The Pattern of Progress Through Patents

The following is an except from Blast Cleaning and Allied Processes - Volume 1 by H. F. Plaster. This book is an invaluable resource for our industry and we will be sharing parts of it with you in the next few issues of the newsletter.

Machine designs

The following resume of the principal patents over the 100 years since the first was taken out in the year 1870, produces many points of considerable interest. Those selected are representative of the more important patents and are indicative of the stage in development or the original thought at a particular moment in time. Many patents taken out were not capable of development, and yet again many were not promoted until after a lapse of many years. It is believed that patents covered are representative of international progress, there being some similarity in thought and development. If there is any variation in trends it is probably greatest in the field of centrifugal blast cleaning machines, the European Continent favoring the “batter” type wheel, against the British and American preference for the “slider” type wheel. This is not to suggest the slide type of blast wheel design is unknown or not used on the Continent. The original development was towards the batter wheel, though in latter years the slide type wheels are becoming more accepted and developed. A further example is the suggested wide use on the Continent towards the use of cut wire pellets as an abrasive for a broad field of application. Yet the facts available prove that the production of cut wire pellets is but a fraction of that of other forms of metallic abrasives. Steel shot, for example, is being produced in ever-increasing quantities.

From this it will be seen that though at first sight there seems to be apparent differences in international techniques, to some marked degree, this is not so when the position is more closely analyzed. However, the development of some of the patents are examined and analyzed more closely in the later text of this work.

B. C. Tilghman

A tribute must be paid to the brilliancy of Benjamin Chew Tilghman's vision when he foresaw a potential field in the process of impacting abrasive upon the surfaces of materials. Now may be seen the result of the “impact” he expected and ultimately produced upon industry. It is not simply the date of filing of his application, but what he wrote into the specification that is most revealing. B. C. Tilghman, of Philadelphia, Pennsylvania, was granted Patent No. 2147 in the United Kingdom in the year 1870. In the same year (on 3 November) he was granted Patent No. 2900 which was but three months after his first patent (1870). If we examine these patents it will be found that Tilghman had in these thoughts covered all the possible principles of the process, even thought it took eventually sixty years for all his ideas to be perfected. The original Patent No. 2147 covered the projection of abrasives by means “of a jet of steam, air, water and other suitable gaseous or liquid medium”. It also covered “any method or arrangement of jets or currents of steam, air, water, etc.” Additionally, he also maintained “the sand may be propelled by a current of air produced by suction, or a partial vacuum”.

Tilghman’s Original Design

In the original specification, Patent No. 2147, it was stated the invention “relates to the cutting, boring, grinding, dressing, and pulverizing of stone, metal, glass, wood and other hard or solid substances by means of a stream of sand, or grains of quartz, or of other suitable material artificially driven, as projectiles rapidly against them by a jet of steam, air, water, or other suitable gas or liquid, which jet may be made to ornament glass and other polished surfaces by partially depolishing such surfaces so as to produce any desired pattern thereon”.

The term “sand” in the specification was meant to imply small grains or particles of any hard substance of any degree of fineness, of which quartz sand is a type. The hardest steel, chilled cast iron, or other metal can be cut or ground by a rapidly projected stream of sand. Articles of cast or wrought metal may have their surfaces smoothed and cleaned from slag, scale or other incrustation.

It was noted that “where a jet of water under heavy pressure is used, as in hydraulic mining, the addition of sand will cause it to cut away hard and close grained substances, upon which water alone would have little or no effect”.

It was believed that steam would be the most convenient source of energy, particularly for high velocities but that in certain circumstances air or water would be cheaper. Steam pressure was used up to 400 lb/in2 (29.12 kg/cm²). Tilghman proved that efficiency increased with the increase in pressure. His design (Fig. 1) was...
simple and yet engineeringly sound. The sand was fed into a funnel (a) which was connected by a flexible tube with a turning point (b) to an iron or steel tube (c) of a convenient length and about 0.17 inch (14.31 mm) bore, which was called the sand tube. This tube was firmly secured exactly in the center of another steel tube (d) which was approximately 1/2 inch (12.7 mm) bore, that was termed the steam tube. At the junction of the pipes (b) and the sand tube (c) a plug (e) and a gland is used to locate and centralize the pipes. The bore of the outer tube (d) was reduced to 0.250 inch (6.35 mm) for a distance of about 1/4 inch (6.35 mm) from its end. Similarly the sand tube was reduced to 0.230 inch (5.84 mm) to permit a clearance of approximately 0.015 inch between the sand tube and the steam tube. The steam tube (d) is connected to a steam boiler by the holes (f and f) and the tee piece (g) which located the stuffing boxes (h and h) to the jointed pipes (o and o) to permit the jet to be directed in any direction. A wrought, chilled cast iron or steel tube (i) that was termed the nozzle and about 0.380 inch (9.65 mm) bore and about 6 inch (152.4 mm) long was fastened to the end of the steam tube. The end of the steam tube (c) is accurately adjusted and firmly fastened exactly in the center of the steam tube (d) so that the annular opening was everywhere of the same width and the nozzle tube was adjusted so that the axis or central line coincides perfectly with the axis of the steam jet issuing from the annular opening. The perfect accuracy of the parts was important. The bore of the nozzle tube was adjusted by trial to the size and pressure of the steam jet so as to produce the desired suction at the sand tube.

