July 31, 1945. A. H. EPPLER 2,380,738

ART OF SAND BLASTING

Filed July 29, 1940 3 Sheets-Sheet 1

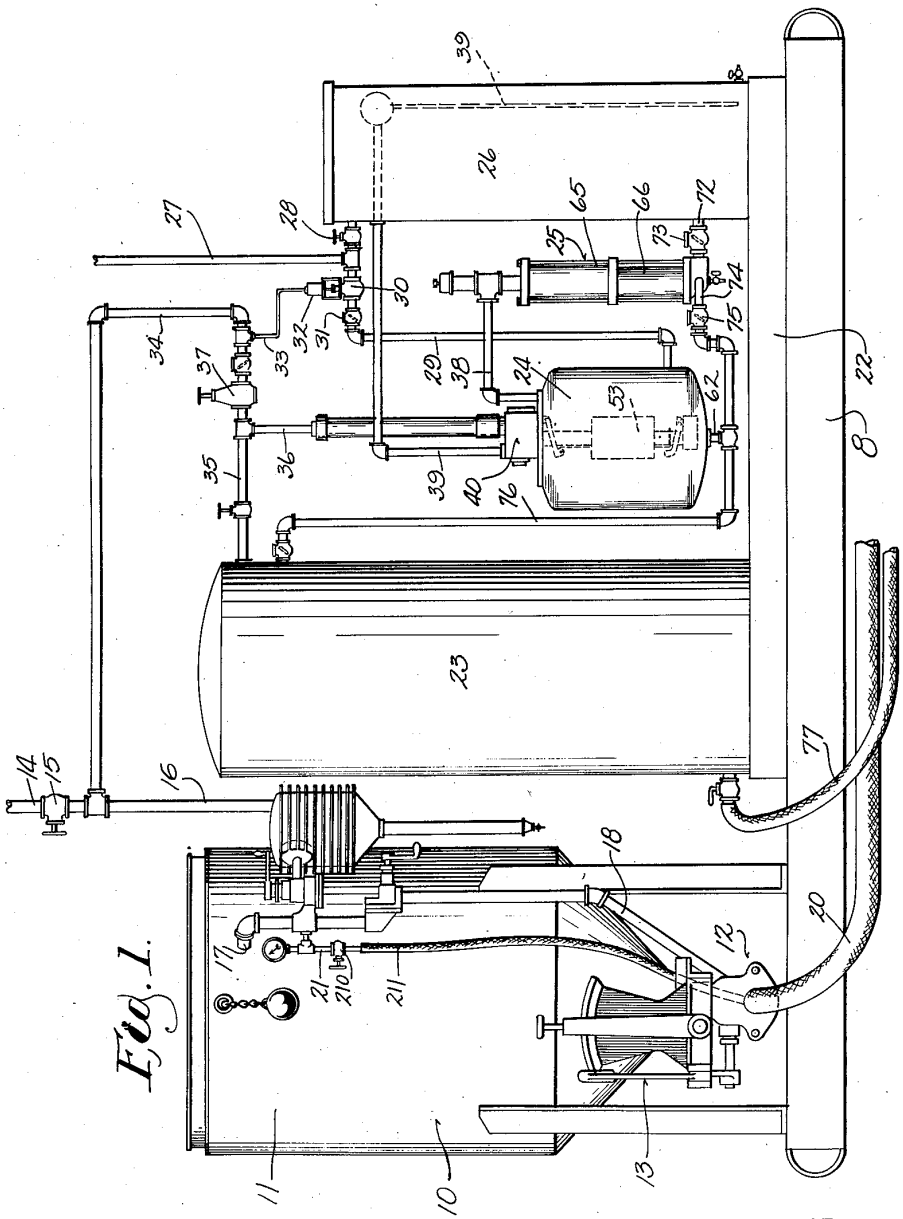


Fig. 1.

INVENTOR
ARTHUR H. EPPLER
BY
Wheeler, Wheeler & Wheeler
ATTORNEYS.

