United States Patent

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[54] **EXPLOSIVE BLAST-ACTUATED LIQUID DISTRIBUTORS FOR IRRIGATING APPARATUSES AND PROCESSES OF OPERATION THEREFOR**

22 Claims, 19 Drawing Figs.

[52] **U.S. Cl.** **239/11,** 239/129, 239/177
[51] **Int. Cl.** **B05b 3/00**
[50] **Field of Search** 103/249, 250; 417/73, 74; 239/11, 177, 129

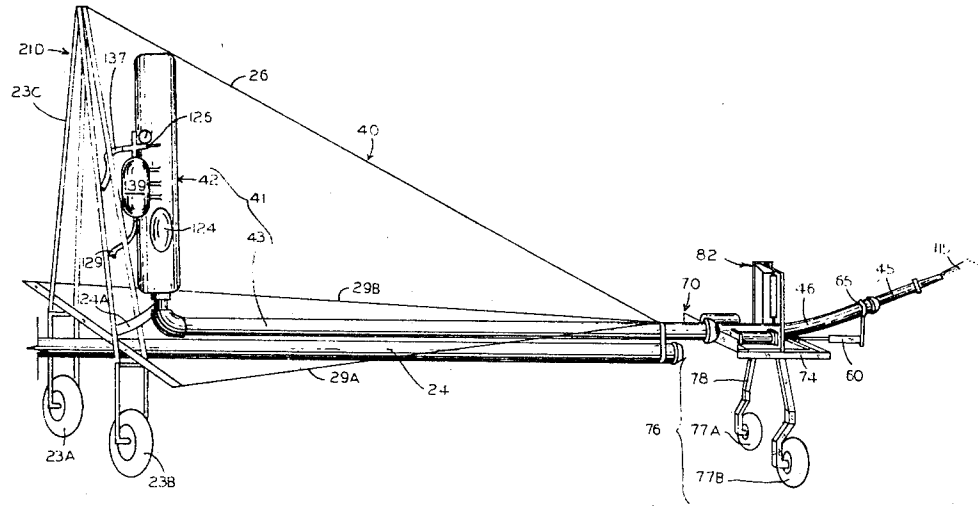
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Primary Examiner—Lloyd L. King
Assistant Examiner—John J. Love
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ABSTRACT: An explosive blast-actuated liquid-distributing assembly is transported by and located at or near and operatively connected to the radial or outer end tower of a circular irrigation system for applying successive increments of water as a spray to successive sectors of corner areas extending to substantial distances from the end of that circular irrigating system.



