These tubular wheels were made of iron, six feet in diameter, and the reaction of mercury was employed to give revolution to them. The engine moved, but was found to be inefficient, and was abandoned, although it had been tried in very favourable circumstances. The principle of action is this. Steam is admitted into a circular channel, or chamber, on the circumference of a wheel. This chamber is partially filled with some liquid ; the pressure of the steam is expended in pushing the mercury in one direction, and the end of the chamber in the opposite way; so that, while the liquid is thus forced out of the chamber, the chamber is by an equal force pushed away from the liquid. The wheel is thus moved round. It is apparent that a part of the force is employed in propelling the wheel, and the remainder is expended in overcoming the resistance of the liquid of reaction, and expelling it from the chambers, which remainder is a large portion of the power withdrawn from useful effect.

Class IV.—Rotatory engines of the revolving piston are constructed on a much better principle, a.∙.d hold out much fairer prospects of successful competition with those of the reciprocating piston, than any of the species of the first three classes that have been already considered. In these classes the steam is not confined in rigid vessels, but its action is expended in producing currents in fluids, and expending motion in medial effects, which are useless. This is not the case in the steam-engine of the revolving piston. The steam is confined in a close and rigid chamber, and acts only on solid in flexible surfaces, and escapes along confined passages, so that its full effect may be obtained in useful work. Abstractly considered, it is an engine capable of giving out the full power of the steam, and, therefore, may fairly be imagined to come into competition with the ordinary reciprocating crank engine. The objections to it are entirely of a practical nature, and regard the engine, not in its abstract mathematical form, but as a machine made of destructiblematter—of matter imperfectly elastic—of surfaces offering resistance to motion—of matter obeying the known laws of motion and rest. These objections are not the less valid that they are of a sensible and tangible, rather than a speculative description. But, as a natural consequence of the more plausible deceptions held out by this species than by any of the three preceding ones, it has followed that the fallacies of this class have been more widely seductive than the others ; and many eminent mechanicians have been led astray by them. The fallacy of this class of engines we shall expose in conjunction with the next class, as the same misconceptions lie, to a considerable extent, at the root of both.

Class V.—Revolving mechanism substituted for the crank of the common steam-engine, for the purpose of obtaining from the reciprocating piston a rotatory effect otherwise than by the crank, and in a better manner than by the crank, forms a class of inventions involving fallacies similar to those **in** which the revolving piston has origi­nated. These two may therefore be considered together.

Although the name of Watt has been included in the list of inventors of substitutes for the crank, it should be observed that he was only driven to the invention of a substitute by the circumstance of a patent having been previously obtained for the crank in its simple form ; and that he abandoned his beautiful, but more complex, mechanism on the instant that the elementary crank was re leased from the fetters of monopoly. lt is due also to his memory to say, that the sun and planet wheel, which he substituted for the crank, is a disguised crank, possessing all the valuable properties, excepting simplicity and smallness of friction, which give to the crank its pre sent eminence as a mean of obtaining rotatory effect. It is remarkable that the fallacies regarding the now universally employed crank were coeval with its first sug­

gestion as the vehicle of rotative steam power. John Stewart, in describing his mechanism for this purpose, in the Philosophical Transactions, 1777, observes that “the crank or winch is a mode of obtaining the circular motion which naturally occurs in theory, but in practice it would be impossible, from the nature of the motion of the engine, which depends on the force of the steam, and cannot be ascertained in its length ; and, therefore, on the first varia tion, the machine would either be broke to pieces or turned back.” Mr Smeaton agrees with Mr Stewart on the inapplicability of the crank ; but adduces another objection, “ That great loss would be incurred by the absolute stop of the whole mass of moving parts as often as the direction of the motion is changed, and that al though a heavy flywheel might be applied to regulate the motion, it would be a great encumbrance to the mill." In such phrase of evil omen was it thus confidently pre­dicted that the simple means now in everyday use for the communication of steam power to revolving machinery would either be attended with great loss, be very desultory in its action, or altogether break the machine to pieces. At that time, however, the crank was not in use ; but the very same objections are still urged by those who have, every day, before them the practical confutation of their assertions.

I. In the abstract and purely theoretical view of the subject, it can be shown that the present mode of ap­plying the steam possesses none of the disadvantages, and that the rotatory mode possesses none of the superiority attributed to it.

In making the comparison between the rotating and reciprocating piston, let it be supposed that the vessels containing the steam are equally rigid, equally perfect in their form, and are equally divested of friction, and that there shall have been obtained for the steam a *point d'appui* as satisfactory in the case of the rotatory, as that which the reciprocating engine possesses in the ends of the cylinder; then, upon this hypothetical condition, neither engine will excel the other, each will move over a space with a power and velocity proportioned to the steam which it makes use of, and that engine will do most work which uses the greatest quantity of steam.

The great fundamental principle in the construction of machinery is, that the work done depends in quantity only upon the quantity and velocity of the power applied, and not at all upon the form of the machine ; in other words, that a machine has no power, either of consuming or creating motive power; that it can only transmit it ; that it can only modify it to suit particular purposes ; and that what it loses in pressure it will gain in velocity; this is on the supposition, of course, that the machine is perfectly well made, without friction, and without permit ting the escape and waste of power in some effect not conducive to the end in view. Setting out, then, from this great fundamental principle of virtual velocities, we might satisfy ourselves with asserting the truth we now wish to establish as a simple self-evident deduction from it, and conclude that from this great principle of virtual velocities there could not possibly be loss of power by the crank steam-engine.

This summary process would not, however, satisfy the enquirer or inventor who has taken the erroneous view of the subject, unless he were given to understand how this great doctrine may be made to bear on the peculiar difficulties of the case. He will return upon us with the question—“ How is it that, in the common crank, we are able to show that, at two given points in its revolu tion, the position is such that an infinite power would produce no effect at all ; that there are only two instants of time in which the force and its effect are equal; and that, at every other point, the pressure given out by the steam to the crank is less than the original pressure of