



Allweld Mobile Sandblasting

"Specializing in Surface Preparation & Protective Coatings"

www.AllweldSandblasting.com

Since 1984

(604) 299-0932
1 (888) 599-0932

Oct. 17, 1939.

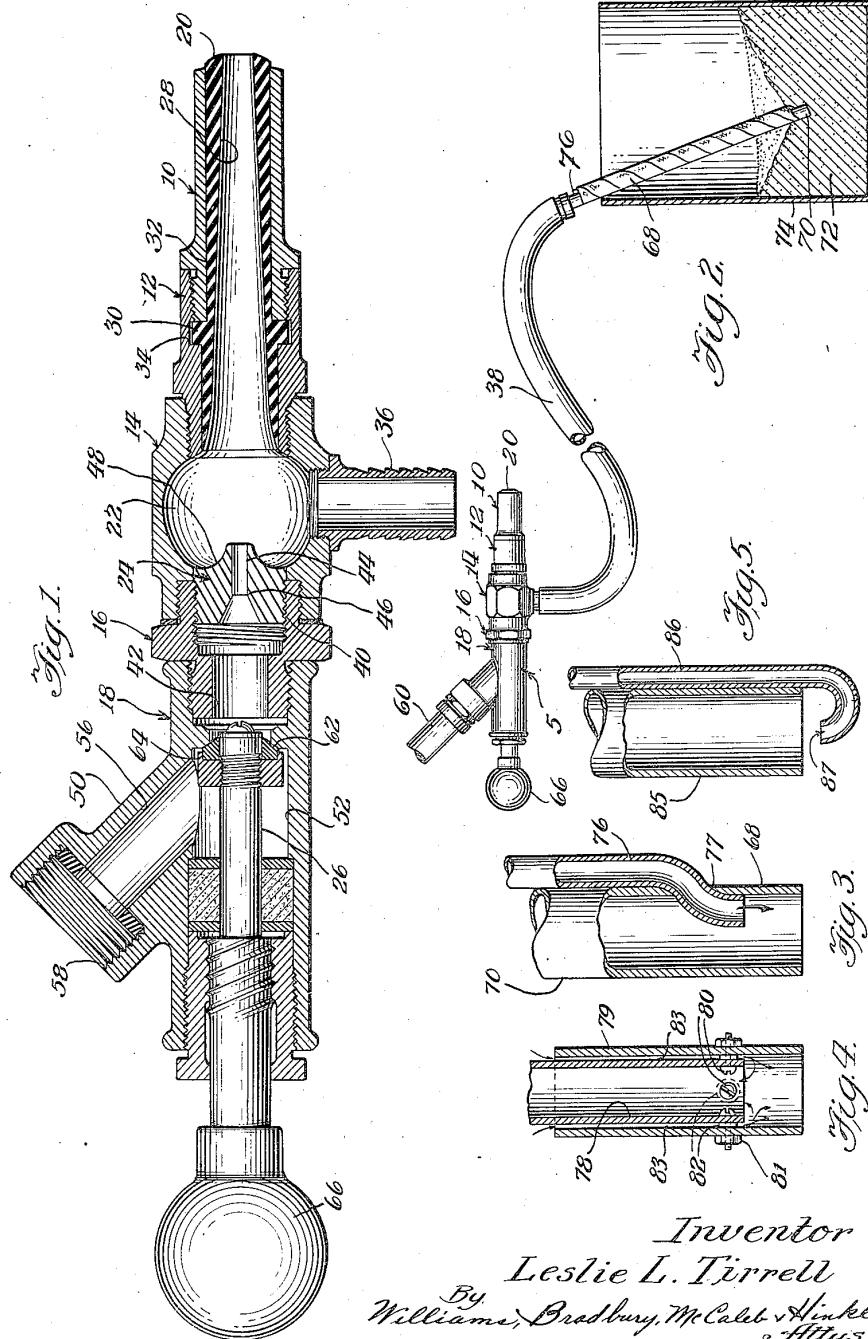
L. L. TIRRELL

2,176,577

SANDBLAST DEVICE

Filed April 3, 1937

2 Sheets-Sheet 1





Allweld Mobile Sandblasting

"Specializing in Surface Preparation & Protective Coatings"

www.AllweldSandblasting.com

Since 1984

(604) 299-0932
1 (888) 599-0932

Oct. 17, 1939.

