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(54) Title: STRIPE REMOVAL SYSTEM

(57) Abstract: A system for removing paint and other coatings from hard surfaces is mounted on a truck for over-the-road travel. The truck bed carries a high power vacuum pump, a self propelled tractor with an attached blast head, a liquid reservoir, a sump or vacuum tank, and a ramp for loading the tractor. The reservoir is connected to a low pressure pump that transfers water to the high pressure pump. The high pressure pump is connected to the blast head by a high pressure hose. A vacuum hose is connected to the sump which has an internal enclosure for separating the waste materials from the liquid for easy dumping of semi dried materials.



WO 2006/014352 A2

1                                   **STRIPE REMOVAL SYSTEM**

2       **Field of the invention**

3               This invention relates to the field of high pressure  
4       water cleaning devices for highways, runways, parking decks,  
5       and other hard surfaces.

6       Prior art Background

7               The use of paint stripes on road surfaces is the  
8       accepted method to indicate vehicle lanes, crossing lanes,  
9       parking areas and numerous other indicators. Various  
10       pavement marking techniques are known, including the use of  
11       traffic paint, thermoplastic, epoxy paint and preformed  
12       tapes. Common pavement surfaces are asphalt and concrete.  
13       Most pavement marking systems are intended to be as durable  
14       and permanent as possible, and resistant to weathering and  
15       wear from traffic.

16       The removal of such striping is typically required when the  
17       road is to be resurfaced or if the indication is to be  
18       changed. The removal of such stripes is typically  
19       performed by use of abrasive wheels, grinding teeth, or the  
20       blasting of abrasive particles against the material to be  
21       removed. The use of these carbide teeth and grinding wheels  
22       results in an undesirable trench or groove in the road.

23       For example, paint, when used for roadway marking,  
24       penetrates into the pavement, perhaps 1/8 -3/8 inch, so that  
25       mere surface removal of the paint is not sufficient to  
26       remove the marking. For example, a pavement marking removal  
27       technique that uses abrasive wheels or teeth can create  
28       excessive heat which may be suitable for removing painted  
29       markings but can melt thermoplastic materials causing  
30       equipment to gum up, by reconstituting the thermoplastic.

31       Current pavement marking removal machines typically  
32       employ various forms of cutting devices to remove the  
33       marking material, as well as a portion of the underlying  
34       layer of pavement material, for example, 1/8 - 3/8 inch, in  
35       order to effectively remove painted lines, including paint

1 which has penetrated the porous pavement. A common type of  
2 machine employed for removing pavement marking is known as  
3 a "Road Pro" grinder manufactured by Dickson Industries,  
4 Inc., in Dickson U.S. Pat. No. 5,236,278. This type of  
5 machine employs parallel passive shafts that extend between  
6 circular rotating end plates. Hardened steel star wheels are  
7 carried on the parallel passive shafts, and these star  
8 wheels strike and abrade the pavement surface.

9 Another approach to pavement marking removal is the use  
10 of diamond saw blades arranged to make a dado cut. Still  
11 other

12 types of machines use grinders or shot blast as described in  
13 Patent Registrations 4,753,052; 4,376,358; 3,900,969;  
14 4,336,671; 3,977,128 and 4,377,924.

15 NLB Corporation markets a high pressure water jet  
16 system for removing paint from pavement under the name  
17 "StarJet". The water jet system includes a blast head frame  
18 mounted on an attachment to the front bumper of a prime-  
19 mover truck. Casters support the frame for movement over  
20 the pavement and the path of the blast head is controlled by  
21 the driver steering the truck. Because of the position of  
22 the driver and the cab body of the prime-mover, it is  
23 difficult to see the blast head's position with regard to  
24 the stripes on the pavement. Any vision at all requires the  
25 driver to lean out of the driver's side window resulting in  
26 fatigue and other non ergonomically efficient factors.  
27 Positioning the head to the passenger side is performed  
28 manually with some difficulty and greatly complicating the  
29 driver's ability to view the blast path. The driver must  
30 now position himself in an almost upright standing position.  
31 Further, due to the length of the extension holding the  
32 blast head, the angular off-set, and the swivel of the  
33 casters, the movement of the wheel of the truck is not  
34 directly related to the path of the blast head.

1           NLB Corporation also has another system marketed under  
2 the mark "StripeJet", that is a self propelled tractor with  
3 a blast head on the front of the tractor. The blast head  
4 has a shroud and high pressure inlet with a vacuum recovery.

5           Another stripe removal system is marketed by the  
6 Blasters Corporation which is mounted on a truck similar to  
7 the "StarJet" device. Another model appears to be a self-  
8 powered four wheeled tractor, similar to a grass mower,  
9 which supports a driver and is connected to the prime-mover  
10 by high pressure lines for delivery of high pressure water  
11 to a blast head. The blast head is on the front of the  
12 tractor.

13           The problem with the prior art is the inability to  
14 place an operator close to the material removal site by use  
15 of a device that has over-all dimensions that allow for easy  
16 transfer sideways on a truck or trailer having a width less  
17 than 8' 6".

#### 18 19 **SUMMARY OF THE PRESENT INVENTION**

20           Briefly, disclosed is a cleaning system for removing  
21 coatings from a hard surface by high pressure liquid. The  
22 system employs a liquid reservoir connected to a high  
23 pressure pump for directing ultra high pressure water  
24 through a blast head mounted on a self-propelled mobile  
25 frame. The mobile frame is a self-propelled tractor wherein  
26 the blast head and tractor are of a size for removably  
27 docking transversely on a bed of said truck. The cleaning  
28 system is mounted on the truck or pulled behind the truck on  
29 a trailer. The truck is then tethered to the tractor during  
30 operation. The truck bed includes a ramp sized to support  
31 the tractor for docking and transport.