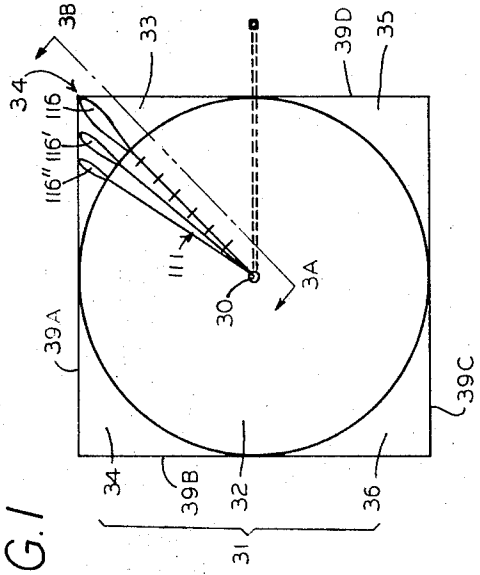


FIG. 1

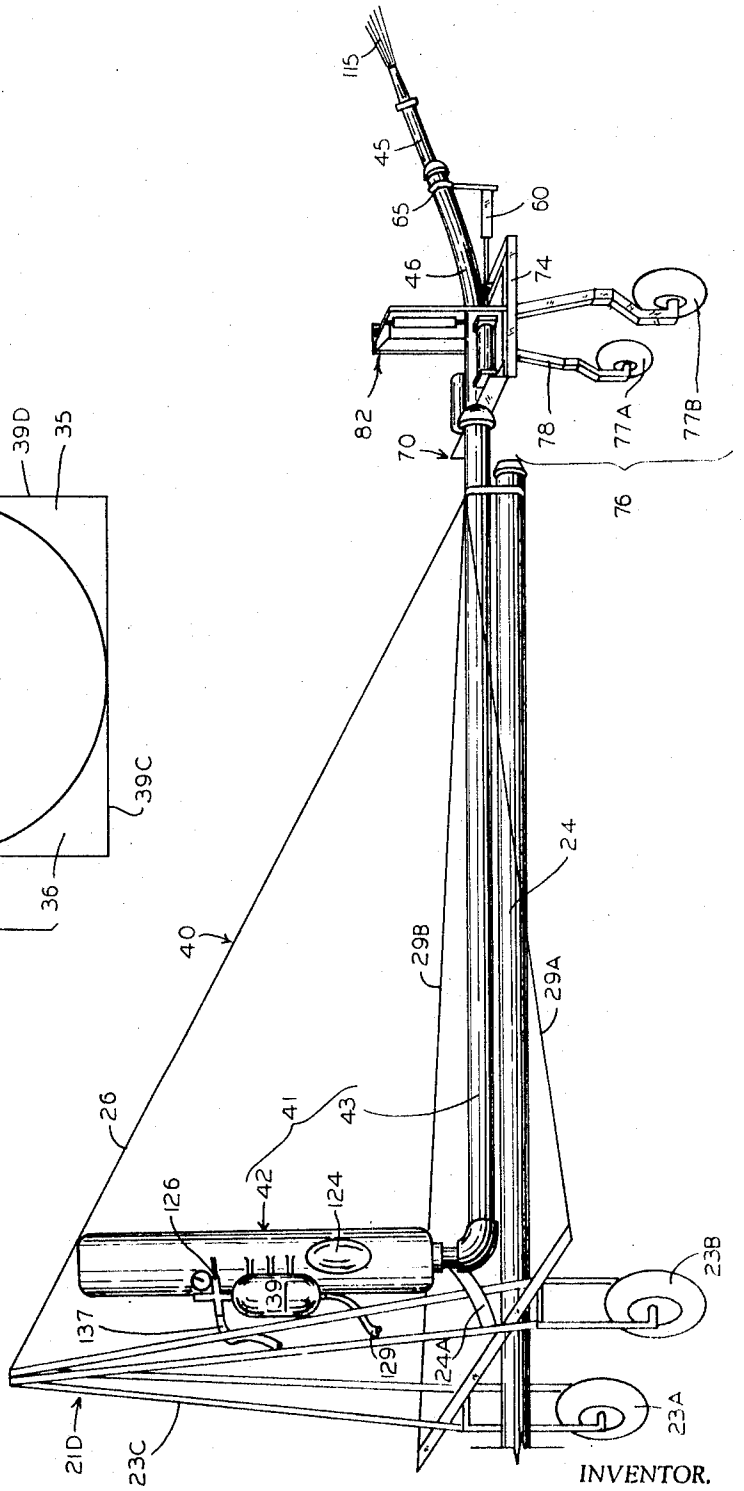


FIG. 2

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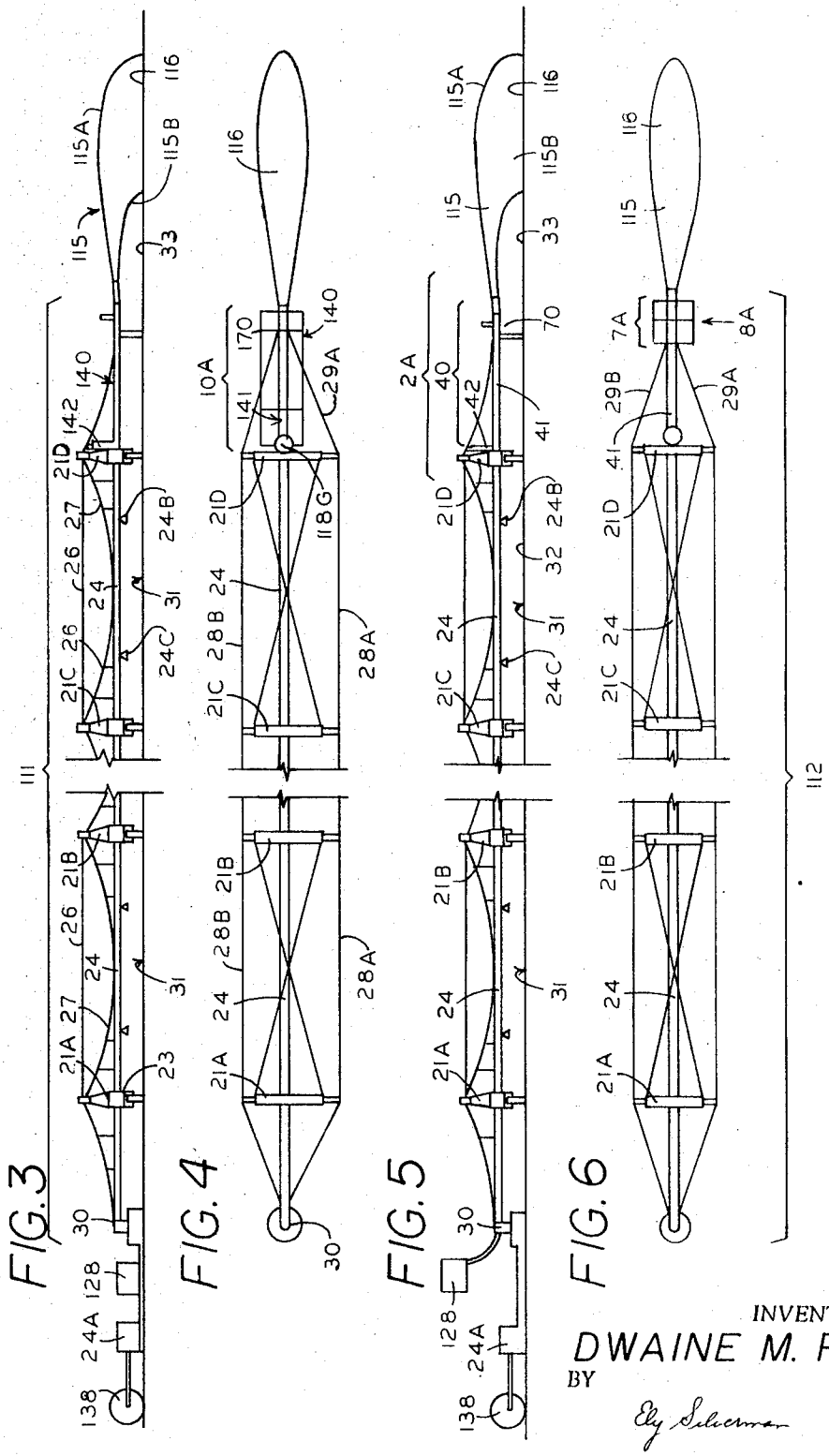


