Sept. 22, 1964 M. E. HUKILL 3,149,428

SNOW REMOVAL APPARATUS

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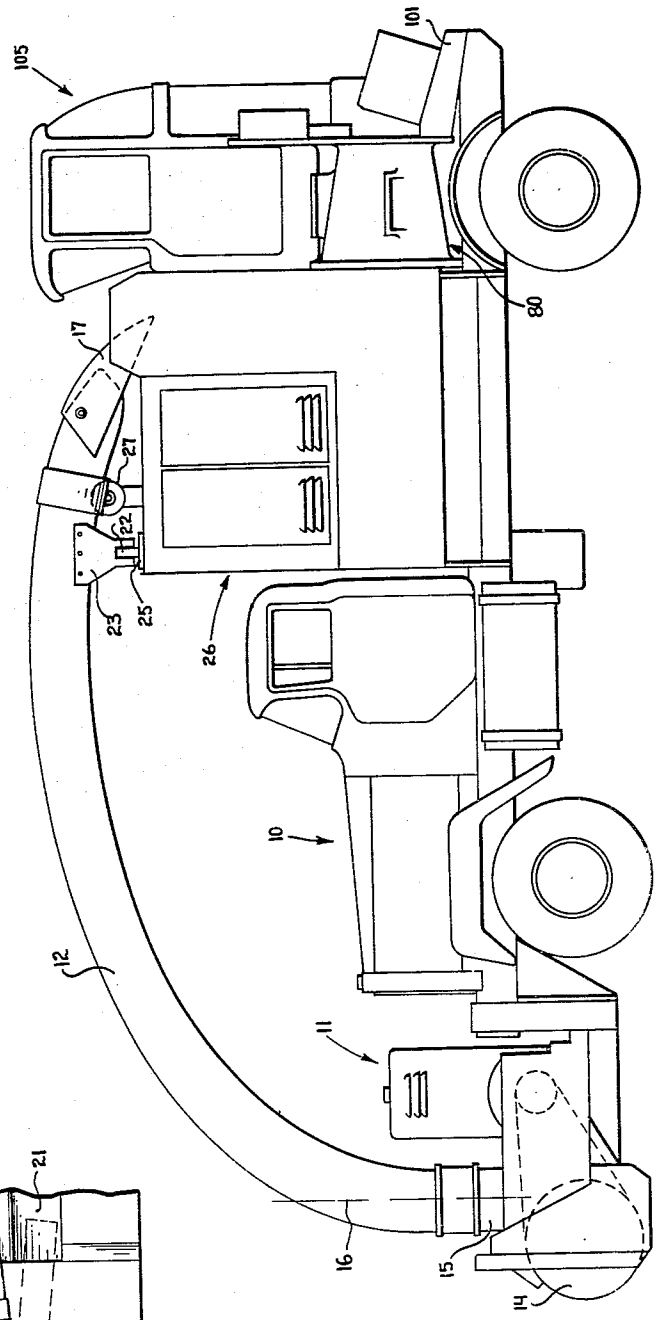
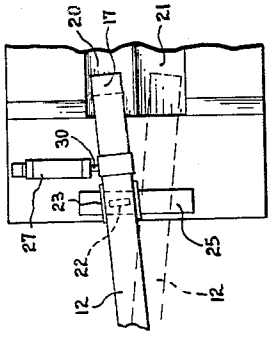


Fig. 1.

Fig. 5.



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SNOW REMOVAL APPARATUS

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Fig. 3.

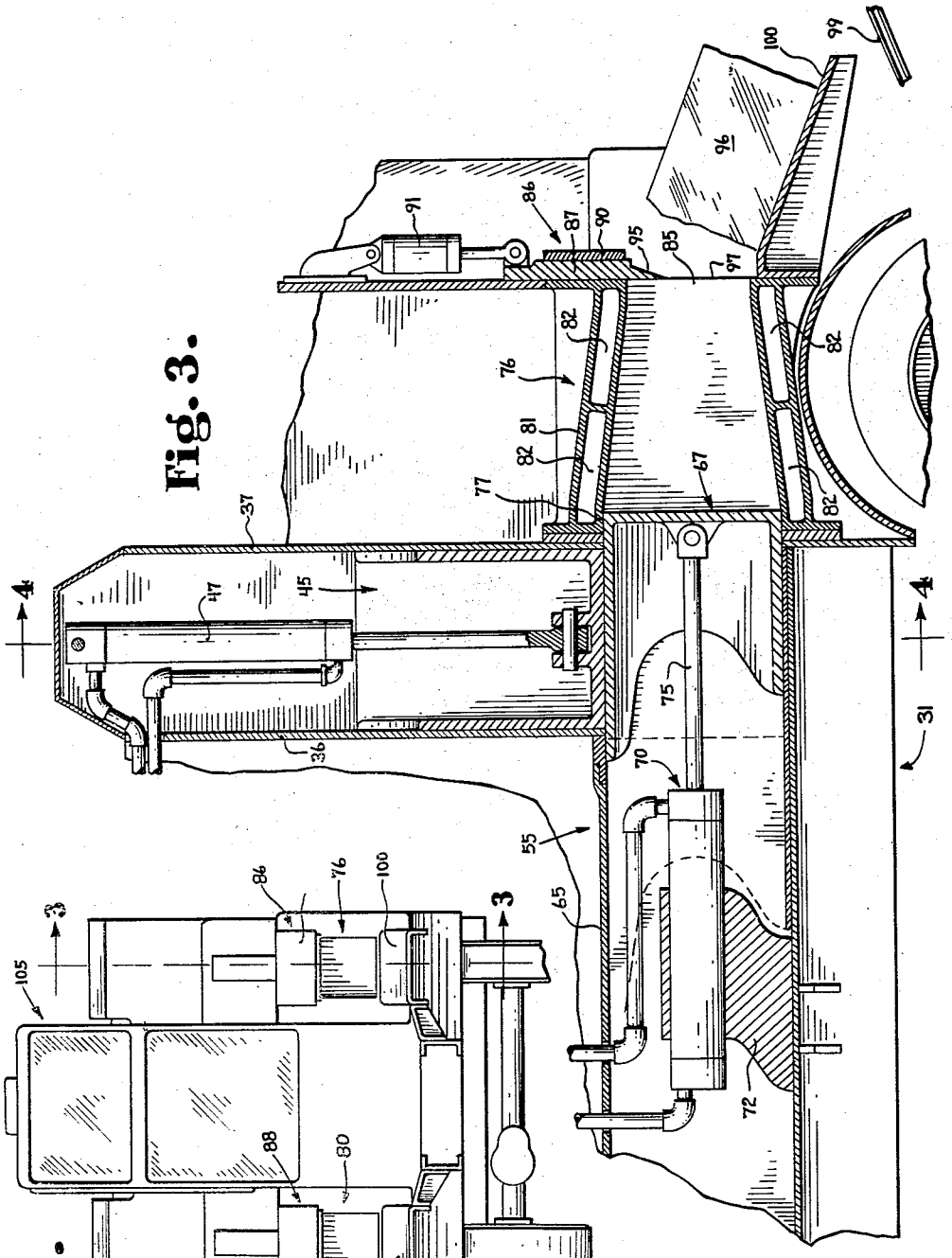


Fig. 2.