32           It is an object of this invention to provide a vacuum  
33 recovery truck mounted stripe removal system having a  
34 compact unit for safe, fast over-the-road travel to job  
35 sites.

1           It is another object of this invention to provide a  
2           unit that is quickly deployed, with hoses not having to be  
3           disconnected, and in operation at the job site.

4           It is a further object of this invention to provide a  
5           tractor mounted blast head that is hydraulically articulated  
6           from left to right and at the same time when moved all the  
7           way to the right this also brings the blast head closer to  
8           the wheels of the tractor thereby reducing its overall  
9           dimension to under 8' 6" when in its upright and locked  
10          position to reduce the over-all dimensions of the blast head  
11          for over-the-road transportation.

12          It is still another object of this invention to provide  
13          a blast head that is articulated to swing horizontally  
14          independently of the tractor path for more flexibility in  
15          coverage.

16          It is a further object of this invention to provide a  
17          high pressure water jet for removal of paint or other  
18          coverings and a vacuum recovery system for the water and  
19          debris being generated.

20          It is yet another object of this invention to provide  
21          a collection/filter receptacle for the removed materials for  
22          ease of disposal and the release of filtered wastewater.  
23          This allows an operator to easily regain all of the  
24          available capacity not occupied by paint chips or road  
25          debris of the vacuum chamber by simply releasing the dump  
26          valve. All of the remaining debris is retained until such  
27          time as the vacuum chamber is completely full of actual  
28          debris. The amount of capacity able to be regained will be  
29          continually diminished as the vacuum tank fills with debris  
30          and will eventually reach a point of inefficiency at which  
31          point it must be dumped. When the material is dumped, it is  
32          dumping semi dried, dewatered debris in which the wastewater  
33          is not mixed with the debris.

34          Other objectives and advantages of this invention will  
35          become apparent from the following description taken in

1 conjunction with the accompanying drawings wherein are set  
2 forth, by way of illustration and example, certain  
3 embodiments of this invention. The drawings constitute a  
4 part of this specification and include exemplary embodiments  
5 of the present invention and illustrate various objects and  
6 features thereof.

7

#### 8 **BRIEF DESCRIPTION OF THE DRAWINGS**

9 While the novel features of the invention are set forth  
10 with particularity in the appended claims, the invention,  
11 both as to organization and content, will be better  
12 understood and appreciated from the following detailed  
13 description, taken in conjunction with the drawings, in  
14 which:

15 Fig. 1 is a side view of the stripe removal system;

16 Fig. 2 is a perspective of the stripe removal system  
17 with blast head deployed;

18 Fig. 3 is a front view of the blast head and tractor;

19 Fig. 4 is perspective of the blast head link;

20 Fig. 5 is a side view of the tractor with blast head  
21 stowed;

22 Fig. 6 is a side view of the liquid reservoir and sump;  
23 and

24 Fig. 7 is a perspective of the sump and waste removal  
25 system.

26

27

1     **DETAILED DESCRIPTION OF THE INVENTION**

2           The paint removal system 10, shown in Fig. 1, includes  
3     a prime-mover truck 11 and a trailer 12. The truck has a  
4     forward cab-over 18 for the driving controls and operator.  
5     Mounted on the bed 12 of the truck is the water reservoir  
6     13 and the sump 14 or vacuum chamber. The reservoir and  
7     sump are interconnected by a strategically positioned duct  
8     for continuous dumping of filtered wastewater when operating  
9     from a fixed position where liquid is supplied to the high  
10    pressure pump by a means other than the reservoir 13.

11          The sump 14 is positioned on the rear end of the bed  
12    12. The rear portion 19 of the bed is pivotally mounted on  
13    the truck frame and hydraulically powered to move in the  
14    vertical plane permitting dumping of the contents of the  
15    sump 14. The sump 14 is connected to the vacuum pump 15 by  
16    hose 16. The intake of a high power vacuum pump capable of  
17    approximately 1100 CFM (cubic feet per minute) is connected  
18    to the vacuum tank. The vacuum tank and pump are also  
19    mounted on the bed of the prime-mover 11.

20          A ramp 19 is hinged to the edge of the bed 12 between  
21    the vacuum pump 15 and the cab 18. The ramp can be lowered  
22    to provide a pathway for the self propelled tractor 20. As  
23    shown, the ramp 19 is in the stowed or traveling position  
24    for highway transport. When the ramp is unfolded it is  
25    approximately 9 feet in length.

26          The trailer 12 is removably attached to the prime-mover  
27    through a conventional trailer hitch 21. Mounted on the bed  
28    22 of the trailer is a high pressure fluid pump greater than  
29    25,000 - 40,000 psi and from 2-15 gallons per minute. A  
30    high pressure hose connects the pump with the blast head  
31    during operations.

32          In Fig. 2 the mobile tractor 20 is illustrated in the  
33    normal operations position. The tractor is similar to a  
34    riding mower with a small engine self propelling the  
35    tractor. The blast head 23 has at least one and up to

1 sixteen high pressure nozzles delivering high pressure fluid  
2 to the surface to be cleaned. The high pressure nozzle is  
3 carried on a chassis 24 mounted on casters 25. A shroud 27  
4 descends from the chassis and surrounds the high pressure  
5 nozzle. The blast head is connected to the high pressure  
6 hose by line 26 and the shroud 27 is connected to the sump  
7 by waste removal hose 28. The high pressure hose 26 and the  
8 vacuum hose 28 is supported by a swinging boom 29 which is  
9 mounted on the prime mover 11 shown in Figure 1 to provide  
10 freedom of movement for the tractor and to prevent tangling  
11 or running over of the hoses by the prime mover.

