INSIDE DIAMETER CYLINDRICAL BLAST CLEANING ATTACHMENT APPARATUS

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ABSTRACT
As a means of increasing the productivity and improving the safety of an internal diameter cylindrical blast cleaning, the introduction of an attachment apparatus makes it possible to eliminate or dramatically reduce the use of personnel inside a blast chamber while the process is ongoing thus improving safety of the process and improving the productivity and uniformity of the blasting process. The apparatus includes three principal elements: a blast chamber in which a cylindrical product to be treated is mounted on a device that rotates the cylindrical product to be treated; one or more blasting systems and one or more blasting operators. The system includes a delivery means for delivering a blast material output device into the inside of cylindrical product.
INSIDE DIAMETER CYLINDRICAL BLAST CLEANING ATTACHMENT APPARATUS

CROSS REFERENCE TO A RELATED APPLICATION


FIELD OF TECHNOLOGY

[0002] The present invention pertains to abrasive blasting devices and in particular to an attachment to improve the safety and productivity of inside diameter (ID) cylindrical blast cleaning.

BACKGROUND

[0003] Abrasive blasting was first patented by Benjamin Tilghman in 1870 with his patent number 108,408A. Much of the background in abrasive blasting is available in a recent book by Andreas Mombert entitled blast cleaning (portions of which are hereby incorporated by reference). For the purposes of this application one is referred to Chapters 4 and 7 entitled “Blast Cleaning Equipment” and “Health, Safety and Environment.”

[0004] Abrasive blasting of steel substrates can provide the best possible surface preparation for coatings adhesion. If done properly, abrasive blasting thoroughly cleans the surface and creates a surface profile for mechanical adhesion. To achieve the economy available through abrasive blasting, the blasting organization must maintain the productivity and efficiency of the cleaning system through careful attention to all of its components.

[0005] The principle of air-supported abrasive blasting is very elementary. Compressed air propels abrasive particles at high velocities to impact and clean a substrate. All the equipment between the air compressor and the emission of abrasive particles is used to supply, convey, and accelerate the abrasive.

[0006] Three basic components are found in most abrasive blasting operations: the equipment, the abrasive, and the personnel. Careful attention to these 3 basic components is the key to the success or failure of the entire operation.

[0007] Equipment

[0008] For abrasive blasting, as with any discipline, efficiency and productivity are directly affected by the appropriateness of the tools that are used. As shown in FIG. 1 these tools 100 include: an air compressor 102 and an optional breathing air compressor 104 or an ambient air pump 106; a blast machine 108; abrasive/media material 110; a blast hose 112; a remote control hose 114; a blast nozzle 116; a breathing air filter 118; and a respirator hose 120 and a respirator (for the blasting operator) 122.

[0009] Air Compressor

[0010] The air compressor is one of the most critical pieces of equipment in the entire operation. It is also one of the most costly, and demands proper maintenance. Because the volume and pressure of the compressed air determine the speed of the abrasive as it exits the nozzle, and thus its cleaning productivity, maintenance of air volume and pressure is critical.


[0012] The abrasive blast machine must be an ASME-coded vessel, designed to meet all safety laws. Blast machines are designed and chosen primarily for their abrasive capacity and if required, for their portability. Their overall design, however, is an essential factor in their efficiency and productivity. For proper functioning, the air pressure inside the blast machine must be equal to the air pressure flowing through the external piping. While there are relatively few moving parts, the machine should have certain features to increase its efficiency. These features include an automatic filling valve (pop-up valve) that seals when air is supplied to the machine and opens when air is turned off, a concave head for ease in filling with abrasive, and a conical bottom that permits the smooth and complete flow of abrasive into the abrasive metering valve.

[0013] Blast Hose

[0014] The sole purpose of blast hose is to convey the air-driven abrasive from the blast machine to the blast nozzle. The abrasive/air mixture should flow freely without passing through any undersized hose or fittings that could cause excessive wear and pressure loss.

[0015] Nozzles

[0016] Blast nozzles are designed to meet a wide variety of needs, and they are supplied in various lengths and configurations. In addition, various materials are used for both the liner and the outer jacket. Proper nozzle selection depends upon the surface to be treated, the size of the overall job to be done, the amount of compressed air that is available, and the type of abrasive to be used. When the air and abrasive reach the blast nozzle, the nozzle design should allow for rapid acceleration of the mixture to be evenly dispersed in a high velocity pattern.