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SNOW REMOVAL APPARATUS

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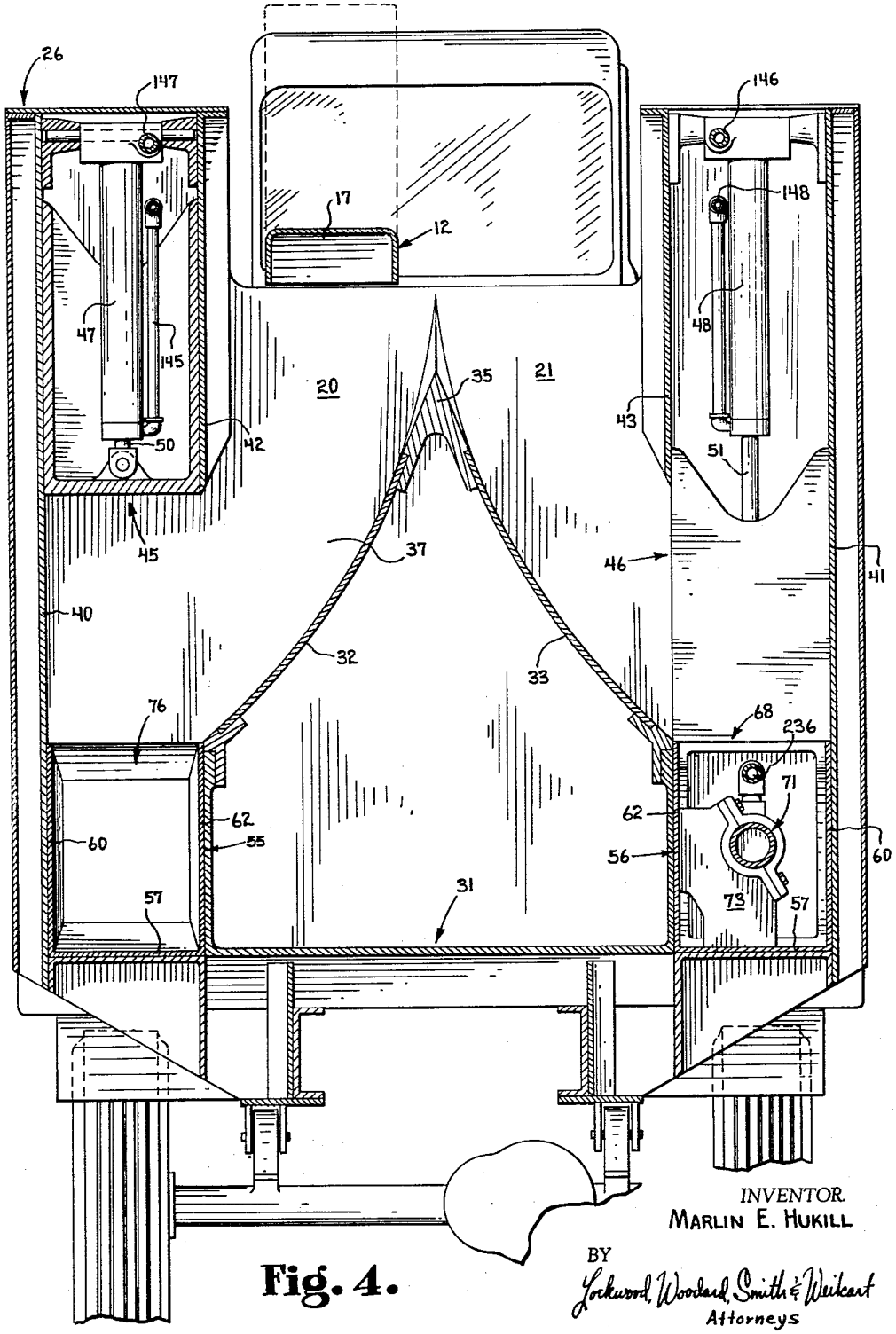


Fig. 4.

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SNOW REMOVAL APPARATUS

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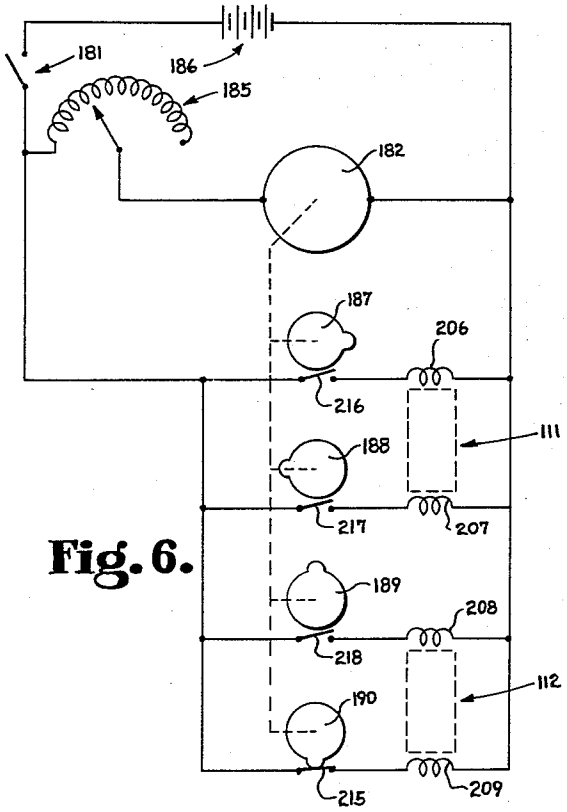
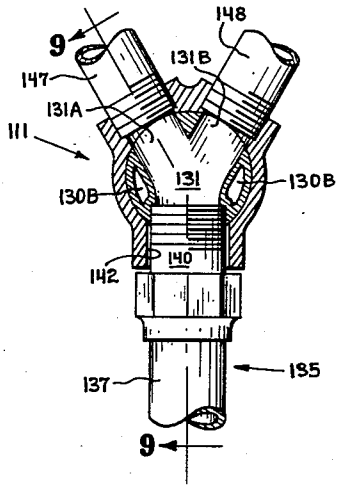


Fig. 6.

Fig. 8.



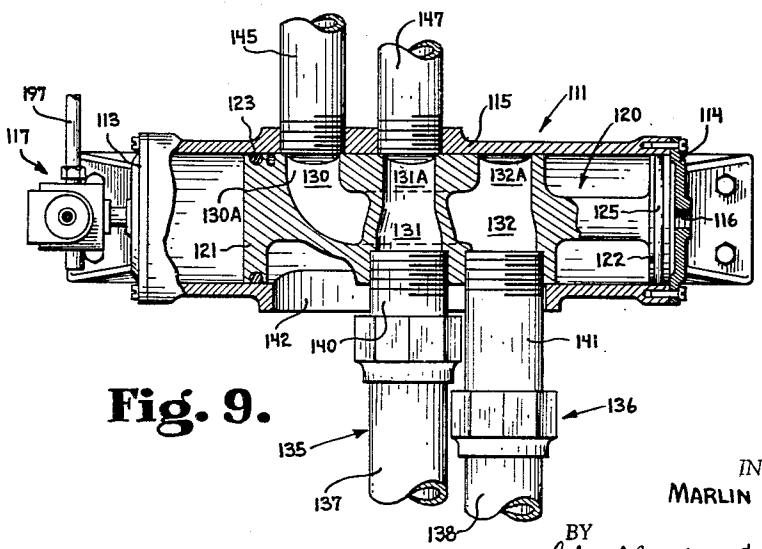


Fig. 9.