July 31, 1945. A. H. EPPLER 2,380,738

ART OF SAND BLASTING

Filed July 29, 1940 3 Sheets-Sheet 2

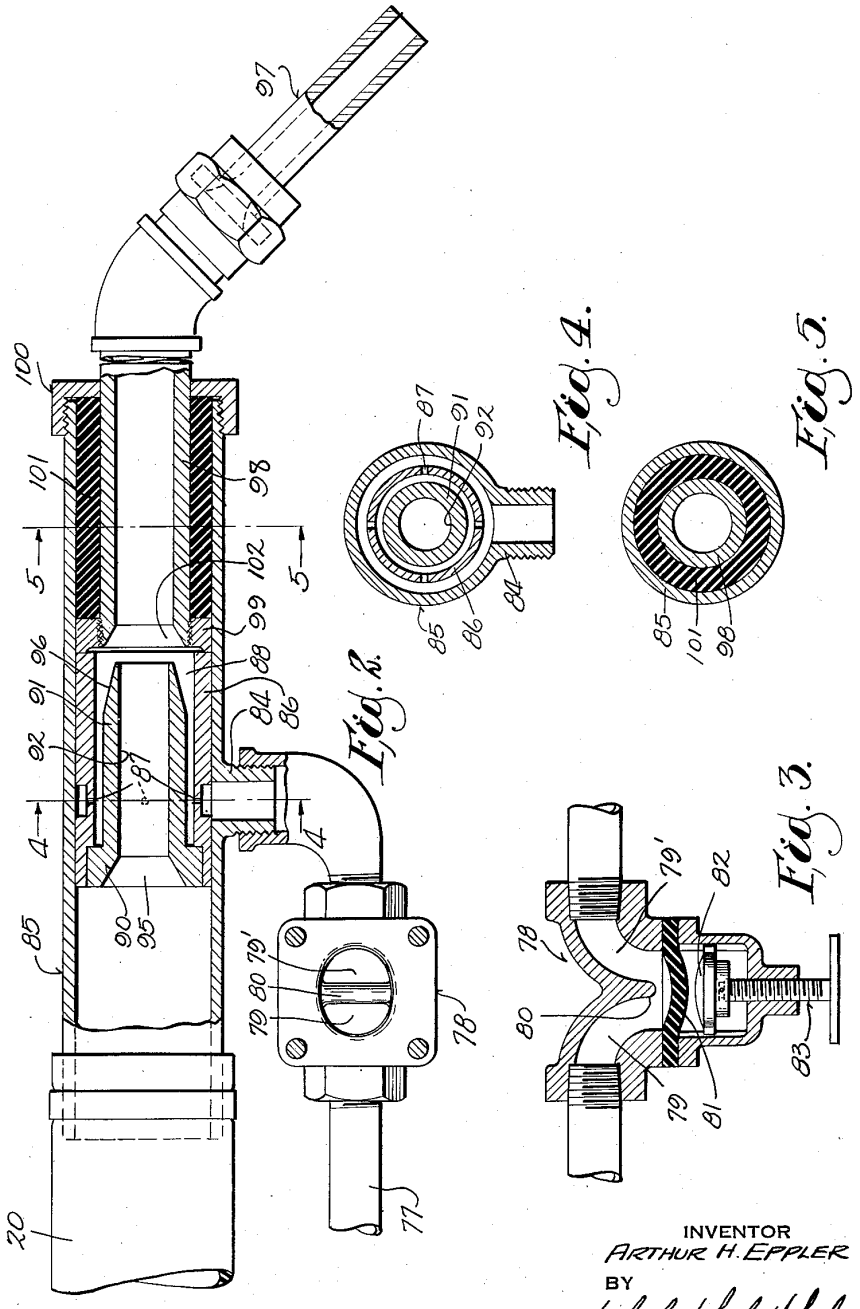


Fig. 2.

Fig. 4.

Fig. 5.

Fig. 3.

INVENTOR
ARTHUR H. EPPLER
BY
Wheeler, Wheeler & Wheeler
ATTORNEYS.

July 31, 1945. A. H. EPPLER 2,380,738

ART OF SAND BLASTING

Filed July 29, 1940 3 Sheets-Sheet 3

Fig. 7.