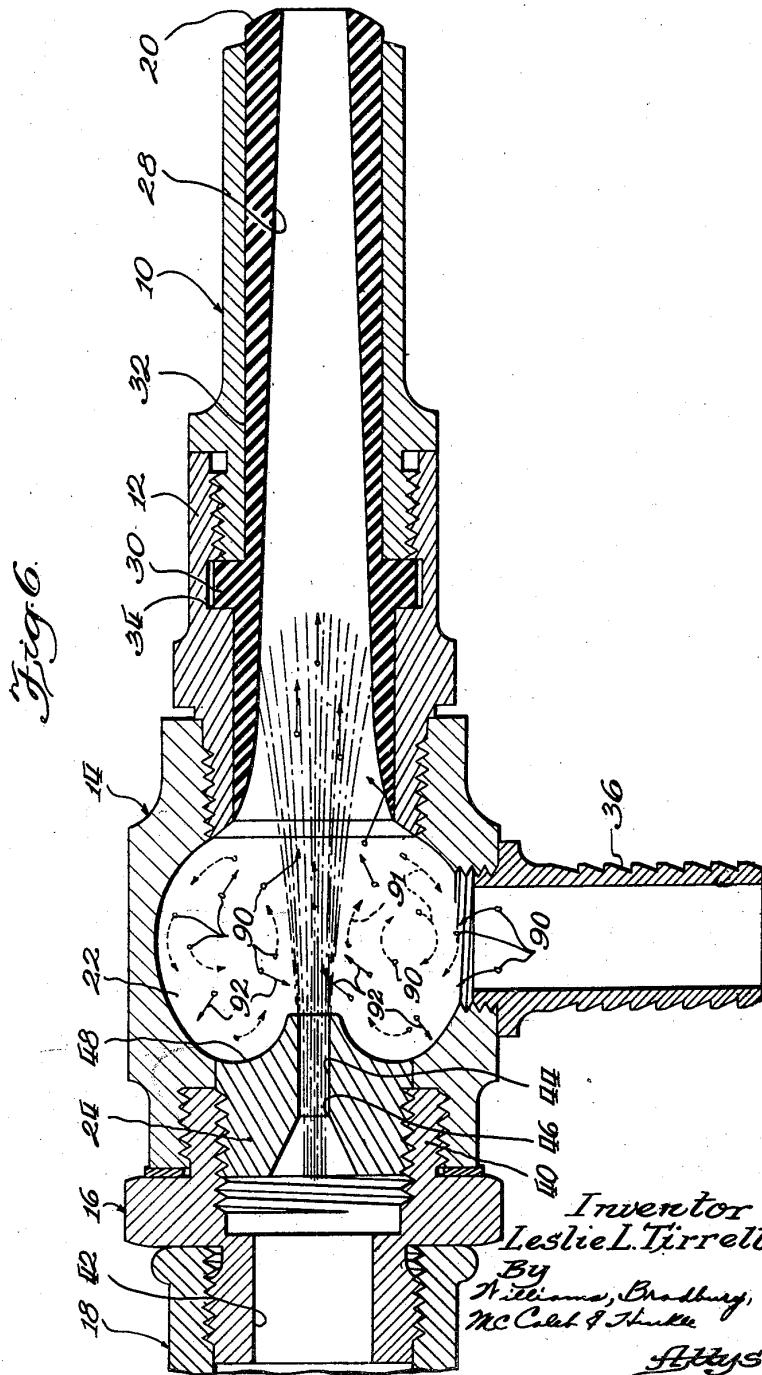
L. L. TIRRELL

2,176,577

SANDBLAST DEVICE

Filed April 3, 1937

2 Sheets-Sheet 2





Patented Oct. 17, 1939

2,176,577

UNITED STATES PATENT OFFICE

2,176,577

SANDBLAST DEVICE

Leslie L. Tirrell, Benton Harbor, Mich., assignor
to The Hydroblast Corporation, Chicago, Ill., a
corporation of Illinois

Application April 3, 1937, Serial No. 134,692

4 Claims. (Cl. 51—8)

This invention relates to improvements in sandblast guns and more particularly to a sandblast gun that is operated by hydraulic pressure.