[0017] Since the air pressure that exits an air compressor is always higher than nozzle pressure, a nozzle pressure gauge must be used to measure the actual pressure at the nozzle. Once again, the work performed is in direct proportion to the volume and pressure at the blast nozzle.

[0018] Abrasive Selection

[0019] Abrasive selection is determined by the scope of the job, the job location, and the desired surface finish, which may be determined by the coating manufacturer or the owner of the equipment or structure that is being treated. A wide variety of abrasives is readily available throughout the world, and any of several types may be chosen to accomplish the required surface cleaning.

[0020] Personnel

[0021] Equipment that has been properly selected for the job and the correct abrasive for the surface to be treated produce the necessary “power” to operate at a consistent pace. It is the blasting operator, however, who controls the equipment and determines the ultimate productivity and job efficiency. Blasting operators therefore must be properly trained and protected from the health and safety hazards of abrasive blasting.

[0022] In nearly all trades, the cost of labor is at least equal to if not higher than the cost of equipment and supplies. Personnel can make or break any abrasive blasting job. Properly trained, abrasive blast operators can turn an otherwise potential failure into a profitable operation. They should be trained in the use of the equipment, safety, proper blasting techniques, and a control of surface profile, surface cleanliness standards, and coating manufacturers’ requirements for the end condition of steel for each coating used.
Blasting operators who are well trained on the equipment will be able to tell instantly if it is functioning at full capacity. If it is not, they will be able to make appropriate adjustments in techniques or equipment set-up. Adjustments in technique might include nozzle angle, nozzle distance from the surface, and nozzle dwell time. Adjustments in equipment set-up could include changing air pressure, adjusting the abrasive metering valve, or using different diameter hose.

Every operator must be protected in his work environment, for his own safety and for the safety of those workers who may be in the same area. Abrasive blast operator safety regulations are set by local, state, and federal agencies. All abrasive blast operators must wear NIOSH- (National Institute of Occupational Safety and Health) approved, airfed helmets or hoods. This equipment must be supplied with at least Class D breathing air.

In the case of supplied air from the blast machine compressor, a carbon monoxide alarm or converter, an overheating alarm, and a breathing air filter are essential. The filter will remove light oils and mists and some odors that are usually associated with air compressors that require oil for lubrication. The carbon monoxide alarm will alert personnel to the presence of potentially injurious levels of carbon monoxide that may be in the breathing air supply. The converter can remove dangerous levels of carbon monoxide.

Typically, air compressors will raise the air temperature above ambient. There are lightweight devices attached to the operator’s belt that will cool or even raise the temperature of the compressed air that is supplied to the operator.

Complete blast suits, which are made of breathable cotton fabric that is leather-faced, and leather gloves round out the operator safety equipment. Because an operator’s productivity can be greatly affected by his comfort or discomfort, it is important to select safety clothing and equipment that minimize weight, heat, and impediments to movement.

FIG. 2 illustrates the typical equipment and protective devices used by a blasting operator 200. These protective devices include: a helmet 202; a supplied air respirator 204; safety glasses 206; a blast suit 208; gloves 210; a breathing air tube assembly 212; a flow connector 214; a respirator hose 216; safety shoes 218 and a deadman handle 220. While wearing all this protective clothing the blasting operator negotiates a blast hose 222 and a nozzle 224.

After considering the essential elements that make abrasive blasting systems productive, it is still difficult to estimate production rates. The variability of system set-ups, the blasting operator’s skill or lack thereof, the condition of the surface to be treated, abrasive characteristics, and environmental considerations make any calculations merely estimates.

Conclusion

It is well known that correct surface preparation is essential to achieving the full life of any coating or coating system. Abrasive blasting is recognized as the most effective means of obtaining the correct surface cleanliness and surface profile. Careful attention to all the components of an abrasive blasting system, including the air supply, the abrasive blast equipment, the abrasive, and the expertise of the blasting operator can assure that any abrasive blasting operation obtains its maximum level of efficiency.

This discussion of these productivity effects of abrasive blast cleaning equipment discussed above contains portions that were originally published by Clemco Industries in September, 1989. The basic principles discussed herein are still valid today.