FIG. 3

FIG. 4

FIG. 5

FIG. 6

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FIG. 7

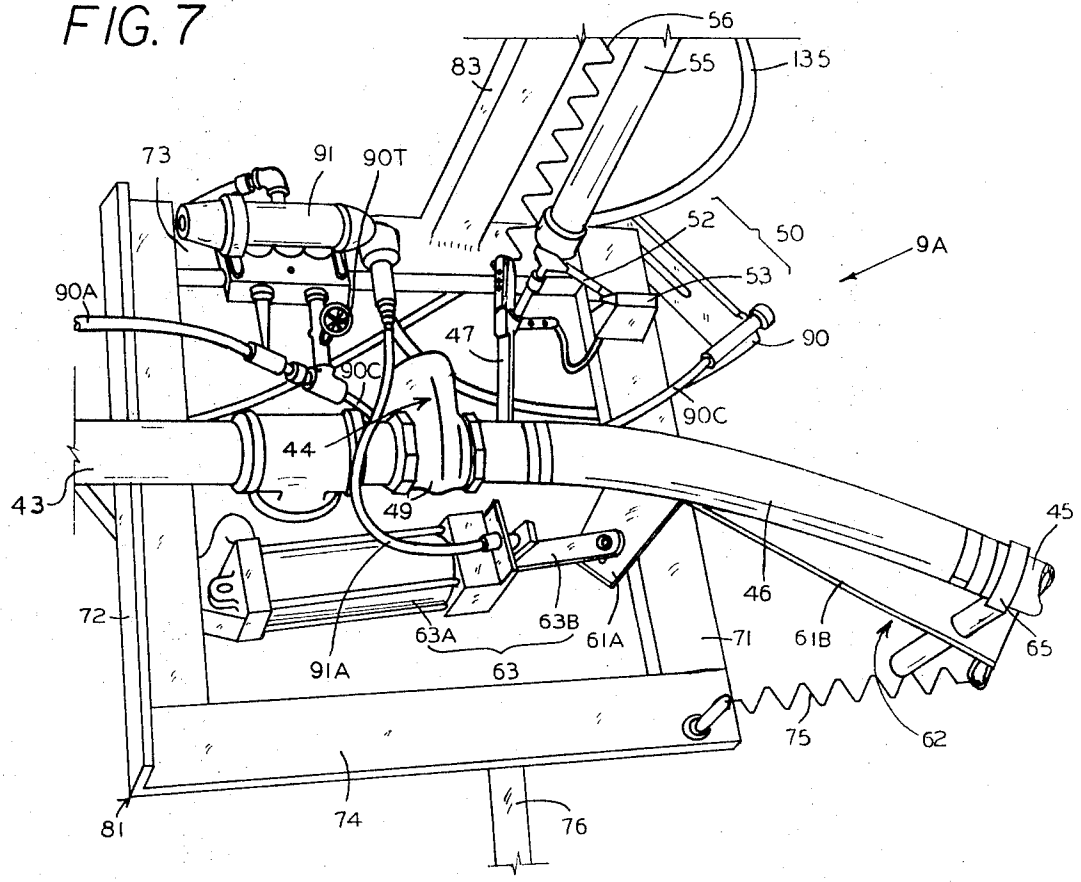
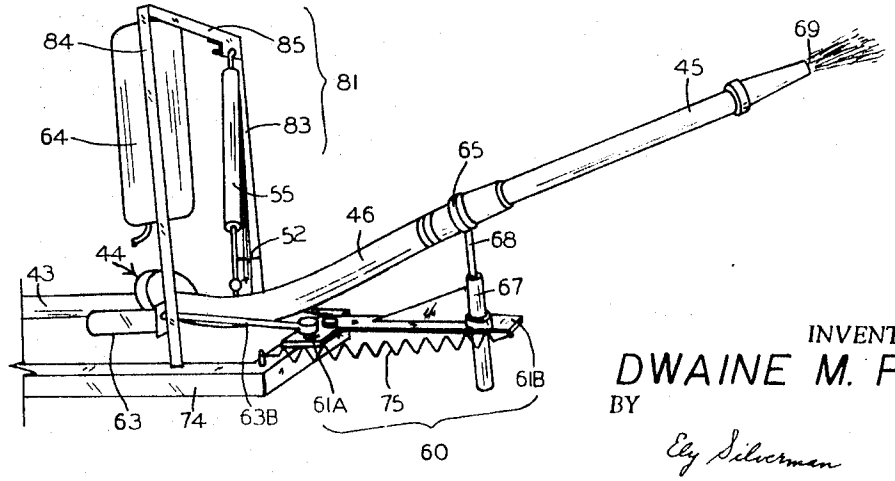