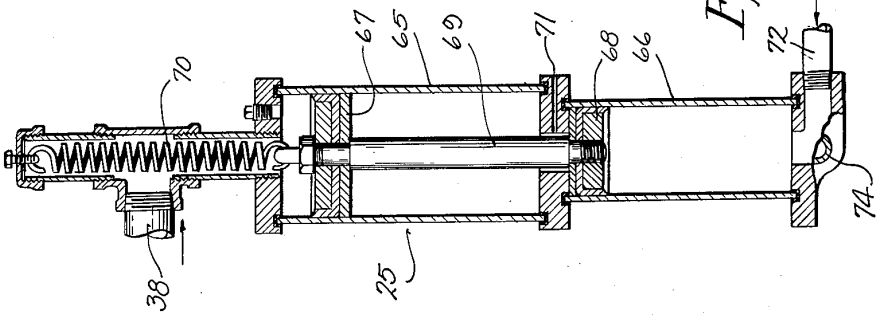
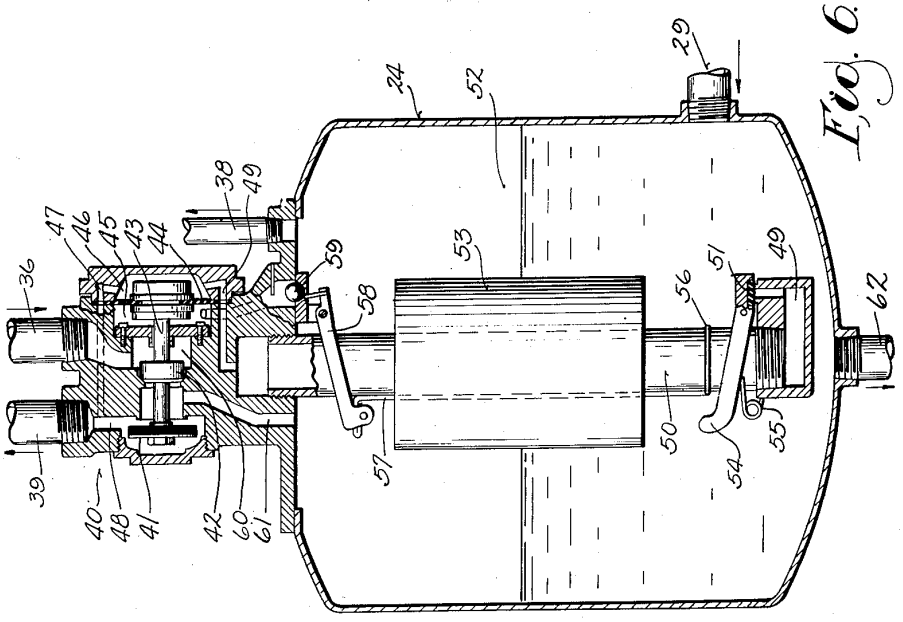


Fig. 6.



INVENTOR
ARTHUR H. EPPLER
BY
Wheeler, Wheeler & Wheeler
ATTORNEYS.

Patented July 31, 1945 2,380,738

UNITED STATES PATENT OFFICE

2,380,738

ART OF SANDBLASTING

Arthur H. Eppler, Milwaukee, Wis.

Application July 29, 1940, Serial No. 348,130

11 Claims. (Cl. 51—8)

This invention relates to improvements in the art of sand blasting. By sand blasting I include, of course, the use of other forms of abrasive, the word "sand" being employed generically for the purposes of this description.

It is the object of the invention to provide an improved means and method for sand blasting and simultaneously inhibiting the corrosion or oxidation of the freshly cleaned surface while at the same time making the sand blast more effective and enabling the use of cheaper grades of sand than have heretofore been regarded as practical.

More specifically, it is an object of the invention to provide a sand blasting method and apparatus in which minute quantities of a liquid carrier for chemical material are sprayed with the pneumatically propelled sand at the surface to be cleaned. In the past it has been thought necessary for effective high speed sand blasting work to employ special grades of sharp sand entirely free from dust, but in the use of my invention I find that I am able to use inexpensive common sand from practically any source without dust hazard, and to make such common sand cut even more rapidly than the best sand heretofore available. It is my theory that the dust present in common sand has in the methods and apparatus of the prior art operated to cushion the action of the sharp particles upon the work. I have found that even a minute proportion of water will not only carry the rust inhibiting chemicals but will minimize the menace of silicosis by laying the dust, and because cheap sand used in my apparatus cuts at least as effectively as the highest grade sand in prior art structures, I believe that the mist or vapor delivered through the sand blast nozzle in my device accomplishes this result by segregating the dust and either increasing its mass and its velocity to match the mass and velocity of the larger particles, or by removing the dust from the path of the larger particles, or by enveloping fine particles of sand in globules of liquid to produce the results noted.

