

[54] **HIGH PRESSURE JET CLEANING
DEVICE**[75] Inventors: **Willard F. Foster**, Alden; **Robert W. Wild**, South Wales, both of N.Y.[73] Assignee: **C. H. Heist Corporation**, Buffalo, N.Y.[22] Filed: **Jan. 6, 1971**[21] Appl. No.: **104,276**[52] U.S. Cl. **239/287, 239/175**[51] Int. Cl. **B05b 9/02**[58] Field of Search **239/172, 176, 287, 239/286, 175, 150; 134/172, 198; 51/8, 11, 12**[56] **References Cited****UNITED STATES PATENTS**

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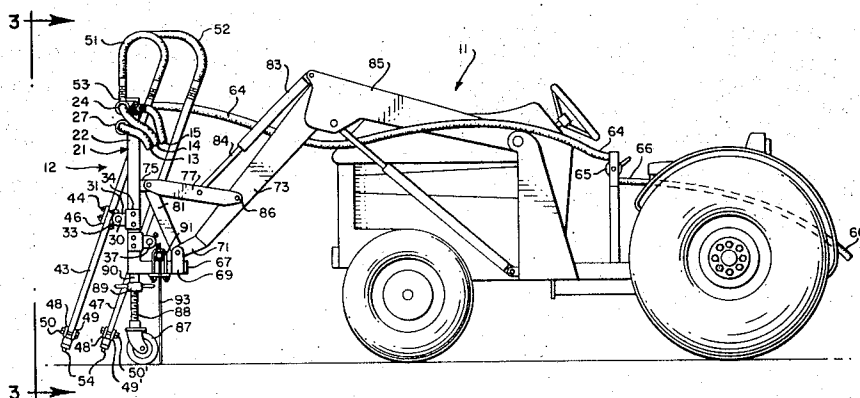
Primary Examiner—M. Henson Wood, Jr.

Assistant Examiner—John J. Love

Attorney—Sommer, Weber & Gastel

[57] **ABSTRACT**

A machine for cleaning a surface by means of high pressure jets of liquid comprising a frame for mounting on a vehicle, a manifold on the frame, a plurality of lances in communication with said manifold, a plurality of nozzles in said lances for supplying fan-shaped jets of liquid for impingement on said surface to be cleaned, said nozzles being oriented to cause the jets to be inclined at an acute angle to the direction of motion of said vehicle and being proximate each other so as to clean a swath on said surface as said vehicle traverses said surface, and adjustment means for adjusting the inclination of the lances relative to the vertical and for adjusting the orientation of said nozzles relative to the direction of travel of said vehicle, and a plurality of pump units for supplying high pressure liquid to the manifold. The foregoing machine is used in a system which includes a source of water and a plurality of motor-pump units placed in parallel across the machine and the source for producing a sufficient quantity of water at a sufficiently high pressure for supplying the above described machine.

10 Claims, 19 Drawing Figures

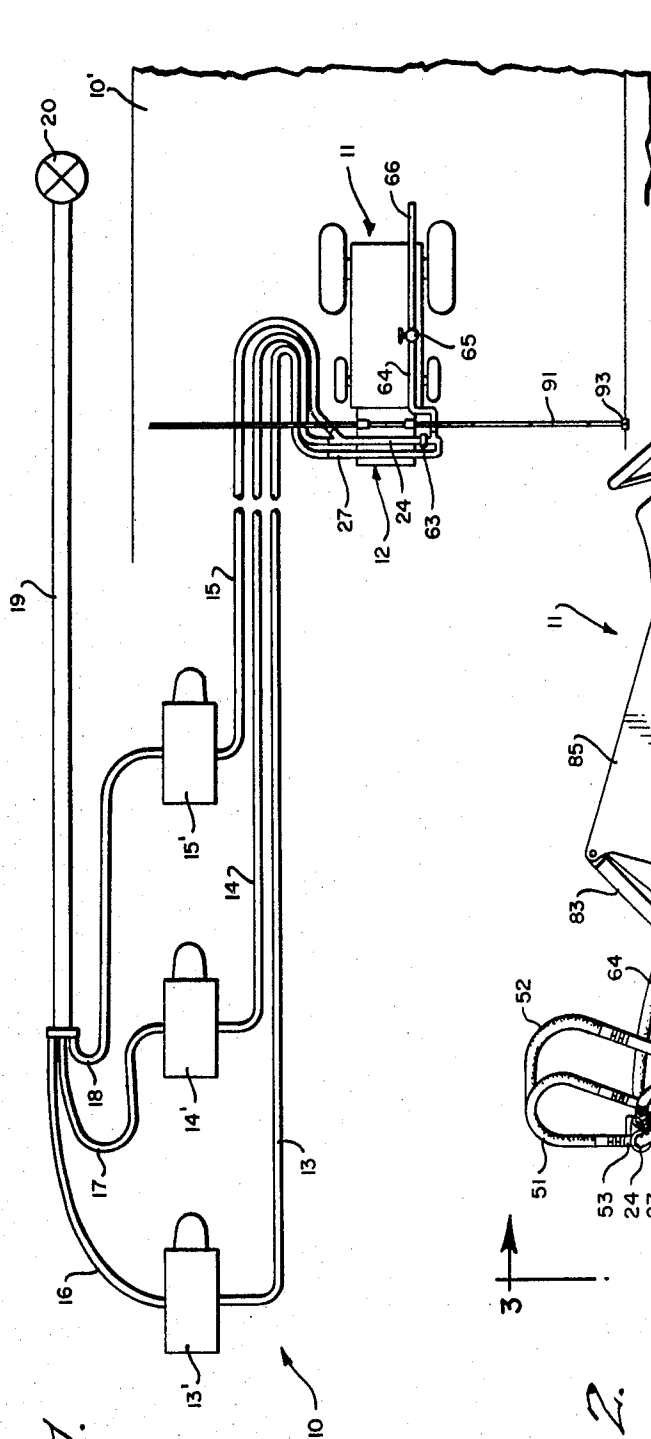


Fig. 1.