FIG. 8



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FIG. 9

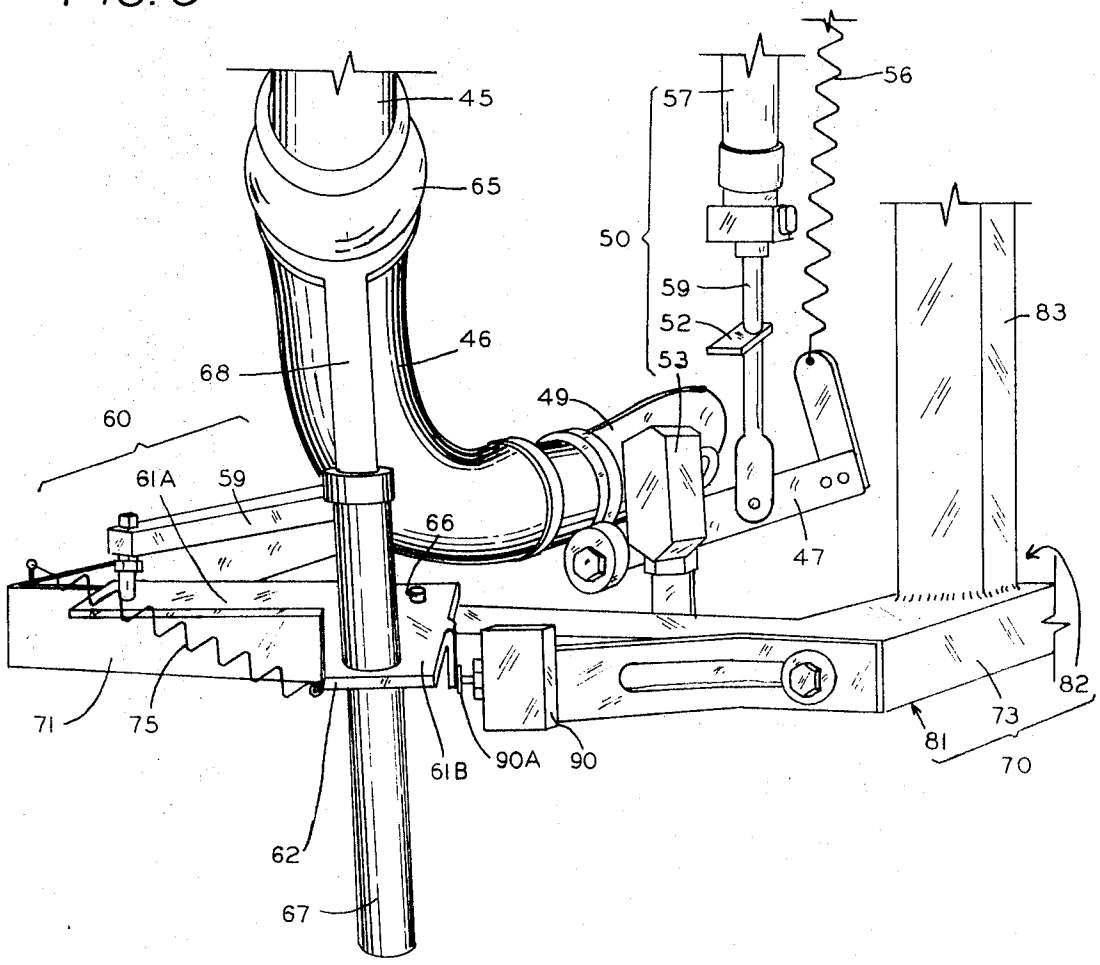