Further objects of the invention have to do with means for successfully mixing the chemicals with the water in the desired proportions and with the necessary accuracy to be acceptable both from the standpoint of economy and result.

Still other objects of the invention have to do with the solution of the problem of supplying water or other suitable liquid carrier with chemical material to the sand blast nozzle and preventing the liquid from clogging or stopping the nozzle during intervals when the sand is not flowing thereto.

Still other objects of the invention have to do with the mounting of conventional sand blast nozzle tips interchangeably on the handle portion of the nozzle.

A still further object is to obtain the aforesaid advantages while at the same time sufficiently moistening the abrasive so as to preclude the building up of a positive magnetic charge upon ferrous metal objects which are treated, such a charge being a deterent to machining as well as to the magnetic flux testing of the metal. Such a charge is frequently the result of dry sand blasting of ferrous metals. It is not present in hydraulic sand blasting but the hydraulic sand blasting has other disadvantages avoided by the use of the invention herein disclosed.

Other objects will be apparent to those skilled in the art upon study of the following specification of my invention.

In the drawings:

Fig. 1 is a side elevation of those portions of the apparatus which are relatively stationary and by which the nozzle is supplied.

Fig. 2 is a view on an enlarged scale showing the nozzle apparatus largely in longitudinal section.

Fig. 3 is a longitudinal section through the valve which controls the supply of liquid to the nozzle.

Fig. 4 is a view taken in section on line 4—4 of Fig. 2.

Fig. 5 is a view taken in section on line 5—5 of Fig. 2.

Fig. 6 is an enlarged detail view in axial section through the water pump and metering arrangement.

Fig. 7 is a view on an enlarged scale in axial section through the pneumatically operated chemical pump and metering arrangement.

Like parts are identified by the same reference characters throughout the several views.

The apparatus shown in Fig. 1 is mounted for convenience on a base 8, which may be pulled about over the ground like a stone boat or may be carried on the chassis of a truck. The device shown at 10 is a conventional commercial sand blast generator. It includes a large tank or hopper 11 within which the sand is contained, and a mixer 12 in which there is a cut-off valve (not shown) actuated by the control lever 13. Air from the compressed air line 14 is supplied subject to the main control valve 15 to a pipe 16 which leads to the generator. A portion of the

air passes through pipe 17 to the top of the tank 11 and another portion of the air passes through pipe 18 to the mixer 12 from which the air and the entrained sand are delivered to the hose 20 which leads to the nozzle hereinafter to be described. The details of the above mechanism are not shown or described for the reason that they form no part of the invention, with the exception of a by-pass pipe at 21 communicating, subject to the control of a metering valve 210, through the hose 211 with the sand blast hose 20.

The metering valve 210 is of the type which may either be shut off completely or opened only to a predetermined and very slight extent. Because of the introduction of water into the nozzle in the manner hereinafter to be described, the water might accumulate in the nozzle and mix with sand therein to cause the sand to cake and stop the nozzle if it were not for this by-pass which, even though the valve controlled by lever 13 may be momentarily closed, will nevertheless permit a sufficient quantity of air to flow through the hose 20 to keep the nozzle open and to keep the water moving toward the nozzle discharge.

On a separate sub-base 22 are mounted a pressure tank 23, the pneumatically operated water metering pump 24, the pneumatically operated chemical metering pump 25, and the chemical storage tank 26.

The water supply pipe 27 communicates with the chemical storage tank 26 by means of valve 28 only for the purpose of facilitating the filling of the chemical tank for the dilution of the chemicals placed therein. The main purpose of the water connection at 27 is to supply the pump 24 by means of pipe 29 with which pipe 27 communicates subject to an automatic pressure control cut-off valve 30 and a check valve 31. The cut-off valve 30 is self-closing and is held open only by the pressure of air admitted to its control chamber 32 through pipe 33 from the air supply pipe 34 which communicates with the main air pipe 14. When the main control valve 15 is cut off, the water valve 30 closes itself. When the control valve 15 is open, the air pressure also opens the water valve to leave the apparatus in condition for operation.