12 As shown in Figs. 3-5, the blast head 23 is connected  
13 to the tractor 20 by an articulated link 31 which is capable  
14 of horizontal movement, as shown in Figs. 3 and 4, and  
15 vertical movement, as shown in Fig. 5. A bar 32 is attached  
16 to the tractor frame by rods 33 and 34. The bar 32 is  
17 located between the front wheels of the tractor. The  
18 horizontal swinging movement of the link results in a  
19 widened path of the high pressure nozzle to adjust for  
20 different widths or patterns of striping of the surface  
21 being cleaned and deviations in direction of the tractor.  
22 The horizontal movement is powered by the hydraulic cylinder  
23 35 connected to bar 32 which may be controlled by the  
24 operator moving a joy stick on the tractor. As the  
25 hydraulic piston 36, connected to the trailing arm 37, arm  
26 37 and 38 move, with the trailing arms rotating about pins  
27 39 and 40 attached by brackets 41 and 42 on bar 32.

28 The forward end of the articulated link 31 has a plate  
29 43 connected to the forward ends of trailing arms 37 and 38.  
30 The arms 37 and 38 are rotatably connected to the plate by  
31 brackets 41' and 42' holding pins 39' and 40', respectively.  
32 The forward arms 44 and 45 are rotatably connected to the  
33 plate 43 to rotate vertically. Pins 46 and 47 extend  
34 horizontally through brackets 48 and 49. Another hydraulic  
35 cylinder 50 is connected to the plate 43 and the piston 51



1 is connected to the forward end of the arm 44. As the  
2 piston 51 moves, the distance between the surface to be  
3 cleaned and the blast head 23 changes. The vertical  
4 movement permits elevation changes to accommodate the  
5 contours of the surface. Further, the blast head 23 may be  
6 raised to the vertical position and then manually flipped up  
7 and back reducing the overall length to permit the tractor  
8 20 and blast head 23 to be stowed on a truck bed sideways  
9 consuming a space of less than 8' 6" for highway travel,  
10 shown in Fig. 5. The forward ends of the arms 44 and 45 are  
11 attached by pins 52 and 53 to brackets 54 and 55 to prevent  
12 binding as the arms are manipulated. The brackets are  
13 mounted on blast head attachment plate 56.

14 A blast head attachment plate 56 is removably connected  
15 to the chassis 24 of the blast head 23 to provide support  
16 and control of the blast head from the tractor through the  
17 link 31.

18 The liquid reservoir 13 and the sump 14 are shown in  
19 Fig. 6. As illustrated, the liquid reservoir and vacuum  
20 chamber have a common enclosure with an internal partition  
21 dividing them. The sump 14 has an inlet 57 for connection  
22 by hose 28 to the vacuum shroud 27. An outlet 58 is  
23 connected to the vacuum pup hose 16. The liquid reservoir  
24 has a hatch 60 for inspecting and cleaning the reservoir  
25 with approximately 600-1500 gallons of liquid. An outlet 61  
26 is connected to a low pressure pump by a low pressure  
27 suction hose 62. The low pressure 12 volt pump is used to  
28 pump water out of the reservoir 13 back to the water  
29 blasting pump 12 at about 40 Psi and 20 g.p.m.

30 A recycling valve 63 is mounted in a connector pipe 64  
31 having one end opening into the reservoir 13 and the other  
32 end opening into the sump 14. The connector is located near  
33 the top of the sump and reservoir to allow for some settling  
34 of debris in the sump. The valve 63 opens or closes the  
35 connection.

1           In Fig. 7, the sump 14 is shown with the rear door 65  
2   open for unloading the porous enclosure 64. The door has a  
3   seal (not shown) to maintain the negative pressure therein  
4   during operation. The porous enclosure may be a wire screen  
5   or mesh box sized to fit within the sump 14. An additional  
6   filter bag with having between 5-200 micron porosity may be  
7   inserted into the enclosure. The dimensions of the  
8   enclosure 64 are somewhat less than the interior of the sump  
9   which provides a marginal area 65 between the enclosure and  
10   the interior walls and floor of the sump which provides an  
11   exit path for filtered water through valve 70. The inlet 57  
12   empties into the enclosure 64 thereby preventing coatings  
13   from being entrained in the vacuum system. One side of the  
14   enclosure is hinged and latched to permit entry into the  
15   enclosure or removal of the filter bags. By opening the  
16   sump door and raising the dump bed of the truck, the waste  
17   material can be easily and quickly removed without prolonged  
18   interruption of the operations. The filter bag is the  
19   disposal container, and is dumped with the material. A  
20   permanent filter material can also be utilized which  
21   requires cleaning after each use but does not waste a filter  
22   bag each time it is dumped.

23           In operation, the process for using the disclosed  
24   equipment in a mobile operation for stripe removal:

25           1. Connection valve remains closed. Water side is  
26   used only as a fresh water supply and is not placed under  
27   vacuum at any time.

28           2. Filter material positioned in the vacuum tank at  
29   a distance off the walls and floor of the tank. A filter  
30   "bag" may also be hung by hooks from the ceiling to produce  
31   even cleaner waste water.

32           3. The vacuum tank is placed under vacuum by starting  
33   the diesel powered vacuum pump which is connected by an air  
34   outlet hose to the vacuum tank.

1           4. As strip material is removed creating a slurry of  
2 water and debris, the mixture is drawn through the inlet  
3 hose into the vacuum tank being trapped in the filter.

4           5. When the vacuum tank reaches its full capacity, a  
5 shutoff ball is forced upwards toward the air outlet hose  
6 and makes contact with a ball seal causing loss of tank  
7 vacuum.