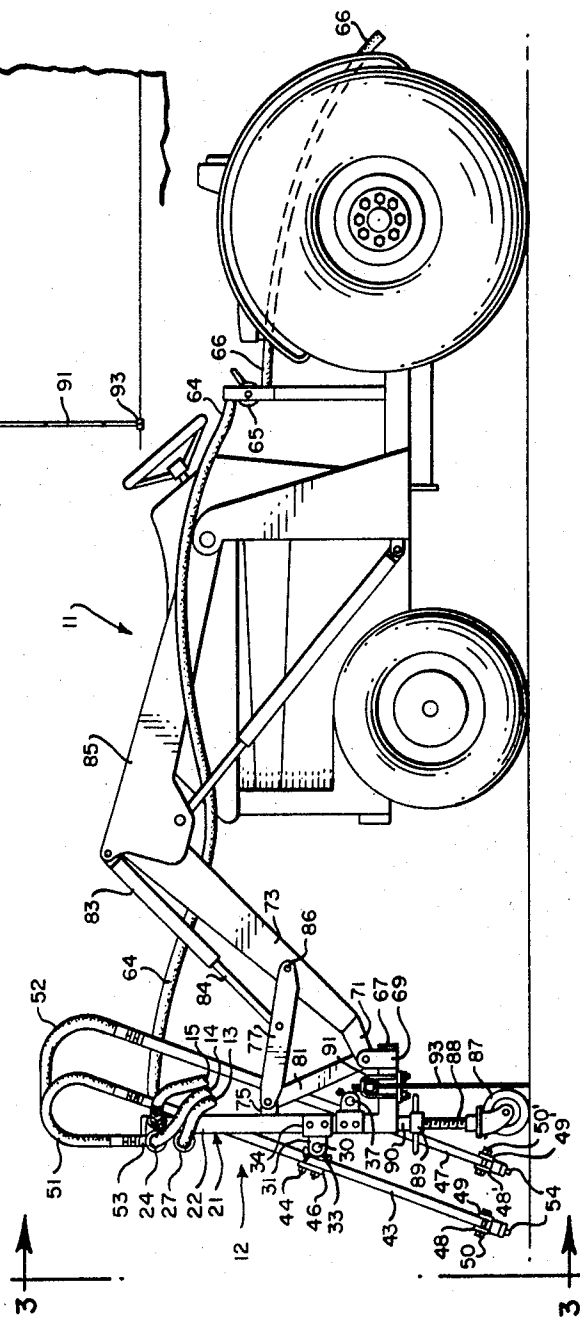


Fig. 2.

INVENTOR
 Robert W. Wild
 Willard F. Foster
 BY
Sommer Weber & Gastel
 ATTORNEYS

Fig. 3.

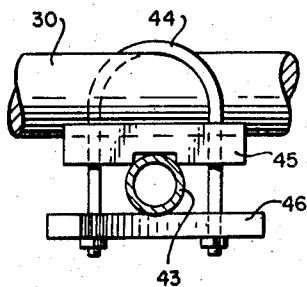
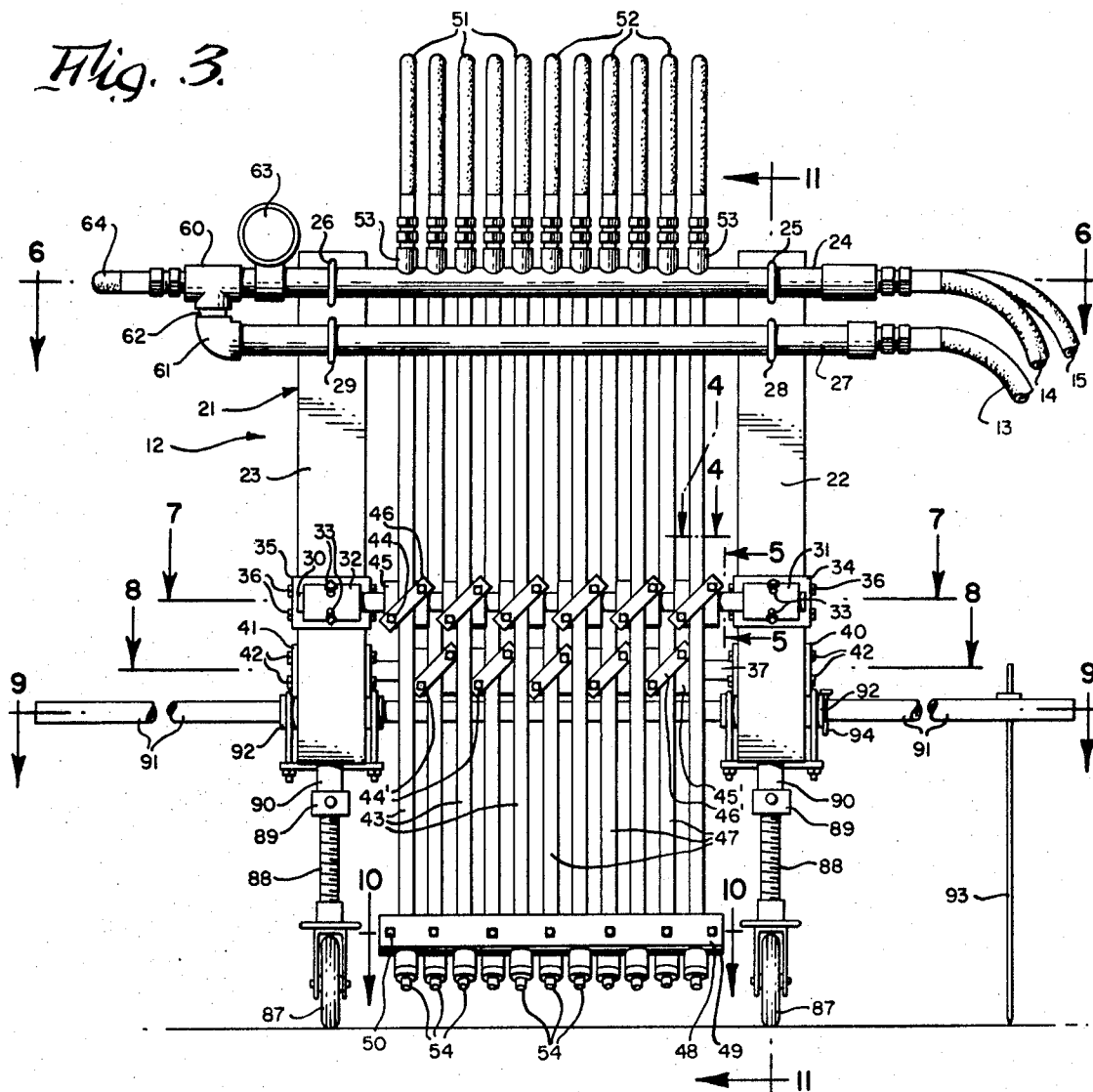


Fig. 4.

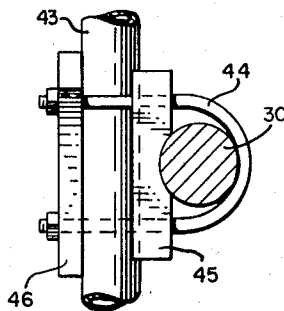


Fig. 5.

INVENTOR.

Robert W. Wild
Willard F. Foster

BY

Sommer Weber & Gastel
ATTORNEYS

Fig. 6.

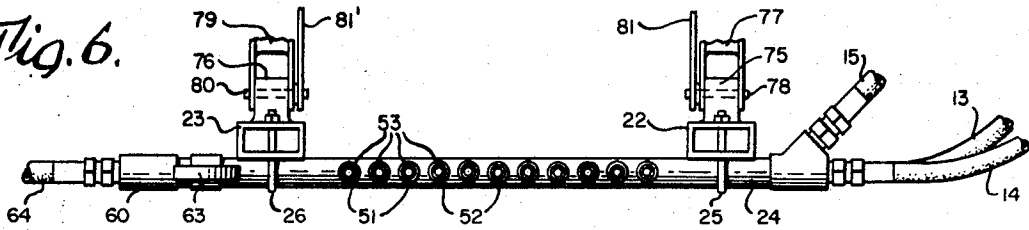


Fig. 7.