Pipe 34 not only supplies the control chamber 32 of the automatic valve 30, but also supplies the pressure tank 23 and the pump by means of pipes 35 and 36 respectively, both of which are subject to the control of the regulating or reducing valve 37. The valve 37 may be adjusted to a fixed setting which will automatically compensate or equalize pressures according to the hose lengths and sizes of hoses used in the apparatus to arrive at a negative pressure or partial vacuum at the point where the liquid enters the gun at 87. Pipe 35 is provided with a normally closed cut-off valve which is only opened to build up a sufficient head of air in the top of tank 23 against which the water and chemical admitted to the tank may operate.

The pump 24, shown in detail in Fig. 6, is likewise of conventional commercial design and hence will be described but briefly. In addition to the air admission pipe 36 and the water admission pipe 29 previously described, the pump has a pipe 38 communicating with the chemical pump 25 and a pipe 39 which serves as an air discharge pipe and which, for the purposes of this invention, leads to a point below the surface of the chemicals in tank 26, such tank being freely vented to the atmosphere whereby the air escaping through the submerged outlet 39 aerates and mixes the chemicals.

The construction and operation of the pneumatically driven water pump are as follows:

In the control head 40 is an air exhaust valve 41 and an air inlet valve 42 mounted on the same stem 43 and connected with a diaphragm 44. The diaphragm has its opposing faces exposed to the chambers 45 and 46 respectively. Chamber 46 communicates through duct 47 with the discharge conduit 48 which leads to the air exhaust pipe 39. The same chamber 46 at the right hand side of the diaphragm as viewed in Fig. 6 communicates through a duct 49 with a tubular post 50 and thence subject to the control of valve 51 with the interior of the pump chamber 52.

The float 53 reciprocates on the guide post 50. At its lower extreme of movement it operates the lever 54 which opens valve 51, the valve being closed by spring 55. At its lower extreme of movement the float 53 also engages a ring 56 connected by link 57 with lever 58 which displaces the ball valve 59 which is normally seated by gravity to cut off communication between the pump chamber 52 and the diaphragm chamber 45. Diaphragm chamber 45 has restricted communication through the annular clearance around the valve stem 43 with the inlet chamber 60.

The chamber 52 being full of water admitted through pipe 29 subject to the control of check valve 31, the float will be in contact with lever 58 which will thereupon be displaced to permit the seating of valve 59. When valve 59 is closed the air leaking around the valve stem from inlet chamber 60 into diaphragm chamber 45 will act on the diaphragm in a direction to seat the air exhaust valve 41 and to open the air inlet valve 42, thereby letting air flow from the supply pipe 36 into the water chamber 52 through duct 61.

The air pressure exerted on the surface of the water will expel the water from chamber 52 through the water discharge pipe 62, thereby lowering the float 53. In the lowermost position of the float the float will open valve 59 and valve 51 as above described, thus permitting the pressure in the tank or chamber 52 to pass upwardly through the post 50 into diaphragm chamber 46, thus equalizing the pressure in the diaphragm chamber 46 with that in chamber 45 and permitting the air pressure on the exhaust valve to displace the valve assembly to a position where the inlet will be closed and the outlet valve 41 will be open. The water supply under pressure through pipe 27 will now open the check valve 31 and enter the bottom of tank 52, thus displacing the air therefrom through duct 61 and discharge pipe 39, raising the float to the point where the cycle will be repeated in the manner above described.

As previously indicated, the air discharged from the pump through exhaust pipe 39 is used to agitate the chemicals in tank 26.

The chemical pump 25 is a double piston arrangement having an air cylinder 65 and a displacement cylinder 66 in which respectively are disposed the pistons 67 and 68 connected by piston rod 69. The tension spring 70 normally holds the piston and connecting rod assembly in an elevated position as shown in Fig. 7. Pipe 38 communicates with the air cylinder 65 above piston 67. Both cylinders, between the respective pistons, are vented through duct 71. The chemical from tank 26 is admitted through pipe

72 subject to the control of a check valve 73 and is discharged through pipe 74 subject to the control of a check valve 75, pipe 74 leading to the outlet pipe 62 from the water pump and thence communicating through pipe 76 with the pressure tank 23.

In actual practice the water pump displaces 2½ gallons of water in each operation and the chemical pump 25 displaces ¼ pint of chemical in each operation. It will, of course, be understood that the water pump 24 may be used for pumping any suitable solvent or rust resisting chemical, the term "water" being used herein for the purpose of description and not of limitation.