In the art of cleaning and abrading, it has been customary to use steam or air as the motive power for projecting the abrasive from a sandblast gun. The use of water or other liquid, however, is more desirable than the use of steam or air since it costs less, prevents silicosis, effectively removes core sand from castings, washes back the used abrasive to a point where it can be collected and reemployed, avoids burning the surface being blasted; and provides better vision for the operator. Water or liquid, having higher surface tension and greater density than air or steam, also provides a more forceful and easily controlled stream. In the past, the use of water has generally been regarded as impractical, since a large amount of water has been required to project a relatively small amount of abrasive. This is because a stream of water projecting from one jet to another through a sand injection chamber in the gun is not easily penetrated by the abrasive particles. Consequently, only a small amount of abrasive is incorporated into the liquid stream.

The principal object of this invention is to provide a practical method for driving the abrasive particles into the liquid stream. A further object is to provide a method in which a small solid stream of water under high pressure can be employed to project a relatively large amount of abrasive. Other objects and advantages will appear hereinafter in this specification.

I have found that a very small substantially solid stream of water or other liquid when employed under sufficiently high pressure, can be used to project a relatively large amount of abrasive, provided the abrasive can be driven into the stream. This I accomplish by so proportioning and shaping the mixing chamber that the abrasive particles mixed with air are rotated at high velocity and are thereby driven into the liquid stream by the resulting centrifugal force. The air in this mixture becomes incorporated with the water stream and aids the entry of the abrasive particles thereto in a manner to be described.

For the purposes of illustration, I have shown one form of apparatus in which the method may be satisfactorily used. This apparatus is shown in the accompanying drawings, in which the various parts are always designated by the same numerals throughout the several views.

Fig. 1 is a longitudinal sectional view of a gun embodying this invention;

Fig. 2 is an elevation of the gun connected to a feeder in a sand bucket, the bucket being shown in section;

Fig. 3 is a partial sectional view of the sand feeder;

Fig. 4 is a partial sectional view of an alternative sand feeder; and

Fig. 5 is a partial sectional view of another alternative sand feeder.

Fig. 6 is a fragmentary sectional view of a portion of the gun shown in Fig. 1 and includes a representation of the liquid jet and abrasive particles.

In the drawings, the gun 5 consists of a tube made up of the axially aligned sections 10, 12, 14, 16 and 18. Within this tube are a nozzle 20, a chamber 22, a large nozzle 24, and a water valve 26.

The nozzle 20 is of substantially cylindrical section with a tapered axial hole 28 extending therethrough. This hole 28 is smallest at the forward end and increases in size gradually as it extends rearwardly until it reaches a point near its rear end from where it flares outwardly 25 to the periphery of the nozzle. This nozzle 20 has an external annular ridge 30 that is clamped between the sections 10 and 12 of the nozzle casing when they are screwed together.

The nozzle casing consists of the two sections 10 and 12 which when fitted together form a sleeve with an axial hole 32 to fit the nozzle 20 and an annular groove 34 to hold the ridge 30, so that the nozzle 20 will not be forced from the gun by the projected abrasive and water mixture.

Behind the nozzle 20 is the section 14 containing an annular recess 22 that is largest at a point near its center and is rounded inwardly toward both ends, so that it is of less diameter at its ends than in the center.

Into the lower side of this chamber 22 the abrasive is brought through the nipple 36, which is connected to the sand hose 38.

Fitted to the rearward side of the section 14 is the bushing 16 provided with an internal thread 40 into which is fitted the rear nozzle 24. Extending rearwardly through the bushing 16 is a water passage 42.