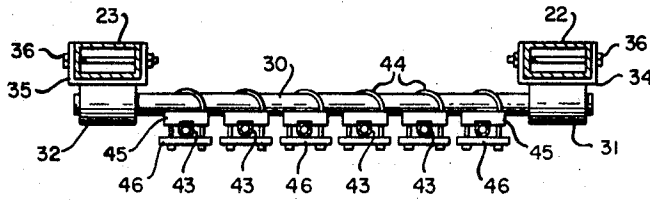


Fig. 8.

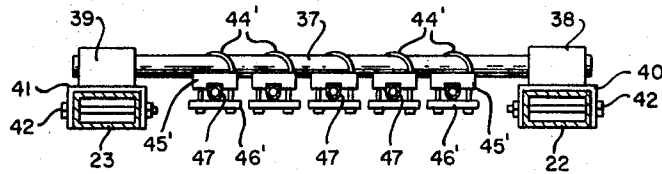


Fig. 9.

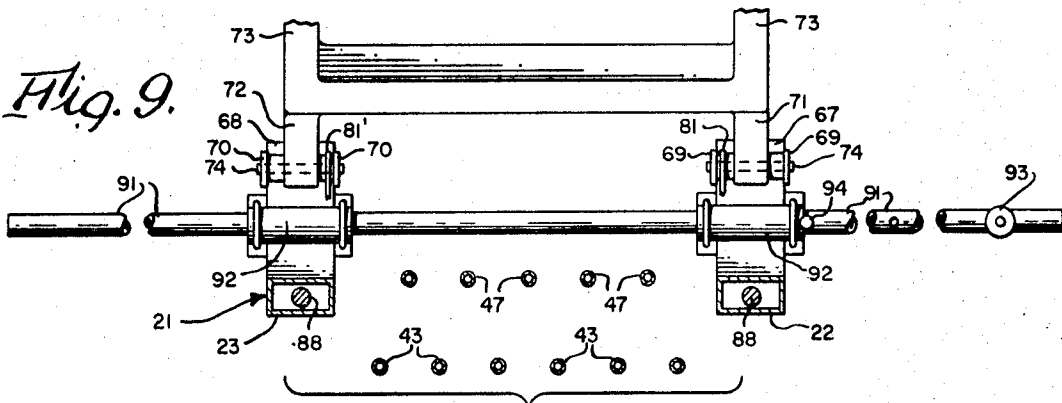
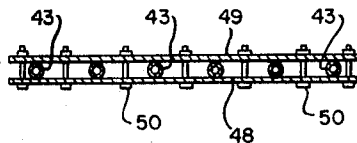


Fig. 10.

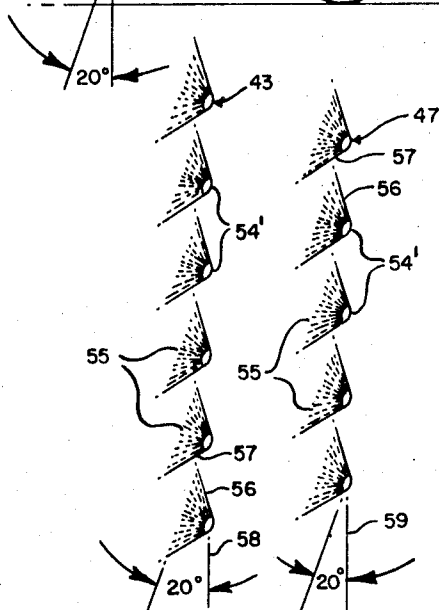
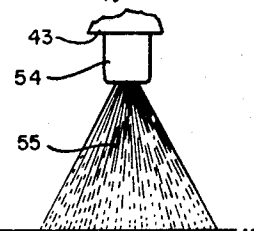
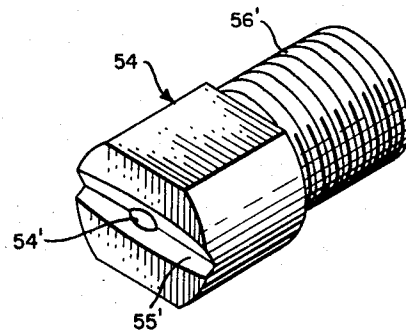
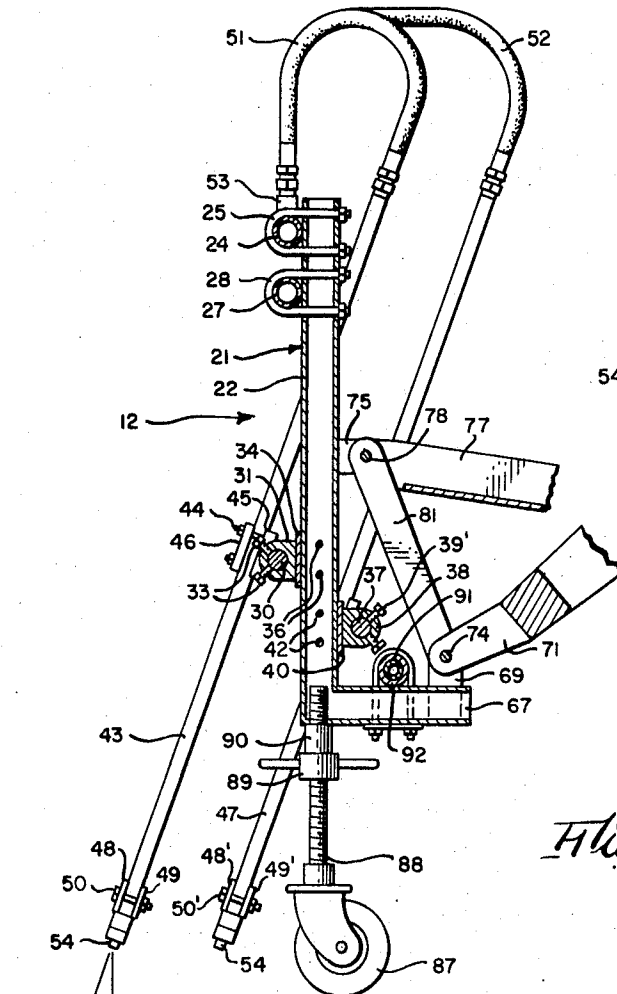