In operation the steam would be turned on and would issue with great velocity from the annular opening (m). This created a suction and a current of air in the sand tube (c). The sliding valve at the bottom of the sand box opened and sand is fed into the funnel (a) from where it would be carried by a current of air through the sand tube, from where it is sucked into the steam jet and driven forward and out through the nozzle. A dull red light may sometimes be seen at the point of impact between the sand and the stone.

It was of advantage when cutting long narrow grooves to arrange parallel guide plates of iron or steel (u) about 1 1/2 inches (38.1 mm) wide and projecting about 3 inches (76.2 mm) from the end of the nozzle leaving between the plates a space equal in breadth to the bore of the nozzle tube. The effect of the plates was to prevent the sandblast from diverging and to produce edges and grooves more even and regular.

Tilghman was aware that this system has limitations and that part of the pressure of the jet was lost. He sometimes used a strong closed vessel to contain the sand and introduced a pressure of steam or air above the sand. By regulating the cock on the pipe leading to the top of the closed vessel and the cock leading to the impelling jet a current of fluid carrying with it the abrasive would result. This was the basic idea of the pressure vessel or “sand pot” as it is sometimes referred to, that forms a standard part of modern equipment.

**Tilghman’s Blast Wheel Patent**

In his subsequent patent in 1870 Tilghman covered the projection of abrasives by means of a centrifugal device. In fact, Tilghman patented both the “batter” wheel (Fig. 2) and the “slider” wheel (Fig. 3), both of which are present-day methods in the technique of blasting and in constant use. In two patents in a single year, Tilghman had covered all the possibilities in the process of “sandblasting”.

Two years later, 1872, patent No. 3626 was granted to Tilghman in which he stated he had produced and used “chilled iron globules” and he had also “used grains made by cutting of short lengths of fine wires”. It is true he had in mind at that time the use of these materials in connection with the sawing of stone and granite. Nevertheless, these very materials have played a most significant part in the promotion of the blast processes.

Tilghman described the method he used to produce iron shot as follows: “One method which I used for forming cast iron into grains is to pour the melted metal on to the surface of a plate of cast iron, about 30 inches in diameter, revolving in a horizontal plane about nine hundred turns per minute. The metal is thus scattered into small drops, which are whirled outward and solidify in their flight, and fall into water which chills and hardens them. Finely divided streams of water are applied so as to prevent the iron plate becoming too hot. By operating in a close box or chamber, the atmosphere of which has been deprived of oxygen, the tendency of the drops of hot metal to burn will be prevented. The more rapid the rotation of the plate and the more fluid the metal the smaller will be the grains produced.”

![Fig. 2. The original design by B. C. Tilghman produced in 1870 of what became known industrially as the “batter” type centrifugal blast unit.](image)

**1877.** Within seven years of his first patent, Tilghman produced a machine of intricate and yet very effective design to clean and sharpen old files. The sand that was used as the abrasive was projected by means of steam jets. His Patent No. 4575 is described later in this book.

A contemporary, and a colleague of Tilghman’s and an excellent engineer, J. E. Mathewson, was to make a number of valuable
contributions to the blast cleaning processes. In 1877 he was granted patent No. 1584 for a machine designed to operate upon the surface of glass, stone, marble, wood, metal and other hard substances. The machine was based upon “...a means of an exhausting apparatus to produce a partial vacuum...” (Patent No. 2147, Tilghman, B. C., 1870). A simple means to produce a partial vacuum was by the stroke of a lever operating a set of bellows. This system is described elsewhere in the book, in connection with the marking of glass tumblers. In the same year, in fact under the same patent number, Mathewson designed a machine to etch sheet glass (Patent No. 1584, Mathewson, J. E., 1877). He deliberately chose the vacuum system to overcome the problem of working upon the glass as he put it, “in a confined chamber with a pressure system”. Such a method was of a very “cumbersome and expensive character and a great inconvenience” and has been experienced from the escape of fine dust into the workroom. Mathewson’s invention was to obviate such inconveniences and to reduce the cost of the apparatus. Instead, therefore, of forcing the sand under a pressure of air, an exhausting fan was used to produce a partial vacuum in a close chamber, and the external air would rush into the chamber to fill up the vacuum. By this means the incoming air is made to pass up a narrow pipe or channel and carry with it a regulated quantity of sand.

It will be understood that the construction and arrangement of the various parts of the apparatus will vary according to the character and form of the articles to be operated upon, but the principles of working would be the same in all cases.