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SNOW REMOVAL APPARATUS

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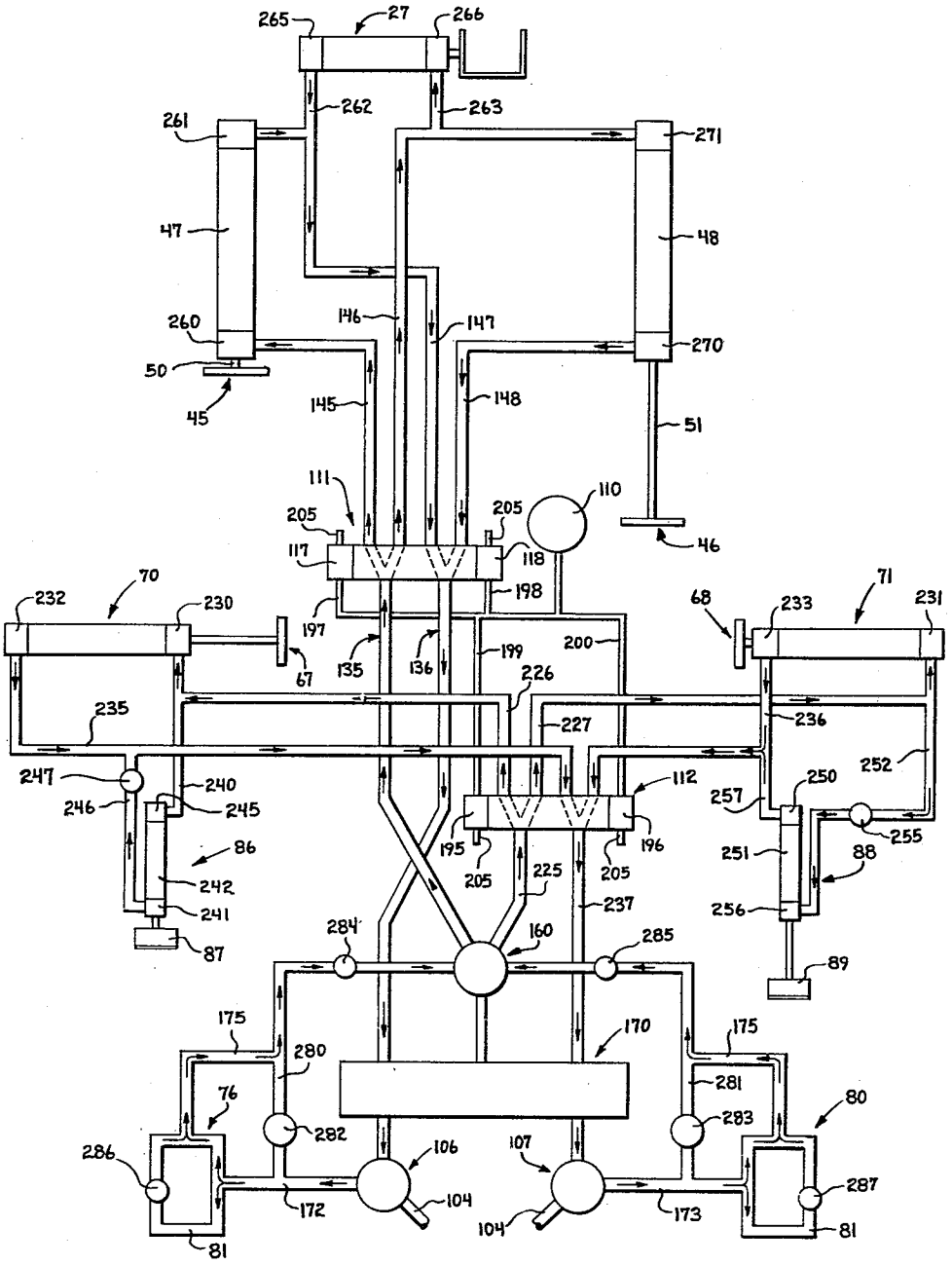


Fig. 7.

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SNOW REMOVAL APPARATUS

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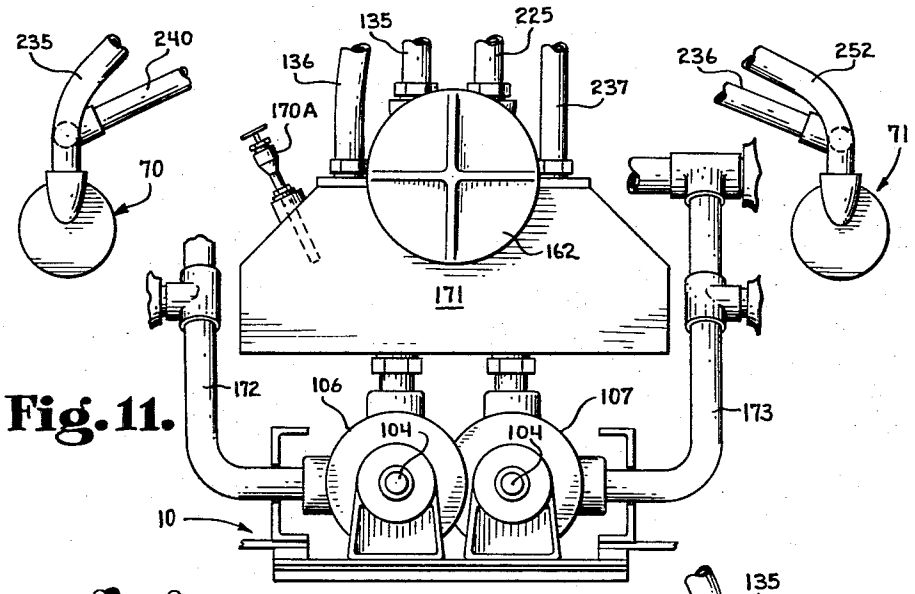


Fig. 11.

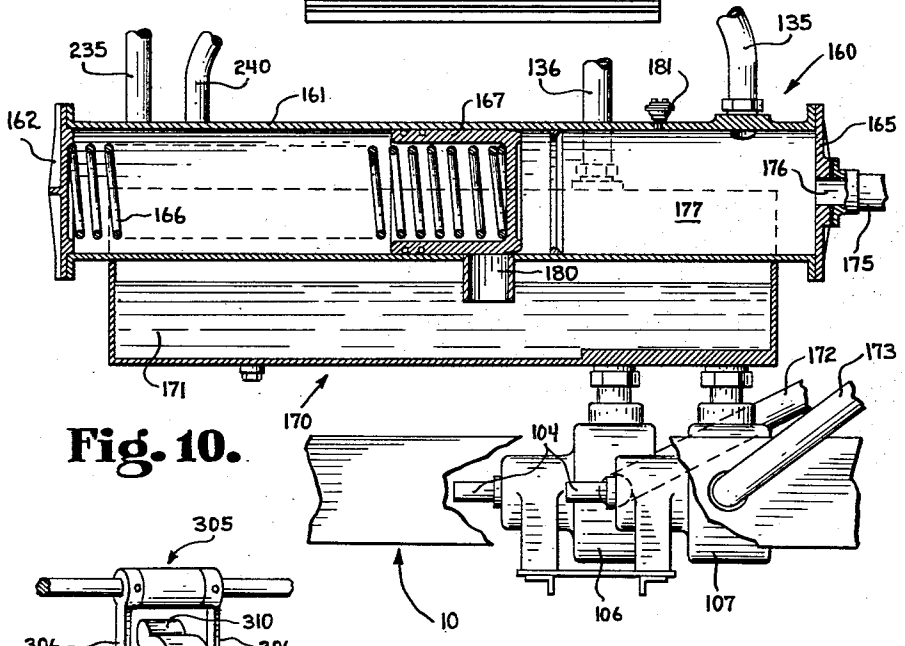


Fig. 10.