INVENTOR

Robert W. Wild
Willard F. Foster

BY

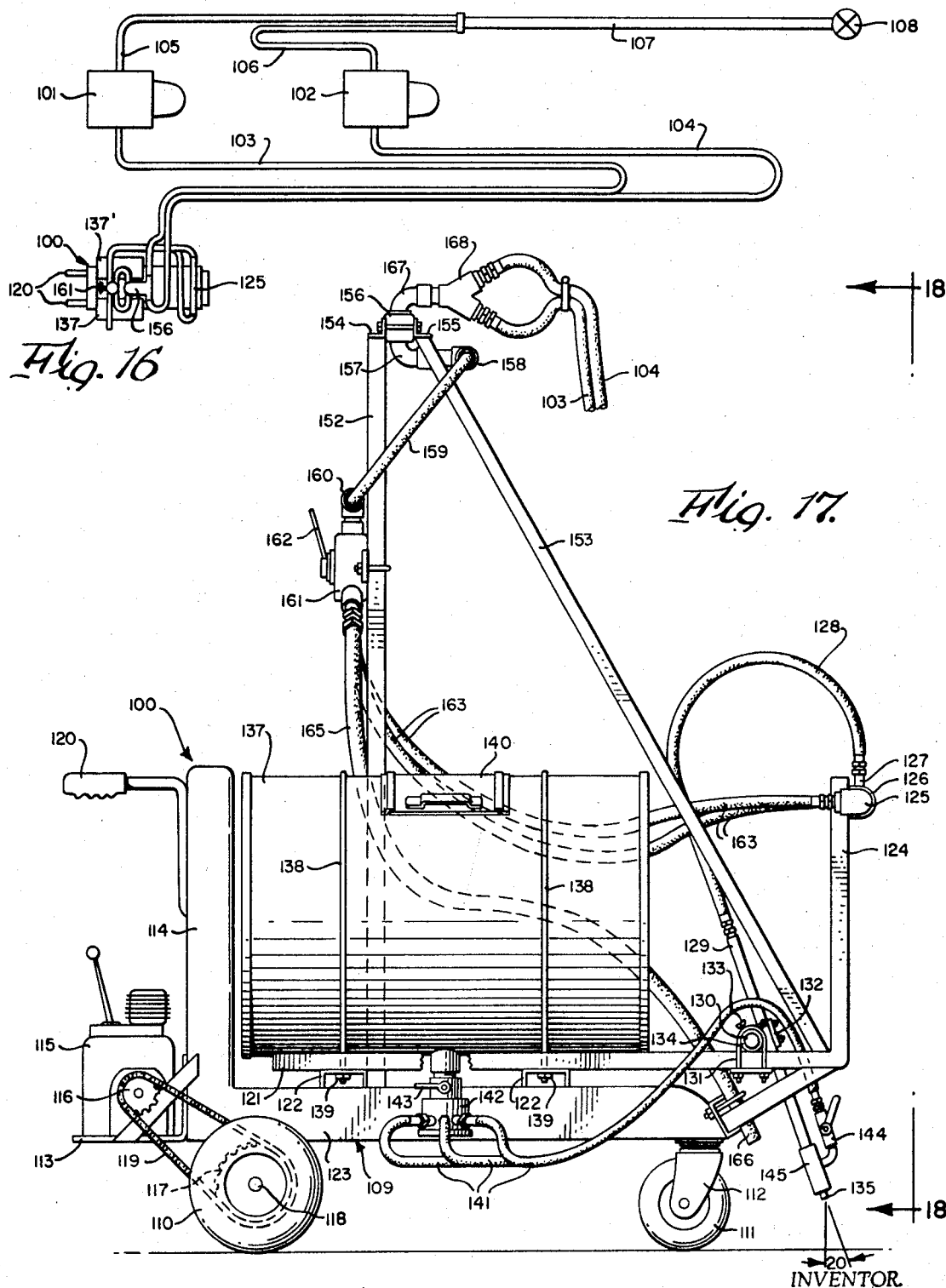
Sommer Weber & Gastel
ATTORNEYS



INVENTOR.

Robert W. Wild
Willard F. Foster

BY
Sommer Weber & Gastel
ATTORNEYS



INVENTOR.
 Robert W. Wild
 Willard F. Foster
 BY
Sommer Weber & Gastel
 ATTORNEYS

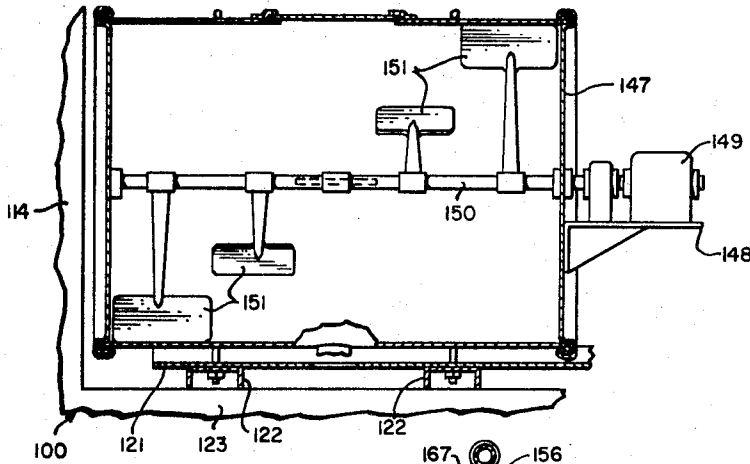


Fig. 19.