8           6. The drain valve is then opened on the vacuum tank.  
9 The drain permits water to drain through the filter material  
10 and into the open cavity between the walls and floor  
11 allowing an exit from the drain.

12

13           7. The shutoff valve is closed allowing for a  
14 capacity equal to the capacity previously occupied by dirty  
15 water, only the debris slurry remains inside the tank.

16           8. Steps 1 - 7 are repeated until the strip is  
17 removed.

18           9. Upon opening of a door to the vacuum container,  
19 allows for a removal of all debris captured in the filter.

20           The instant invention may also be used in a non-mobile  
21 setting in continuous operation as follows.

22           1. The connection valve remains open except when it  
23 is necessary to dump the water side. Water side is used as  
24 an overflow vacuum tank and is under vacuum much of the  
25 time.

26           2. Filter material positioned in the vacuum tank at  
27 a distance off the walls and floor of the tank. A filter  
28 "bag" may also be hung by hooks from the ceiling to produce  
29 even cleaner waste water.

30           3. Vacuum tank is placed under vacuum by starting the  
31 diesel powered vacuum pump which is connected by the air  
32 outlet hose to the vacuum tank. Water side is under vacuum  
33 as well by way of connection valve.

34

1           4. As strip material is removed creating a slurry of  
2 water and debris, the mixture is drawn through the inlet  
3 hose into the vacuum tank being trapped in the filter.

4           5. As the debris and water level rise to the level of  
5 the connection valve, the water will begin flowing through  
6 the connection valve into the water side. The water in the  
7 water side tank will be filtered water as the water has had  
8 to first flow through the filter material to reach the  
9 connection valve.

10          6. When the waste water has reached the level of the  
11 connection valve it will be visible to the operator through  
12 a strategically positioned sight glass. At that point,  
13 without shutting down the vacuum or the operation, the  
14 operator closes the connection valve which releases the  
15 water side tank from vacuum.

16          7 Next, the operator must open the drain valve on  
17 the water side to release the waste water being held there.

18          8. After the water tank has drained completely, the  
19 water side drain valve must be closed.

20          9. The connection valve is reopened allowing  
21 wastewater to flow freely into the water side box.

22          10. Repeating of steps 1 - 9 while never shutting down  
23 or affecting the blasting operation whatsoever. This may be  
24 continued until the vacuum tank is full of debris.

25          11. It is now necessary to shut off the vacuum power  
26 unit and open the drain valve on the vacuum tank. This  
27 allows the water to drain through the filter material, into  
28 the open cavity between the walls and floor, and exit the  
29 drain. This allows the debris to dewater.

30          12. Opening of the vacuum door allows for a release  
31 of all material to repeat the process.

32          A number of embodiments of the present invention have  
33 been described. Nevertheless, it will be understood that  
34 various modifications may be made without departing from the  
35 spirit and scope of the invention. Accordingly, it is to be

1     understood that the invention is not to be limited by the  
2     specific illustrated embodiment but only by the scope of the  
3     appended claims.

4

1     **CLAIMS**

2     What is claimed is:

3         1. A cleaning system for removing coatings from a hard  
4 surface by high pressure liquid comprising a liquid  
5 reservoir connected to a high pressure pump, said pump  
6 connected to a mobile blast head by a high pressure hose,  
7 said blast head having at least one high pressure nozzle for  
8 delivering high pressure liquid onto a hard surface, a waste  
9 removal hose connected at one end to said blast head and at  
10 the other end to a sump for collection of liquid and  
11 coating, said sump connected to said liquid reservoir,  
12 whereby liquid is pumped through said high pressure hose  
13 from said reservoir and exits said high pressure nozzle onto  
14 the hard surface removing coatings therefrom, said liquid  
15 and coatings entrained by said waste removal hose to said  
16 sump, said coatings collected in said sump and the waste  
17 liquid exiting through said outlet.

18

19         2. A cleaning system of claim 1 wherein a high power  
20 vacuum pump is connected to said sump.

21

22         3. A cleaning system of claim 2 wherein a shroud is  
23 connected to said blast head, said shroud surrounds said at  
24 least one nozzle and forms a negative pressure chamber.

25

26         4. A cleaning system of claim 3 wherein said liquid  
27 reservoir, said sump and said high power vacuum pump are  
28 mounted on a mobile frame, said mobile frame forms an  
29 integral part of a truck having a bed and an cab, said truck  
30 being self-propelled.

31

32         5. A cleaning system of claim 3 wherein said mobile  
33 blast head is attached to a wheeled chassis for maneuvering  
34 over the hard surface.

35

1           6. A cleaning system of claim 5 wherein said wheeled  
2 chassis is attached to a self-propelled tractor and said  
3 mobile blast head and tractor are of a size for removably  
4 docking transversely on said bed of said truck.

5  
6           7. A cleaning system of claim 6 wherein said bed  
7 includes a ramp, said ramp connected to said bed for raising  
8 and lowering said ramp, said ramp sized to support said  
9 tractor for docking transversely on said bed.

10  
11           8. A cleaning system for removing coatings from a hard  
12 surface by high pressure liquid comprising a water reservoir  
13 connected to a high pressure pump, said pump connected to a  
14 mobile blast head by a high pressure hose, said blast head  
15 having at least one high pressure nozzle for delivering high  
16 pressure liquid onto a hard surface, a liquid and debris  
17 removal hose connected at one end to an inlet of a vacuum  
18 chamber and connected at the other end to said blast head to  
19 remove liquid and coating from said blast head, a high power  
20 vacuum pump connected to said vacuum chamber, said vacuum  
21 chamber having a rigid outside wall defining an interior, a  
22 wire mesh screen in said interior spaced inwardly of said  
23 rigid outside wall and forming an enclosure, said inlet  
24 inside said enclosure, said vacuum chamber having an outlet  
25 for the liquid, said outlet between said rigid wall and said  
26 enclosure, said outlet of said vacuum chamber connected to  
27 said reservoir for re-circulation of the liquid, whereby  
28 liquid is pumped through said high pressure hose from said  
29 reservoir and exits said high pressure nozzle onto the hard  
30 surface removing coatings therefrom, said liquid and  
31 coatings entrained by said high powered vacuum in said  
32 vacuum hose to said vacuum chamber through said inlet, said  
33 coatings collected by said filter screen in said vacuum  
34 chamber and the liquid exiting through said outlet.