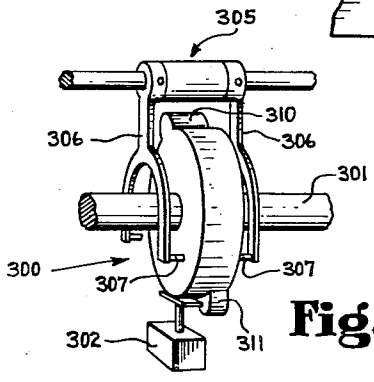


Fig. 12.

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United States Patent Office 3,149,428 Patented Sept. 22, 1964

3,149,428

SNOW REMOVAL APPARATUS

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Filed May 28, 1962, Ser. No. 197,947
8 Claims. (Cl. 37—10)

The present invention relates to snow compacting apparatus and to certain subcombinations thereof.

Various apparatus is available for clearing snow from streets, highways and the like. Most such devices operate on a "plowing" principle whereby the removed snow is thrown to the sides of the street or highway. Such a method poses a problem especially in large cities and other locations where there is little extra space because the plowed snow takes up space and may block sidewalks, building entrances and the like. Consequently, one object of the present invention is to provide improved means for collecting and compressing snow to a fraction of its original volume whereby space is saved.

A further object of the invention is to provide snow compacting apparatus of novel and improved construction.

Another object of the present invention is to provide snow compacting apparatus incorporating means for compressing the snow into rectangular blocks whereby it may be easily stacked and handled.

Still another object of the present invention is to provide novel snow compacting apparatus incorporating an improved hydraulic valve.

A further object of the invention is to provide an improved hydraulic valve.

Still a further object of the invention is to provide hydraulic snow compacting apparatus incorporating novel means for cooling the hydraulic fluid.

Related objects and advantages will become apparent as the description proceeds.

One embodiment of the invention comprises a snow compacting device including a first conduit having a reduced sized extrusion orifice at one end, a second conduit leading downwardly and opening into said first conduit adjacent said extrusion orifice, a first piston reciprocal in said second conduit to force material in said second conduit into said first conduit, said first piston being projectable toward said first conduit to a position closing off said opening, a second piston reciprocal in said first conduit to force material through said extrusion orifice, means for placing material in said second conduit, and control means for actuating said first piston to project to said position and to hold said position while said second piston projects.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

FIG. 1 is a side elevation of a snow removal vehicle embodying the present invention.

FIG. 2 is a rear elevation of the vehicle of FIG. 1.

FIG. 3 is an enlarged vertical section taken along the line 3—3 of FIG. 2 in the direction of the arrows.

FIG. 4 is a vertical section taken along the line 4—4 of FIG. 3.

FIG. 5 is a fragmentary top plan view of a portion of the structure illustrated in FIG. 1.

FIG. 6 is a electrical schematic of the illustrated embodiment of the invention.

FIG. 7 is a schematic diagram of the hydraulic circuit of the illustrated embodiment.

FIG. 8 is a transverse section of a hydraulic valve forming a part of the circuit illustrated in FIG. 7.

FIG. 9 is a section taken along the line 9—9 of FIG. 8 and including the axis of the valve.

FIG. 10 is a side elevation of a portion of the hydraulic system including an accumulator and associated structure.

FIG. 11 is an end elevation of the structure of FIG. 10.

FIG. 12 is a fragmentary perspective view of an alternative form of control system for the present invention.

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Referring now more particularly to the drawings, there is illustrated a truck **10** having a conventional snow blower **11** mounted on the front end thereof. The snow blower **11** may be, for example, a Snow Master BB Blower manufactured by Sicard Industries, Inc., of Watertown, New York. The particular illustrated Sicard blower is provided with an elongated truck loading chute **12** which is rotatably mounted upon the frame **15** of the blower for pivoting about an axis **16**. As is suggested in FIG. 5, the chute **12** is pivotal between the solid line position and the dotted line position so that the exhaust end **17** of the chute can discharge into either of two inlet conduits **20** and **21**. In general, the snow blower **11** functions to collect the snow which is in front of the truck as the truck moves forwardly, to move the snow inwardly toward the chute by screw conveyor **14**, and to then move the snow upwardly through the chute **12** by means of a blower, the snow exhausting at the discharge end **17** of the chute.

The discharge end **17** of the chute is supported by a roller **22** which is rotatably mounted upon the bracket **23** which is, in turn, secured to the chute **12**. The roller **22** travels transversely of the vehicle upon a pad **25** fixed to the upper surface of the snow compacting apparatus housing **26**. The chute **12** is moved back and forth between the solid and dotted line positions of FIG. 5 by a hydraulic cylinder **27** fixed to the upper surface of the housing **26** and having a piston rod **30** secured to the chute **12**.

Referring to FIG. 4, certain details of the snow compacting apparatus are illustrated as including the pair of conduits **20** and **21** which are supported upon the frame or bed **31** of the truck. More particularly, the conduits **20** and **21** include lower or base walls **32** and **33** having secured to their upper ends an upwardly pointed divider member **35**. The conduits **20** and **21** further include front and rear walls **36** and **37** which are fixed with relation to the frame **31**. The conduits **20** and **21** terminate at vertically extending side walls **40** and **41** which are fixed with relation to the frame and which, together with the front and rear walls **36** and **37** and inner walls **42** and **43**, form guide means for vertically reciprocal pistons **45** and **46**.

The inner walls **42** and **43** are fixed with relation to the frame of the apparatus and together with the outer walls **40** and **41** pivotally support the upper ends of hydraulic cylinders **47** and **48**, the piston rods **50** and **51** of which are secured to the pistons **45** and **46** for reciprocation thereof. The pistons **45** and **46** can travel between two vertically spaced positions one of which is shown in FIG. 4 for the piston **45** and the other of which is shown for the piston **46**. As will become evident below, the piston **45** is always down when the piston **46** is up and vice versa so that first one side of the snow compacting machine is operating, then the other side is operating. Thus, the snow discharge chute **12** is arranged to first discharge snow into the conduit **20** when the piston **45** is up or going up and to then discharge snow into the

conduit 21 when the piston 45 is up or is going up after which the cycle is repeated. It can be appreciated that such operation prevents the collection of an excessive amount of snow in one or the other of the conduits 20 or 21. The movement of the chute 12 also prevents excessive stacking of the snow in any one spot.

A pair of further conduits 55 and 56 are mounted upon the frame 31 and include base walls 57, outside walls 60, inside walls 62 and top walls 65, all of which are fixed with relation to the frame 31. A piston 67 and a piston 68 are reciprocal, respectively, within the conduits 55 and 56. The pistons are reciprocated by means of hydraulic cylinders 70 and 71 which are fixedly mounted upon the frame 31 by mounting members 72 and 73 and are connected to the pistons 67 and 68 by means of piston rods 75.