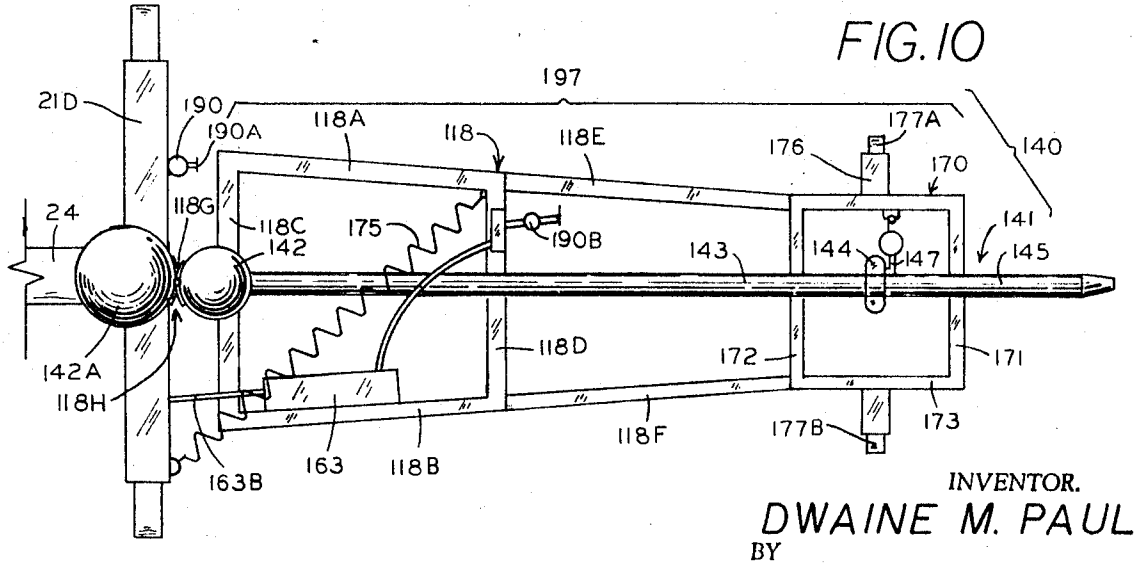
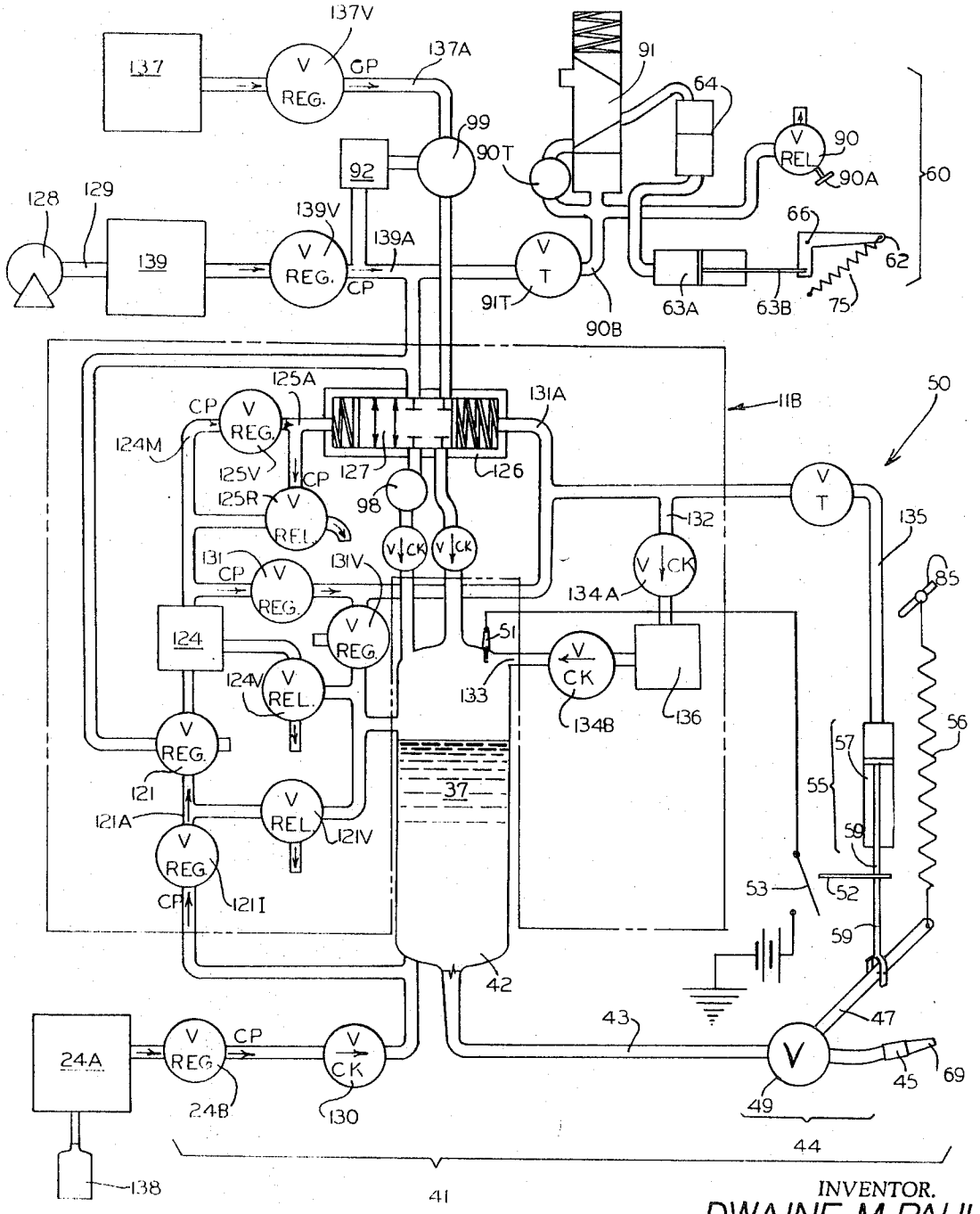