1           9. A cleaning system of claim 8 wherein a porous  
2 flexible bag is removably inserted in said enclosure, said  
3 bag having a mouth surrounding said inlet whereby said  
4 coatings are collected in said bag.

5

6           10. A cleaning system of claim 8 wherein said  
7 reservoir, said vacuum chamber, said vacuum pump and said  
8 blast head are mounted on the bed of a truck.

9

10           11. In a cleaning system for removing coatings from a  
11 hard surface by high pressure liquid comprising a mobile  
12 blast head including at least one high pressure nozzle for  
13 directing high pressure liquid onto a hard surface, an  
14 articulating link attaching said blast head to a self  
15 propelled tractor, said link having a leading end and a  
16 trailing end, said blast head connected to said leading end,  
17 said trailing end connected to said tractor whereby said  
18 blast head is movable horizontally and vertically in  
19 relation to a hard surface.

20

21           12. In a cleaning system of claim 11 wherein said  
22 tractor has a pair of front wheels spaced apart, a bar fixed  
23 to said tractor between said front wheels, said link having  
24 trailing arms rotatably connected to said bar for rotation  
25 in a horizontal plane, said link either fully to the left or  
26 right and then fully vertically.

27

28           13. A process for removing material comprising the  
29 steps of:

30           1. providing a vacuum tank and a water tank with a  
31 connection valve therebetween, closing of said connection  
32 valve;

33           2. inserting a filter material in said vacuum tank;

34           3. creating a vacuum in said vacuum tank by use of a  
35 vacuum pump powered by an internal combustion engine;



1           4.     directing ultra high pressure water at a material  
2     to be removed creating a debris slurry, said slurry drawn  
3     into said vacuum tank being trapped in said filter.

4           5.     breaking of the vacuum when said vacuum tank  
5     reaches full capacity;

6           6.     draining water from said vacuum tank through said  
7     filter material; and

8           7.     repeating steps 1-7 until said filter bag is  
9     filled.

10

11           14.    A process for removing material comprising the  
12    steps of:

13           1.     providing a vacuum tank and a water tank with a  
14    connection valve there between, opening said connection  
15    valve;

16

17           2.     inserting a filter material in said vacuum tank;

18           3.     creating a vacuum in said vacuum tank by use of a  
19    vacuum pump powered by an internal combustion engine;

20           4.     directing ultra high pressure water at a material  
21    to be removed creating a debris slurry, said slurry drawn  
22    into said vacuum tank being trapped in said filter.

23           5.     allow water to pass from said vacuum tank through  
24    said connection valve to said water tank when the water  
25    level rises to the level of said connection valve;

26           6.     closing of said connection valve releasing vacuum  
27    from said water side tank;

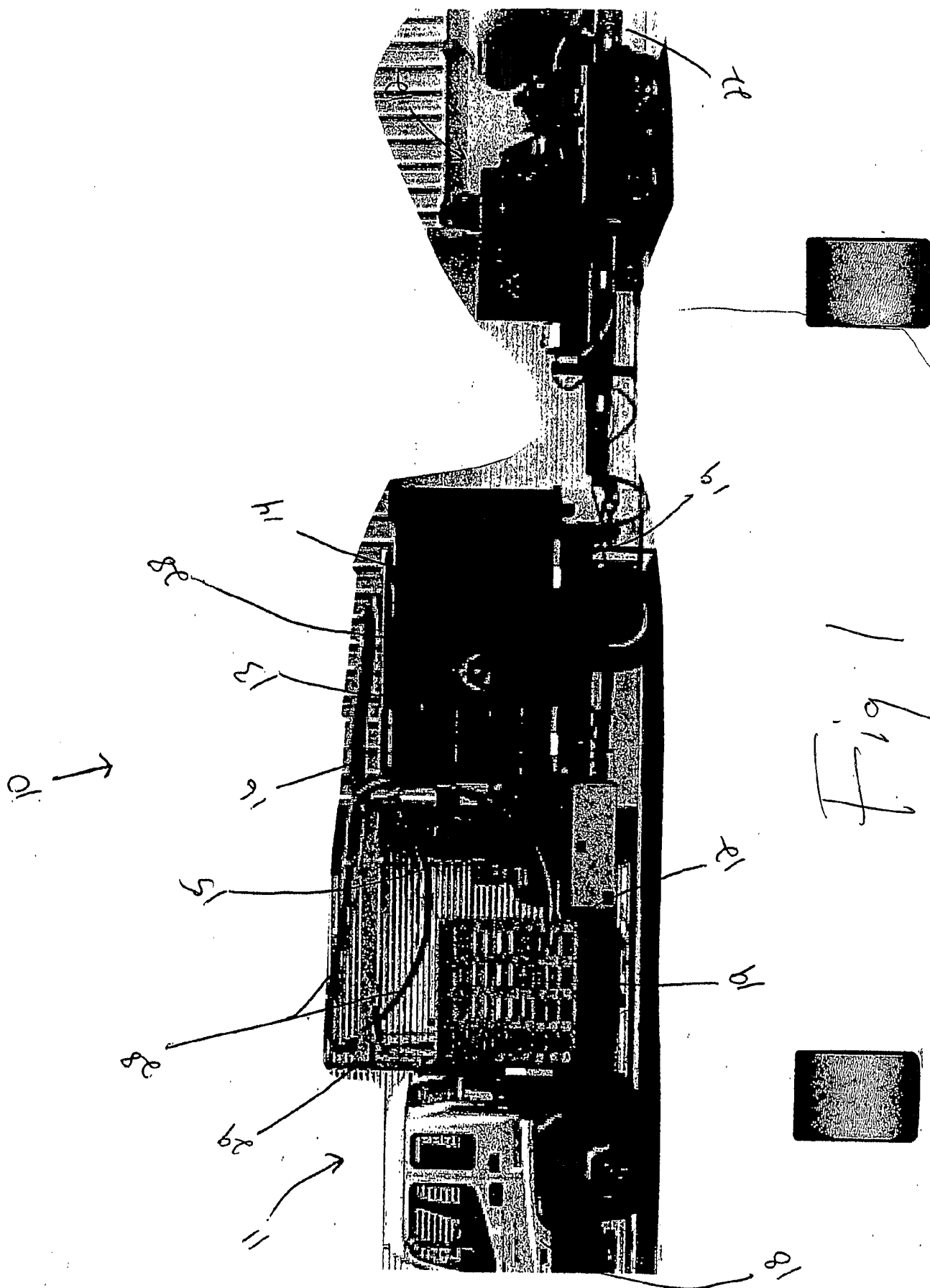
28           7.     draining of water from said water tank;

