rangements for this purpose have, however, been at Iength accomplished, and crank-engines are now in Cornwall doing the same work as the average of those that have no crank. We have before us the printed reports of last year, stating the duty done by the crank-engines of Charleston and Wheal Kitty, constructed by Mr Sims. We have also before us indications of the *actual pressure of the steam On the cylinder,* as obtained by a very accurate indicator, applied in the course of the summer of 1837 by Mr Smith for Mr Fairbairn of Manchester, who visited the mines for that purpose, and has been kind enough to favour us with a copy of his diagrams and observations. We have thus the means of comparing the power actually exerted on the piston with the work done, and find the result of the comparison to he, that *the work done is within ten per cent of being perfectly equal to the power employed.* Here, then we arrive at this conclusion, that the utmost conceivable reach of improvement in the mechanism of the steam-engine, if it even attained to perfection, would not save more than a few per cents. That the crank engine is, therefore, as at present used, as near in practice to the perfection of mechanism as any thing we can hope to ob­tain, is, we think, satisfactorily explained.

2. The crank, as a means of converting the reciprocation of the piston of a steam-engine into continuous revolving movement, possesses certain singular and beautiful properties which distinguish it from every other means of producing that conversion, and which appear to be so perfectly adapted to the nature of steam and the constitution of solid matter, that we are indebted to it mate rially, though indirectly, for the very great advantages which we derive from the modern steam-engine as a source of mechanical power. Let us examine into the causes of this well-established practical superiority of the crank to all other modes of producing revolving motion. Let it be observed, that in the reciprocating piston, from which the crank derives its motion, the following things take place : the piston is to be put in motion in one direction, then stopped, then put in motion in the opposite direction, stopped again, and then its motion resumed in the first direction. We shall see how admirably the crank adapts itself to these changes ; so that, while the piston with which it is rigidly connected takes every velocity between its maximum velocity and perfect rest, the crank goes forward with a motion perfectly regular and perfectly unimpeded. The necessity of this gradual change from motion to rest, and a reverse direction of motion, is ob vious. Matter in motion acquires momentum and can not be stopped, but its impetus must be equally and gradually removed, otherwise these moving parts are subjected to concussion as if by the stroke of a hammer, and must either suffer injury or produce it ; for, when in motion, matter requires a force to stop it equal to the force which gave it that motion. And, on the other hand, when brought to rest, matter cannot instantly be set in motion in the opposite direction without a stroke and concussion equally violent. To work smoothly, durably, profitably, and uniformly, matter must be put in motion by gentle gradations, beginning with a very gentle ve 1ocity, and gradually increasing in velocity like a body set in motion down an inclined plane, where, if it move one foot in the first second, it moves three in the next, five in the next, seven in the next, and so on : and in like manner in coming to rest, it must do so in the same gradual way in which an arrow shot from a bow ver­tically into the air loses its motion ; for in the end of its course it moves seven feet in the first quarter of the last second of time, five feet in the next quarter of a second, three feet in the next, and only one foot in the last, and then subsides into rest at the instant

before it again recommences motion downwards, which it does in a manner perfectly similar. It is required, therefore, that while the motion which the steam gives off by the crank be uniform and continuous, the parts of the engine itself shall be allowed time to be alternately brought into a state of rest, without shock, concussion, or jolt, and equally, gradually, and gently be again urged to their greatest velocity in the opposite direction. All this the crank effects with the most exquisite nicety of adjustment; it stops the piston when in motion as gently and softly as if a cushion of eider were placed to receive it; and after having brought it to rest again begins and accelerates its motion, as gradually and gently, to the highest velocity in the opposite direction. An adjustment so perfect is only possible in such a rela tion as that which subsists between the circle of the crank and the axis of the piston. Now if we compare this mode of action with any of the substitutes for the crank, by which it has been proposed to gain uriformity of power, we shall find that in these it would be required that the transitions from rest to motion and from motion to rest should be instantaneous ; and hen∣∙e such arrangements, being soon disordered, have been abandoned, lt will also be found that in rotatory engines it is necessary that the transitions and changes of arrangement, where these exist, are necessarily instantaneous, or if not, that steam is lost, or that the boasted uniformity of power is sacrificed.

3. The next property of the crank, as an elementary machine for the conversion of motion, is its remarkable power of reducing errors of construction, arrangement, and execution. It is one of the highest recommendations of a piece of mechanism that any trivial errors committed in its construction shall not materially injure its efficiency; and that any slight derangement in its adjustment shall not be attended with immediate deterioration or aggravated injury ; but that, on the other hand, the efficiency of the machine shall be consistent with such degrees of correctness in workmanship, and accuracy in adjustment, and care in making use of it, as are consistent with the ordinary amount of intelligence and attention of ordinary workmen ; and that the progress of derangement and ne­cessary tear arid wear shall be so gradual as to give timely warning of danger, and admit of ready repair and re-adjustment. The crank is precisely such a piece of mechanism. Errors in adjustment or construction of valves and other vital mechanism, are diminished in effect by the crank one hundredfold; the changes of the valves, the essential part of the mechanism, take place only at the top and bottom of the stroke. Now at these instants the crank is on the “ line of the centres,” as it is technically called ; and it is just in this position that a minimum of force is made to act on the crank, so that if the valves do not open with perfect precision, but either a little too soon, or a little too late, then will such error at that part of the circuit be of comparatively trifling consequence, because then the motion of the piston is so slight, that through an arc of twenty degrees of the crank it does not describe the hundredth part of that space ; and the effect of any error committed within that range, will not affect the result in the crank by one hundredth part of its full amount.

In like manner, errors in management and errors arising from wearing, are reduced a hundredfold in effect by transmission through the crank. It has frequently been to us matter of astonishment, to see at the mouths of coalpits, mines, and quarries, mere remnants of engines, frail rusty old fragments of iron and wood, so loose as scarcely to stand upright upon their bases, to see these superannuated drudges still performing heavy work to a very large percentage of their full power.