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## WILLIAM BAXTER AND HIS INVENTIONS.

William Baxter is the son of George Baxter, a Scotch engineer, who, in the year 1805, emigrated to America with his family, settled near Morristown, N.J., and in that locality constructed two of the first cotton mills built in this country.

The subject of this sketch, the youngest son, was born November 22, 1822, and is, therefore, now 51 years of age. When a boy he was placed at work in his father's factory, thus inheriting and acquiring mechanical taste and skill in no small degree. Even when quite a child, he made several ingenious improvements in his father's machinery, and at the age of 12 he was placed in the machine shop of Alexander Paul, of Paterson, where he worked upon the first locomotive ever built in that city. He soon after went with Stephen Vail, of Morristown, and was one of the assistants of Professor Morse in bringing out the magnetic telegraph, helping to put it in operation for the sending of the first message. Returning to Paterson, he remained in that city from 1840 to 1846, superintending the erection of machinery and making many inventions and improvements. Meanwhile he was an extensive reader and a hard student, becoming familiar with the works of the best authors on mechanical engineering, and acquiring the French and Spanish languages. His reputation extended, and he became favorably known as a designer and constructor. He was engaged for some time with the Newark Machine Company, Newark, N. J, where he made the pleasant and profitable acquaintance of Seth Boyden.