FIG. 10



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FIG. 11

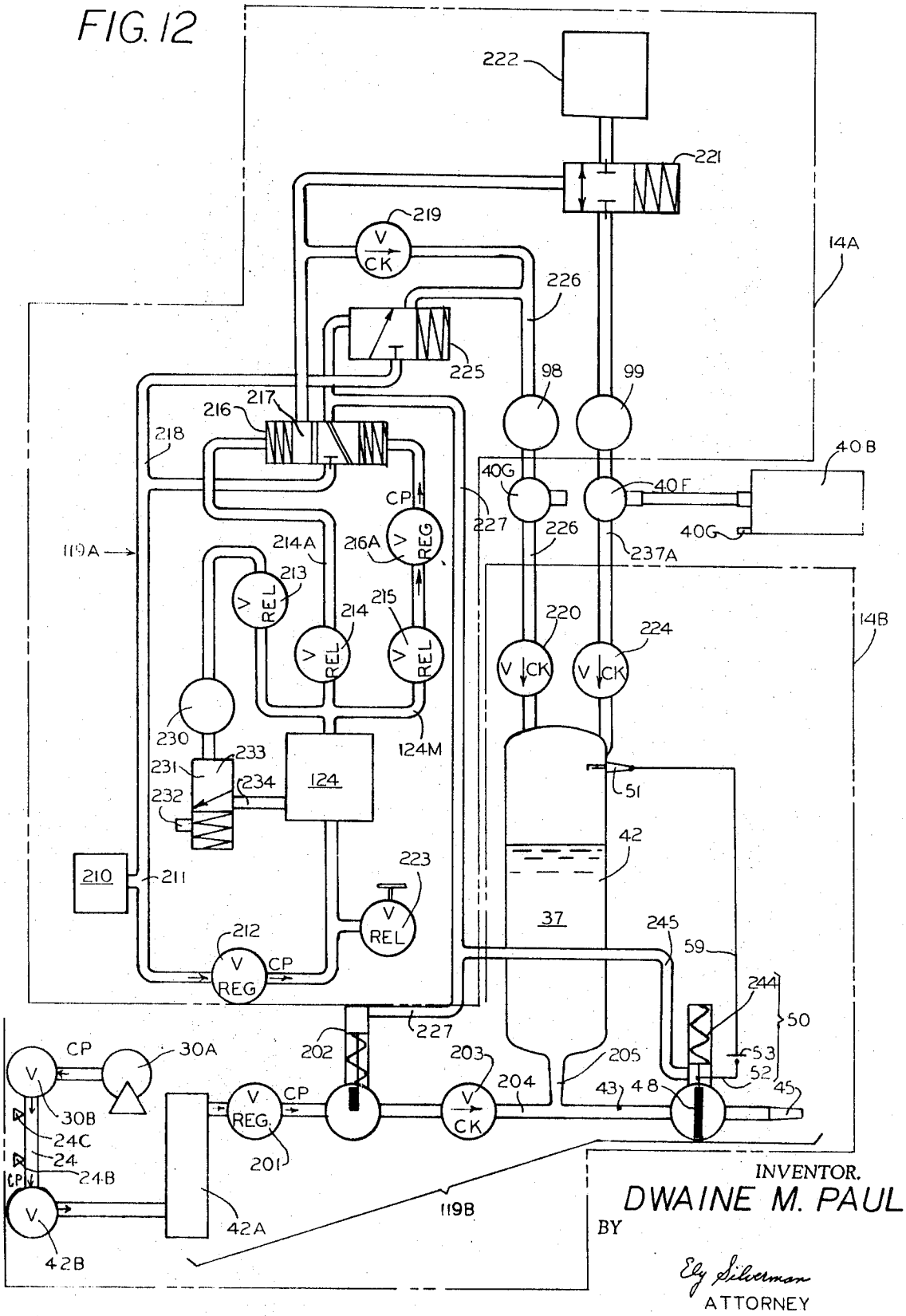


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FIG. 12


222
221
219
V CK
14A
226
225
98
99
216
217
218
40B
40G
40F
CP
227
REG
214A
216A
119A
213
REL
214
215
220
224
CK
14B
230
124M
231
233
234
232
124
51
42
210
211
223
37
245
59
212
CP
244
50
202
227
203
205
53
52
204
43
48
45
30A
30B
24C
24
24B
201
42A
119B
42B
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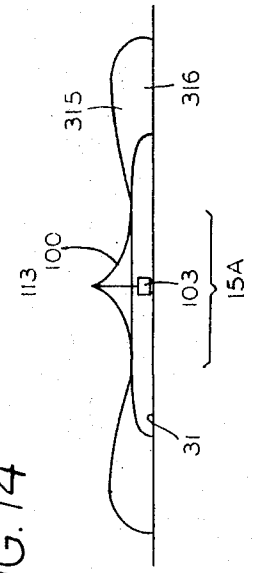