The personnel affects discussed above are a significant productivity and safety element that needs improvement. The elements discussed above are common to most blasting systems. However, the productivity and safety issues associated with blast cleaning are greater with the use of blasting chambers used to remove impurities inside a cylindrical device used for wind turbines and other tower type devices. Such blasting chambers existing require the installation of the cylindrical tower inside the blasting chamber, with a device for rotating the tower device. Such blasting chambers are well known to those of ordinary skill of the art. The blasting operator in such a facility needs to stand inside the device while it is rotating while pointing the nozzle toward the inside diameter of the rotating device. The safety and productivity issues discussed above are magnified by the awkward position the blasting operator needs to be while applying the abrasive material to the inside diameter of the tower device. Such a tower device may have a diameter exceeding 40 feet and length exceeding 110 feet long when in its horizontal position. There is a need for a device that overcomes these productivity and safety issues.

SUMMARY

As a means of increasing the productivity and improving the safety of internal diameter cylindrical blast cleaning the introduction of an attachment apparatus as described herein makes it possible to eliminate or dramatically reduce the use of personnel inside a blast chamber while the cleaning process is ongoing.

An internal diameter cylindrical blast apparatus comprises three principal elements: a blast chamber in which a cylindrical product to be to be treated is mounted on a device that rotates the product to be treated; one or more blasting systems and one or more blasting operators. The attachment apparatus described herein makes it possible to eliminate the one or more blasting operators within the blasting, thus improving safety of the process and improving the productivity and uniformity of the blasting process.

The attachment system comprises a delivery means for delivering a blast material output device into the inside of the product to be treated by controlling the distance of the output device from the inside diameter of the product and additionally controlling the horizontal distance and speed of the output device. Both of these are functionally while the product is being rotated by the blasting system.

An attachment apparatus includes a boom supporting subsystem; a boom system; and a blast material output device support subsystem that provide the abrasive material to clean the item to be treated.

The boom supporting subsystem provides: the physical support for the attachment apparatus; an adjustment of the vertical height of the boom subsystem and the blast material output device support system; controls the horizontal speed and distance of movement of the beam system and blast material output device support system and house a control system to control the functions of the attachment apparatus.

The boom system is the physical boom that provides: supports the blast material output device support system; transports a blast hose to the blast material output device subsystem and supports any needed control cables from the
boom system support system to the blast material output device subsystem. The boom sub-system may have a lattice type structure in which the lattice structure provides both a means of support and a positioning guide for a robotic controlled or fixed abrasive material output device.

[0040] The blast material output subsystem includes the blast system output device and positions the blast system output device for optimum cleaning of the cylindrical product to be treated. The blast system output device may be a blast nozzle or an abrasive blast wheel.

[0041] The attachment apparatus is controlled by a separate programmable logic controller (PLC) device; a PLC controlled by an existing computer or by a computer.

[0042] The position and shape of the product to be treated lends itself to the use of two identical or similar attachment apparatuses with each traversing the blasting chamber and the product from each end. With such a usage, productivity is improved with less time being required to clean a product. It also permits the use of shorter booms.

[0043] The attachment apparatus embodiment of the invention may be an add on device to an existing blasting system or it may be integrated within a newly designed or newly installed blasting system.

[0044] As discussed the use of attachment of the attachment apparatus described herein is to improve the safety of blasting inside diametric cylindrical products and to improve the productivity of blast cleaning inside diameter products.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] These and other features, aspects, and advantages of the present embodiments(s) of the invention will become better understood with regard to the following description, appended claims, and accompanying drawings where:

[0046] FIG. 1 illustrates parts of a compressed air system for blast cleaning operation;

[0047] FIG. 2 illustrates a typical example of personnel protective equipment used in a blast cleaning operation;

[0048] FIG. 3 illustrates an inside diameter cylindrical blast cleaning system using a blasting operator;

[0049] FIG. 4 illustrates an inside diameter cylindrical blast cleaning system including an embodiment of the attachment apparatus;

[0050] FIG. 5 illustrates an exemplary attachment apparatus; and

[0051] FIG. 6 illustrates the use of two attachment apparatuses within a single cylindrical product.

DETAILED DESCRIPTION

[0052] As a means of increasing the productivity and improving the safety of inside diameter cylindrical blast cleaning the introduction of an attachment apparatus makes it possible to eliminate or dramatically reduce the use of personnel inside a blast chamber while the blasting process is ongoing.