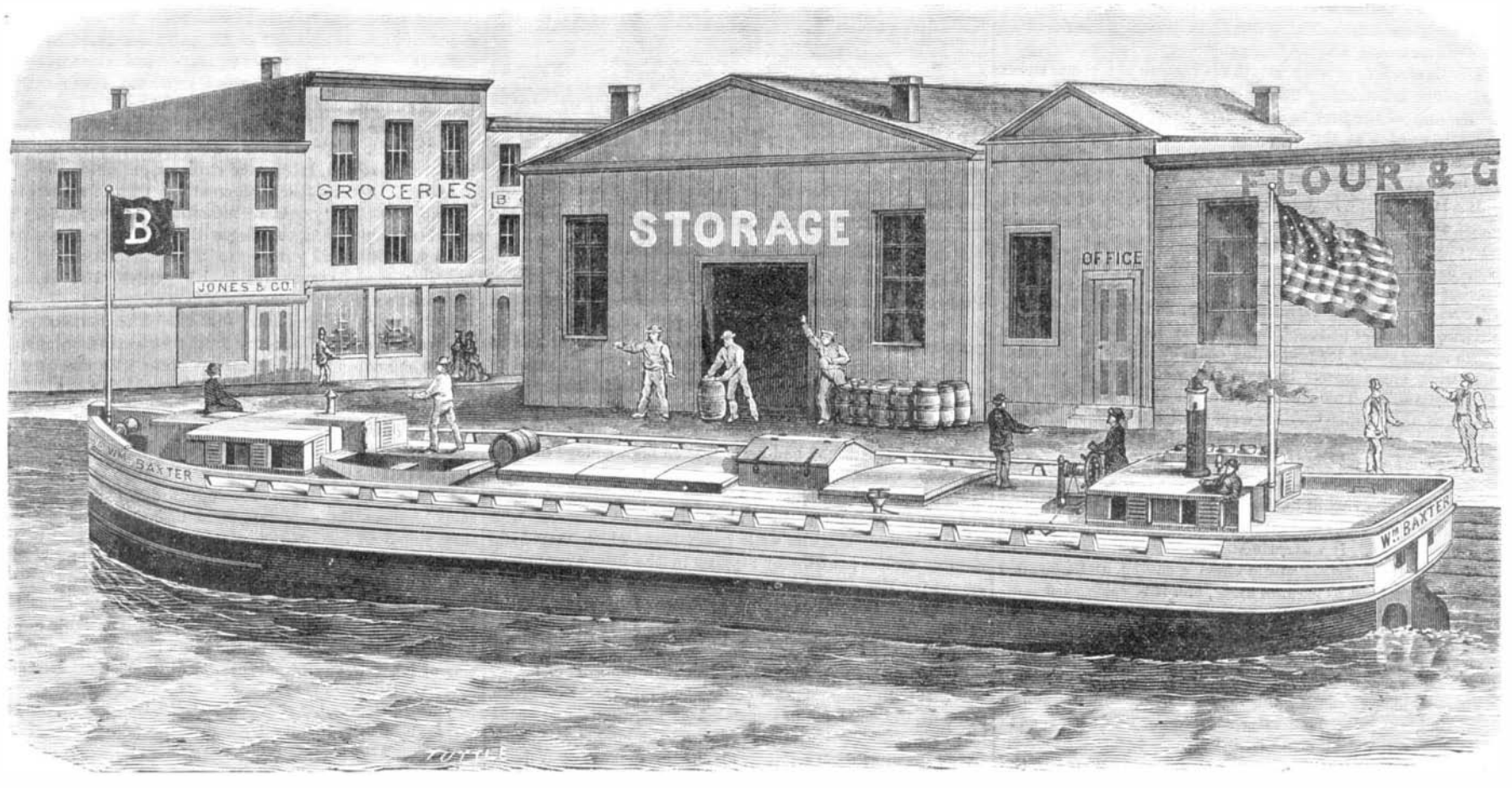
In 1851 he was called to Mexico, to erect an extensive cotton factory. For ten years Mr. Baxter was engaged in that country, in works of great magnitude, among which may be mentioned a cotton factory at Talamantes, another near Penyon Blanco (an Indian pass), where he built up a new town in the desert, naming it Belen, which, in English, is Bethlehem; also a woolen factory at the same place, and a large number of extensive mining works at Parral and other places. At Santa Catarina, he constructed a reservoir or artificial lake for the irrigation of the hacienda of Señor Montez, about 20 square leagues in extent, and which also furnished power for mills. In all he erected in Mexico some fifteen different works. The dams at Belen and Santa Catarina were very difficult jobs of engineering, all previous attempts to hold the water at those places having been failures. They were built across cañons at the foot of the Sierra Madre mountains, where the gorges were 300 to 400 feet in width, in which ran torrents, often rising 60 feet in a few hours during heavy rains. It was prophesied that these structures would never stand, but they still remain firm. They were constructed upon a new principle, unlike any previous work. The masonry was from 30 to 40 feet high, 60 feet thick at the base, and 10 feet at the top, sloped on both sides, in curved lines, which received and discharged the water horizontally and without shock, thus preventing those excavations by the plunging of the water, so destructive to such works; they were also curved or arched against the streams, and the abutments planted against the solid rock of the mountains. These great reservoirs, with their gates and sluices, were the admiration of all the engineers of the army of occupation.

WILLIAM BAXTER,

For one of the cotton factories he constructed a turbine wheel, made of gun metal and finished as highly as a steam engine, the design being an improvement upon the French turbine of Fourneyron. The machine, giving a larger percentage of the power of the stream than any previous form, excited considerable interest among French engineers, several of whom examined it and transmitted drawings and details of the same, together with particulars of the calculations, to the French Academy of Sciences.

These works were carried on under great disadvantages, necessitating not only the procurement and manufacture of material but the instruction of workmen. Machinery, besides, had to be built, and roads constructed; while, in addition to these difficulties, the labor had to be prosecuted in the proximity of hostile Indians, and required constant military protection. Every establishment, however, erected in Mexico proved a financial success.

During these years Mr. Baxter received from the government of Mexico, both Imperial and Republican, the highest marks of consideration ever extended by them to any private citizen, unless it may have been Mr. Seward. He was offered decorations and even titles, and was urged by the State of Chihuahua to establish and take the presidency of a college of arts and sciences, on the plan of the Cornell University




BAXTER'S STEAM CANAL BOAT.

which he declined to do on account of the disturbed state of the government at that time. He was frequently furnished with official passes by both the governments of Maximilian and the Republic, of which the following is a specimen, and shows the high regard in which he was held by all parties, he being strictly neutral in all their struggles:

"BY THE PRESIDENT OF THE REPUBLIC OF MEXICO.