FIG. 14

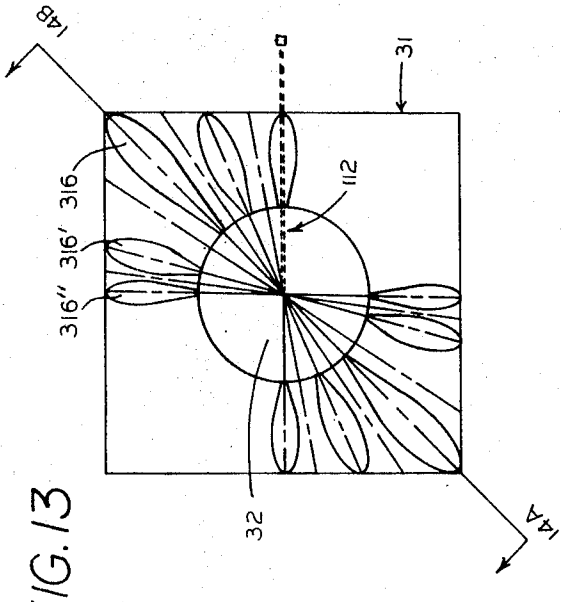


FIG. 13

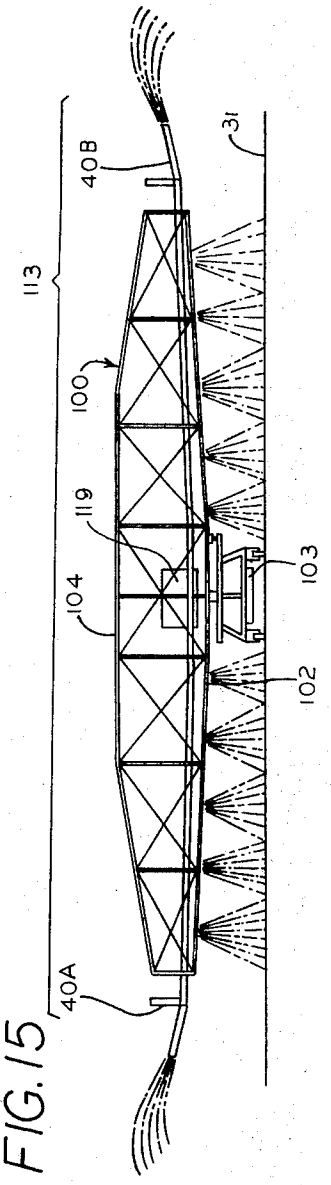


FIG. 15

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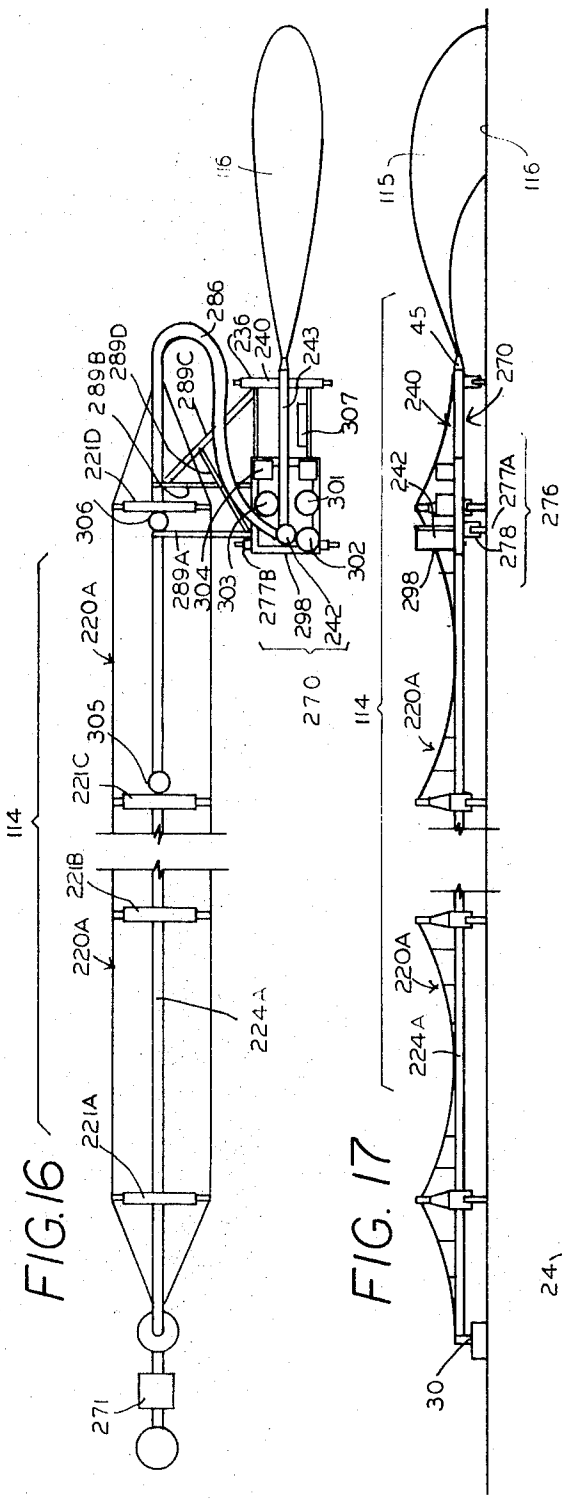