The opposite sides of the snow compacting apparatus are identical with the exception that they are operatively connected so as to operate alternately. Thus, when the pistons 45 and 67 are in the down and rearward position of FIG. 3, the pistons 46 and 68 are in the upward and forward position shown or suggested for the pistons 45 and 67 in FIG. 4.

The conduits 55 and 56 further include (during certain periods of the operation) the lower face of the pistons 45 and 46. Thus, as shown in FIG. 3, the piston 45 moves to its lowermost position compacting snow therebeneath and then the piston 67 is driven rearwardly of the vehicle further compacting the snow and forcing it into an extruder 76 fixed with relation to the frame and having its entrance end 77 in registry with the conduit 55. An identical extruder 80 is fixed to the frame on the other side of the snow compacting apparatus and is similarly arranged with respect to the conduit 56. Referring to the extruder 76 which is representative of both, a jacket 81 is provided having conduits 82 therethrough for passage of oil which is used in the hydraulic system of the present embodiment.

Because of the heat caused by friction in the hydraulic system, the oil becomes heated and must be cooled. By passing the oil through the jacket 81 of the extruder, the oil is cooled and a crust is formed on the outside of the extruded snow. This crust is formed by reason of the fact that snow is first melted at its extreme exterior and then refrozen as it moves out of the exit end 85 of the extruder.

At the exit end of each extruder, there is mounted a chopper 86 and 88 which includes a depending blade 87 and 89 vertically reciprocal within an opening defined by a housing member 90 fixed to the rear end of the extruder. Each of the blades 87 is vertically reciprocated by a hydraulic cylinder 91 and 92. It should be mentioned that each of the blades 87 has a tapered and pointed lower chopping portion 95. Thus, the action of the chopper is more in the nature of an ice pick to split or crack the compacted snow (or ice) 96 along the plane 97 after a certain amount thereof has moved out of the extruder 76 or 80. The block 96 of compacted snow or ice then travels downwardly on a chute 100 or 101 and drops to the street. The ice can then be picked up by further trucks or alternatively can be deposited from the chute 100 or 101 directly onto a wagon or the like possibly incorporating a conveyor 99 and towed by the truck 10.

A cab 105 is mounted upon the rear end of the truck bed 31 whereby a machine operator can control the operation of the snow compacting apparatus and also can control any conveyor or loader that conceivably would be incorporated in a wagon towed by the truck 10. In general, the truck 10 is conventional with the possible exception that it is provided with power take-offs 104 adapted to drive the pumps 106 and 107 (FIG. 7) which may be mounted on the truck at any desired location. Also, the truck should incorporate a low-speed transmission whereby the truck speed may be geared down to

one and one-half to two miles per hour at maximum engine power. Also provided is a conventional air compressor 110 (FIG. 7) which may be mounted at any convenient location on the truck.

Referring more particularly to FIG. 7, there is illustrated schematically valves 111 and 112 which are identical and each of which is provided for one side of the snow compacting apparatus. A representative one of the valves 111 is shown in FIGS. 8 and 9 and includes a housing made up of end plates 113 and 114 bolted to a generally cylindrical portion 115. The end plates 113 and 114 have central openings 116 therethrough which permit the passage of air under pressure. Solenoid operated valves 117 and 118 are mounted at each end of the valve 111 so as to control the entrance of air into the openings 116.

Reciprocal within the cylinder 115 is a piston 120 having cylindrical portions 121 and 122 at its opposite ends which receive piston rings 123 and 125 at suitable peripheral recesses therein. Thus, the air under pressure conducted into the cylinder 115 through the openings 116 does not leak past the cylindrical portions 121 and 122 and instead functions merely to transfer the piston from the rightward end of the cylinder 115 (as shown in FIG. 9) to the leftward end of the cylinder and vice versa.

The piston 120 is provided with passages 130, 131 and 132. Each of the passages 130, 131 and 132 is forked at its upper end into two passages. For example, the passage 131 as shown in FIG. 8 forks into the passages 131A and 131B. The passage 130 extends from its upward and leftward end (as viewed in FIG. 9) downwardly and rightwardly, diverges into two passages 130B which are on opposite sides of the passage 131 and again converges into a single passage which merges with the passage 132. A pair of conduits 135 and 136 which are flexible at their portions 137 and 138 are connected to the piston 120 at the lower ends of the passages 131 and 132, respectively. The upper ends 140 and 141 of the conduits 135 and 136 are rigid and slide within an elongated opening 142 in the bottom of the cylinder 115. The conduit ends 140 and 141 thus function as guide means together with the elongated slot 142 preventing the piston 120 from rotating in the cylinder 115.

When the piston is in the rightward position illustrated in FIG. 9, the passages 130A and 130B are in communication with conduits 145 and 146 and the passages 131A and 131B are in communication with the conduits 147 and 148. If the piston is moved to the leftward end of its travel as viewed in FIG. 9, the coupling is reversed. In other words, the passages 131A and 131B are coupled to the conduits 145 and 146 and the passages 132A and 132B are coupled to the conduits 147 and 148 (as suggested in FIG. 7). Since the passages 130 and 132 are in communication with one another, movement of the piston from one end of its travel to the other merely reverses the coupling of the conduits 135 and 136 to the conduits 145 and 146 and the conduits 147 and 148.

Referring more particularly to FIGS. 10 and 11, the details of an accumulator 160 illustrated schematically in FIG. 7 are shown. The accumulator includes a cylinder 161 which is fixedly mounted upon the vehicle and has end plates 162 and 165 fixed thereto. The end plate 162 is closed and has a compression spring 166 bearing thereagainst. The other end of the compression spring is received within and bears against a piston 167 which is reciprocal within the cylinder 161. The cylinder 161 is fixedly secured to a reservoir 170 which is partially filled with oil 171 and is open to the atmosphere through a breather and oil gauge 170A. Oil is continuously pumped from the reservoir 170 by the pumps 106 and 107, the oil passing through the pumps and through conduits 172 and 173 into the jackets 81 of the extruders 76 and 80.

The oil then passes from the extruders 76 and 80 into conduits 175 into the cylinder 161, it being noted that

the end plate 165 has an opening 176 therethrough for the passage of the oil. The accumulator 160 maintains the oil pressure within the pressure chamber 177 relatively constant by means of the piston 167 and a bypass conduit 180 leading from the cylinder 161 into the reservoir 170. When the pressure within the pressure chamber 177 increases excessively, the piston 167 is forced leftwardly as viewed in FIG. 10 to a position permitting passage of the oil into the reservoir through the bypass 180 thus reducing the pressure of the oil. The piston 167 can also move rightwardly in the cylinder 161 as the pressure in the pressure chamber 177 decreases. Since the spring rate of the compression spring 166 is constant, a given position of the piston 167 always corresponds to the given pressure of the oil within the pressure chamber 177.

Referring to FIG. 6 as well as FIG. 10, the accumulator 160 is provided with a pressure switch 181 which opens whenever the pressure within the pressure chamber falls below a certain predetermined value. Opening of the switch 181 cuts off the hydraulically operated apparatus in a manner to be described so that the pressure of the oil in the pressure chamber can be increased by the pumps 105 and 107.