"*To all the Authorities, both Military and Civil, wherever this may be presented*:

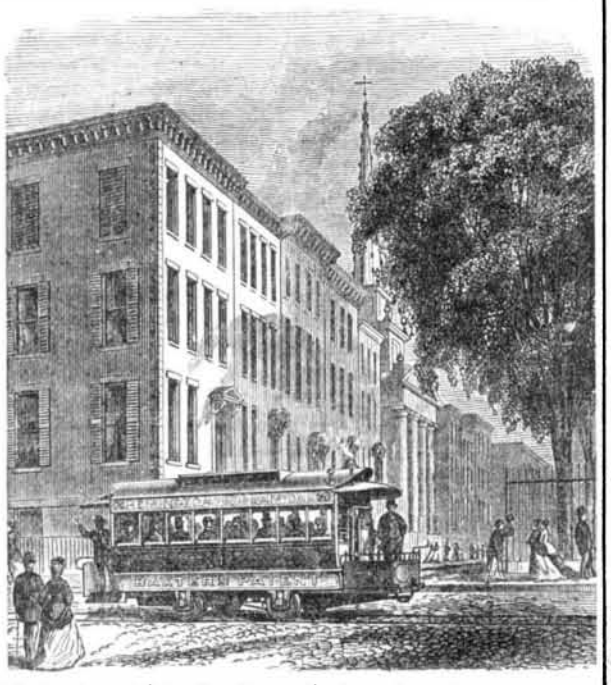
"The bearer of this, Don Guillermo Baxter, an American engineer, is passing through the country on his own private business, and you are hereby commanded to give him whatever protection and assistance he may require, and a military escort when he shall demand the same, Señor Baxter being worthy of the most distinguished consideration.

BENITO JUAREZ."

On his return home, in 1867, he traveled from Durango to the city of Mexico with the President and Cabinet, under the protection of their military escort, making extensive examinations of the mining districts through which they passed.

Since that time, Mr. Baxter has been constantly at work on one mechanical problem after another. On his way home to the States, more as a diversion than otherwise, he whittled out of a piece of pine a model of what is known as "the Baxter adjustable S wrench," which, by means of its peculiar shape, enables the workman to reach parts of complicated machinery previously inaccessible. This indispensable little tool is to be found in factories and workshops in every part of the world. It is manufactured at Birmingham, Conn.

Having established his residence at Newark, N. J., Mr.



Baxter turned his attention to the invention of a small, compact, portable, safe, and economical steam power, which should be so easy to manage as to warrant its introduction for all uses among the people. This resulted in bringing out, in the year 1868, the now widely known and justly celebrated Baxter engine. Already thousands of these engines are in use in all parts of the country, and many have been and are being sent to foreign lands. They are manufactured by the Colt Fire Arms Company, Hartford, Conn., on the interchangeable principle, each piece being made in duplicate, which is the first instance of this feature in the manufacture of such machinery.

In these matters, Mr. Baxter has received most valuable aid and assistance from Mr. William D. Russell, President of the Baxter Steam Engine Company.

Mr. Baxter's next work was the invention of a steam street car, which is attracting great attention, and can hardly fail to be one of the first to come into extensive if not general use, as soon as the prejudice against the application of steam to that purpose shall have been overcome. These cars are built at the celebrated Remington Works, Ilion, N. Y.

