Mitch about the time of this diſcovery, viz. 1763, Mr James Watt, eſtabliſhed in Glaſgow in the com­mercial line, was amusing himſelf with repairing a working; model of the ſteam-engine which belonged to the philoſophical apparatus of the univerſity. Mr Watt was a perſon of a truly philoſophical mind, eminent­ly converſant in all branches of natural knowledge, and the pupil and intimate friend of Dr Black. In the courſe of the above-mentioned amuſement many curious facts in the production and condenſation of steam occurred to him; and among others, that remark­able fact which is always appealed to by Dr Black as the proof of the immenſe quantity of heat which is contained in a very minute quantity of water in the form of elaſtic ſteam. When a quantity of water is heated ſeveral degrees above the boiling point in a cloſe digeſter, if a hole be opened, the ſteam ruſhes out with prodigious violence, and the heat of the remaining wa­ter is reduced, in the courſe of three or four seconds, to the boiling temperature. The water of the ſteam which has iſſued amounts only to a very few drops ; and yet theſe have carried off with them the whole exceſs of heat from the water in the digeſter.

Since then a certain quantity of ſteam contains ſo great a quantity of heat, it muſt expend a great quan­tity of fuel ; and no conduction of furnace can pre­vent this. Mr Watt thereſore ſet his invention to work to diſcover methods of husbanding this heat. The cy­linder of his little model was heated almoſt in an inſtant, ſo that it could not be touched by the hand. It could not be otherwiſe, becauſe it condenſed the vapour by abſtracting its heat. But all the heat thus communica­ted to the cylinder, and waſted by it on ſurrounding bodies, contributed nothing to the performance of the engine, and muſt be taken away at every injection, and again communicated and waſted. Mr Watt quickly underſtood the whole proceſs which was going on with­in the cylinder, and which we have considered ſo mi­nutely, and ſaw that a very conſiderable portion of the ſteam muſt be waſted in warming the cylinder. His first attempts were made to aſcertain how much was thus waſted, and he found that it was not leſs than three or four times as much as would fill the cylinder and work the engine. He attempted to diminiſh this waſte by uſing wooden cylinders. But though this produced a ſensible diminution of the waſte, other reasons forced him to give them up. He then caſed his metal cylinders in a wooden cafe with light wood aſhes between. By this, and uſing no more injection than was abſolutely neceſſary for the condenſation, he redu­ced the waſte almoſt one half. But by uſing ſo ſmall a quantity of cold, water, the inside of the cylinder was hardly brought below the boiling temperature ; and there conſequently remained in it a ſteam of very considerable elaſticity, which robbed the engine of a pro­portional part of the atmoſpherical preſſure. He ſaw that this was unavoidable as long as the condenſation was performed in the cylinder; The thought struck him to attempt the condenſation in another place. His firſt experiment was made in the simpleſt manner. A globular veſſel communicated by means of a long pipe of one inch diameter with the bottom of his little cy­linder of four inches diameter and 30 inches long. This pipe had a ſtop-cock, and the globe was immerſed in a veſſel of cold , water. When the piſton was at the top, and the cylinder filled with ſtrong ſteam, he turned the cock. It was ſcarcely turned, nay he did not think it completely turned, when the ſides of his cylinder (only ſtrong tin-plate) were cruſhed together like an empty bladder. This ſurpriſed and delighted him. A new cylinder was immediately made of braſs ſufficiently thick, and nicely bored. When the experiment was repeated with this cylinder, the condenſation was ſo ra­pid, that he could not ſay that any time was expended in it. But the moſt valuable diſeovery was, that the vacuum in the cylinder was, as he hoped, almoſt perfect. Mr Watt found, that when he uſed water in the boiler pur­ged of air by long boiling, nothing that was very ſenſibly inferior to the preſſure of the atmoſphere on the piſton could hinder it from coming quite down to the bottom of the cylinder. This alone was gaining a great deal, for in moſt engines the remaining elaſticity of the ſteam was not leſs than 1/8th of the atmoſpherical preſſure, and therefore took away 1/8th of the power of the engine.

Having gained this capital point, Mr Watt found many difficulties to ſtruggle with before he could get the machine to continue its motion. The water pro­duced from the condenſed ſteam, and the air which was extricated from it, or which penetrated through un­avoidable leaks, behoved to accumulate in the condensing veſſel, and could not be voided in any way similar to that adopted in Newcomen’s engine. He took another method : He applied pumps to extract both, which were worked by the great beam. The contri­vance is eaſy to any good mechanic ; only we muſt obſerve,that the piſton of the water-pump muſt be under the ſurface of the water in the condenſer, that the water may enter the pump by its own weight, becauſe there is no atmoſpherical preſſure there to force it in. We muſt alſo obſerve, that a conſiderable force is neceſſarily ex­pended here, becauſe, as there is but one ſtroke for rare­fying the air, and this rarefaction muſt be nearly com­plete, the air-pump muſt be of large dimenſions, and its piſton muſt act againſt the whole preſſure of the at­moſphere. Mr Watt, however, found that this force could be easily ſpared from his machine, already ſo much improved in reſpect of power.

Thus has the ſteam-engine received a very considerable improvement. The cylinder may be allowed to remain very hot ; nay, boiling hot, and yet the con­denſation be completely performed. The only elaſtic ſteam that now remains is the ſmall quantity in the pipe of communication. Even this ſmall quantity Mr Watt at laſt got rid of, by admitting a ſmall jet of cold water up this pipe to meet the ſteam in its paſſage to the con­denſer. This both cooled this part of the apparatus in a ſituation where it was not neceſſary to warm it again, and it quickened the condenſation. He found at laſt that the ſmall pipe of communication was of itſelf ſufficiently large for the condenſation, and that no ſeparate veſſel, under the name of condenſer, was neceſsary. This circumſtance ſhows the prodigious rapidity of the condenſation. We may add, that unleſs this had been the caſe, his improvement would have been vaſtly diminiſhed ; for a large condenſer would have required a much larger air-pump, which would have expended much of the power of the engine. By theſe means the vacuum below the piſton is greatly improved : for it will appear clear to any perſon who underſtands the ſubject, that as long as any part of the condenſer is