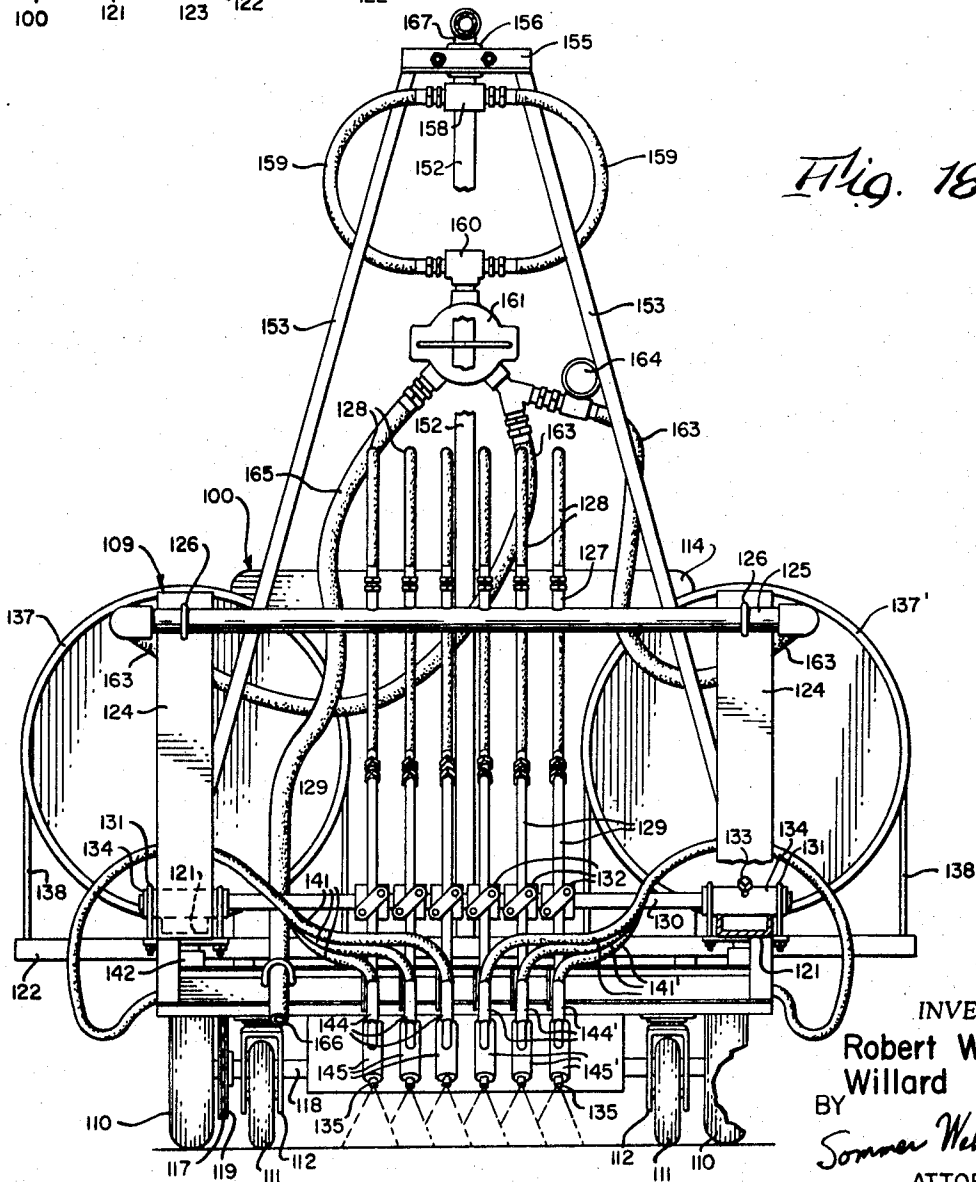


Fig. 18.

INVENTOR:
Robert W. Wild
Willard F. Foster
BY
Sommer Weber & Glatel
ATTORNEYS

HIGH PRESSURE JET CLEANING DEVICE

The present invention relates to an improved device and system for cleaning large areas, such as runways, by means of high pressure jets of water.

In the past the cleaning of rubber tire marks from airport runways has been very difficult and costly. The tire marks on the runways had to be removed from time to time because of the hazard which they posed. First of all, they obscured the markings on the runways and secondly, they caused the runways to be hazardously slick during rainy weather. In the past the runways were sometimes cleaned by the application of chemical solutions, which was time consuming and costly as well as in some instances detrimental to the foliage on the sides of the runway. Abrasive devices were also used, such as rotating brushes or the like but these were highly ineffective. In fact, there was no known way of removing the tire markings on runways in an efficient and reasonably inexpensive manner.

It is accordingly the primary object of the present invention to provide a high pressure water jet type of cleaning apparatus which can clean rubber tire marks from runways in a highly efficient and economical manner.

Another object of the present invention is to provide an improved system for supplying high pressure liquid to a runway cleaning machine in sufficient quantities and at sufficiently high pressures so as to perform effective cleaning.

A further object of the present invention is to provide an improved cleaning machine for cleaning airport runways by means of high pressure jets of liquid in which the jets are so oriented relative to each other and relative to the runway so that they produce a highly efficient cleaning without in any way interfering with each other. Other objects and attendant advantages of the present invention will readily be perceived hereafter.

The improved runway cleaning machine of the present invention includes a frame mounted on the front of the vehicle, a manifold on the frame, a plurality of adjacent nozzles in communication with the manifold with each of the nozzles being of a configuration for supplying a fan-shaped jet of high pressure liquid, said jets being oriented relative to each other to cause the jets to overlap each other transversely of the direction of movement of said frame without interfering with each other, and means for supplying water to said nozzles in a sufficient quantity and at a sufficiently high pressure to effect cleaning of the surface.

The improved system of the present invention comprises a first conduit in communication with a source of liquid, such as a hydrant, a plurality of second conduits in communication with said first conduit, a plurality of motor-pump units severally in communication with said second conduits, a plurality of third conduits severally in communication with said plurality of motor-pump units, and a vehicle mounted high pressure water jet producing unit in communication with said third conduits.

The present invention will be more fully understood when the following portions of the specification are read in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic view of the improved system of the present invention which is utilized for cleaning a runway or the like by means of high pressure liquid jets;

FIG. 2 is a side elevational view of the improved apparatus of the present invention mounted on the front of a suitable tractor;

FIG. 3 is a view taken substantially along line 3—3 of FIG. 2 and showing the improved apparatus in front elevation;

FIG. 4 is a fragmentary cross sectional view taken substantially along line 4—4 of FIG. 3 and showing the manner in which the lances are secured to the remainder of the frame;

FIG. 5 is a fragmentary cross sectional view taken along line 5—5 of FIG. 3 and showing the same subject matter as FIG. 4 but from a different view;

FIG. 6 is a fragmentary cross sectional view taken substantially along line 6—6 of FIG. 3 and showing the relationship between the manifold and the conduits leading therefrom;

FIG. 7 is a fragmentary cross sectional view taken substantially along line 7—7 of FIG. 3 and showing the manner in which the front row of lances are secured to the frame, with certain portions of the apparatus being omitted in the interest of clarity;

FIG. 8 is a fragmentary cross sectional view taken substantially along line 8—8 of FIG. 3 and showing the manner in which the rear row of lances are secured to the frame, with certain portions of the apparatus being omitted in the interest of clarity;

FIG. 9 is a fragmentary cross sectional view taken substantially along line 9—9 of FIG. 3 and showing the manner in which the alignment member is secured to the remainder of the frame and also showing the orientation of the first and second rows of lances relative to the frame;

FIG. 10 is a view taken substantially along line 10—10 of FIG. 3 and showing the manner in which the lower ends of the lances are secured to each other;

FIG. 11 is a fragmentary cross sectional view taken substantially along line 11—11 of FIG. 3 and showing details of the frame and the manner in which the lances are mounted thereon;

FIG. 12 is an enlarged perspective view showing the shape of the nozzles which are used to provide a fan-shaped jet;

FIG. 13 is a schematic view showing in plan the orientation between the first and second rows of nozzles and showing how the jets produced thereby are oriented at an acute angle relative to the direction of movement of the vehicle;

FIG. 14 is a schematic view showing the fan-shaped jet produced by each of the nozzles;

FIG. 15 is a view taken substantially in the direction of arrows 15—15 of FIG. 14 for the purpose of showing that the fan jet possesses very little thickness in a lateral direction;

FIG. 16 is a schematic view of a system which includes an alternate type of high pressure jet producing apparatus;

FIG. 17 is a side elevational view of a motor driven cart which supplies a mixture of sand and water in the form of water jets for cleaning an airport runway and also includes a swivel connection for mounting the high pressure hoses on the apparatus;

FIG. 18 is a front elevational view of the vehicle shown in FIG. 17 taken in the direction of arrows 18—18 of FIG. 17; and

FIG. 19 is a fragmentary side elevational view of an alternate form of sand-drum which may be mounted on the vehicle.

