provement of estates ; was an able man, and drew neatly and accurately, which was not very common in those days. He died in 1737, at an early age, leaving “ A Survey of the River Clyde, from Glasgow to the Point of Toward,” which was published by his brother several years afterwards. James, his younger brother, of an active, ingenious, and enterprising mind, became a merchant in Greenock, and was for upwards of twenty years a member of the town council, a magistrate, and a zealous promoter of the im­provements of the town. By his wife, Agnes Muirhead, he had two sons, James, the subject of the present article, and John, a youth of promising abilities, who was lost at sea soon after he became of age. Misfortunes in trade, and the decay of the faculties of his mind, occasioned his retire­ment from business some years before his death, which happened in 1782, in his eighty-fourth year.

James Watt, his eldest son, and only surviving child, was born at Grcenock, the 19th January 1736. He re­ceived the rudiments of his education in the public schools of his native town ; but, from the extreme delicacy of his constitution, was with difficulty enabled to attend the clas­ses, and owed much of his acquirements to his studious habits at home. Little more is known of his early years, than that, from the first, he manifested a partiality for me­chanical contrivances and operations, and frequently em­ployed himself in that way. The desire of improvement in an art then little practised in Scotland, induced him to go to London in his eighteenth year, and there to place him­self under the tuition of a mathematical instrument maker ; but he remained little more than a twelvemonth, the infirm state of his health compelling his return to his paternal roof.

In that short period, he appears to have made great pro­ficiency, and he continued, after his return to Scotland, to perfect himself in this art, both at home and on his visits to his mother’s relations at Glasgow, where it was his wish to establish himself. But some opposition being made by the corporations, who considered him as an intruder upon their privileges, the professors of the university took him under their protection, and accommodated him with an apartment and premises for carrying on his business within their pre­cincts, with the title and office of *mathematical instrument maker to the university.* This took place in 1757, when he was twenty-one years of age, and it must be inferred, that he had already given satisfactory proofs of talent to the eminent men who then adorned that seat of learning; of whom it is sufficient to mention the names of Robert Simson, Adam Smith, Dr Black, and Dr Dick the pro­fessor of natural philosophy. There Mr Watt applied se­dulously to business, and in the few intervals which its concerns and ill health allowed, cultivated those various talents which distinguished him in after life ; and there a lasting friendship was formed with the kindred minds of Dr Black, and of Mr, afterwards Dr Robison, then a student at the university, and nearly of his own age. He remained in the college until some time in the year 1763, when he removed into the town previously to his marriage with his cousin, Miss Miller, which took place in the summer of the following year.

The steam-engine had been a frequent subject of con­versation between Mr Robison and himself, and the for­mer had suggested the possibility of its application to the moving of wheel-carriages. About the year 1761 or 1762, Mr Watt had tried some experiments on the force of steam in a Papin’s digester, and had constructed and worked with strong steam a small model, consisting of an inverted sy­ringe, the bottom of the rod of which was loaded with a weight, alternately admitting the steam below the piston, and letting it off to the atmosphere. Observing the im­perfections of this construction, he soon abandoned it ; but the attention necessary to be bestowed upon his business prevented his reconsidering it, until the winter of 1763-4, when he was employed by the professor of natural philo­sophy to put in order a working model of a steam-engine upon Newcomen’s construction. When he had repaired it and set it to work, he found that the boiler, though large in proportion to the cylinder, was barely able to supply it with steam for a few strokes per minute, and that a great quantity of injection-water was required, though it was but lightly loaded by the pump attached to it. It soon occur­red that the cause lay in the little cylinder (two inches diameter, six inches stroke), exposing a greater surface to condense the steam than the cylinders of larger engines did, in proportion to their respective contents. By short­ening the column of water in the pump, less steam and less injection-water were required, and the model worked at a proper speed. Thus the purpose for which it was put into his hands was accomplished ; and with this mode of account­ing for the defect, and this result, most artists would have been satisfied ; but the case was different with Mr Watt. He had now become aware of a great consumption of steam, and his curiosity was excited to a more accurate investigation of the causes, in which he proceeded in a truly philosophical manner. The cylinder of his small model being of brass, he conceived that less steam would be condensed by substitut­ing cylinders of some material which would transmit heat more slowly. He made a larger model, with a cylinder (six inches diameter, and one foot stroke) of wood soaked in oil and baked to dryness. He ascertained, from experiments made with boilers of various constructions, that the evapo­ration of boiling water is neither in proportion to the eva­porating surface, nor to the quantity of water, as had been supposed, but to the heat that enters it ; and that the lat­ter depended chiefly on the quantity of surface exposed to the action of the fire. He likewise determined the weight of coal required for the evaporation of any given quantity of water. Being convinced that there existed a great error in the statement which had been previously given of the bulk of water when converted into steam, he proceeded to examine that point by experiment, and discovered that water, converted into steam of the heat of boiling water, was expanded to 1800 times its bulk, or, as a rule for ready calculation, that a cubic inch of water produced a cubic foot of steam. He constructed a boiler to be applied to his model, which should show, by inspection, the quantity of water evaporated, and consequently would enable him to calculate the quantity of steam used in every stroke of the engine. This he now proved to be several times the full of the cylinder. He also observed, that all attempts to improve the vacuum, by throwing in more injection-water, caused a disproportionate waste of steam ; and it occurred to him that the cause of this was the boiling of water in vacuo at very low heats (recently determined, by Dr Cul­len, to be under 100°) ; consequently, at greater heats, the injection-water was converted into steam in the cylinder, and resisted the descent of the piston. He now perceived clearly, that the great waste of steam proceeded from its being chilled and condensed by the coldness of the cylin­der before it was sufficiently heated to retain it in an elas­tic state ; and that, to derive the greatest advantage, the cylinder should always be kept as hot as the steam which entered it, and that, when the steam was condensed, it should be cooled down to 100°, or lower, in order to make the vacuum complete. Early in 1765, the fortunate thought occurred to him of accomplishing this by condensing the steam in a separate vessel, exhausted of air, and kept cool by injection, between which and the cylinder a communi­cation was to be opened every time steam was to be con­densed, while the cylinder itself was to be kept constantly hot. No sooner had this occurred to him, than the means of effecting it presented themselves in rapid succession. These in a great measure have already been described in the