In FIG. 6, there is schematically illustrated a D.C. motor 182 which is controlled as to speed by a variable resistor 185. The cab 105 of the snow compacting machine is provided with a lever (not shown) which may be manually operated to change the setting of the variable resistor 185. When the switch 181 is open, the motor 182 receives no current from the battery 186 and thus, stops rotation. When the switch 181 is closed, the motor does operate and does rotate at a speed determined by the setting of the variable resistor 185.

The motor 182 is provided with four cams 187, 188, 189 and 190 mounted on the drive shaft thereof. Each of the cams 187–190 is associated with a respective one of solenoid valves 117, 118, 195 and 196. The valves 117, 118, 195 and 196 are identical and may be, for example, Type 8317 Asco valve manufactured by Automatic Switch Company, of Florham Park, New Jersey. Each of these valves 117, 118, 195 and 196 is a solenoid operated valve which controls a pneumatic line 197, 198, 199 and 200, respectively. Each of these valves includes a vent 205 to atmosphere which is connected to one of the openings 116 of either the hydraulic valve 111 or the hydraulic valve 112 when the respective valve 117, 118, 195 or 196 is unactuated. The valves 117, 118, 195 and 196 include spring means which normally retain the valves in the unactuated position. When in such an unactuated position, the pneumatic valves close off the discharge end of the pneumatic conduits 197–200 thus preventing leakage therefrom.

When any of the valves 117, 118, 195 or 196 is actuated by its solenoid 206, 207, 208 or 209, respectively. the vent 205 to atmosphere is closed off and the air pressure conduit 197–200 of the respective valve is coupled to the respective opening 116 whereby the piston 121 of the valve 111 or 112 is forced away from the respective valve 117, 118, 195 or 196.

Referring to FIGS. 6 and 7, the apparatus is shown schematically as being in a given dynamic operating position. In this position, the chute 12 is positioned over the conduit 20 by reason of the fact that the hydraulic motor 27 is retracted. The vertically movable snow compacting piston 45 is in its uppermost position and the extrusion piston 67 is projected. The other vertically movable snow compacting piston 46 is projected into a downward position and the horizontal extrusion piston 68 is in a retracted position as shown.

The electrical circuitry and structure of the present device is in the position shown in FIG. 6, that is with the raised portion of the cam 190 projecting downwardly so as to close the switch 215, thus energizing the solenoid 209 of the pneumatic valve 196 causing air pressure from the compressor 110 to be conducted through the hose 200 into the rightward end of the valve 112 forcing the piston thereof leftwardly. The various other cams 187–189 are positioned as shown in FIG. 6 with the raised portion of the cam 187 90° away from actuation of the switch 215, with the raised portion of cam 188 270° away from actuation of the switch 217 and with the raised portion of the cam 189 180° away from actuation of the switch 218.

When the valve 112 is so actuated by the pneumatic valve 196, the pressure line 225 leading from the accumulator 160 to the valve 212 is connected through the valve to the pressure lines 226 and 227 which read respectively to one end 230 anad 231 of piston motors 70 and 71, respectively. Such pressure from the accumulator tends to retract the piston 67 of the piston motors 70 and to project the piston 68 of the piston motor 71, the opposite ends 232 and 233 of the piston motors 70 and 71 being connected to atmosphere through the lines 235 and 236 which lead into the valve 112 and are coupled by the valve 112 to atmospheric pressure line 237 coupled to and conducting flow into the reservoir 170.

The pressure from the valve 112 and through the line 226 is also coupled to a line 240 which is connected with one end 245 of the piston motor 242 of the chopper 85. Such pressure causes the blade 87 of the motor to be projected, the opposite end 241 of the motor being coupled to atmosphere through the reservoir 170, the line 237, the valve 112, the line 235 and the line 246. Such projection of the piston motor 85 causes the blade 87 to be forced downwardly in order to chop or strike the compacted snow being extruded from the extruder 76. It will be noted that a valve 247, which is manually operated, controls the flow through the line 245. This valve 247 is in the cab 105 so that the operation of the chopper 86 can be cut off if desired and the chopper held in up position. Thus, if the valve 247 is closed when the chopper 85 is up, hydraulic fluid between the valve and piston and in the piston will lock the blade in up position even though there is pressure above atmosphere in line 240.

The pressure line 227 is connected to one end 256 of the motor 251 of the chopper 88 by means of hose 252. Similarly to the chopper 86, the hose 252 is controlled by a manually operated valve 255 located within the cab 105. The opposite end 250 of the motor 251 is connected through a conduit 257 to the line 236 which as explained above is at atmospheric pressure. Thus, at the instant of operation here discussed, blade 89 is down but is being raised out of the path of the extruder piston 68 so that compacted snow can be forced out of extruder 80.

As above mentioned, it is assumed that the apparatus is in operation and that the motor 182 is rotating the cams 187–190. During the next 90° of rotation of the motor, the piston 67 is retracted and the piston 68 is projected. The speed of retraction of piston 67 will be relatively constant because the pressure hoses to and from the motor 70 are of a constant size and the pressure within the accumulator 160 is relatively constant. The speed of projection of the piston 68 can vary because of the fact that there may be a greater or lesser amount of snow being compacted by this piston. The apparatus is designed, however, in such a way (the pressure hoses are of such diameter and the accumulator pressure is of such a value) that the maximum amount of snow that might be compressed (the most dense snow) will slow down the projection of the piston 68 only to such an extent as to cause the piston to occupy the time of a one-quarter rotation of the motor 182 when the motor is operating at top speed as determined by the position of the variable resistor 185. Similarly, the pressure conduits or hoses leading to and from the motor 70 of the piston 67 should be designed in such a way (be of such diameter) as to insure that the piston is retracted within 90° rotation of the motor 182 when the motor is rotating at top speed.

Assuming, therefore, that the motor 182 rotates through

90° in a given time interval, the pistons 27 and 67 will be retracted and the piston 68 will be projected. Such retraction of the piston 67 moves it out of the way of the snow entering the conduit 20 so that the snow can drop downwardly into the conduit 55. Such projection of the piston 68 forces the already partially compacted snow in the conduit 55 to be further compacted and forced rearwardly of the vehicle through the extruder 80 so that it passes out of the snow compacting device in the form of a rectangular highly compressed solid block. When the cam 190 moves away from the switch 215, the switch returns to its open position, thus cutting off air pressure flow to the pneumatic valve 195. Such cutting off does not, however, have any effect on the position of the valve 112 but does leave it free to be actuated by the pneumatic valve 195 and the pneumatic pressure hose 199.

Thus, when the motor has rotated the above mentioned 90°, the raised portion of the cam 187 engages the switch 216 closing it and energizing the solenoid 206 associated with the pneumatic valve 117. The valve 117 then is actuated by the solenoid to allow pressure from the line 197 to pass through the valve and into the opening 116 at the leftward end of the cylinder 115. The piston 120 is then forced to the rightward position illustrated in FIG. 9 wherein the conduit 135 is connected with the conduits 147 and 148 and the conduit 136 is connected with the conduits 145 and 146. Thus, the pressure in the line 145 will drop to atmosphere and the end 260 of the piston motor 47 will be at atmospheric pressure.