[0053] FIG. 3 illustrates in a block diagram form the principal elements of an inside diameter cylindrical product blast cleaning system that uses a blasting operator within the product to be blasted 300. As discussed above, the source of the energy for the blasting comes from an air compressor 302 that is connected to a blast machine 304 that combines the air energy with the abrasive material 306 to be used for the blasting. A blast hose 308 couples an output of the blast machine 304 to a blast material output device (nozzle) 310.

[0054] The cylindrical product 312 is mounted to a moveable cylindrical product support 314 for moving the cylindrical product 312 into a blasting chamber 316. A device for rotating the cylindrical product may be part of or attached to said cylindrical product support 314.

[0055] Since a blasting operator 316 needs protection during the blasting process a breathing air compressor 318 and breathing air filter (not shown) provide breathing air via a respirator (not shown) worn by the blasting operator 316. Additionally the blasting operator needs to wear safety glasses, a helmet, a breathing tube assembly, a blast suit, and gloves and use a deadman's handle for his protection as shown in FIG. 2 and discussed above.

[0056] The blasting operator steps into the rotating cylindrical product and sprays the blast material onto the inside diameter of the cylindrical product with the blast material output device (nozzle). Many such systems do use a computer control system 320 as illustrated in FIG. 3 to control the parameters of compressed air, rate of flow of abrasive material and rotations speed of the cylindrical product while the actual application of the abrasive material is primarily under the control of the blasting operator.

[0057] The purpose of the embodiments of the invention is to provide an attachment system for existing abrasive blast systems and or be part of any new abrasive blast cleaning systems is to provide a method of securing and holding in place the abrasive blast material output device inside the internal diameter of a rotating cylindrical product, while at the same time controlling both the distance the abrasive blast material output device is from the substrate being abrasive blast cleaned and the speed of travel of the abrasive blast material device relative to the cleaning rate of the blast stream. Both distance and travel is controlled by the use of a programmable logic controller and drive systems.

[0058] The necessity of the attachment system has been created as a result of the need and requirements set forth by various manufacturing processes, whereas, the internal surfaces of certain products are required by corrosion control experts to be abrasive blast cleaned such that all impurities of the surface are removed while attaining a mechanical etch somewhat uniform for the application and adhesion of corrosion control products. The ability to provide and economical process to access the internal areas of the cylindrical products without the use of personnel has created the necessity for the aforementioned attachment.

[0059] Several factors contribute to the necessity. A first factor contributing to the necessity of the attachment is safety. Today the process is achieved by a manual abrasive blasting process, wherein, a blasting operator, fully suited in a breathing air hood, abrasive blasting suit and gloves, combined with breathable air hoses (as shown in FIG. 2) attached and manually holding an abrasive blast hose and nozzle, is inserted into the inner diameter of the rotating cylindrical product. Many personnel injuries are created as a result of the various hoses getting caught on brackets and gussets internal to the rotating cylindrical products.

[0060] Uniformity in abrasive blast cleaning is in direct relationship to the distance the abrasive blast nozzle is from the substrate being blast cleaned, hence the need of the attachment to maintain within tolerance the distance the abrasive nozzle is from the substrate being abrasive blast cleaned.

[0061] Specifications as set forth by the corrosion experts vary the degree or level of cleaning, time of exposure required to dwell on the area being cleaned. Therefore, as a result of the
aforementioned attachment to control the time of exposure by way of travel speed is critical to the degree of cleanliness and profile.

[0062] Challenges facing the process and attempts by others include: manufacturers have researched the ability to achieve the aforementioned process with other than the use of a manual operation, attempts have been made to have a spinning abrasive blast cleaning nozzle, wherein the abrasive discharge section of the nozzle spins, much like a pin wheel and distributes the abrasive to the internal dimensions of stationary cylindrical product, while a tripod of supports with casters are manually pulled through the cylindrical product. The success of the devise or attachment has been primarily on smooth internal surfaces, small in diameter without brackets or gussets.

[0063] An abrasive blast wheel, a process where in the abrasive is pushed onto a series of vanes and thrown by the force of an electric driven motor, has been mounted onto a manually pushed wheeled device. The wheeled devise small in nature is manually guided through the cylindrical products as it delivers the abrasive uniform and perpendicular the substrate surface. The ability to supply the abrasive to the device along with the need to straddle or override the brackets and gussets has made this device very difficult to work with.

