was at first used exclusively for casting purposes. In 1516 a cast-iron gun weighing nearly 5 tons was made, and in 1588 the Spaniards armed their Armada with cast-iron guns as well as with the more familiar bronze weapons.

When, many years later, it was found that cast iron was the most suitable starting-point for the manufacture of iron and steel, the demand for it increased rapidly. In 1800 the United Kingdom produced about ¼ million tons of pig iron, a quantity that in 1913 had increased to a maximum of more than 10 million tons. In 1925 it had fallen to little more than 6 million tons—the aftermath of the War.

Structural Features of the Earth.[1]

ARGAND'S distinguished services in unravelling the structure and history of the Pennine Alps, and of the Alps in general, ensure a respectful hearing for his present wider venture. Wide it undoubtedly is, for its seemingly ample title, "La tectonique de l'Asie," in no way contains it. Asia furnishes the text, the subject is Suess's own, the face of the earth.

It is interesting to find de Margerie, who did so much to secure recognition for Suess's masterpiece, acting as godfather to the new arrival. Argand explains that the basis of his memoir is a manuscript map, of which he prepared a first draft in 1912. The following year, de Margerie introduced this map to the notice of the Canadian meeting of the International Geological Congress, and since then has done all in his power to secure its publication. The Belgian meeting, 1922, promised us the map. The memoir, at any rate, is in our hands. In acknowledging his debt to de Margerie, Argand admits that he could not have faced the task without the help of this 'prince de la bibliographie.' Where so much is given, it may seem churlish to grumble, but many a student will miss any attempt at a considered bibliography in connexion with Argand's memoir. Perhaps the author felt that, when one writes of the world, the catalogues of libraries are themselves the bibliography.

Argand considers that modern knowledge requires a modification and extension of Suess's achievement, not a reconstruction. He starts by adopting Bertrand's *time-definition* of mountain building, employing it in a somewhat elastic sense: the Caledonian Cycle of mountain-building belongs to Lower Palæozoic times; the Hercynian to Upper Palæozoic times; and the Alpine to Secondary, Tertiary, Quaternary, and Recent times.

The deformations produced by horizontal pressure acting during any particular cycle are of several

[1] "La tectonique de l'Asie," *Compt. rendus*, Congrès Géol. Internat., Session xiii, 1922: Belgique, 1924. By E. Argand. Pp. 171-372 (Contents, pp. 365-372), Figs. 1-27.