The line 147 which was previously at atmosphere will then be pressurized through the line 135 leading from the accumulator and pressure will thus be supplied to the end 261 of the piston motor 47. The line 262 connected to the line 147 and the line 263 connected to the line 146 will cause high pressure and atmospheric pressure, respectively, to be conducted to the ends 265 and 266, respectively, of the chute motor 26 causing the chute to be transferred from the position shown in FIG. 4 to a position over the conduit 21. The pressure hoses are of such size and the pressure from the accumulator is of such level as to cause the chute to occupy a certain amount of time in moving from its position as shown in FIG. 4 to a position over the conduit 21. During this time of movement, the piston 46 is retracting in order to get out of the way of the snow which will be deposited in the conduit 21 by means of the chute 12. It should be understood that the fact that the pistons 68 and 46 are projected does not make impossible the reception of snow in the conduit 21. When the pistons 46 and 68 are retracted, then the snow can move downwardly in the conduit 21 and into the conduit 56 (assuming piston 68 is retracted).

As mentioned, the piston 46 retracts. This retraction is produced by high pressure in the conduits 148 and atmospheric pressure in the conduit 146, these conduits leading respectively to the end 270 and the end 271 of the piston motor 48.

Projection of the piston motors 27 and 47 and the retraction of the piston motor 48 is accomplished within 90° rotation of the motor 182. Thus, the cam 187 moves away from the switch 216 at the beginning of such 90° rotation allowing the switch to open and causing the valve 117 to return to its previous position with the leftward end of the cylinder 115 at atmospheric pressure through the vent 205 and with the pressure conduit 197 cut off by the valve 117. At the completion of such second 90° rotation of the motor, the switch 218 is closed by the projected portion of the cam 189, thus energizing the solenoid 208 and actuating the pneumatic valve 195 admitting pressure to the leftward end of the hydraulic valve 112 from the pressure line 199 and cutting off the atmospheric vent 205. The valve 112 is therefore caused to reverse the connection of its hydraulic lines and to connect the hydraulic pressure line 225 to the hydraulic lines 235 and 236.

Simultaneously, the atmospheric line 237 is connected to the lines 226 and 227. Such reversal of pressure causes the piston motor 70 to exert pressure on the pistons 67 in an effort to project the piston and causes the piston motor 71 to exert pressure on the piston 68 urging it to retract. It should be noted that the piston 45 is now projected and in the position shown in FIG. 3 wherein the lower face of the piston 45 forms a part of the wall of the conduit 55. Thus, the snow which was in the conduit 20 and below the piston 45 is compacted and is ready for further compaction and extrusion by the piston 67. Furthermore, the projection of the piston 67 scrapes the bottom face of the piston 45 removing the snow therefrom.

It is not believed to be necessary to describe the further 180° rotation of the motor 182 (to complete the cycle) inasmuch as the operation produced thereby is identical to the above described operation with the exception that the one side of the machine is performing the functions described above for the opposite side of the machine.

In FIG. 7, it will be noted that a by-pass line 280 connects the lines 172 and 175 and a by-pass line 281 connects the lines 173 and 175. These by-pass lines are controlled by thermostatically operated valves 282 and 283, the respective thermostats 284 and 285 of which are mounted within the pressure lines 175 of the extruders 76 and 80 just upstream of the accumulator 160. When the temperature of the oil, sensed by, for example, the thermostat 285, rises above a given desired value, the thermostat of the valve 282 closes the by-pass valve 282 causing all the oil to go through the extruder 76. If the ambient temperature is very warm, this operation might serve to melt a substantial portion of the snow so that the extruded blocks will not be as heavy and difficult to dispose of.

The temperature of the extruders also plays a part in their operation. If this temperature falls below a given value, then the outer coating of the snow will not be melted by the extruders in order to freeze again as ice after extrusion to provide a hard coat for the compacted blocks. Consequently, further thermostats 286 and 287 may be provided in the jackets of the extruders to close the respective by-pass valves if the temperature of the extrusion jackets drops below a predetermined value.

The above described embodiment provides one compression action of the vertical pistons for one compression action of the horizontal pistons. The speed of the above described device is, of course, controlled by the operator in the cab who controls the variable resistor 185 so that compactions occur more or less rapidly. In FIG. 12 there is illustrated a further embodiment which is identical to the above described embodiment except that the projections of the vertical pistons occur twice as often as the projections of the horizontal pistons if such operation is desired by the operator.

In FIG. 12, there is illustrated a cam 300 which corresponds to one of the cams 187 or 188 in FIG. 6. It will be remembered that the cams 187 and 188 are associated with the pneumatic valves 117 and 118, respectively, which are associated with hydraulic valve 111. The hydraulic valve 111, of course, controls the projection and retraction of the vertical pistons 45 and 46. The embodiment of FIG. 6 includes a cam shaft which is not movable axially with relation to the motor 182. The embodiment of FIG. 12 includes a cam shaft 301 which is movable axially with relation to the motor of the embodiment and which is also movable axially with relation to the switch 302 which corresponds to either the switch 216 or 217. The cam 300 is fixed upon the shaft 301 and may be moved axially by rightward or leftward movement of the actuating arrangement 305 which includes yokes 306 each having inwardly project-

ing pusher pads 307 for engaging the surface of the cam.

When the cam is in the position shown in FIG. 12, rotation of the shaft 301 causes the raised portion 310 to produce one actuation of the switch 302 for each complete rotation of the cam. The cam 300 may be moved axially leftwardly as viewed in FIG. 12 to a position wherein one complete rotation of the cam 300 produces two actuations of the switch 302 by the raised portion 310 and the raised portion 311 which is spaced 180° about the cam with relation to the raised portion 310. The embodiment of FIG. 12 is identical to the embodiment of FIG. 6 as regards the cams 189 and 190, each of these cams having only a single raised portion for actuating its respective switch. This raised portion would extend the complete thickness of the cam as does the raised portion 310 in FIG. 12. The embodiment of FIG. 12 includes an additional cam similar to the cam 300 but with its raised portions located oppositely on the shaft 301. In other words, the raised portion having a half thickness similar to the raised portion 311 is spaced 180° from the raised portion 311 while the full thickness raised portion corresponding to the raised portion 310 is located at 180° to the raised portion 310. It will be appreciated that when the shaft 301 is in the axial position of FIG. 12, the operation of the device is identical to the above described device. When the shaft 301 is moved axially leftwardly so that the raised portion 311 actuates the switch 302, the operation of the device of FIG. 12 will be identical to the above described operation except that the vertical snow compacting pistons 45 and 46 will reciprocate twice for every single reciprocation of the horizontal snow compacting and extruding pistons 67 and 68. For certain types of snow conditions, the later type of operation may be desirable. For example, if the snow is very light and fluffy, it will require a greater amount of compaction than when the snow is very dense. This greater compaction will be provided by the double reciprocations of the vertical pistons prior to the extrusion by the horizontal pistons.

From the above description, it will be obvious that the present invention provides snow compacting apparatus of novel and improved construction. It will also be clear that the present invention includes means whereby the snow is compacted to a fraction of its original volume, thus saving space. It should be further evident that the present invention provides means for compacting the snow into rectangular blocks whereby it may be easily stacked and handled.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention and the scope of the claims are also desired to be protected.

The invention claimed is:

1. A snow compacting device comprising a conduit having an extrusion orifice at one end and an opening adjacent said one end, a liquid carrying jacket around said conduit at said one end, a first piston reciprocal to force material into said conduit through said opening, said first piston being projectible toward said conduit to a position closing off said opening, a second piston reciprocal in said conduit to force material through said extrusion orifice, a hydraulic system for projecting and retracting said pistons, said hydraulic system leading through said liquid carrying jacket for cooling the hydraulic fluid and heating the extruded material, and control means for actuating said first piston to project to said position and to hold said position while said second piston projects.