29           8.     closing said drain valve;

30           9.     opening said connection valve;

31           10.    repeating steps 1-9 until said filter bag is  
32    filled.

33



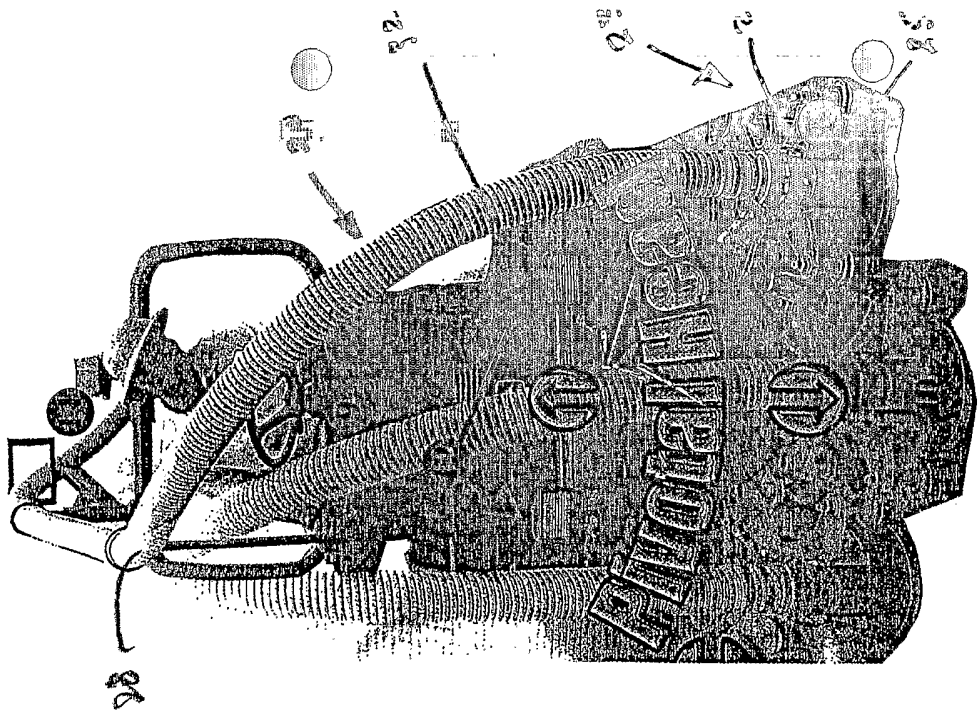


FIG. 3

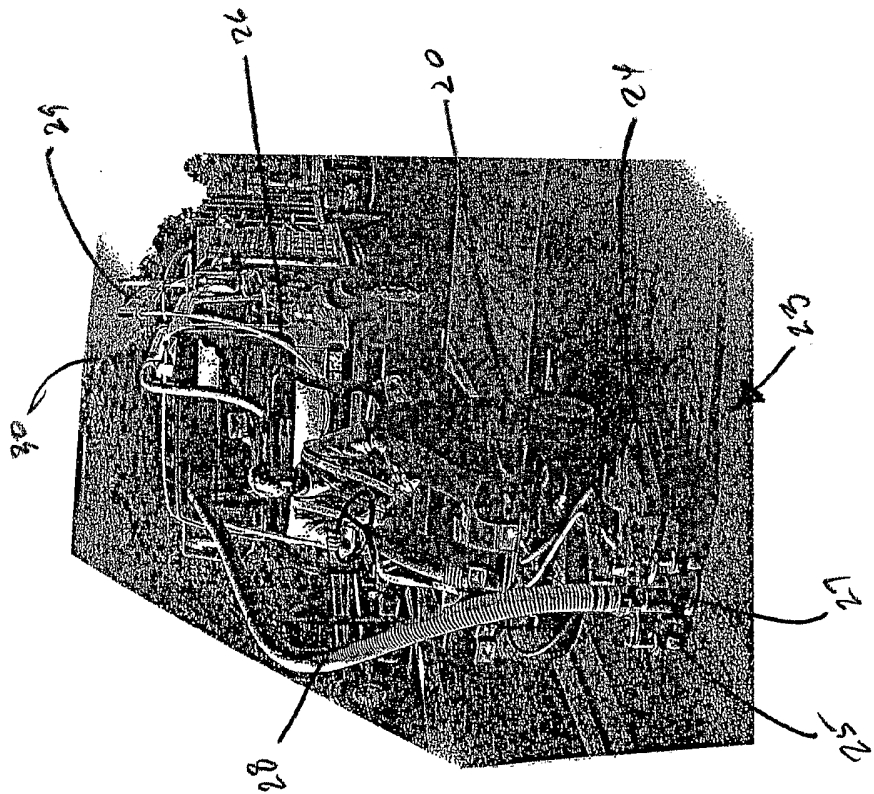
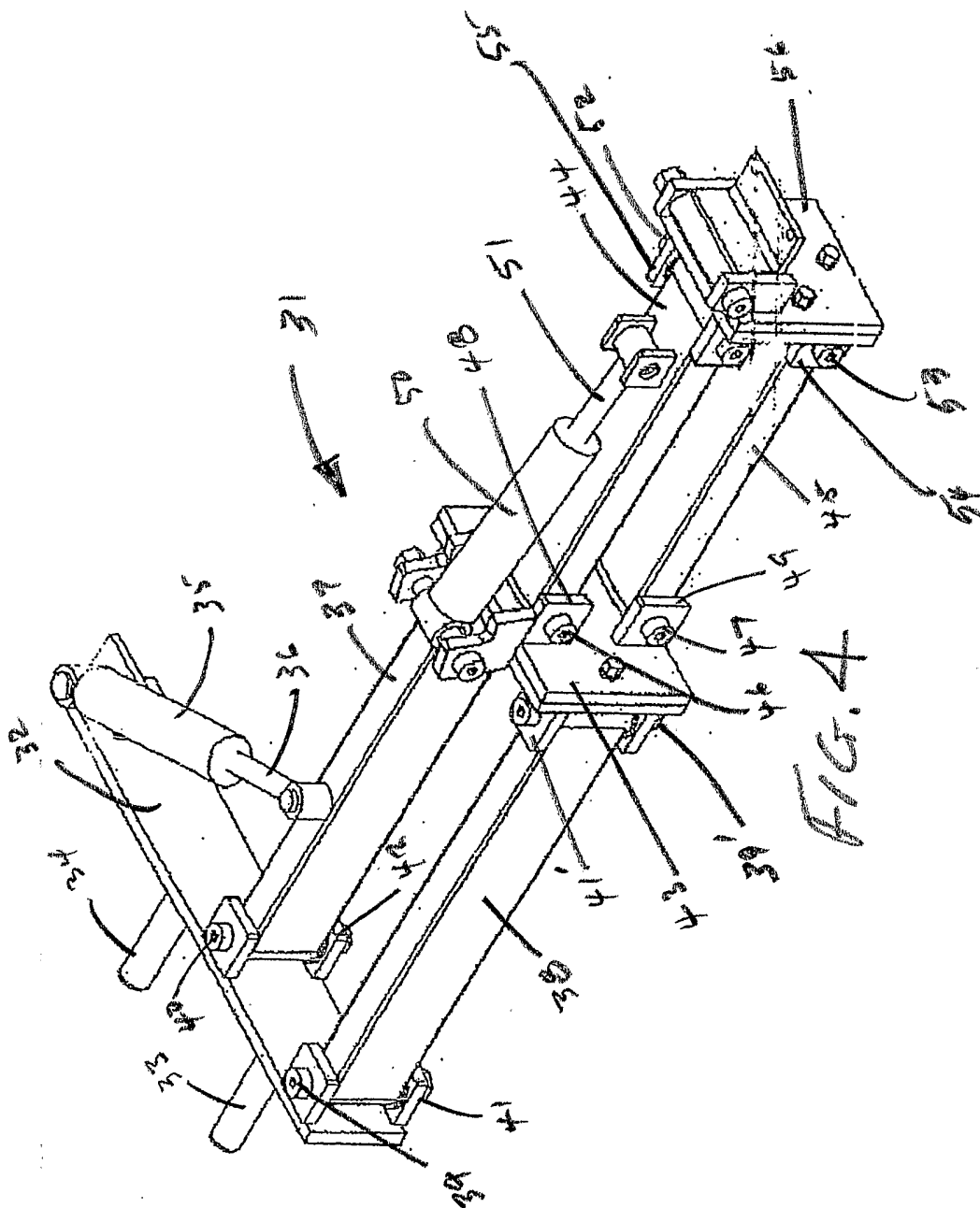