[0064] Additionally, the use of a tower assembly at both ends external to the cylindrical product, tied together with a lattice type structure internal to the cylindrical product, from which the lattice structure provides both a means of support and a guide for a robotic controlled abrasive blast nozzle or a cable driven cart with a fixed abrasive blast nozzle has proved to be successful means of abrasive blast cleaning the internal components of cylindrical products. However, such a device requires set-up time, thus reducing the productivity of the process. These three methods each have their disadvantages as described above.

[0065] Although simple in design, the embodiments of the invention herein of a cylindrical blast cleaning attachment is such that the attachment is capable of providing a means of supporting abrasive output devices such as an abrasive blast cleaning nozzle or an abrasive blast wheel(s) within the internal areas of a product without the need of internal personnel, having the ability by Programmable Logistic Controlled systems to continually control the distance the abrasive output device is from the substrate being abrasive blast cleaned while at the same time utilizing a Programmable Logistic Controlled drive systems to maneuver the abrasive output device horizontal travel at a controlled speed.

[0066] FIG. 4 illustrates a block diagram form the principal elements of an inside diameter cylindrical blasting system that uses an attachment apparatus within the product to be blasted 400. As discussed above the source of the energy for the blasting comes from an air compressor 402 that is connected to a blast machine 404 that combines the air energy with the abrasive material 406 to be used for the blasting. A blast hose 408 couples an output of the blast machine 404 to a blast material output device (nozzle) 410.

[0067] The cylindrical product 412 is mounted to a moveable cylindrical product support 414 for moving the cylindrical product into a blasting chamber. A device for rotating the cylindrical product (not shown) may be part of or attached to said cylindrical product support 414. An embodiment of the attachment apparatus is added to the above elements to deliver the abrasive material 406 to the inside diameter of the product 412 without a human blasting operator being within the product to be treated.

[0068] Components of the attachment system include three sub-systems including a boom support subsystem, a boom subsystem and a blast material output device support subsystem. A Programmed Logic Controller guides the boom support subsystem to place the blast material output device in an optimal position for the blast activity within the product to be treated and guide the speed at which the abrasive blast material output device is moved horizontally along the length of the product to be treated. The optimal position for the blast activity is function several variable including, but not limited to; the nature of abrasive material and the nature of the material to be removed from the product.

[0069] The boom subsystem can utilize various methods of designs and materials. The support itself may be: a full length support structure; telescopic in nature or in sections of various lengths. The support itself may be made of: steel; aluminum; stainless steel; or composites. The support structure needs to extend to the lengths necessary to achieve a satisfactory reach to the internal areas of the product requiring the abrasive blast cleaning process. Certain lengths of the boom subsystem require a method of design to prevent sagging, these methods include: cable system supports; air cylinder supports; hydraulic supports; torsion bar assembly supports; or chain tension supports. The support system needs to maintain a rigid system capable of supporting: the blast material output device and the blast hose and fittings and the backpressure or force of repose created by the blast cleaning process.

[0070] The boom subsystem itself is mounted to a method of movement, the boom support subsystem. The method of movement needs to be capable of supporting the extension of the support itself. The methods of movement including but not limited to: a rail type car; a wagon type car or cart; motor driven tractor type frames; or steel supported trolley type systems. The method of power for the movement includes but is not limited to: electric driven motors; gas or diesel powered engine; cable pull systems; or powered trolley systems. Drive systems include, but are not limited to: chain and sprocket; belt; rack and pinion; gears; hydraulics; air cylinders; or gear systems.

[0071] The programmable logic controller may be of any readily available manufacture. The controller is to control both the speed of horizontal travel and distance the blast material output device is from the substrate being abrasive blast cleaned. The method of adjustment or devises controlled by the Programmable Logic Controller may be but not limited to electric motor drives, hydrostatically controlled systems, air cylinders, hydraulic cylinders and or air bag type systems.

[0072] The attachment system is designed to be an attachment to an existing system an inside diameter cylindrical product blasting system that uses a blasting operator within a cylindrical product to be blasted as discussed above and illustrated in FIG. 4. A newly designed inside diameter cylindrical product blasting system may use the attachment system in an original design.

[0073] FIG. 5 illustrates the attachment system 500 having three sub-systems including a boom support subsystem 502, a boom subsystem 504 and an abrasive blast material output device support subsystem 506. Since the boom subsystem 502 is essentially a cantilever system, the primary purpose of the boom support subsystem is to provide the support for the
boom subsystem and the abrasive blast material output device support subsystem. The boom support subsystem 502 is a wheeled device that provides the support discussed above as well providing height adjustment and a drive system for moving the attachment system into a blast chamber.