2. A snow compacting device comprising a first conduit having a reduced sized extrusion orifice at one end, a liquid carrying jacket contacting and surrounding said first conduit at said one end, a second conduit leading downwardly and opening into said first conduit adjacent said extrusion orifice, a first piston reciprocal in said second conduit to force material in said second conduit into said first conduit, said first piston being projectible toward said first conduit to a position closing off said opening, a second piston reciprocal in said first conduit to force material through said extrusion orifice, means for placing material in said second conduit, a hydraulic system for projecting and retracting said pistons, said hydraulic system leading through said liquid carrying jacket for cooling the hydraulic fluid and heating the extruded material, and control means for actuating said hydraulic system to project said first piston to said position and to hold said first piston in said position while said second piston projects.

3. A snow compacting device comprising an extruder, hydraulically operated means for pressurizing snow within said extruder for the extrusion thereof from said extruder, said extruder having a liquid carrying jacket therearound, said hydraulically operated means incorporating ducts leading into and out of said liquid carrying jacket whereby the hydraulic fluid of said means can be cooled in said liquid carrying jacket.

4. The snow compacting device of claim 3 additionally comprising a by-pass hydraulic conduit in parallel with said extruder and a valve controlling flow through said by-pass conduit thermostats in said system and extruder controlling said valve and normally maintaining said valve open except when the temperature of the hydraulic fluid in the system rises above a predetermined value or the temperature of the extruder falls below a predetermined value.

5. A snow compacting machine comprising a vehicle, a pair of extruders mounted on said vehicle, a pair of horizontally extending conduits mounted on said vehicle, each of said conduits leading into a respective extruder, a pair of sloping conduits fixed to said vehicle, said sloping conduits having upper ends which open upwardly and are contiguous, said sloping conduits extending outwardly and downwardly to open into respective ones of said horizontally extending conduits immediately adjacent said extruders, a pair of vertically reciprocal pistons mounted on said vehicle, each of said pistons being projectible into a respective one of said sloping conduits to a position flush with and closing off the opening of the respective sloping conduit into the respective horizontal conduit, a pair of horizontally reciprocal pistons mounted on said vehicle and each received in a respective one of said horizontal conduits for projection toward the extruders and across the vertical reciprocal piston associated with the respective conduit to force the snow out of the respective extruder, means mounted on said vehicle for picking up snow as the vehicle moves and for depositing it into the upper ends of said sloping conduits, and control means for actuating said pistons to project one of said vertically reciprocal pistons, then the horizontally reciprocal piston associated therewith, then the other vertically reciprocal piston, then the horizontal piston associated therewith, said control means also operating to actuate said depositing means to alternately deposit snow in each of the two upwardly opening conduits.

6. A snow compacting machine comprising a vehicle, a pair of extruders mounted on said vehicle with their extrusion orifices facing rearwardly of the vehicle and having a rectangular cross section, a liquid carrying jacket integral with and surrounding said extruders, a pair of horizontally extending conduits mounted on said vehicle, each of said conduits leading into a respective extruder, a pair of sloping conduits fixed to said vehicle, said sloping conduits having upper ends which open upwardly and are contiguous, said sloping conduits extending outwardly and downwardly to open into respective ones of said horizontally extending conduits immediately adjacent said extruders, a pair of vertically reciprocal pistons mounted on said vehicle, each of said pistons being projectible into a

respective one of said sloping conduits to a position flush with and closing off the opening of the respective sloping conduit into the respective horizontal conduit, a pair of horizontally reciprocal pistons mounted on said vehicle and each received in a respective one of said horizontal conduits for projection toward the extruders and across the vertical reciprocal piston associated with the respective conduit to force the snow out of the respective extruder, a hydraulic system for projecting and retracting said pistons, said hydraulic system leading through said liquid carrying jacket for cooling the hydraulic fluid and heating the extruded material, means mounted on said vehicle for picking up snow as the vehicle moves and for depositing it into the upper ends of said sloping conduits, and control means for actuating said hydraulic system to project one of said vertically reciprocal pistons, then the horizontally reciprocal piston associated therewith, then the other vertically reciprocal piston, then the horizontal piston associated therewith, said control means also operating to actuate said depositing means to alternately deposit snow in each of the two upwardly opening conduits.

7. A snow compacting machine comprising a vehicle, a pair of extruders mounted on said vehicle with their extrusion orifices facing rearwardly of the vehicle and having a rectangular cross section, a pair of horizontally extending conduits mounted on said vehicle, each of said conduits leading into a respective extruder, a pair of sloping conduits fixed to said vehicle, said sloping conduits having upper ends which open upwardly and are contiguous, said sloping conduits extending outwardly and downwardly to open into respective ones of said horizontally extending conduits immediately adjacent said extruders, a pair of vertically reciprocal pistons mounted on said vehicle, each of said pistons being projectible into a respective one of said sloping conduits to a position flush with and closing off the opening of the respective sloping conduit into the respective horizontal conduit, a pair of horizontally reciprocal pistons mounted on said vehicle and each received in a respective one of said horizontal conduits for projection toward the extruders and across the vertical reciprocal piston associated with the respective conduit to force the snow out of the respective extruder, and means mounted on said vehicle for picking up snow as the vehicle moves and for depositing it into the upper ends of said sloping conduits, and control means for actuating said pistons to project one of said vertically reciprocal pistons and simultaneously retract the other of said vertically reciprocal pistons, and then to project the horizontally reciprocal piston associated with said one vertically reciprocal piston and simultaneously retract the other of said horizontally reciprocal pistons, and then to project the other vertically reciprocal piston and simultaneously retract the one vertically reciprocal piston, and then to project the horizontal piston associated with the other vertically reciprocal piston and simultaneously retract the one horizontally reciprocal piston, said control means also operating to actuate said depositing means to alternately deposit snow in each of the two upwardly opening conduits.

8. A snow compacting machine comprising a vehicle, a pair of extruders mounted on said vehicle with their extrusion orifices facing rearwardly of the vehicle and having a rectangular cross section, a pair of horizontally extending conduits mounted on said vehicle, each of said conduits leading into a respective extruder, a pair of sloping conduits fixed to said vehicle, said sloping conduits having upper ends which open upwardly and are contiguous, said sloping conduits extending outwardly and downwardly to open into respective ones of said horizontally extending conduits immediately adjacent said extruders, a pair of vertically reciprocal pistons mounted on said vehicle, each of said pistons being projectible into a respective one of said sloping conduits to a position flush with and closing off the opening of the respective sloping conduit into the respective horizontal conduit, a pair of horizontally reciprocal pistons mounted on said vehicle and each received in a respective one of said horizontal conduits for projection toward the extruders and across the vertical reciprocal piston associated with the respective conduit to force the snow out of the respective extruder, and means mounted on said vehicle for picking up snow as the vehicle moves and for depositing it into the upper ends of said sloping conduits, and control means for actuating said pistons to project said vertically reciprocal pistons twice for every single projection of said horizontally reciprocal pistons, said control means also operating to actuate said depositing means to alternately deposit snow in each of the two upwardly opening conduits.

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