His last triumph is the successful introduction of steam in canal navigation, a problem which had previously baffled all the engineering talent which had been applied to it. It had long been considered impossible; but the State of New York, having offered a large reward for its solution, a great number of competitors came forward, and Mr. Baxter has just been awarded the first prize. The difficulty has never been the mere use of steam for propelling boats on canals, but to compete with horse power in economy, and thus to cheapen transportation. The official record of the trial trip gives credit to the Baxter boat for a speed of 3·09 miles per hour, upon a consumption of $14\frac{82}{100}$ lbs. coal per mile, carrying a load of more than 200 tuns in addition to her machinery and fuel, which may be condensed as follows: One tun of freight, sixty miles, at a cost of one cent for coal; or, in other words, it is carrying freight at twice the speed and half the cost of the horse boats. It was estimated by the Commissioners of Award that this result would effect a saving of $4,000,000 per annum on the Erie canal alone, and it is calculated that, when the system shall have been generally introduced, the yearly saving on all the canals of the country will not fall short of $10,000,000; it will also double the capacity of all canals, being a complete solution of the problem of cheap transportation, enhancing the value of every acre of land in the West, but being no greater boon to the producer than to the consumer, inasmuch as it will reduce the cost of bread on the sea board, while enhancing the price of wheat in the Western granaries.

It would be difficult to overestimate the value, to the community and to the world, of such lives as Mr. Baxter's. The fame such men achieve is rarely commensurate with their deserts. Soldiers, statesmen, orators, authors, artists, all are likely to stand more conspicuously forth before their fellow men, but impelled by his imperative instincts, the mechanical inventor calls to his aid, and into exercise and active use, executive and financial ability; he inspires men to the establishment of new industries, and the employment of thousands of hands; he gives work to both capital and labor, and is the leading force of civilization. No better example can be given of the truth of this assertion than reference to the army of men employed in various capacities upon the inventions of Mr. Baxter, and the number of skilled mechanics required, not only in the manufacture, but in their operation. The portable engine, the street car, and the steam canal boat, all require engineers, and it is not impossible that a hundred thousand young men will, by the influence of these inventions, acquire the necessary knowledge and be lifted to a higher level than they now occupy.

It is not likely that Mr. Baxter will now rest upon his laurels; he is just in the prime of life and in vigorous health, and it is far more probable that, under the impulse of his wider experience, and the stimulus of constantly increasing reputation, his active brain will be at work upon new and perhaps greater problems.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(Illustrated articles are marked with an asterisk.)



## FORMIC FUNGUS FARMERS.

A short time ago there was discovered in Texas a race of diminutive grangers who had solved the transportation problem by the simple and sensible plan of raising all the grain required for their communities, each for itself and at its own doors, and letting other communities do the same or go hungry. They were ants, clever little fellows, whose agricultural operations were carried on with the utmost system and success, and who were thought to be the only creatures not human who had arrived at so high a stage of civilization. Other harvesting ants collect the chance productions of the fields or trust to the husbandry of man for their supplies of grain; but these are independent farmers, who surround their colonies with grain land, which they keep clear of useless growths by nipping in the bud every plant except the rice grass whose seeds they intend to gather for their winter store, thus giving evidence of no small degree of calculation and forethought, as well as industrial economy.

But it appears that they are not alone in this sort of thing, and that their operations are slight and simple compared with those of the *œcodoma* of Central America, better known as leaf-cutting ants. These leaf cutters have long been notorious as the most destructive of all the insect pests of tropical America, the tender-leaved fruit plants introduced from other localities suffering especially from their ravages. Indeed, multitudes of plantations of orange, mango, and lemon trees have been stripped and destroyed by them, so that in many parts this otherwise profitable industry has had to be given up entirely.