It will be apparent from the foregoing that the operation of the chemical pump is entirely automatic, being controlled by the operation of the water pump. When air is admitted to the water chamber 52 to expel the water therefrom, the air pressure is communicated through pipe 38 to the air cylinder 65 of the chemical pump, thereby forcing piston 67 downwardly whereby piston 68 expels the charge of chemical from the displacement cylinder 66 of the chemical pump. Thus the chemical and the water flow together from pipes 62 and 74 respectively, into pipe 76 and thence to the storage tank 23 where the mixture is stored under a head of approximately 20 pounds more or less of air which is confined in the top of said tank.

When the exhaust valve 41 in the water pump is opened to relieve the pressure of air in tank 52, the pressure on piston 67 of the chemical pump is likewise relieved through pipe 38, whereby the spring 70 lifts the piston assembly in the chemical pump to introduce a fresh charge of chemical through pump 72 and check valve 73 into the displacement cylinder 66.

From the bottom of the storage tank 23 the liquid line 77 leads to an atomizing fitting in the nozzle subject to the control of a diaphragm valve 78 which is shown in detail in Fig. 3. While this valve is of conventional manufacture it is important to use a valve of this general type because no other valve has been found to be as satisfactory and as free from clogging in a device where sand is used. This valve has an inlet passage at 79 and a discharge passage at 79' between which there is a partition at 80 upon which the diaphragm 81 may be forced to seat by the pressure member 82 actuated by a screw 83.

The liquid supplied through pipe 77 subject to the control of valve 78 is admitted through a ported boss 84 to the interior of the handle portion 85 of the nozzle. Within this handle, in registry with the boss, is a sleeve 86 having an annular peripheral channel coacting with the tube of the handle to comprise a closed passage through which the water is distributed to the various orifices at 87 through which the water may pass sleeve 86 into the annular mixing chamber at 88.

A special fitting at 90 is secured in the end of sleeve 86 and has a stem portion 91 projecting centrally through sleeve 86 to guide the sand blast therethrough. The inner bore 92 traversed by the sand blast is counterbored at 95 to provide a tapered inlet. Externally the fitting is tapered near its discharge end at 96. The diameter of this bore will be varied according to the size of the nozzle. Roughly its cross sectional diameter is approximately twice that of the nozzle. For example, I use a fitting with a ¾" bore when I employ a ⅜" nozzle, and I use a fitting with a ⅝" bore for a ¼ to $\frac{5}{16}$" nozzle.

The nozzle proper as indicated at 97, is of generally conventional design. It is, however, provided with a novel arrangement for interchangeably mounting it on the handle tube 85. For this purpose the nozzle stem 98 is provided with a flange 99 having an external peripheral diameter adapting it to fit reasonably closely within the handle tube 85. At its end the handle tube 85 is provided with an annular nut 100 and between this nut and the flange 99 I interpose a rubber sleeve 101 which is placed under compression when the nut is turned up upon the end of tube 85. The rubber sleeve not only holds the nozzle stem 98 in position, but also serves as a packing to prevent leakage while permitting an immediate change of nozzles. It is not even necessary to use tools, for the pressure which can be exerted in tightening the nut 100 by hand is entirely adequate to hold the nozzle in place and to distort the rubber packing 101 in such a way as to pack the device adequately. The internal bore through the nozzle stem 98 is counterbored to provide a tapered inlet or mixing chamber at 102 which is maintained in the proper desired relationship to the tapered end 96 of fitting 91 by the pressure contact of flange 99 with the end of sleeve 86. The air and sand passing across the gap between fitting 91 and the nozzle stem 98 aspirates into the stream the mist of chemically treated water which has been delivered through the fine apertures 87 into the annular space at 88.

As previously explained, throughout the period when the device is in use a small amount of air by-passed through the hose 211 is continually flowing through the nozzle whether or not the main stream of sand and air is flowing. This relatively small amount of air is sufficient to keep up the aspiration of water from the annular passage 88 under all circumstances, thus preventing any accumulations of water within the handle and also tending to prevent sand from clogging the water passages.

