ton-rod K terminates in a triangular frame III, from the apex of which the connecting rod R descends to the crank S ; and to the extremities of its base are attached the piston-rods OO of the air-pumps EE, which are in this case two in number, and situated one on each side of the cylinder. The triangular frame III is confined to move in a vertical direction, by its cross-head *gg* being guided in the slide *pp.* The remaining parts are, A the cylinder, CC the condensers, *aa* the valve-chest, F the feed-pumps, worked by an eccentric *ff,* U*u* the eccentric and valve-gear, and *e e e e* the framing of the engine.

Plate ccccxc. Fig. 1 of this plate is a side-eleva­tion, and fig. 2 an elevation of the cylinder end, of a pair of marine engines constructed by Messrs Seaward of the Canal Ironworks, Limehouse, for H. Μ. steam-frigates Gorgon, Cyclops, Prometheus, and Electo. These en­gines are of a peculiar construction ; the crank, as in the engines of the last plate, being directly above the cylin­der, the connecting rod only intervening between it and the piston-rod. They are of the class of the vibrating pillar-engines, the pillar which supports the beam turn­ing upon a centre at its lower end. A is the cylinder, B the valve-chest, C the condenser, E the air-pump, K the piston-rod, R the connecting rod, S the crank, GGG the beam, *g* the vibrating pillar, L the radius rod, N the air-pump side rod, M the air-pump cross-head.

STEEL.—As good iron is the basis of good steel, all that has been said under the articles iron and smelting in reference to the sources and means of procuring that metal in a state of purity, may be advantageously refer­red to as a preliminary to the present.

Steel is a carburet of iron, with probably a slight mixture of other substances which are more or less essential to its perfection, and certainly in most cases with some alloy which is not essential, but which, on the contrary, is to some extent injurious. This descrip­tion would equally apply to cast-iron, which differs from steel as to its ingredients principally in the quantity of carbon, cast-iron having sometimes one- fifteenth part, and good steel seldom more than one two-hundredth part of that substance. The difference between the proportions of the carbon does little, how­ever, to explain the difference between cast-iron and steel; for, while the condition of cast-iron is retained, it is found that diminishing the quantity of carbon renders it still less like good steel. It appears, in short, that the good qualities of steel—and they are very various— depend upon circumstances partly chemical and partly mechanical, which have hitherto detied analysis. It is not even precisely known whether the union of the iron and carbon is a chemical or mechanical union : perhaps it may be partly one and partly the other, for reasons which will presently be given.

In consequence of this ignorance as to what constitutes the essential qualities of good steel, the processes by which favourable results have been obtained have in nearly all cases been empirical, and in many instances have been real or pretended secrets. The processes are of a nature to forbid any very nice calculations, and they are liable to great and unappreciable modifications in the execution. For example, steel being, as before stated, a carburet of iron, and having generally a slight admixture of oxyde of iron, must be subject to many incalculable changes during its successive exposures to violent heat in contact with carbonaceous fuel and atmospheric air. Moreover, the hammering, on which many of its good properties depend, is obviously an operation which cannot be meted out with very scrupulous nicety, and is besides liable to be very much influenced by the temperature of the metal and by the direction of the blows in reference to the mechanical structure of the mass.

A good practical essay on steel, it is therefore evi­dent, would consist in an exceedingly minute detail of the actual operations applied to a certain description of ore, or to a known specimen of manufactured iron, which, with certain sorts of fuel, had been found uniformly to produce steel peculiarly adapted to certain purposes. Such an essay would form a volume, and it would still convey imperfectly what it professed to teach, because in all the processes there are certain stages of the con­version whose advent is judged of by the experienced eye and hand of the skilful workman, from symptoms which can be explained only to the sight and touch. Hero we only propose to describe, in very general terms, some of the principal processes, so as to convey a knowledge of the *theory* of steel-making without pro­fessing to give the actual practice. We must pre­mise, that the destination of the steel is of great im­portance in estimating even the theory of those pro­cesses, as may be well supposed when it is recollected that a lancet will fracture almost like glass, while a bricklayer’s trowel is required to cut the most refractory lump of semi-vitrified clay in the shape of a brick. These two instruments are perhaps at the extremities of the scale, the perfect hardness and brittleness of the lancet contrasting with the extraordinary toughness and tena­city of the trowel.

It was at one time, indeed, thought so difficult to com­bine these last-mentioned qualities with sufficient hard­ness to sever a good stock-brick, that trowels were made of a plate of iron to supply the toughness, and an edge of steel to give the hardness. Even at the present time it is supposed that the peculiar qualities of certain sword-blades result from their being combinations of hard steel with soft tenacious iron fibre ; and that the variegated or *damasked* surface of such blades is owing to the different appearances presented by the iron and steel. By some this effect has been supposed to result from chemical changes acting partially upon the original car­buret, depositing the carbon more profusely in some parts of the iron than in others. It may arise, as already hinted, from some portions of the carburet being in a chemical, and others only in a mechanical state of union. According to other authorities, the structure in question has been manufactured expressly by binding up portions of soft iron wire with ingots of steel, and hammering the whole into a mass at a high temperature. Such a process will, it is known, produce very similar appearances. Whatever be the truth in regard to the sword-blades, certain combinations of iron and steel in parallel laminæ are advantageously employed for some put poses. The carpenter's *plane-iron,* for example, consists of a very thin hard steel face on an iron back ; because this instru­ment requires to unite a cutting edge nearly equal to that of the lancet with a tenacity which shall encounter unin­jured the hardest knots ; a trial almost as severe as that applied to the trowel.

One great cause of the uncertainty and obscurity attend­ing the practice of steel-making, is the importance of the hammering or other mechanical parts of the operation. If