The improved high pressure jet cleaning system 10 of the present invention is especially adapted for the cleaning of rubber tire marks from airport runways. More specifically, the system utilizes a vehicle 11 in the nature of a tractor which is driven by an operator and carries at its forward end a high pressure water jet producing unit 12 which directs high pressure water jets against the runway in a pattern which removes the rubber markings thereon in swaths as the vehicle traverses the runway. The high pressure water is supplied to unit 12 by means of a plurality of flexible conduits 13, 14 and 15 which are in communication with motor-pumping units 13', 14' and 15', which in this instance are automotive trucks which carry motor-pump units for increasing the pressure of water which is supplied thereto through conduits 16, 17 and 18, respectively, which in turn receive their water supply from conduit 19, which may be an irrigation pipe or the like which is suitably coupled to a hydrant 20 or any other suitable water source such as a stream or the like. By the use of the foregoing system extremely large quantities of water are supplied at extremely high pressure to the vehicle mounted high pressure jet producing unit 12. By the use of the foregoing system a plurality of relatively small mobile pumping units such as 13', 14' and 15' may be utilized to supply the high pressure water, as it would be highly impractical to use a single large unit for the quantities and pressures required.

The high pressure jet producing unit 12 includes a frame 21 consisting essentially of a pair of vertical box-like sections or brace members 22 and 23 which are secured in spaced relationship to each other by suitable cross members. In this respect, as can be seen from FIGS. 3, 6 and 11, manifold conduit 24 is a first cross member which is secured to members 22 and 23 by U-bolts 25 and 26, respectively, and manifold conduit 27 is a second cross member which is secured to members 22 and 23 by U-bolts 28 and 29, respectively. Furthermore, as can be seen from FIGS. 3 and 7, a cross bar 30 has its ends secured to sleeves 31 and 32 by means of set screws 33, sleeves 31 and 32 being welded to channel members 34 and 35, respectively, which are secured to members 22 and 23, respectively, by means of bolts 36 which extend through the sides of channels 34 and 35 and through brace members 22 and 23 (FIG. 7). A lower cross brace 37 (FIG. 8) has its ends received in sleeves 38 and 39 and is secured thereto by means of set screws 39'. Sleeves 38 and 39 in turn are rigidly affixed, as by welding, to channel-shaped members 40 and 41, respectively, which fit around brace members 22 and 23, respectively, and are secured thereto by means of bolts 42. It can thus be seen that the cross members 24, 27, 30 and 37 provide a rigid framework in conjunction with frame members 22 and 23.

A plurality of water conducting lances are secured to the cross members 30 and 37. In this respect, as can best be seen from FIGS. 3, 11 and 7, a plurality of lances 43 are secured to cross brace 30 by means of U-bolts 44 which extend around brace 30 and mount blocks 45 and 46 which bracket each of the lances 43 in the manner depicted in FIGS. 4 and 5. As can be

seen, lances 43 are located in alignment in a front row transversely across the vehicle.

A second row of lances is also provided, each of the lances being designated by numeral 47 and these lances are located in a row which lies rearwardly of the front row. Each of these lances is rigidly secured to cross bar 37 by means of U-bolts 44' which are identical to U-bolts 44 described above and shown in FIGS. 4 and 5. Furthermore, U-bolts 44' are used in conjunction with blocks 45' and 46' which are identical to blocks 45 and 46 described above and shown in FIGS. 4 and 5. As can be seen from FIGS. 3, 9 and 13, lances 47 are staggered relative to lances 43 so that the jets supplied by those in the second row will effectively fall between the jets supplied by those in the front row to thus produce a complete swath, as will become more apparent hereafter.

The lower ends of lances 43 are held between plates 48 and 49 which are secured to each other by bolts 50. The lower ends of lances 47 are secured to each other by plates 48' and 49' which are secured to each other by bolts 50' (FIG. 11), elements 48', 49' and 50' being identical to elements 48, 49 and 50, respectively.

The upper ends of lances 43 are in communication with flexible conduits 51 and the upper ends of lances 47 are in communication with flexible conduits 52, all of said conduits being coupled to manifold 24 through suitable coupling members attached to nipples 53 which are in communication with conduit 24.

Suitably mounted on the lower ends of each of the lances is a nozzle 54 (FIG. 12) which produces a fan-shaped jet 55 (FIGS. 14 and 15) which is extremely broad transverse of the direction of movement of the vehicle and which is relatively thin from a side view. This jet provides almost a knife-like cutting edge which is capable of cutting the accumulated rubber from the surface of the runway. Essentially each nozzle 54 consists of a body having a bore 54' therein which is intersected by groove 55' at its outer end, the nozzle also having a threaded end 56' which is screwed into the end of the lances. Nozzle 59 is a commercially obtainable type produced by the Spraying Systems Corporation of Bellwood, Illinois, and is shown on page 30 in their Catalog No. 25-A, published in 1966. These nozzles are of the general type shown in U.S. Pat. Nos. 2,621,078, 2,683,627 and 2,701,412. As can best be seen from the schematic diagram of FIG. 13, the nozzles in the front row 58 are oriented relative to each other so that the jets 55 are oriented at a 20° angle to the row in which they are located. Furthermore, it can be seen that the nozzles 54 in the second row 59 are also oriented in the same manner. The reason for orienting the nozzles of each row at an acute angle to the line in which they are located is so that the sides of the adjacent jets in each row will not oppose each other to nullify their effect. In this respect, by orienting the nozzles in the manner shown so that the jets 55 essentially lie at an angle of about 20° to the line in which they are located, the edge 56, for example, of one jet will not interfere with the edge 57 of an adjacent jet because the latter falls forward of the former. The adjacent jets 55 of each row are preferably placed sufficiently close to each other so that when they are viewed from the front of the vehicle, the edges of the jets will be seen to overlap each other. However, in this particu-

lar embodiment this is not totally necessary inasmuch as the front jets 55 in the front row 58 are staggered with respect to the jets in the rear row 59 so that the space between any two adjacent jets 55 in front row 58 is overlapped by a jet 55 in the rear row. By virtue of the foregoing orientation a relatively wide swath can be produced on the runway as the vehicle traverses it and there will not be any lines between the adjacent jets because of the overlapping relationship noted above between the jets produced by the nozzles in the front and rear rows. The reason that the jets in the rear row are staggered relative to the jets in the front row is because each jet is less powerful at its outer edges, so that the rear jet between the two front jet supplements the diminished cutting action at the outer edges of the front jets.

As also can be seen from FIG. 11, the lances themselves are inclined at an angle of approximately 20° to the vertical. This causes the angle of impingement of the jets 55 to be such that a reasonably good cutting action is obtained which removes the foreign matter from the surface of the runway. It will be appreciated, of course, that with the nozzles which are used the above described angle of 20° for the orientation of the nozzles relative to each other and the angle of 20° for the orientation of the lances relative to the vertical may be departed from if desired depending on the material which is being cut or the type of nozzle which is being used. In this respect the angle of the jet emanating from each nozzle can be adjusted very easily by loosening the U-bolt 44 which holds the lance in position and by rotating the lance manually any desired amount and thereafter retightening the U-bolt. The angle which the lance makes with the vertical can also be adjusted at the same time when the U-bolt is loosened. Thus there is only one connector which has to be manipulated for adjusting the lance both for the angle it makes with the vertical and for the angle which its jet makes in a direction transverse to the frame. The foregoing is possible because of the fact that conduits 51 and 52 are flexible. During the foregoing adjustments bolts 50 are loosened sufficiently and then retightened after the adjustment has been made.