In a description of the machine (Fig. 4) the glass sheet is placed upon an endless chain (b) and conveyed forward by means of loose bars. About mid-way from the two ends of the table an opening is made to receive a vacuum box (j) in which is made a long narrow slit (f). The outer sides of the box (j) are connected with the horizontal ducts (j') one end of which is closed while the other is turned up and terminates in the inclined channel or chamber (j). At the center of the vacuum box (j) and immediately below the long slot (j') is fixed the vertical pipe (k) which is made in the form of a long narrow box with an opening at the upper end of the same length as the slot (j'). A trumpet mouth (k') is fitted to the lower end of this pipe (k) and a curved guide plate (l) is inserted into the trumpet mouth. The sand is permitted to fall from openings in the underside of the horizontal pipe (m) into a funnel or hopper (m') from whence it passes on to the curved plate (l). The width of the opening through which the sand passes is regulated by an adjustable plate (n) carried by arms (n') and a rocking shaft (n') mounted in bearings attached to the main frame of the machine. The sand is fed by means of a scroll conveyor (m) along the pipe (m') to the hopper (m') from a source of supply (p). Being drawn up by the vacuum created in the box (j) the sand will pass up through the slit (j') and strike the underside of the sheet that is slowly moving over the slit. The sand is drawn by the ducts (j') into an exhausting chamber where longitudinal and transverse baffle plates are fitted to arrest the sand and cause it to fall down into the system for re-use.

Mathewson was aware of the problem connected with the exhausting air and the fine grit that is carried over and the damage that can be inflicted upon the fan blades. To overcome this Mathewson designed an exhausting apparatus of special merit that would more effectively operate at the considerably lower speeds. This unit was based upon the rocking movement of a baffle drawing the air in through a set of valves and exhausting through a similar set.

1885. One of the first practical designs for a sandblast machine for a specific purpose was taken out in the year 1885. This machine used for the roughening of chilled iron rolls was based upon gravity fed nozzles that were power traversed over the face of the roll. This...
was indeed another patent fulfillment of Tilghman who by this time must have been well known at the patent office, for his patents covered very many designs and ideas additional to those for the processes of sandblasting.

1893. To Mathewson must be credited for the first practical design of pressure vessel used for sandblasting of any real worth. His design produced in 1893 (Patent No. 12306) was fitted with a slide bar abrasive mixture valve that was to be used for forty years, almost without the slightest modification. It should be stated that Tilghman was not unaware of the necessity to pressurize the feed of abrasive when using an enclosed vessel and he makes a point of this in his first patent, No. 2147 (1870), p. 10. His design of pressure vessel was of the double dump valve (mushroom valve) that enables the process to be continuously operated.

1894. Mathewson’s patent for the light sheet metal valves was a considerable step forward in compressor design. The sandblasting process at that time was moving away gradually from the use of steam as the propelling medium to that of compressed air with fewer problems and greater flexibility. In this same year, Mathewson designed and patented an improved operator’s helmet proving that he and Tilghman were not to overlook any fact of the process of sandblasting that may improve or effect the efficiency in any way. Between them they could be said to have covered almost every possibility in promoting and exploiting the process.

1896. In 1896, A Mr. D. Young was granted a patent for a design in which a steel vessel was used as an elutriator to mix “…finely divided ground sand of the nature of meal…” to enable it to be drawn off as an abrasive mixture to the blast nozzle.

1903. Sandblast rooms had been primitively designed up until 1903, and in that year Mathewson produced an idea that was a basic design for fifty years. His system was to use the ventilation fan to lift the spent abrasive from the hoppers beneath the room to a cleaning unit prior to re-use. This was an extremely sound method and had much to commend it. The greatest problem, that of heavy wear due to the moving abrasive, would not present the same difficulty today with the introduction of modern wear resistant materials. Reference is made to this type of installation later in the book.

The original process of sandblasting, as has been stated, was based upon the use of steam as the form of energy. Compressed air was a logical successor and substitute. In 1903 Mr. G. C. Marks issued Patent No. 3629 for a design based upon a combination of compressed air, sand and water. This could be said to be one of the original designs of the vapor blast system. At the time the patentee visualized his process being used in “closed-in places such as the hold of ships”. ☞

News Release

New Syclone Blast Nozzle From Problast Brings Many Benefits

As a further example of its continuous development program aimed at increasing the cost effectiveness and efficiency of blast cleaning nozzles, Problast has launched the Syclone range.

The new Syclone long life venturi nozzle is available in a range of standard orifice sizes from 6.5mm to 13mm and was developed especially for use with the harsher abrasives such as alumina and chilled cast iron.

The key feature is an one-piece liner which is manufactured from an advanced lightweight, hi-tec material. Field trials have proved that the life expectancy of a Syclone nozzle is well in excess of an equivalent tungsten carbide or silicon carbide nozzle, minimizing replacement, compressed air and media costs. It is also safer in use; as the liner is bonded to the outer jacket, should it shatter, it cannot fly out of the casing.

A soft nylon jacket absorbs impact shock, thereby protecting the liner from mechanical damage. It also eliminates potentially dangerous sparks which can occur when a metal jacketed nozzle strikes a metal substrate.

The result is a high performance, full throat nozzle which is less than half the weight of a metal jacketed tungsten carbide nozzle. It is more comparable to a boron type nozzle at a fraction of the cost.

For more information contact Jim Lyons at 01629 812513 or Bob Paterson at 0114 2571681. ☞

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