crank-axle at X, which shaft is also employed to work • the governor-balls *ww.* The whole foundations are solid red sandstone rock, in which excavations are made for the shafts and ropes.

Plates cccclxxiii, cccclxxiv, cccclxxv. This very beautiful pair of engines was constructed by Mr Fair­bairn of Manchester ; and they are the property of Messrs Bailey and Co. of Staley Bridge, near Man­chester. They are employed to drive a cotton-mill, and possess many excellent adaptations to this purpose.

These engines are of a similar form to those employed in large steam-vessels, and will serve very well to conduct the student from the common to the marine engine. The working beam or great lever LLL is, as it were, split in two, one of the halves being placed on each side of the engine, but united at the middle by a large gudgeon or main-centre, LL, and at the one end by a cross-head, L*p*L, and side rods, RL and RL, and at the other end by a cross-tail of similar form, and the connecting rod KL, which turns the crank KX. The moving mass is thus placed lower, and the whole rendered more compact, than the common house-engine.

This double marine engine is reckoned preferable in the manufacture of cotton to an engine of the common kind. The double engine gives a considerable degree of uniformity to the velocity produced ; and the approxima­tion to uniformity is rendered still more perfect by the short stroke, in which the variations of force recur at shorter intervals than with a long stroke. A striking peculiarity in this pair of engines is the large fly-wheel, WWW, formed of toothed segments, which receives the moving force of both engines, and gives it out directly, and with a high velocity, to the mill-shafts, YY. Not only is the requisite speed of revolution attained very readily and quickly by this means, but the momentum of the wheel is immediately conveyed to the shaft, instead of passing through a series of wheel and axle work. The durability and excellence of this arrangement are unques­tionable.

The section, fig. 1, plate cccclxxiv, shows the details of many of the parts. The steam pipe SSS from the boiler conducts the steam into a space SS, forming a jacket round the cylinder AA. The piston P has metallic rings on its periphery as packing ; U and V, the upper and lower steam-ports, are wholly formed in the cover and bottom plate of the cylinder, and are closed and opened alternately by two short D-slides in two separate valve-chests above and below. The steam enters the upper chest from the jacket at S, where the throttle valve is inserted, and passes through the valve. The packing on the back of the valve is screwed down from above by a vertical spindle, and the eduction takes place through E by a hollow vertical column on one side of the valve-chest, while the steam passes down to the lower port through another column. The condenser C is a single casting, placed immediately below the valve-chest, and is entered by the injection pipe *cc* at c, of which the aperture is regulated by a slide-valve and vertical spindle ending in a screw. F is the foot-valve, governing the communication between the condenser and air-pump G; H is the air-pump piston, with common clack-valves ; and M is the delivery-valve, opening outwards into the hot well. The waste-pipe is immediately below M ; and the feed-pump and pipe *f* are in the masonry below the lever, so as to draw the feed-water from the waste-pipe.

The valves DD receive motion by an apparatus some­what peculiar. A stud in the crank-pin K carries round a small radius rod *x x* on an axis, concentric with the crank ; a smaller crank on this axis or shaft has a length equal to half the throw of the valve, or equal to that which would be given to the usual eccentric, and by a bar *x x* similar to the eccentric rod, the valve is moved by this lesser crank, just as by an eccentric. This gearing has the advantage of lightness and precision, *m m m* are the usual links of the parallel motion ; *d* is a counterpoise to the weight of the valve, *w w* are the weights of the governor.

Plate ccccxxLvι. This is one of that class called the rotatory steam-engine; a class comprehending many varie­ties, of which we hear much and see but little. The en­gine is here given as an illustration of this very unsuc­cessful class of engines, by one of its least exception­able examples. It has actually been in use for some years, being frequently employed to turn the machinery of a large establishment. We have seen it working smoothly and well. Yet we have not been able to recog­nize in it any reason for giving it an equality, much less a preference, in comparison with the common engine. It can be reversed in the same way as a common engine. It was invented by Mr Yule of Glasgow, by whom it was patented, and is still in the works of Thomas Edington, Esq., at Glasgow.

SSS is a double steam-pipe, either branch of which may be employed according as the engine is to go forward or backward. A A is the cylinder firmly fixed on a stone foundation, and in its centre is an axis XX, upon one side of which and eccentric to the cylinder is an inner cylin­der or barrel turned quite true, and fixed to revolve with the axis X, and so to form the piston P, which is to receive and give out the force of the steam. RR furnishes the *point d'appui,* the surface of reaction, which resists the force of the steam and forms a fixed obstacle. It is a flat slide or sluice, (see fig. 5,) resting on the barrel pis­ton P, and maintained by guides always in a vertical posi­tion. It passes into the cylinder through a rectangular stuffing box, and is raised and depressed by a small ec­centric pin *x x,* so as to remain always upon the surface of the piston drum. All the working surfaces are ren­dered steam-tight by metallic packings. EEE is the eduction passage into the condenser or the open air, DD are slide-valves to be reversed when the engine is to go backwards. On the revolving axis of the piston X are toothed wheels, *gg,* working other two, *gg,* which have a common axis *zz,* carrying a fly-wheel, and driv­ing the machinery to be worked by the engine. Fig 6. shows the ports at DD. Fig. 7 shows the guides of the slide RR.

Plates cccclxxvii, cccclxxviii, cccclxxix exhibit views of a pair of beautiful marine engines, constructed by Mr Napier, for the four British and North American royal mail steam-ships Britannia, Acadia, Caledonia, and Columbia, plying between Liverpool, Halifax, (Nova Scotia) and Boston, (U. S.) The following are the general dimensions of the vessel and engines.

Ft. in.

Length from figure-head to taffrail, . 228

Length of keel and fore-rake, . . 206

Breadth of beam between paddles, . 34 6

Depth of hold, . . , . 22 6

Diameter of paddle-wheel, . . 28

Length of floats, ∙ . . 26

Diameter of cylinder, . . . 6

Length of stroke, . . 6 10

The power or the engines is about 240 horse power. The paddle shafts make 16 revolutions per minute. The tonnage of the vessel by the old law is about 1200 tons.

Plate cccclxxvii is a side elevation of one of the engines.

Plate cccclxxviii is the elevation of the crank end of the engines, and Plate cccclxxix the elevation of the cylinder end. By an inspection of these engravings it will be seen, that the parts of the engines are sus-