A TRIBUTE TO BENJAMIN CHEW TILGHMAN.

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INTRODUCTION

It may have been a theory, a bare idea an insight, – or just an inspiration. Whatever it was, perhaps just a shot in the dark, it set off what was to become one of the most intriguing industries in the whole world.
As is often the case, myths grow up as happened in this case. It was said that B.C.Tilghman, when a General in the army, had seen the effect of wind blown sand upon glass windows, in the desert. The sand had etched the glass where unprotected and revealed the contrast against parts that were covered by steel mesh.
The story had been told over such a long period of time that it has become widely accepted. When we look at the facts there is some basis for the story. It is interesting to read the recording in The National Cyclopaedia of American Biography:–
"Benjamin Chew Tilghman was born in Philadelphia on October 26th. 1821, the third child of Benjamin and Anne Marie (McMurtie). His father was descended from Richard Tilghman. a surgeon in the British Navy, under Admiral Blake, who having signed the petition that justice be done to Charles Stuart, was flouted as regicide by the Royalists and just before Charles II came to the throne, emigrated to Lord Baltimore's colony in Maryland.Here he obtained lands on the Charles River and built his home.His descendants have been prominent at the Bar and jurists for generations.
Tilghman was educated at Bristol College and later at the University of Pennsylvania where he graduated in 1839, maintaining the traditions of his family. He studied law and was admitted to the Bar but never practised his profession. His younger brother, Richard was very close to him and co–operated in all his research. They journeyed through Europe together visiting laboratories, chemical works and mills. It is reported that he perfected the production of steel shot of extraordinary hardness for use in sawing, drilling and grinding of stone. A particular use was for under a ring drill used in prospecting mines and quarries and veins of oil.
When the war broke out he promptly enlisted as Captain in the 26th. regiment of the U.S.Volunteers. He moved quickly from Captain to Colonel and was severly wounded at Chancellorsville. By the close of the war he had risen to the rank of General and was in command of a brigade in Florida.
Shortly after this he discovered a process for making paper from wood fibre. This was another indication of Tilghman's active mind. He also patented a design for a torpedo to be propelled "rocket fashion" by a slow burning powder. It was not successful"

INVENTION OF THE SAND BLAST PROCESS.

We continue with the record in the biography:–
"In 1871 Tilghman invented the sand blast, devising an apparatus which in economy has never been surpassed. The sand blast is employed for removing scale from forgings and castings. For depolishing glass, china and other brittle substances. For producing cameo effects on glass of different hue. For labelling bottles used by chemists and druggists.For scouring the outside of bank safes.For the smoothing of armour plates of warships.For incising marble, limestone and granite with letters and ornaments. For removing dirt from buildings of brick and stone. For cleaning tubes, tanks and boilers. For refacing wheels of emery and corundum. For granulating celluloid films for cameras. For bringing into relief the grains of wood. For perfecting the joints in reservoirs, boilers and tanks. For preparing steel rails and girders for welding.. For finishing files and rasps as first manufactered or in restoring their points after wear. For exposing cracks in the teeth of milling machines and for taking off the layers of paint successively laid on a ship."

This is an early and excellent account of some of the numerous applications of the sand blast process. What must be absorbed is the infinite detail that Tilghman covered in his first patent no: 104,408.(USA) filed in 1870..(Fig.1.) It is necessary to read it its completeness to appreciate the considerable depth of research he carried out

to support his claim. Here he defines the size and pressure of the jet stream so as to produce the amount of suction desired by the sand tube. For the sake of brevity the stream of sand impelled will be hereafter termed the "sand blast".
Tilghman realised the limitations of the first design and that more efficient would be, "—— a strong closed vessel to contain the sand and to introduce a current of air under pressure above the sand" (Patent no: 2147.(UK). This was his next step from the syphon method.to what is now referred to as the "direct pressure system". The research work and detail that Tilghman carried out before he registered his first patent is remarkable when it is realised he only left the army seven years before. It is not only the scope of his work,but the intimate detail he reveals. In it he not only covers the technique in cutting, boring and drilling stone, but also covers minutely the making of designs and artistry on glass by means of various types of stencils that may be used from the point of resistance and durability. He covered the use of such items as lace, dried leaves and patterns cut from strong writing paper, and describes the huge variety of adhesives he had used.