The rear nozzle 24 has a cylindrical opening 44 therethrough which cones outwardly and rearwardly from a point 46 near its center. The external forward face 48 of the nozzle 24 substantially continues the curve of the chamber 22, so that the inside surface of the chamber 22 plus 56



Allweld Mobile Sandblasting

"Specializing in Surface Preparation & Protective Coatings"

www.AllweldSandblasting.com

Since 1984

(604) 299-0932
1 (888) 599-0932

2

8,176,577

the contiguous surface 48 of the nozzle 24 forms a modified toroidal surface.

The bushing 16 is joined at its rearward end to section 18 which contains a rearwardly extending recess 52 containing a valve 26 which is of well known construction; extending obliquely outwardly from the recess 52 is a water inlet passage 56 provided with a thread 58 at its outward end for attaching a water hose 60. Near the forward end of the section 18 is a valve seat 62 against which is forced a valve washer 64 when a knob 66 is turned to the right, thereby cutting off the flow of water through the gun.

The sand hose 38 is connected to a feeder 68 which consists of a sand pipe 70 joined to the hose and extending for an inch or two into some sand 72 in a barrel 74. Fastened to this pipe 70 is a tube 76 which is open to the air at the top and extends through an opening 77 in the sand pipe 70 at a point near its lower end. The lower end of the tube 76 is approximately one-half inch from the bottom of the pipe 70.

Since in operation the part of the tube 76 that is inside the pipe 70 is cut away in time by the abrasive particles, I prefer to join the two together by clamps or friction tape, so that the tube 76 can be easily removed from the pipe 70 and a new tube substituted.

In Figs. 4 and 5 are shown two alternate feeders 30 that may be substituted for the above described feeder 68. Both of these alternate forms have a sand pipe connected to the hose 38 to supply sand thereto, and differ from the feeder 68 only in the manner in which air is mixed with the sand

35 particles. In Fig. 4 a sand pipe 78 is surrounded by a sleeve 79, the inside diameter of which is somewhat larger than the outside diameter of the pipe 78. The sleeve 79 projects about one-half inch below the end of the pipe 78 and is secured in spaced relation thereto by means of bolts 80, nuts 81 and spacing washers 82, thus providing an annular space 83 for the passage of air.

In Fig. 5 a sand pipe 85 is provided with a tube 45 86 open to the atmosphere at the top and which extends downwardly along the pipe 85 and at the end thereof is curved inwardly and upwardly so that the opening 87 of the tube faces upwardly and is about one-quarter inch below the surface of the pipe.

50 When it is desired to operate the apparatus, the gun is connected to a relatively high pressure water supply, in the nature of 700 pounds per square inch, and to the sand hose 38. The feeder 68 is thrust into the sand 72 about an inch or so.

55 When the valve 26 is opened by turning the knob 66, the water flows through the chamber 56, around the valve 26, and into the passage 42. As illustrated in Fig. 6, the water passes through the opening 44 in the nozzle 24 and comes out as a jet moving at great velocity. This jet of water passes through the abrasive injection chamber 22 and the front nozzle opening 28.

60 Since the nozzle opening 44 is cylindrical, the water passing therethrough will encounter considerably more friction along the surface than in the center. This friction causes the surface of the jet to be retarded with respect to the center, thereby causing the jet of water to expand as it 65 passes through the chamber 22, and produce a depression therein and within the sand hose 38. Consequently air will flow downwardly through the tube 76 and into the sand pipe 70. This jet of air strikes the sand at the lower end of the 70 pipe 70 and agitates it. The air then flows up

inside of the pipe 70 to the gun, carrying the sand along in suspension. Because of the resistance offered to the flow of air by the tube 76 and by the weight of the sand particles in the pipe 70 and hose 38, the air enters the chamber 22 in a rarefied condition.

If the sand feeder shown in Fig. 4 is used, the operation is similar to that described above, excepting that here the air flows downwardly through the annular space 83 instead of through the tube 76.

When the construction shown in Fig. 5 is used, the open end of the pipe is forced into the sand bucket. Air under the influence of suction in the mixing chamber and sand pipe flows through the tube 86, passes from the opening 87 up through the sand into the pipe 85, thereby carrying the particles along in suspension.