[0074] The boom subsystem 504 is attached to the boom support system 502 on one end and supports the abrasive material output device support subsystem 506 on the other end. The boom subsystem carries a blast hose 508 for connection to the abrasive material output device 510 mounted on the abrasive material device support subsystem 506. The boom sub-system 504 may have a lattice type structure in which the lattice structure provides both a means of support and a positioning guide for a robotic controlled or fixed abrasive material output device.

[0075] The boom support subsystem 502 is a wheeled device, drive cart 512 having drive wheels 514 driven by a horizontal travel drive device 518. The boom support system also provides an elevation control for the boom subsystem 502 and the abrasive material output device support subsystem 506. The elevation control includes a plurality of elevation adjustments 516 driven by an elevation drive 518.

[0076] In order to minimize any sagging or drop of the cantilever supported boom sub-system, the boom subsystem 504 has a boom sag support assembly that includes a series support elements 522 that support a cable 524 fastened to the a abrasive material output device support subsystem 506 end of the boom subassembly 504 and the other end is coupled to the drive cart 524. This cable assists in keeping the boom subassembly at a constant height throughout its length. Depending upon the structural strength of the boom subassembly, it may be necessary to provide greater height of the cable supports and provide a triangular shape of the path of the cable from the abrasive material output device support subsystem 506 end and the boom support subsystem 502 end of the boom subassembly. The two main functions of the attachment assembly are to adjust the height of the abrasive blast material device to an optimum height of the abrasive blast material device and to adjust horizontally position the nozzle along the length of the product to be treated as the blasting proceeds as illustrated above. The product to be treated will be rotating at a speed controlled by the non-attachment portions of the system as described above. Therefore the attachment apparatus system 500 controls the vertical placement of the nozzle through the elevation adjustment mechanism 516 of the boom support subsystem 502. It also controls the speed of the movement of the attachment apparatus and horizontal distance of the travel of abrasive material output device.

[0077] A PLC control system mounted within boom support subassembly which includes an input from outside the blast chamber via a control cable (or by wireless means) instructs the attachment 500 to move into the blast chamber and the horizontal movement within the blast chamber, including its speed and distance of the drive cart within the blast chamber. The PLC also instructs the attachment 500 to move the boom subassembly and the abrasive output device to an optimum height. These are two of the principal functions that have been previously done by a human blasting operator within the blasting environment. The use of the attachment eliminates potential safety hazards for the human blasting operator and provides a more productive use of the time in the blasting chamber. The system potentially improves the quality of the blasting operating because the system is less subject to the variable of human mistake by eliminating potential areas of under blasting or over blasting of the inside surface of the product to be treated.

[0079] FIG. 6 illustrates a typical inside diameter cylindrical blast cleaning apparatus 600. In this FIG. 6 we additionally illustrate the use two attachment apparatuses each operating from opposite ends of a blast chamber 602.

[0080] A cylindrical product 604 to be treated ranges from large diameter pipes such as used in the petroleum industry to wind turbine towers. Each of these need to have clean surfaces to extend their life as discussed above. Each of the attachment apparatuses 606 and 608 as illustrated in FIG. 6 and described above. Each attachment apparatus comprises three sub-systems including a boom support subsystem 610, a boom subsystem 612 and an abrasive blast material output device support subsystem 614 . . . . The actual abrasive cleaning is performed within the blast chamber 602 that keeps the abrasive material away from an outside environment and reduces the noise and other environmental hazards of the blasting process. The doors on each end of the blast chamber need to be designed to permit entrance of the attachment assembly yet effectively “seal” the blast chamber during the blasting operation. The diameters of these items to be treated may be as much as 40 feet with lengths as long as 110 feet. However it is believed the embodiment described herein could accommodate much larger examples.

[0081] An item to be treated, cylindrical product 604 is mounted on a cylindrical product transport and rotation system 618 that moves the cylindrical product 604 to be treated in and out of the blast chamber 602 and rotates the cylindrical product 604 to be treated about its longitudinal axis. The rotation system 618 is mounted on a rail track system or rubber tires 620 by a plurality of wheels that roll on the rail track system 622 or rubber tires 620 within the blast chamber 602. The rail system 622 extends out of both ends of the blast chamber 602.