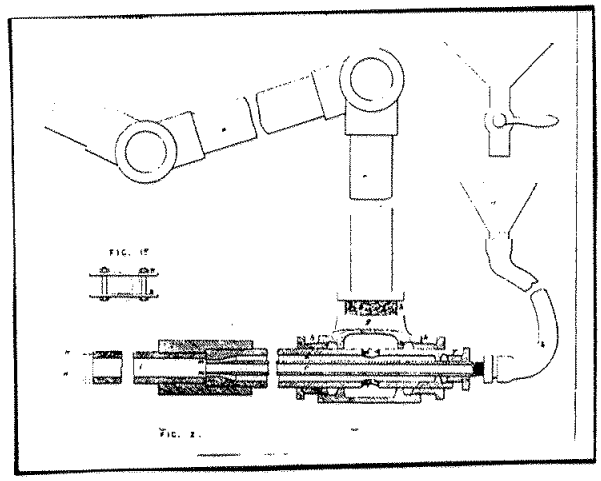

Fig.1. TILGHMNAN'S ORIGINAL PATENT.

SAND BLASTING - USING THE VACUUM TECHNIQUE.

A dramatic move from using steam, compressed air or water, Tilghman in his original patent reveals an entirely different technique of treating sheet glass. He found that where only a small amount of material is to be cut or ground away from a hard surface, and where only a moderate velocity of sand is required,the current of air produced by a fan (Fig.2) lends itself to a continuous operation. In engraving designs on glass this method is preferable to steam as the sand is kept dry. When using steam the sand may become damp and adhere and clog the fine lines and detail.The air current is about 4 inches (101.6mm) water pressure It should be noted that this method so widely different from what one may consider Tilghman's first thoughts was included in his first patent no.2147 (UK) 1870.

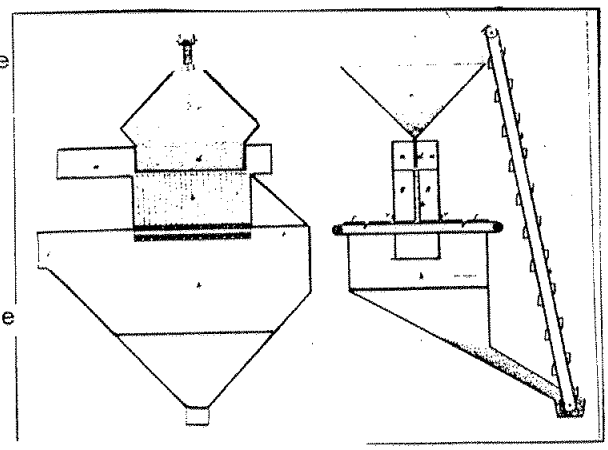

Fig.2. VACUUM SAND BLAST.

MECHANICAL SYSTEM OF SAND BLASTING.

On November 3rd.1870 Tilghman's next patent was issued No:2900 (UK) which is an alternative method of projecting abrasive. He outlined two types of blast wheel, one of a paddle type (Fig.3.) which would strike the sand being fed down. The blades were to be covered with caoutchouc (rubber) so that the sand would be less shattered by the impact. The alternative wheel (Fig.4) was a tubular-type with the sand being fed to the core so that it may be thrown outwards by centrifugal force. A modified version of the batter wheel by Beeg (Ref.1) was in use in the foundry trade in Europe by the turn of the century.
A directionally controlled wheel, which was the ultimate in design, did not come into us

until the mid-thirties when by skilful engineering it revolutionised industry.

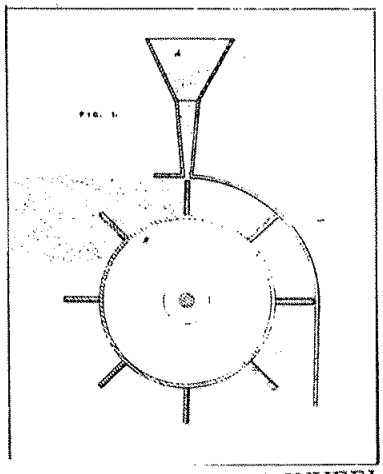

FIG.3 PADDLE TYPE WHEEL

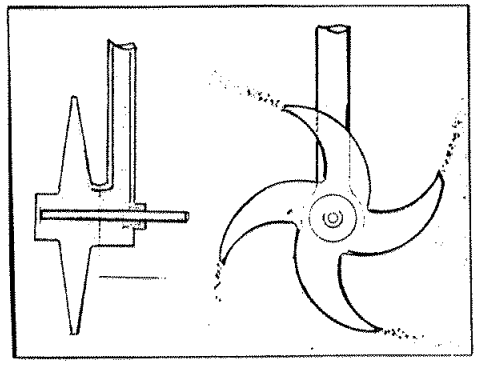

FIG.4. TUBULAR TYPE WHEEL.