Of the three sand feeders described, the one shown in Fig. 5 will deliver the largest amount 20 of sand and is to be preferred if large quantities are desired, or if the sand must be lifted a great distance.

As illustrated in Fig. 6, when the sand and air strike the water stream in the gun, the particles 25 such as 90 are driven forwardly, then outwardly, then rearwardly, and then inwardly, as indicated by dotted arrows 91. This is, the particles travel at a high speed which is dependent upon or proportional to the jet speed and in smoke-ring like 30 manner. The centrifugal force produced by this movement of the particles is in substantially the direction illustrated by the arrows such as 92 and drives the sand particles into the liquid stream.

35 Since these abrasive particles are moving much more slowly than the water stream at the instant of impact, their inertia causes them to resist the accelerating force of the stream. Consequently, as each particle strikes the jet of water and is accelerated up to jet velocity, it causes a partial vacuum to be formed on the side of the particle toward the front of the gun. The many small vacuum spaces thus formed are in turn filled by the rarefied air which has been brought into the 40 chamber 22 along with the sand. As the stream of water continues through the chamber 22 these pockets or bubbles of rarefied air provide an easily penetrable surface for additional sand particles, and likewise, sand drawn into the nozzle 50 45 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 1185 1190 1195 1200 1205 1210 1215 1220 1225 1230 1235 1240 1245 1250 1255 1260 1265 1270 1275 1280 1285 1290 1295 1300 1305 1310 1315 1320 1325 1330 1335 1340 1345 1350 1355 1360 1365 1370 1375 1380 1385 1390 1395 1400 1405 1410 1415 1420 1425 1430 1435 1440 1445 1450 1455 1460 1465 1470 1475 1480 1485 1490 1495 1500 1505 1510 1515 1520 1525 1530 1535 1540 1545 1550 1555 1560 1565 1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1670 1675 1680 1685 1690 1695 1700 1705 1710 1715 1720 1725 1730 1735 1740 1745 1750 1755 1760 1765 1770 1775 1780 1785 1790 1795 1800 1805 1810 1815 1820 1825 1830 1835 1840 1845 1850 1855 1860 1865 1870 1875 1880 1885 1890 1895 1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070 2075 2080 2085 2090 2095 2100 2105 2110 2115 2120 2125 2130 2135 2140 2145 2150 2155 2160 2165 2170 2175 2180 2185 2190 2195 2200 2205 2210 2215 2220 2225 2230 2235 2240 2245 2250 2255 2260 2265 2270 2275 2280 2285 2290 2295 2300 2305 2310 2315 2320 2325 2330 2335 2340 2345 2350 2355 2360 2365 2370 2375 2380 2385 2390 2395 2400 2405 2410 2415 2420 2425 2430 2435 2440 2445 2450 2455 2460 2465 2470 2475 2480 2485 2490 2495 2500 2505 2510 2515 2520 2525 2530 2535 2540 2545 2550 2555 2560 2565 2570 2575 2580 2585 2590 2595 2600 2605 2610 2615 2620 2625 2630 2635 2640 2645 2650 2655 2660 2665 2670 2675 2680 2685 2690 2695 2700 2705 2710 2715 2720 2725 2730 2735 2740 2745 2750 2755 2760 2765 2770 2775 2780 2785 2790 2795 2800 2805 2810 2815 2820 2825 2830 2835 2840 2845 2850 2855 2860 2865 2870 2875 2880 2885 2890 2895 2900 2905 2910 2915 2920 2925 2930 2935 2940 2945 2950 2955 2960 2965 2970 2975 2980 2985 2990 