By introducing the chemical into the pneumatically carried stream of sand prior to the discharge thereof, I ensure the thorough commingling of the chemical with the sand carried by the blast so that each particle of sand is believed to be a carrier for the chemical at the time of discharge, thus ensuring the treatment of the sand blasted surface with the chemical at the very instant when it is cleaned.

The protective or rust inhibiting chemicals may be varied according to the requirements of the work. For cleaning steel forgings or castings and for much other work I have used with great success a chemical preparation made up by using in every 100 gallons of water in the chemical tank 3 to 5 ounces of the following preparation:

	Pounds
Trisodium phosphate	100
Zinc oxide (this being used only where the water supply is alkaline)	2
Neutral sodium dichromate (more being used for painting old steel and less for new steel)	4 to 6
Lead phosphate	1
Chemically pure lime (less being used for new steel than for old steel)	6 to 10

Using a $\frac{5}{16}$" nozzle a device made in accordance with the present invention will discharge approximately 450 lbs. of sand per hour in 80 cubic feet of air per minute at 90 lbs. air pressure but it will

only require 15 gallons of water or rust-inhibiting liquid, or less, in an hour.

As compared with pneumatic sand blasting as heretofore known, this small amount of water or rust-inhibiting liquid is adequate to lay the dust, thus substantially completely removing the danger of silicosis. In so doing it renders the blast much more effective. The sand ordinarily used in sand blasting averages approximately $7.50 per ton in cost. With the apparatus herein disclosed it is possible to use cheap sand at approximately $2.50 per ton with equal or better results. As above noted, I ascribe the improved results in part to the fact that the water apparently adheres to the dust particles, possibly giving them increased momentum but more probably removing them completely from the blast and preventing them from cushioning the cutting action of the heavier and sharper particles.

At the same time the amount of water or rust-inhibiting liquid used is not such that the disposal of waste is a problem. The chemicals are carried to the work and left on the surface without being washed away by sluicing quantities of water. Where such small quantities of water are used it is feasible to incorporate chemicals in the sand blast, whereas otherwise it would not be feasible to do so, because the cost would be prohibitive. By mixing the chemicals with the sand blast I ensure the treatment of the surface at the instant when the scale is removed, thus leaving no interval of time between the cleansing and polishing of the surface and the treatment thereof to prevent oxidation. This leaves a much brighter and more permanently rust free surface than has heretofore been possible to achieve.

My improved apparatus has been used in the Far West where water is scarce, and there also the small quantity of water used is significant. While the device actually uses in the neighborhood of 15 gallons of water per hour when a $\frac{5}{16}$'' nozzle is employed, I should regard 25 gallons per hour as being a small quantity for such a nozzle within the meaning of the aforesaid description. A greater quantity would create disposal problems, be wasteful of chemicals, and make the chemical treatment less effective. It will, however, be understood that in reference to the amount of water discharged from the nozzle I am referring to the chemically treated water as stored under pressure in tank 23.

It will be apparent to those skilled in the art that my process does not involve hydraulic sand blasting as that term has previously been known. The small amount of water used is merely a fine mist and the compressed air is still relied upon to furnish the impetus by which the sand blasting operation is conducted.

The sand blasting method herein disclosed constitutes an improved means of cleaning and cutting viscous surfaces. It is adapted to clean light gauge or frail metal parts without warping or buckling thereof, and avoids the generation of heat in the cleansed articles such as commonly results from dry sand blasting thereof, this being particularly important where the treatment is applied to a surface of viscous material which would soften and run when heated.

My improved treatment is also important in completely removing foreign greases or oils from the articles being treated, and in scouring the surfaces of such articles while at the same time leaving such articles free of rust for substantial periods so that they do not require immediate painting for their protection. My improved method is further advantageous in that it is successfully used on wet surfaces without requiring the preliminary drying of such surfaces as has heretofore been necessary in ordinary pneumatic sand blasting.

My improved method is further advantageous in the cleaning of concrete so that new concrete work added thereto will result in a stronger and water-tight bond or union.

The abrasive, including the dust therein contained, is confined by the moisture to the immediate vicinity of the work and does not float in the air but drops to the ground about the work and stays there.

I claim:

1. In a sand blast system, the combination with a sand blast generator and an air supply pipe therefor provided with a control valve, of a connection to said pipe controlled by said valve, a water supply pipe, a chemical supply means, and pumps provided with operating means actuated by said air connection for operation to deliver water and chemicals in predetermined quantities when said valve is open, and means for discharging said water and chemicals with a sand blast from said generator.