[0082] The pair of attachment apparatuses 606 and 608 provide the means for spraying the abrasive material on to the inside surface of the cylindrical product to be treated 604. Each attachment apparatus comprise the three sub-systems and their elements as described above and illustrated in FIG. 5.

[0083] The attachment apparatuses 606 and 608 are identical and are designed to be used at opposite ends of the blast chamber. Using two attachment apparatuses improves the productivity and lessens the time the cylindrical product needs to be in the blasting chamber.

[0084] The functional embodiment of an attachment apparatus for abrasive blast cleaning system has been designed to eliminate the need for personnel needing to be within the blast chamber applying the abrasive material while holding on to a hose and nozzle as illustrated in FIG. 1. Many abrasive blasting system already have a computer means to control the major elements of the blasting process even when a human blasting operator is used with the cylindrical product to be treated. Such a device is a computer that is programmed with the parameters of the specific cleaning job. However, as discussed above when an attachment apparatus is used it additionally uses a Programmable Logic Controller controls the distance of the nozzle from the inside diameter of cylindrical product to be blasted, horizontal distance and horizontal speed of the nozzle.

[0085] A programmable logic controller (PLC) or programmable controller is a digital computer used for automa-
tion of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or lighting fixtures. PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed or non-volatile memory. A PLC is an example of a real-time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result.

[0086] The use and programming of the PLC within this embodiment of a computer controlled ID cylindrical blast cleaning apparatus will upload and download the software for the PLC program from a personal computer type computer for backup and restoration purposes. The program is transferred from a personal computer to the PLC though a programming board which writes the program into a removable chip such as an EEPROM or EPROM. The program will produce instructions for the rotation speed of the item to be treated, distance of the nozzle from the inside diameter of the device to be tested, horizontal distance, horizontal speed of the nozzle and ability to turn abrasive flow on or off based upon the various parameter discussed above.

[0087] As discussed above the PLC program produces instructions for the distance of the nozzle from the inside diameter of the device to be tested, horizontal distance and horizontal speed of the nozzle. The PLC may receive instructions from a computer system used in the non-attachment portions the cylindrical blasting system. The distance of the nozzles 614 from the inside diameter of the item to be treated is communicated to the boom elevation adjustment systems that raise and lower the rigid booms. The horizontal distance and horizontal speed of the nozzles 614 the ability to turn the flow the abrasive on or off are controlled by communication by the PLC to the motorized drive devices. The computer providing these instructions may be coupled to the devices implementing the instructions by hard wire or by wireless communication.

[0088] Additionally, it may be possible to have fault detecting devices mounted to the attachment apparatuses or within the blast chamber to stop the operation if a safety or production problems develops.

[0089] All the features disclosed in this specification (including any accompanying claims, abstract, and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless stated otherwise, each feature disclosed is one example only of generic series of equivalent or similar features.

I claim:

1. An attachment apparatus for a blast cleaning apparatus comprising:
   a boom supporting system;
   a boom subsystem; and
   an abrasive material output device support subsystem.

   wherein said apparatus controls the vertical position of said abrasive material output device within said blast cleaning apparatus and
   further wherein said apparatus controls a horizontal position of said abrasive material device and said apparatus

   controls a horizontal position of said abrasive material device within a product to be treated residing within a blast chamber.

2. The apparatus of claim 1 comprises:
   said boom supporting subsystem further comprising:
   a wheeled device that provides a support for said boom subsystem;
   a height adjustment for said apparatus;
   a drive system for moving said apparatus into and within a product to be treated.

3. The apparatus of claim 2 further comprises:
   a wheeled device having drive wheels driven by a horizontal travel drive device.

4. The apparatus of claim 3 further comprises:
   an elevation control system comprising an elevation drive coupled to a plurality of elevation adjustment mechanisms that provide adjustment of a vertical position of said boom subsystem and said abrasive material output device support subsystem.

5. The apparatus of claim 4 further comprises:
   a series of support elements that support a cable coupled to said abrasive material output device support subsystem end of said boom subassembly and another end is coupled to said wheeled device.

6. The apparatus of claim 5 wherein said each support element may have an increasing height from said abrasive material output device support end of said boom subassembly to said wheel device end of said boom subassembly.

7. The apparatus of claim 6 wherein said include:
   cable system supports;
   air cylinder supports;
   hydraulic supports;
   torsion bar assembly supports;
   or chain tension supports.