As noted above, the high pressure water is supplied to conduits 27 and 24 which comprise the manifold which is in communication with the lances. More specifically, conduits 14 and 15 are in communication with conduit 24 through a suitably Y connection and conduit 13 is in communication with conduit 27. At their other ends conduits 24 and 27 are in communication with each other through tee 60 (FIG. 3), elbow 61 and nipple 62. It can thus be seen that the water which is supplied by pumping units 13', 14' and 15' is received by the manifold consisting of conduits 24 and 27. A pressure gauge 63 is in communication with conduit 24 for indicating the pressure which is being used.

Another conduit 64 is in communication with the manifold and leads to a hand operated valve 65 mounted on the vehicle next to the driver's seat, valve 65 in turn being in communication with dump hose 66. If for any reason it is desired to terminate high pressure liquid flow to nozzles 54, it is merely necessary to manipulate valve 65 and this in turn will cause the water being supplied by the pumping unit to effectively bypass the lances 43 and 47 and this water will be dumped at a lower pressure through dump conduit 66.

The vehicle 11 on which the high pressure water jet unit 12 is mounted, as noted above, is essentially a tractor. Frame 21 includes feet 67 and 68 (FIGS. 9 and 11) which include spaced upstanding ears 69 and 70, respectively, which are mounted on the ends 71 and 72 of the spaced tractor arms 73 by means of pins 74. Ears 75 and 76 are rigidly affixed to and extend rearwardly from frame members 22 and 23, respectively, (FIGS. 6 and 11). Ear 75 is secured to arm 77 of the tractor by pin 78 and ear 76 is secured to an arm 79 of a tractor, which corresponds to arm 77, by means of pin 80. One link 81 secures ears 69 and 75 to each other as shown in FIG. 11, and the other link 81' connects ears 70 and 76. Links 81 are secured to pins 78 or 74. As can best be seen from FIG. 2, a hydraulic motor 82 consisting of a cylinder 83 and a piston 84 is interposed between vehicle frame member 85 and link 77. It will be appreciated that piston 84 is locked relative to cylinder 83 because of the triangle formed by links 77, 81 and 73, and the corresponding triangle (not shown) associated with the other arm 73 effects a similar result with a counterpart (not shown) of cylinder 83 and piston 84.

As can be seen from FIGS. 2, 3 and 11, wheels 87 are pivotally mounted for swiveling action on threaded shafts 88 which are adjustably received in the bottom portions of vertical braces 22 and 23. By manipulating the locking screw 89 the shafts 88 may be loosened and thereafter threaded downwardly or upwardly into nuts 90 which are fixedly secured to the underside of braces 22 and 23. By adjusting the exposed length of shafts 88, the frame may be supported relative to the ground. The wheels 87 maintain the elevation of nozzles 54 a predetermined distance above the surface on which wheels 87 roll. This is necessary so that the desired portion of the jet impinges on the surface.

In operation, the tractor 11 is driven lengthwise of the runway 10' in a forward direction so that the jets produced by the nozzles will exert a combined cleaning and abrading action on the surface of the runway. As can be seen, flexible conduits 13, 14 and 15 will follow along with the vehicle. After the limit of movement has been obtained in a forward direction, as determined by the length of conduits 13, 14 and 15, the tractor is reversed and backed up to return to its original starting point. Thereafter the foregoing procedure is repeated laterally of the preceding run.

In order for the vehicle operator to gauge his position so as to cause adjacent swaths to overlap somewhat and thus to provide a thorough and complete cleaning action, a rod 91 is mounted transversely of the vehicle in oversized sleeves 92. Rod 91 carries a pointer 93 at its outer end and this pointer is aligned with a line on the runway. After a swath has been cut the rod 91 is moved over and a pin 94 is inserted in rod 91 in a suitable hole. During the next run the operator maintains the pointer on the same line as he did on the previous run. This in essence causes the vehicle to be shifted laterally the amount the rod 91 was shifted. The holes in rod 91 which receive pin 94 are spaced a distance apart which is less than the width of the swath, thereby insuring that adjacent swaths will overlap each other as the rod 91 is moved through sleeves 92 a distance which is less than the width of the swath.

By way of example the unit 12 uses 120 gallons of water per minute at 4,000 pounds per square inch. This

is supplied by the three motor-pump units 13', 14' and 15', each pumping 4 gallons per minute at 4,000 pounds per square inch, the motors or engines each producing 100 brake horsepower.

In FIGS. 16-19 an alternate type of high pressure water jet producing system is shown which includes a vehicle 100 which is coupled to motor pump units 101 and 102 by means of high pressure water conduits 103 and 104, respectively. Motor pump units 101 and 102 in turn are coupled to conduits 105 and 106 which are coupled to irrigation pipe or the like 107 which is in communication with a suitable source of water, such as a hydrant 108. The system of FIG. 16 may be identical in all respects to that described above in FIG. 1 except for the vehicle 100, and further, it may supply the water at the above described pressure of 4,000 pounds per square inch at the rate of 120 gallons per minute, as discussed above.

Vehicle 100 includes a frame 109 which is mounted on a pair of rear wheels 110 and front wheels 111 which are pivotally mounted on casters 112. A bracket 113 is secured to the rear wall 114 of frame 109 and mounts a gasoline engine 115 having an output sprocket 116 which is coupled to sprocket 117 on wheel axle 118 by means of chain 119. It will be appreciated that when sprocket 116 is driven, the vehicle 100 will move and its movement is guided by means of an operator who walks behind it and grasps a pair of spaced handles 120.

The vehicle frame 109 includes a pair of spaced channels 121 which rest on spaced channels 122 which are suitably secured to the bed frame 123. Vertical frame members 124 are suitably secured to the ends of channels 121 and mount manifold 125 at their upper ends by means of U-bolts 126. Manifold 125 receives a supply of high pressure water, as will be described in greater detail hereafter and this water is conducted upwardly through nipples 127 to flexible conduits 128 which are in communication with lances 129 secured to cross bar 130 which in turn is affixed to channels 121 by means of U-bolts 131. More specifically, each of the lances 129 is secured to bar 130 by means of U-bolt and block connections 132 which may be identical to the connections described above in detail in FIGS. 4 and 5 relative to the other embodiments of the invention. It can thus be seen that all of the lances 129 are attached to bar 130 and these may be moved in unison by virtue of loosening and tightening set screws 133 mounted in sleeves 134 which is tied down to the above-mentioned channels 121 by means of the U-bolts 131. In other words, bar 130 may be rotated when set screws 133 are loosened and after the lances have been moved in unison to the desired position, set screws 133 are retightened. Mounted on the ends of lances 129 are nozzles 135 which may be identical to nozzles described above relative to the other embodiments of the invention and shown in FIG. 12, these nozzles supplying a fan-shaped jet of high pressure liquid as described above. In this respect, nozzles 135 are oriented as described above, namely so that the fan-shaped jets extend at an angle of about 20° to the direction of travel of the vehicle (longitudinal axis of the vehicle) so that adjacent portions of adjacent jets will overlap transversely of the direction of motion of the vehicle without interfering with each other. This

was described above in detail in FIG. 13. It is to be noted that only one row of jets are used in the embodiment of FIGS. 18 and 19. One row also can be used in the embodiment of FIG. 4, provided the lances are moved sufficiently close to each other. It is also to be noted from FIG. 17 that the lances 129 are inclined at an angle of approximately 20° to the vertical, as in the other embodiments. It will be appreciated that both of the above discussed angles can be varied as required for optimum cleaning action, as the surfaces to be cleaned require.