Hardly had Tilghman's patents and his work been revealed when in 1871 at the 40th. Exhibition of the American Institute of the City of New York he was awarded the Great Medal of Honor of the Institute, for an invention judged as "one of the most remarkable which the age has produced".
This was followed shortly after by Tilghman being awarded the Elliott Cresson Medal at the Franklin Institute with the following citation, "—— the great merit of an invention consists in its extended utility. By means of the sand blast, effects have been produced which would be hard to imitate by any other known mechanical process and with an ease and precision truly remarkable".

CHILLED IRON GLOBULES OR SHOT.

Tilghman's mind appears to have been so active it would have been somewhat difficult to keep pace with him. Earlier it was stated that he invented the manufacture of chilled iron shot, before he joined the army, but his patent was not registered until 1872 under no: 187,239.USA.
The point is that whilst he was bringing out the sand blast process, he was also engrossed in the natural stone business. In this industry there were problems in the cutting and sawing of marble and granite. To aid the operation sand was fed into the teeth of the saw but broke down too quickly and it was Tilghman's vision in seeking and finding a superior alternative which overcame the problem. He not only foresaw what was required but he also designed the method of producing the material. This was to pour a stream of molten metal on to a wetted surface of a saucer-shaped iron plate, revolving rapidly in a horizontal plane. From this the metal breaks up into particles which solidify as they drop into cold water. This is a "short-hand" version of Tilghman's patent filed in 1872 (187,239.USA) and which is far too long to go into details. Tilghman not only produced the material and the technique, but he produced a huge amount of information on how to improve the cutting operation. It should be noted that whilst we are referring to a medium produced over 100 years ago it is still in demand due to its unique properties. Again, the detail in the patent can only be described as absorbing, and it should be noted that whilst Tilghman's first thought of the use of the material in the stone industry, he does mention its use in "abrading glass, pottery and similar hard materials

FILE SHARPENING.

Tilghman's next patent issued in 1877 (No: 252,279.usa) was for sharpening and re-sharpening files and rasps. This started an enormous industry in the United States, Britain Germany and elsewhere and the story of it is huge in itself.
Special technique was introduced by projecting a stream "--- of very fine sand and

and water in a fluid mud state,at a specific angle on to the file at great velocity.The process was sometimes referred to as the Liquid Grindstone and treated new files cut much faster and worked more freely. Their superiority is shown to a marked degree when used upon gunmetal, cast and wrought iron where great pressure is necessary to make an ordinary file to be effective.

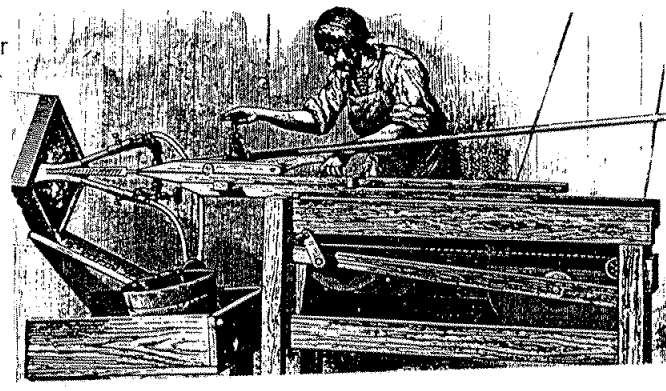

FIG.5.FILE SHARPENING.

TILGHMAN'S COMMERCIAL ENTERPRISE.

The first company that Tilghman started was with his brother,Richard. They launched B.C. & R.A. Tilghman based at 1112-1126 South Eleventh Street,Philadelphia Pa. and produced chilled iron shot. This was manufactured for and sold to the stone industry. Books were published to provide the technique for using metallic shot instead of sand. Every point of issue was covered, and included the advantages, the durability, the saving of power,the speed of cutting and the cost of labour

Around 1879 Tilghman moved to London and formed Tilghman's Patent Sand Blast Co. at Gray's Inn Road. There the company provided a service for the users of files and rasps. At that time the price for sharpening one dozen files was one shilling and six pence. The next move was to Sheffield, where the file sharpening practice could be enlarged in the heartland of the industry. The old manufacturers with their established methods of production did not wish to be disturbed by a technique that was considered to be "foreign". It was when the American files were imported, treated by the new sand blast sharpening practice, that the improved method was ultimately accepted.

