other at the summit unites them. The eccentric disc works between the side forks of the ro∣l, and bears against its top and bottom plates, as seen in fig. 117. The other forks of the rod are made, in width, equal to the diameter of the axle, which thus prevents the rod from deviating from the vertical position as seen in fig. 118 ; a handle is added to work by hand, and the reversing process is performed as usual.

*The Crank —*One of the most important appendages of the steam-engine is the crank, by means of which the force of steam, although at first producing motion only upwards and downwards in the right line of the axis of the cylinder, is nevertheless rendered capable of exerting that force equally well in a circular direction. When the steam-engine is only employed for some such purpose as pumping up water, no crank is necessary, but as some of the most usual and valuable applications of the steam-engine are those where it turns wheels of mills, cotton machinery, steam-vessels, or locomotive engines, the crank, by which this is accomplished in an admirable and simple manner, which has superseded every other plan of trans mission, is entitled to very minute consideration.

A crank is an elementary machine which has been used from the earliest times for the purpose of converting a revolving into a rectilineal motion, or the reverse. It is figured in the old machines of the Egyptians, Chinese, Greeks, and Romans, and in water machinery it has been in common use from the time of Ctesebius.

A crank is merely a handle to a wheel, by which it may be turned round. Let *a* x be an axis of a wheel *b c d, a* R P the usual bent (or crooked) handle, by which it is turned round by the man, whose arm first pushes it from him, and then draws it towards him, and so continually turns the “wheel round, then the part *a* R radiating from the centre, is called the crank, the axis *a* x is called the crank-axle, and the straight part PR is called the crank-pin.

Now imagine, instead of a man’s arm, a rigid metallic connecting-rod, and instead of the strength of his body, conceive the force of steam to be applied through a cylinder piston and piston-rod to the crank by means of the connecting-rod, and the steam will produce the revolution of the wheel by means of the crank, axle, and pin, as in the figure, A the cylinder, *p* the piston-rod, *p* R the connecting rod, R the crank, and *a x* the axis.

On examining, in detail, the action of the crank, it is to be observed that the force exerted by the steam is neither continuous in direction nor in action. If the steam be admitted first below the piston, it forces it to the top of the cylinder ; it is then cut off preparatory to its being admitted above the piston ; and in the interval it has no motive action. When admitted above the piston, it forces it to the bottom of the cylinder; and again there is a cessation in its action during the change in the position of the valve. Now it is evident that this recurring cessation of action between the alternating impulses, would prevent the production of continuous revolution in the wheel, but for the power of the wheel itself of continuing the motion, by what is termed the momentum of its mass. When the steam, during a stroke of the machine, is acting most powerfully on the piston, part of its power is absorbed in giving motion to the wheel; and when, at the end of the stroke, it ceases for a time to act, the wheel gives out the power which it had absorbed, and continues its motion until the next stroke gives it a fresh accession of power. A wheel of this kind, when attached to an axle for the purpose of equalizing motion, is termed a fly wheel; and to obtain the full benefits of its equal zing

power, it is made of large diameter, that its rim may move rapidly, and it is made of great weight, being formed either of lead or iron, that it may acquire mo­mentum to render the motion ns uniform as possible.

Still, however, it must be remembered, that the equalization of the motion produced by the flywheel is partial, not perfect. Matter only takes up or gives out force when it changes from one velocity to a different one. If, therefore, the flywheel take up into itself the accession of force of the steam at one part of the stroke, it does so by slightly accelerating its motion; and if it give out force during the cessation of the stroke, it is by slightly redu­cing its own velocity in so doing. The approximation to perfect uniformity in the motion of the steam-engine, will be proportioned to the mass of matter in the rim of the wheel and to the square of the wheel’s velocity. Although, therefore, the flywheel improves the action of the crank, so as to make it perfectly adapted to all ordinary purposes, still the effect is not so equable as the power of a waterwheel, where *extreme* delicacy is re quired. In all ordinary cases it is sufficiently uniform.

The folIowing substitute for a fly-wheel was suggested and constructed by Mr Buckle of Soho, for Mr Lucy of Birmingham, and is an admirable and elegant substitute or auxiliary ; so as to be, for even the most delicate operations, practically perfect. Mr Lucy had constructed at Birmingham a flour mill driven by steam ; and it had been his object to obtain perfection without any limitation of expense. He had got one of Bolton and Watt's best steam-engines, and yet he found that his mill neither produced such perfect flour nor moved so smoothly as mills driven by water. On the contrary, it was found that the irregularity of the motion produced a larger quantity of coarse than of fine flour, at a mercantile loss to the owner; and it was likewise found that the irregular pro pulsion *a tergo* interfering with the uniform motion, to wards which the millstones tended by their own momentum, produced a clanging reciprocation along the whole line of toothed gearing, which was most injurious, and rapidly destructive to the toothed wheels. When we visited the spot in 1838, the ruins of former wheels, most unequally worn and totally destroyed, were strewed about the yard. The usual plan of increasing the weight of the fly-wheel was resorted to without success ; and Mr Lucy applied to Mr Buckle to propose a remedy for the evil. This remedy Mr Buckle found in the very simple contrivance of a pneumatic pump. In the mint at Soho a pneumatic pump had been introduced by Mr Watt, for the purpose of producing a reaction, on the principle of the experiments of Otto Guericke, which we have already de scribed. The force of the steam-engine was made to draw up a piston from the bottom of a cylinder, leaving a va\cuum below it. Into this vacuum the piston was again carried down, after the action of the steam had ceased, by the whole force of the atmosphere, amounting to about 15 lbs. on every inch of its surface. Thus the atmosphere was rendered a reservoir of power, the power being first of all taken up by forming the vacuum, and again given