FIG. 2



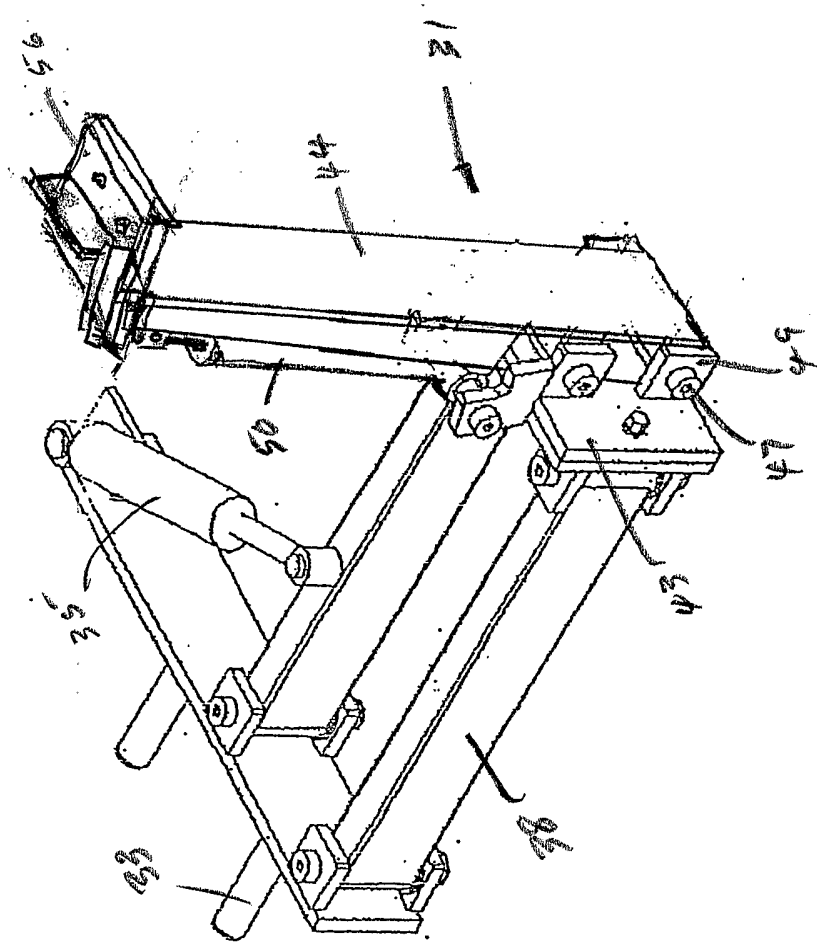


FIG. 5

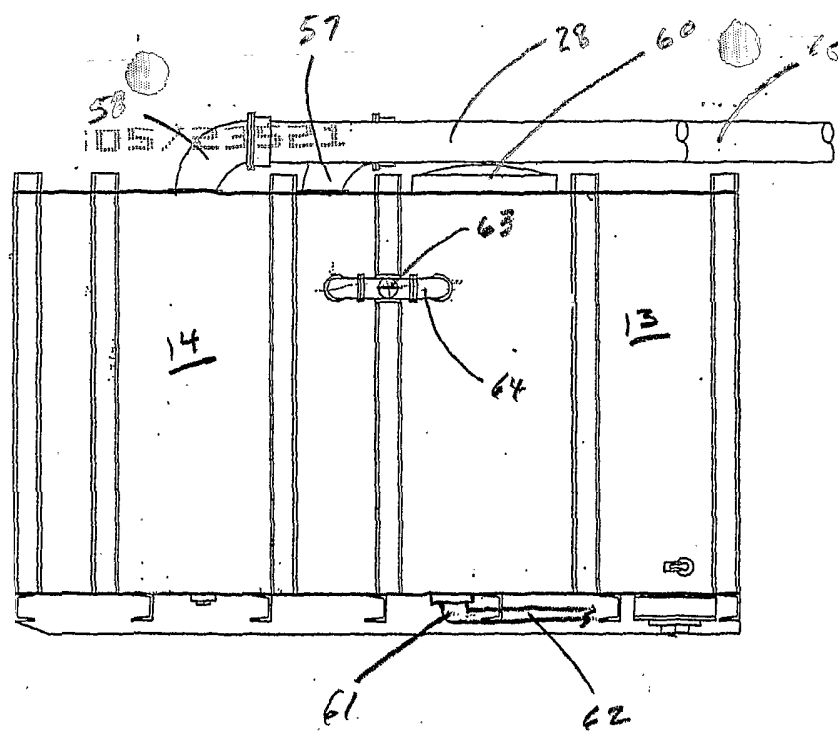


FIG. 6

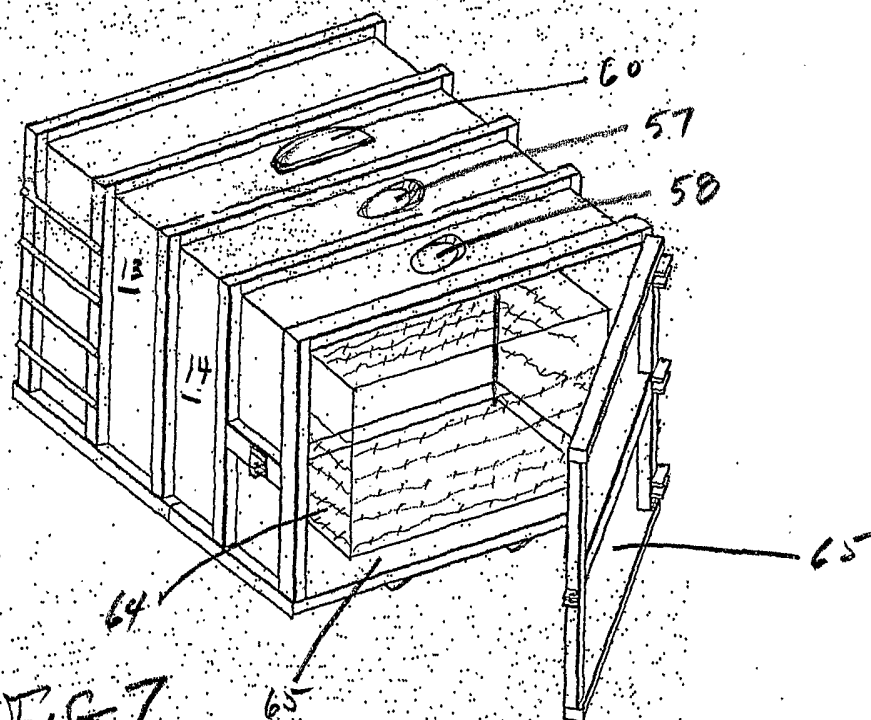


FIG. 7