It appears that when Tilghman had satisfied himself that he had done all he could for Sheffield, he moved to Altrincham in Cheshire. This must have been about 1885 for at that time he lived at Sandiway Road in that town, and had taken a commercial interest in George Richards Ltd. a well established machine tool company.

GRAVITY FEED SYSTEM.

In 1885 Tilghman took out patent No: 13,510 (UK) for roughening iron and steel rolls used for granulation purposes such as milling grain. In this instance he described another method of using sand blast technique; the abrasive held in a hopper and fed by gravity to the nozzle where it is propelled at a pressure of 70psi(4.92kg/cm2).Whilst this is an accepted and established method Tilghman did suggest he might prefer the system of his colleague J.E.Mathewson who took out patent No: 15,980 (UK) in 1884. This is known today as direct pressure and was an improvement of Tilghman's original idea (Fig.6) It would have been of some satisfaction to Tilghman if he could have perceived the potential of some of his ideas.Roughening steel rolls ultimately became one of the most critical and precise operations in connection with the manufacture of steel (tin) cans.The steel is

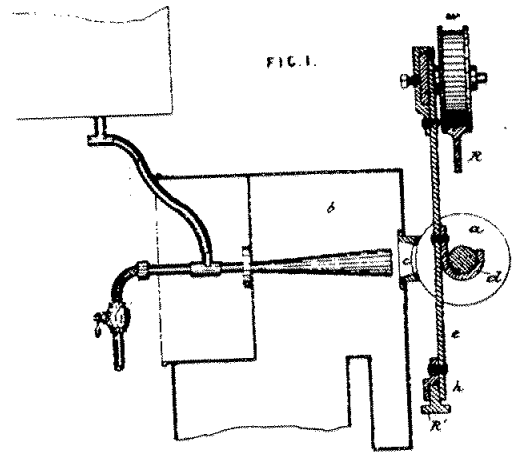

FIG.6 GRAVITY FEED METHOD.

rolled between two heavy steel rolls, one with a bright polished finish and the other grit blasted to a highly critical standard.This induces a compressive stress into the metal by which the steel sheet assumes a natural curvature.

TILGHMANS PATENT SAND BLAST COMPANY LIMITED

In 1879 Tilghman opened the new works in Altrincham which became the hub of sand blasting in Great Britain. Whilst the technique and production methods improved and new applications were found and "sand blast" became the accepted term for the processing, tthe use of sand was frowned upon because of the health hazard. Chilled iron shot,particularly grit, became the natural replacement. Because shot broke too readily in use, grit became the accepted standard due to its excellent cleaning properties, producing bright silvery surfaces on most materials.
Over the years grit became well established and was ideal for use with the directionally controlled blast wheel. This wheel, introduced in the mid-thirties, revolutionised the industry in that whilst 1.HP. was required to project ½lb.(0.226kg) of metallic abrasive by compressed air, the technique was progressively perfected so that 20lbs.(9.07kg) can be projected by the same horse power by the modern blast wheel.. Multiple wheel machines are now built which are capable of dealing mechanically with massive production hitherto never visualised. A major problem at the time of the new blasting technique being introduced was with vehicle leaf springs which failed frequently. Efforts were made to overcome the problem by covering the springs with grease and wrapping in waterproof material. Other attempts were made by placing zinc shims between the leaves to ease movement and help to resist the corrosive conditions.
A vehicle spring manufacturer installed a two wheel type blast machine and using chilled iron grit found a vast improvement in the life of the springs. Had chilled iron shot been used the result would have been questionable because of the weakness induced by the odd broken pieces. These are known as "notches" and may not be so destructive when they are "en masse" as produced by grit. (Ref.2) The product had not only an improvement in but under deflection tests, the springs reached between 500,000 and 600,000 cycles before failure. Because of the cleanliness and the receptive surface the manufacturer decided to coat the surface with zinc to a thickness of 0.003" (0.762mm.). A deflection test was abandoned after reaching 1,000,000 cycles without sign of failure.

STEEL SHOT.

The next revolutionary step was the introduction of steel shot. This material though not as hard as chilled iron shot, had all the qualities to make remarkable improvements in the blasting processes. The life of the material is about ten times that of iron shot, it retains its shape and improves the life of a machine because it will withstand the hard metal protection that was introduced as components and linings of the machines.