Their nests generally consist of a cluster of low mounds, pierced by tunnels, from half an inch to six or eight inches in diameter, and situated in a little clearing made by killing the shrubbery through the persistent biting off of buds and leaves, evidently to secure sunshine and a free circulation of air. Leading out from these mounds are well marked paths, it may be half a mile long and several inches wide, thronged like the streets of a great city with busy workers bringing in leafy burdens or hurrying outward for a load. As far as the eye can distinguish their tiny forms, says a recent observer, troops and troops of leaves are seen moving up toward the central point, and disappearing down the tunneled passages. The out-going, empty handed hosts are partly concealed among the bulky burdens of the incomers, and can be distinguished only by looking closely. "The ceaseless, toiling hosts impress one with their power, and one asks: What forest can stand before such invaders? How is it that vegetation is not eaten off the face of the earth? Surely nowhere but in the tropics, where the recuperative powers of Nature are immense and ever active, could such devastations be withstood."

But wonderful as the operations of these leaf cutters are in the open air, they are as nothing to those that go on under ground. Hitherto the use made of the leaves gathered in such immense quantities has been a mystery. Some have thought they must be used directly as food; others, that they were employed in roofing the ants' underground chambers; but no one suspected their real use until the secret was disclosed to the observer already quoted, Mr. Thomas Belt, in the course of certain mining operations which he was superintending in Nicaragua.

On two occasions, earth cuttings were made from below up through very large nests of these ants, in such a way as to lay their operations clearly open to observation. The tunneled passages were found to lead to numerous connected chambers about the size of a man's head, usually three fourths filled with a flocculent mass of light and loosely connected bits of leaves, withered to a brown color and overgrown with a minute white fungus. Mixed with this substance were numbers of ant nurses with pupæ and larvæ.

By numerous observations, which he describes at length, Mr. Belt became convinced that this fungus growth was the real food of the ants; and all of their outside operations were tributary to its cultivation! In other words the leaves are collected, as human farmers collected marl and guano, for indirect use as fertilizers. The ants do not confine themselves to leaves, but take any vegetable substance suitable for growing the fungus on. Nor do they take leaves indiscriminately, grass, for example, being always rejected: and when any ant, more stupid or less experienced than ordinary, makes the mistake of carrying in unsuitable leaves, they are promptly brought out and thrown away. Great care is also taken in regard to the condition of the leaves carried into the chambers. In case a sudden shower comes on, the wet pieces are deposited outside, to be picked up and taken in when nearly dry, should the weather clear up promptly; when spoiled by too much rain, they are left to rot on the ground. On the other hand, in very dry and hot weather, when the leaves would wither on the way to the nest, the ants wait until sundown before going out, or do their gathering wholly in the night.

When a community migrates, the fresh fungus growths are carefully transported to the new burrows in the jaws of the middle sized workers, the larger members of the community acting only as directors of the march or defenders of the rest in case the column is attacked. The nurses already mentioned are the smallest of all, and their duties lie wholly underground, in cutting up the leaves and attending to the young ants. They never carry leaves, but may sometimes be seen running out along the paths with the others, apparently for the fun of the thing; for instead of helping the rest, they perch themselves on the pieces that are being brought in, and so, like petted children, get a ride home.

As might be expected with creatures who have developed so complicated a system of industrial economy, these ants are extremely clever. A single illustration will suffice to show their practical good sense. To drive off a colony which had established themselves in his garden, Mr. Belt gave their nest a soaking with carbolic acid and water. The effect was all that could have been desired. The marauding parties were at once withdrawn from the garden to meet the danger at home; the whole formicarium was disorganized; and big fellows came stalking up to repel the supposed invader, only to descend again in the utmost perplexity. By the next morning a new nest had been established, some yards distant, and the survivors were busy carrying their supplies thither. It happened that between the two stations there was a steep slope. Instead of descending this with their burdens, the ants cast them down at the top, whence they rolled to the bottom, where another relay of laborers picked them up and carried them to the new burrow. It was amusing, says Mr. Belt, to watch the ants hurrying out with bundles of food, dropping them over the slope, then rushing back immediately for more. Is it possible to attribute such a sensible, and at the same time exceptional, division of labor to anything radically different from human intelligence?

GRANITE and macadam are to be banished from the city of London, the Streets Committee having determined to lay down in future nothing but asphalt or wood.