2995 3000 3005 3010 3015 3020 3025 3030 3035 3040 3045 3050 3055 3060 3065 3070 3075 3080 3085 3090 3095 3100 3105 3110 3115 3120 3125 3130 3135 3140 3145 3150 3155 3160 3165 3170 3175 3180 3185 3190 3195 3200 3205 3210 3215 3220 3225 3230 3235 3240 3245 3250 3255 3260 3265 3270 3275 3280 3285 3290 3295 3300 3305 3310 3315 3320 3325 3330 3335 3340 3345 3350 3355 3360 3365 3370 3375 3380 3385 3390 3395 3400 3405 3410 3415 3420 3425 3430 3435 3440 3445 3450 3455 3460 3465 3470 3475 3480 3485 3490 3495 3500 3505 3510 3515 3520 3525 3530 3535 3540 3545 3550 3555 3560 3565 3570 3575 3580 3585 3590 3595 3600 3605 3610 3615 3620 3625 3630 3635 3640 3645 3650 3655 3660 3665 3670 3675 3680 3685 3690 3695 3700 3705 3710 3715 3720 3725 3730 3735 3740 3745 3750 3755 3760 3765 3770 3775 3780 3785 3790 3795 3800 3805 3810 3815 3820 3825 3830 3835 3840 3845 3850 3855 3860 3865 3870 3875 3880 3885 3890 3895 3900 3905 3910 3915 3920 3925 3930 3935 3940 3945 3950 3955 3960 3965 3970 3975 3980 3985 3990 3995 4000 4005 4010 4015 4020 4025 4030 4035 4040 4045 4050 4055 4060 4065 4070 4075 4080 4085 4090 4095 4100 4105 4110 4115 4120 4125 4130 4135 4140 4145 4150 4155 4160 4165 4170 4175 4180 4185 4190 4195 4200 4205 4210 4215 4220 4225 4230 4235 4240 4245 4250 4255 4260 4265 4270 4275 4280 4285 4290 4295 4300 4305 4310 4315 4320 4325 4330 4335 4340 4345 4350 4355 4360 4365 4370 4375 4380 4385 4390 4395 4400 4405 4410 4415 4420 4425 4430 4435 4440 4445 4450 4455 4460 4465 4470 4475 4480 4485 4490 4495 4500 4505 4510 4515 4520 4525 4530 4535 4540 4545 4550 4555 4560 4565 4570 4575 4580 4585 4590 4595 4600 4605 4610 4615 4620 4625 4630 4635 4640 4645 4650 4655 4660 4665 4670 4675 4680 4685 4690 4695 4700 4705 4710 4715 4720 4725 4730 4735 4740 4745 4750 4755 4760 4765 4770 4775 4780 4785 4790 4795 4800 4805 4810 4815 4820 4825 4830 4835 4840 4845 4850 4855 4860 4865 4870 4875 4880 4885 4890 4895 4900 4905 4910 4915 4920 4925 4930 4935 4940 4945 4950 4955 4960 4965 4970 4975 4980 4985 4990 4995 5000 5005 5010 5015 5020 5025 5030 5035 5040 5045 5050 5055 5060 5065 5070 5075 5080 5085 5090 5095 5100 5105 5110 5115 5120 5125 5130 5135 5140 5145 5150 5155 5160 5165 5170 5175 5180 5185 5190 5195 5200 5205 5210 5215 5220 5225 5230 5235 5240 5245 5250 5255 5260 5265 5270 5275 5280 5285 5290 5295 5300 5305 5310 5315 5320 5325 5330 5335 5340 5345 5350 5355 5360 5365 5370 5375 5380 5385 5390 5395 5400 5405 5410 5415 5420 5425 5430 5435 5440 5445 5450 5455 5460 5465 5470 5475 5480 5485 5490 5495 5500 5505 5510 5515 5520 5525 5530 5535 5540 5545 5550 5555 5560 5565 5570 5575 5580 5585 5590 5595 5600 5605 5610 5615 5620 5625 5630 5635 5640 5645 5650 5655 5660 5665 5670 5675 5680 5685 5690 5695 5700 5705 5710 5715 5720 5725 5730 5735 5740 5745 5750 5755 5760 5765 5770 5775 5780 5785 5790 5795 5800 5805 5810 5815 5820 5825 5830 5835 5840 5845 5850 5855 5860 5865 5870 5875 5880 5885 5890 5895 5900 5905 5910 5915 5920 5925 5930 5935 5940 5945 5950 5955 5960 5965 5970 5975 5980 5985 5990 5995 6000 6005 6010 6015 6020 6025 6030 6035 6040 6045 6050 6055 6060 6065 6070 6075 6080 6085 6090 6095 6100 6105 6110 6115 6120 6125 6130 6135 6140 6145 6150 6155 6160 6165 6170 6175 6180 