2. Sand blast apparatus comprising the combination with a sand blast generator, a nozzle, and means including a hose affording communication between the generator and the nozzle, of means including an aspirating device for introducing a liquid into said last mentioned means in the proximity of the nozzle, a liquid supply tank, a chemical meter provided with means for delivering chemical to the liquid supply tank, and means for pneumatically operating said meter, said pneumatic operating means and said generator having a common source of air supply and a common control valve.

3. Sand blast apparatus comprising the combination with a generator and a nozzle, of a water pump, a chemical pump, means for the pneumatic operation of said pumps, means for delivering the effluent of the pumps to the sand blast in proximity to the nozzle, an air supply common to the generator and the means for pneumatic operation of the pumps, a water connection to the water pump, and valve means controlled by said air supply for opening said water connection to said pump when said air supply is effective to actuate the water pump.

4. Sand blast apparatus, comprising the combination with a manually controlled source of elastic fluid supply, a mixing nozzle provided with a main inlet and auxiliary atomizing inlets, a receiver for abrading material, a mixing chamber associated with the receiver and adapted to receive sand therefrom, manually controlled means for directing the elastic fluid to the nozzle either through the receiving and mixing chambers or through a by-pass, and means for delivering chemically charged liquid through the atomizing inlets of said nozzle, whereby said liquid may be utilized for coating particles of sand entrained by the elastic fluid delivered through said nozzle, and for charging the by-passed elastic fluid with rust resisting chemical material.

5. In a sand blasting apparatus provided with a sand container, an associated mixing chamber and a nozzle, the combination therewith of valved pipe connections adapted for delivery of an elastic fluid under pressure to the sand and mixing chamber, and means dependent upon elastic fluid delivery through said pipe connections for charging water with a rust resisting chemical and

jetting it into said nozzle in predetermined proportions to the film of elastic fluid passing therethrough.

6. In a sand blasting apparatus provided with a sand container, an associated mixing chamber and a nozzle, the combination therewith of valved pipe connections adapted for delivery of an elastic fluid under pressure to the sand and mixing chamber, means dependent upon elastic fluid delivery through said pipe connections for charging water with a rust resisting chemical and jetting it into said nozzle in predetermined proportions to the film of elastic fluid passing therethrough, and valved by-pass connections for delivering the elastic fluid to the nozzle and water supply means independently of delivery of sand from the sand container and the mixing chamber.

7. The combination with a pneumatically operated sand blasting apparatus having an air inlet pipe, an outlet pipe provided with an aspirating nozzle and an associated blast nozzle for delivery of air and sand to a surface to be cleaned, of pneumatically operable pumping mechanism adapted for delivery of chemically charged liquid to the aspirating nozzle, said pumping mechanism having power connection with the air inlet pipe, whereby the pumping mechanism may be automatically operated during sand blasting operation.

8. A combination as set forth in claim 7, in which the pumping mechanism has its outlet connected with an annular series of atomizing nozzles leading through the wall of the aspirating nozzle to the annular space about the sand blast, and adapted to atomize the liquid chemical preparatory to its exposure to the suction of the aspirating nozzle and mixture with the sand passing through such nozzle.

9. Sand blast apparatus, comprising the combination with a sand blasting generator, a mixing nozzle and a pipe connection between the generator and the nozzle, of means for metering and supplying to the mixing nozzle, under pressure, atomized liquid charged with rust resisting chemical material in predetermined quantities substantially equal to those required for coating the particles of sand generally with such material, whereby the surface to be cleaned may be coated with the chemical material simultaneously with the impact of the sand particles thereon.

10. A sand blasting process, consisting in generating a dry sand blast, metering, pumping and uniformly distributing quantities of liquid rust resisting chemical material to the particles of sand in particle coating proportions immediately prior to contact of the blast with the surface to be cleaned.

11. A sand blasting process, consisting in generating a dry sand blast, metering, pumping and atomizing quantities of liquid rust resisting chemicals into the sand blast in definitely predetermined proportions to the volume of the blast, and in quantities substantially equal to those required for coating the surface against which the blast is projected.

ARTHUR H. EPPLER.