SHOT-PEENING

Steel shot enabled the introduction of another process which is extremely important in modern day scientific engineering.This may be attributed to Herbert (Ref.3) who was intrigued by the fact that worn components such as gears and cams, were harder after use than as originally fitted. He investigated his theory by dropping selected ball bearings on to test pieces. He proved his point and designed types of machines he named the "Cloudburst" for the purpose of hardness testing. Foppl (Ref.4) and Zimmer (Ref.5) in 1944 both produced papers on the subject and helped to lay the foundation of this important process.

PEEN FORMING

Anothr extremely important process has, like shot-peening turned sand blasting from an elementary process into scientific application. Occasionally the observation of a simple phenomenon can lead to an important development. In a paper by Coleman Sellars (Ref.6) the heading is given as One Curious Fact "—— when a surface is parially protected by templates of metal, these templates curl up under the blows of fine particles". Therein lay the pointer to Almen's valuable work (Ref.7) and the birth of shot peening and peen forming.

RUST PROOFING BLAST SYSTEM.

One of the latest introductions is a method of protecting the exposed surfaces of pretreated components.(Ref.8) The specially produced shot is coated with an outer layer of zinc to an average thickness of 150 microns. The zinc is transferred during the blasting operation on to components to provide protection against corrosion. A specially designed machine was produced for the operation which is fitted with magnetic separators, electronically operated sensors and specially designed control valves to maintain a predetermined balance of coated shot.(Z iron)

THE GROWTH FROM TILGHMANS "SEED OF SAND"

With the conception of sand blast in 1870, it is quite suprising how quickly industry took to it! Glass was the first to be developed in the field of artistry and decoration. The Weights & Measures Departments soon accepted it for the stenciling of glassware (tumblers) with an indelible imprimatur to make them legal measure. (Ref.9) In 1895, the Ardrie House in Scotland was "—— being renewed by the sand blast process and as far as that has been done the house looks newly built" (Ref.10) In the United States on 23rd.July 1897, it was reported in Th Practical Engineer, that the warship, Atalanta, was being sand blasted to remove the old paint and rust. and 14,000 sq.ft. was cleaned at the rate of 6sq.ft. per minute. Similarly in New York, the Department of Public Works used sand blasting on a large scale to clean a massive steel viaduct which carried One Hundred & Fifty Street across the elevated track of the Manhattan Railway.(Ref.11)
All this was before the turn of the century, after which progress grew in all fields of application particularly in the foundry industry where today machines are built to an enormous size weighing many tons.Similar machines are used in ship building. It is difficult to imagine a process that deals with such applications, and at the same time is used to clean human teeth,(Ref.12) removes print from paper (Ref.13) and is used to adjust the frequency of quartz crystals.(Ref.14)

THE TRIBUTE

Benjamin Chew Tilghman had a full, active and positive life He made use of every minute. In his early days he began by taking up the law which he dropped in favour of chemistry. He gave up some of his lifetime to participate in the Civil War, where he appears to have been an able soldier. By the time the war was over he was45 yearsof age and then found time to invent another process to make paper from wood fibre. This was just another of his many inventions, as was the torpedo which he visualised being propelled by slow burning powder. This was followed by his registering of his patent of the sand blast.. The amount of work entailed in this alone has to be studied in some detail to appreciate how much Tilghman had concentrated on the subject. Whilst the original design was for a single operation, he also outlined the method of continuous operation by means of the vacuum method. Two years later when he patented chilled iron shot, he included all the detail of the method of manufacture. One immediately thinks of this in connection with the sand blast process, but initially it was for the stone industry. The volume of work he had done in this field of application has to be seen to appreciate the time and effort he had made.
Yet with all this activity he had not abandoned the sand blast interest and visualised the possibilities of alternatives to steam and air as the the propellants, by using a vacuum system and by mechanical means of a throwing wheel. On top of all this he invented the file sharpening machine which aroused enormous interest and activity in the industry In the early days he worked closely with his brother, Richard and together founded their first company in Philadelphia.
Records suggest that Tilghman was a sociable and amiable man and that despite being subjected to working pressure he appears to have got on well with his colleagues, as for example,J.E.Mathewson of whose work he approved and acknowledged.
Benjamin Chew Tilghman was an Anglo-American, a visionary of outstanding ability and resolution, whose contributions to industry is recognised by too few. His name is still prominent in the descendant of his original company, now linked with an American company as Tilghman-Wheelabrator Limited. He would be fascinated at what his original inventions have acheived world wide in the widest range of industries, and he could feel a great deal of pride.

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