8. The apparatus of claim 1 wherein said apparatus:
   a. adjusts the height of said abrasive material output device to an optimum height;
   b. adjust a horizontally position of said abrasive material output device along a length of said product; and
   c. adjusts a speed of a movement of abrasive material output device as said blasting proceeds within said product to be treated while said product being treated is being rotated.

9. The apparatus of claim 2 wherein said wheeled device may be:
   a rail type car;
   a wagon type car or cart;
   motor driven tractor type frames; or
   a steel supported trolley type system.

10. The apparatus of claim 2 wherein said wheeled device may be powered by:
    electric driven motors;
    gas or diesel powered engine;
    cable pull systems; or
    powered trolley systems.

11. The apparatus of claim 2 wherein said drive systems for said drive cart may include:
    chain and sprocket;
    belt;
    rack and pinion;
    gears;
    hydraulics;
    air cylinders; or
    gear systems.
12. The attachment apparatus of claim 1 wherein said boom subassembly comprises:

- a PLC control system mounted within said boom support subassembly further comprising an input from outside said blast chamber via a control cable or by wireless means to provide instructions to said PLC control system,
- wherein said PLC control system instructs said attachment apparatus to move into said blast chamber and controls its horizontal movement within the blast chamber and said product to be treated, including its speed and distance of said abrasive material output device within the blast chamber and further within controls a height of said abrasive material output device within said product to be treated.

13. The apparatus of claim 1 comprises:

- said boom subsystem is attached to said boom support system on one end and supports said abrasive material output device support subsystem on another end;
- said boom subsystem supports a blast hose for connection said abrasive material output device mounted on said abrasive material device support subsystem.

14. The apparatus of claim 1 wherein said boom subsystem has a lattice type structure in which the lattice structure provides a means of support and a positioning guide for an abrasive material output device.

15. The apparatus of claim 1 comprises:

- said blasting system comprises a single attachment apparatus wherein said attachment apparatus enters into a product to be treated within said blast chamber from either end.

16. The apparatus of claim 1 comprises:

- said blasting system comprises a pair of attachment apparatus wherein each said attachment apparatus enters into said product to be treated within a blasting chamber from opposite ends.

17. The apparatus of claim 1 wherein said abrasive blast material device is a nozzle or an abrasive blast wheel.

18. The apparatus of claim 1 wherein said boom may be:

- a full length support structure;
- telescopic in nature; or
- in sections of various lengths.

19. The apparatus of claim 12 wherein the boom may be made of:

- steel;
- aluminum;
- stainless steel;
- or composites.

20. The apparatus of claim 13 wherein said boom extends to a length to achieve a reach to an entire internal area of said cylindrical product requiring said abrasive blast cleaning process.

21. A cylindrical product blasting apparatus comprising: a compressor; a supply of abrasive material; a blast machine; a blast hose and a blast output device supported by an blasting operator within a rotating cylindrical product to be treated within a blast chamber with said blasting operator being supported by breathing air and safety clothing and mechanisms the improvement comprising:

- an attachment apparatus comprising: a boom supporting subsystem; a boom subsystem; and abrasive blast material output device support subsystem, wherein said attachment apparatus adjust a height of said abrasive blast material device to an optimum height and adjusts horizontally position as well as horizontal speed of movement of said abrasive blast material device along a length of the cylindrical product as the blasting process proceeds,

wherein said attachment apparatus improves the safety and productivity of the blasting process by eliminating a need for the blasting operator within said blast room.

22. In a product blasting process comprising:

- supplying compressed air;
- supplying abrasive material;
- using a blast machine to combine said compressed air to produce abrasive blast material;
- using a blast hose to transport said abrasive blast material to an abrasive blast output device;
- supporting said blast output device by an blasting operator within a rotating cylindrical product to be treated within a blast chamber;
- supporting said blast operator with breathing air and safety clothing and other mechanism, the improvement comprising:
- using an attachment apparatus comprising: a boom supporting subsystem; a boom subsystem; and abrasive blast material output device support subsystem,

wherein said attachment apparatus adjusts a height of said abrasive blast material device to an optimum height and adjusts horizontally position as well as a horizontal speed of movement of said abrasive blast material device along a length of the cylindrical product as the blasting process proceeds,

wherein using said attachment apparatus improves a safety and productivity of said blasting process by eliminating a need for the blasting operator within said blast room.

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