A pair of drums 137 and 137' are spacedly mounted on the vehicle frame for carrying a sand supply. Drums 137 and 137' are secured to channels 122 by means of cables 138 having nuts 139 threaded thereon as shown in FIG. 17. Each of the drums includes a trap door 140 at the top thereof for receiving the sand. As can be seen from FIG. 18, each of the drums 137 and 137' is in communication with three lances. In this respect, conduits 141 extend between distributor 142 on drum 137 and three of the lances 129 and conduits 141' extend between a distributor (not shown) identical to distributor 142 mounted on drum 137' and three other of the lances 129. The distributor 142 and its counterpart each include a valve handle such as 143 which controls the amount of sand passing through the conduits 141-141'.

A valve 144 is located between the end of each of the conduits 141 and a venturi 145, which is located in each lance proximate nozzle 135. The remainder of the lances have associated with them valves 144' and venturis 145' which are the same as members 144 and 145, respectively. It will be appreciated that when valves 144 and 144' are opened a sufficient amount, the flow of the liquid to venturis 145 and 145' will entrain a certain amount of dry sand into the liquid so that the jets emanating from nozzles 135 have a sandblast action along with the high pressure jet cutting action.

An alternate type of sand supply is shown in FIG. 19 which includes a drum 147 which may replace drums 137 and 137'. This drum includes a bracket 148 mounted thereon which in turn mounts motor 149 which drives shaft 150 having spaced paddles 151 axially mounted thereon but oriented at spaced circumferential locations. Drum 147 contains a mixture of sand and water. Paddles 151 agitate the mixture to keep the sand in suspension and it is this mixture which is fed to venturis, such as 145 and 145' through the above described conduits 141 and 141' rather than the dry sand described above. It will be appreciated that a suitable sand injection arrangement such as shown in FIGS. 17-19 can be incorporated in the embodiment of FIGS. 1-15.

The vehicle of FIGS. 17 and 18 includes an arrangement which permits it to be turned at the end of its travel along the runway without causing entanglement of the hoses 103 and 104 carried thereby. This is in contrast to the action of the embodiment shown in the preceding figures wherein the jet cleaning action could be performed efficiently only when the vehicle traveled in one direction on the runway but not on the return direction. In this respect, the vehicle mounts a framework consisting of a rear column 152 and a pair of spaced converging front columns 153. The top of column 152 is secured to angle 154 and the tops of

columns 153 are secured by angles 155. Secured between angles 154 and 155 is a pivotal connector 156 having a lower portion including an elbow 157 secured to tee 158 and having conduits 159 extending therefrom, which in turn are connected to tee 160, which is in communication with manually controlled valve 16 having a handle 162 thereon. By suitable manipulation of handle 162 communication may be effected between conduits 159 and conduits 163 leading to opposite sides of manifold 125. A pressure gauge 164 in one of the conduits 163 gives a reading of the pressure thereon. Handle 162 may also be manipulated to place tee 160 in communication with dump conduit 165 having outlet 166 forwardly of the vehicle whereby a certain amount of the water may be dumped in the event it is desired to reduce the pressure in manifold 125, without changing the setting on the motor-pump units 101 and 102.

The upper portion 167 of swivel unit 156 is connected to a Y 168 which is in communication with conduits 103 and 104. The upper portion 167 of unit 156 is mounted for pivotal movement about a vertical axis relative to the lower portion. Because of the swiveling action of portion 167 it can be seen that vehicle 100 can be turned around 180° when it reaches the end of the limit of its travel, as determined by the length of hoses 103 and 104, without entangling of these hoses relative to the vehicle. Thus vehicle 100 can clean the runway in both directions of its travel. If desired a similar swivel arrangement can be mounted on the embodiment of FIGS. 1-15 to enable it to clean efficiently in both directions of its travel. The additional advantage of being able to turn the vehicle around so that it is always moving forwardly is to make it easier for the vehicle operator, especially in the embodiment of FIGS. 1-15, as it is more difficult to back the vehicle than to drive it in a forward direction.

It can thus be seen that the improved cleaning apparatus of the present invention is manifestly capable of achieving the above enumerated objects and while preferred embodiments have been disclosed, it will be appreciated that the present invention may be otherwise embodied.

What is claimed is:

1. A machine for removing deposits such as rubber tire marks from a surface such as a runway by means of high pressure jets of liquid comprising a frame, means for mounting said frame on a vehicle, a plurality of nozzles on said frame for providing a plurality of fan-shaped jets of liquid having knife-like cutting edges, means for conducting liquid to said nozzles with said liquid being at a pressure sufficient to cause said jets to remove said deposits from said surface, means mounting said nozzles across said frame to provide a continu-

ous swath extending transversely to the direction of movement of said vehicle, said nozzles having a first orientation which causes said fan-shaped jets to be inclined to the vertical, and said nozzles having a second orientation which causes each fan-shaped jet to be so inclined relative to an adjacent fan-shaped jet so as to cause them to overlap in a direction transversely of the direction of movement of said vehicle to provide said continuous swath without intermingling with each other prior to striking said surface whereby each jet will not lessen the force with which an adjacent jet strikes the surface to be cleaned.

2. A machine for cleaning a surface by means of high pressure jets of liquid as set forth in claim 1 wherein said nozzles are also oriented in first and second rows extending transversely of the direction of movement of said frame.

3. A machine for cleaning a surface by means of high pressure jets of liquid as set forth in claim 2 wherein said nozzles of said second row are staggered with respect to the nozzles of said first row whereby certain of the jets produced by the nozzles in said second row fall between the jets produced by certain of said nozzles in said first row.

4. A machine as set forth in claim 1 wherein said first orientation is approximately 20° to the vertical.

5. A machine as set forth in claim 1 wherein said nozzles are aligned substantially in a row and wherein said second orientation is approximately at 20° to the axis of said row.

6. A machine as set forth in claim 1 wherein said pressure is approximately at least 4,000 pounds per square inch.

7. A machine as set forth in claim 1 wherein said liquid is supplied at a volume of approximately 120 gallons per minute.

8. A machine as set forth in claim 7 wherein said pressure is approximately at least 4,000 pounds per square inch.

9. A machine as set forth in claim 1 wherein said means for conducting liquid to said nozzles includes first conduit means in communication with a source of liquid, second conduit means in communication with said nozzles, and a swivel joint between said first and second conduit means to permit said frame to be rotated without accompanying rotation of said first conduit means.

10. A machine for cleaning a surface by means of high pressure jets of liquid as set forth in claim 1 including dump valve means in communication with said nozzles for selectively routing liquid away therefrom so as to terminate flow from said nozzles without terminating flow of said liquid.

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