6185 6190 6195 6200 6205 6210 6215 6220 6225 6230 6235 6240 6245 6250 6255 6260 6265 6270 6275 6280 6285 6290 6295 6300 6305 6310 6315 6320 6325 6330 6335 6340 6345 6350 6355 6360 6365 6370 6375 6380 6385 6390 6395 6400 6405 6410 6415 6420 6425 6430 6435 6440 6445 6450 6455 6460 6465 6470 6475 6480 6485 6490 6495 6500 6505 6510 6515 6520 6525 6530 6535 6540 6545 6550 6555 6560 6565 6570 6575 6580 6585 6590 6595 6600 6605 6610 6615 6620 6625 6630 6635 6640 6645 6650 6655 6660 6665 6670 6675 6680 6685 6690 6695 6700 6705 6710 6715 6720 6725 6730 6735 6740 6745 6750 6755 6760 6765 6770 6775 6780 6785 6790 6795 6800 6805 6810 6815 6820 6825 6830 6835 6840 6845 6850 6855 6860 6865 6870 6875 6880 6885 6890 6895 6900 6905 6910 6915 6920 6925 6930 6935 6940 6945 6950 6955 6960 6965 6970 6975 6980 6985 6990 6995 7000 7005 7010 7015 7020 7025 7030 7035 7040 7045 7050 7055 7060 7065 7070 7075 7080 7085 7090 7095 7100 7105 7110 7115 7120 7125 7130 7135 7140 7145 7150 7155 7160 7165 7170 7175 7180 7185 7190 7195 7200 7205 7210 7215 7220 7225 7230 7235 7240 7245 7250 7255 7260 7265 7270 7275 7280 7285 7290 7295 7300 7305 7310 7315 7320 7325 7330 7335 7340 7345 7350 7355 7360 7365 7370 7375 7380 7385 7390 7395 7400 7405 7410 7415 7420 7425 7430 7435 7440 7445 7450 7455 7460 7465 7470 7475 7480 7485 7490 7495 7500 7505 7510 7515 7520 7525 7530 7535 7540 7545 7550 7555 7560 7565 7570 7575 7580 7585 7590 7595 7600 7605 7610 7615 7620 7625 7630 7635 7640 7645 7650 7655 7660 7665 7670 7675 7680 7685 7690 7695 7700 7705 7710 7715 7720 7725 7730 7735 7740 7745 7750 7755 7760 7765 7770 7775 7780 7785 7790 7795 7800 7805 7810 7815 7820 7825 7830 7835 7840 7845 7850 7855 7860 7865 7870 7875 7880 7885 7890 7895 7900 7905 7910 7915 7920 7925 7930 7935 7940 7945 7950 7955 7960 7965 7970 7975 7980 7985 7990 7995 8000 8005 8010 8015 8020 8025 8030 8035 8040 8045 8050 8055 8060 8065 8070 8075 8080 8085 8090 8095 8100 8105 8110 8115 8120 8125 8130 8135 8140 8145 8150 8155 8160 8165 8170 8175 8180 8185 8190 8195 8200 8205 8210 8215 8220 8225 8230 8235 8240 8245 8250 8255 8260 8265 8270 8275 8280 8285 8290 8295 8300 8305 8310 8315 8320 8325 8330 8335 8340 8345 8350 8355 8360 8365 8370 8375 8380 8385 8390 8395 8400 8405 8410 8415 8420 8425 8430 8435 8440 8445 8450 8455 8460 8465 8470 8475 8480 8485 8490 8495 8500 8505 8510 8515 8520 8525 8530 8535 8540 8545 8550 8555 8560 8565 8570 8575 8580 8585 8590 8595 8600 8605 8610 8615 8620 8625 8630 8635 8640 8645 8650 8655 8660 8665 8670 8675 8680 8685 8690 8695 8700 8705 8710 8715 8720 8725 8730 8735 8740 8745 8750 8755 8760 8765 8770 8775 8780 8785 8790 8795 8800 8805 8810 8815 8820 8825 8830 8835 8840 8845 8850 8855 8860 8865 8870 8875 8880 8885 8890 8895 8900 8905 8910 8915 8920 8925 8930 8935 8940 8945 8950 8955 8960 8965 8970 8975 8980 8985 8990 8995 9000 9005 9010 9015 9020 9025 9030 9035 9040 9045 9050 9055 9060 9065 9070 9075 9080 9085 9090 9095 9100 9105 9110 9115 9120 9125 9130 9135 9140 9145 9150 9155 9160 9165 9170 9175 9180 9185 9190 9195 9200 9205 9210 9215 9220 9225 9230 9235 9240 9245 9250 9255 9260 9265 9270 9275 9280 9285 9290 9295 9300 9305 9310 9315 9320 9325 9330 9335 9340 9345 9350 9355 9360 9365 9370 9



Allweld Mobile Sandblasting

"Specializing in Surface Preparation & Protective Coatings"

www.AllweldSandblasting.com

Since 1984

(604) 299-0932
1 (888) 599-0932

2,176,577

3

those in which particles travel in a smoke-ring. The centrifugal force acting upon the sand particles by virtue of their movement throws them into the stream. The stream also becomes penetrable because of the rarefied air which is also taken in with the sand, as described above, to form a homogeneous mixture of sand, water, and rarefied air in which a small amount of water carries a suitably large quantity of abrasive. This mixture when projected is highly efficient in cleaning and abrading surfaces both because of its abrasive effect and because of the washing properties of the water.

While in the foregoing specification, I have given a preferred embodiment of my device and suggested certain pressures as desirable, it will be understood that the invention may be employed under various conditions with changes in pressures to accommodate the process to different classes of work. Also, it will be understood that the dimensions suggested are for the purpose of illustration only, and wide variations can be made therefore while utilizing the invention.

The foregoing detailed description has been given for the purpose of clearness of understanding only, and no unnecessary limitations should be understood therefrom.

Having described my invention, what I claim as new and useful and desire to protect by Letters Patent is:

1. A method for blast-treating a surface, comprising: passing a non-compressible liquid in a single confined stream and under a high pressure through a loading zone and thence to the surface to be blasted, supplying granular abrasive by suction to said zone, transferring said granular abrasive from said zone into an intimate mixture with said stream, the transference be-

ing accomplished by driving the granular abrasive into said stream by the centrifugal force developed by rapidly moving said granular abrasive in vortex rings within the loading zone by the force of said confined stream.

5

2. The method of admixing abrasive with a rapidly moving liquid stream comprising the steps of projecting the liquid stream, mixing abrasive particles with air, whirling the mixed abrasive particles and air in a space surrounding the projected stream to drive the abrasive particles and air into the liquid stream by centrifugal force to form a porous stream, and collecting more abrasive particles in the open spaces in the porous stream.

15

3. The method of projecting granular abrasive comprising the steps of mixing granular abrasive with air, projecting water as a high velocity jet, whirling the mixture of granular abrasive and air by the force of the jet in planes passing through the axis of the jet in a confined space surrounding said jet and at sufficient speed that the granular abrasive is thrown into the jet by centrifugal force, and reprojecting the water and entrained granular abrasive as a second high velocity jet.

20

4. The method of projecting granular abrasive comprising the steps of projecting a high velocity jet of fluid carrying medium through a confined space, introducing a mixture of granular abrasive and air into the said confined space, whirling the mixture of granular abrasive and air within the confined space by the force of the jet and at a speed dependent upon the speed of the jet, so that centrifugal force throws the granular abrasive into the jet, and reprojecting the fluid carrying medium and entrained granular abrasive as a second high velocity jet.

30

LESLIE L. TIRRELL.

35