FIG. 16

FIG. 17

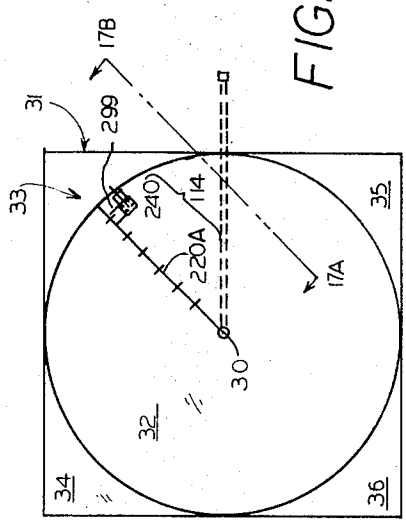


FIG. 18

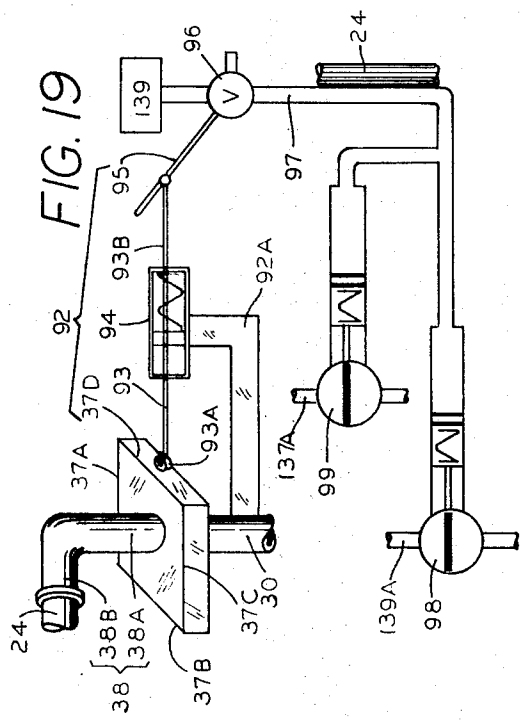


FIG. 19

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EXPLOSIVE BLAST-ACTUATED LIQUID DISTRIBUTORS FOR IRRIGATING APPARATUSES AND PROCESSES OF OPERATION THEREFOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field of this invention is fluid-sprinkling apparatus comprising spraying means carried by a substantially horizontal supply conduit constrained to move about a center fixed to or supported on the ground and having vehicular support means to permit motion of the apparatus during spraying.

2. Description of the Prior Art

The prior art in circularly rotating sprinkler irrigation systems has not met the detriment thereof that such systems cover only approximately 78.6 percent of the area in the center of square fields in which such systems are located. In large scale operations this failure to cover 21.4 percent of the agriculturally productive area is a serious problem. The quantitative aspects of the problem have been not realized and/or not met as loss of area between the corner of a square to a circle therein amounts to 138 acres in each section of land. Flood irrigation is not as uniform, beneficial or effective as spraying to cover that peripheral 21 percent.

In order to create a pressure that will project water as a spray to such corner areas including points 544 feet distant from termination of a 1,320 foot long radial boom a large amount of power is required and large stresses are produced in a water distribution pipe to carry pressures of sufficient magnitude to provide distribution by spraying from a nozzle at the radial end thereof. In view of the substantial volumes of water required in commercial sprinkler irrigation; such stresses require a pipe system and supporting station system that would be economically prohibitively heavy and expensive.

According to this invention the problem of the prior art is met by a system which is light in weight, can be run with or without electricity and is effective, economic and reliable.

SUMMARY OF THE INVENTION

Each of a successive series of interrupted streams or jets of water is periodically projected for 100 to 550 feet peripheral to the area covered by a rotary sprinkler irrigation apparatus to provide a spray of water to each of a series of neighboring narrow radially elongated sectors of a corner area of a noncircular field. The water is projected as elongated initially narrow jets for a sufficiently long time and while the nozzle forming the jetstream is substantially stationary so as to suffer minimum resistance by the air through which the stream passes, yet is of sufficiently short duration to reach the ground as a spray. The source of high-pressure energy or power for these intermittent repeated jets is separate from the source of power for the continuous gentler low-pressure power required to spray the circular area central to the corner areas but a conduit supported in the rotary sprinkler apparatus is used to deliver the water to the position at which each jet is formed therefrom and the rotary sprinkler apparatus provides support and/or transportation for the jet-producing unit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top of plan view of the overall pattern of operation of two types of apparatus according to this invention.

FIG. 2 is a side view of one explosive blast liquid-distributing assembly 40 according to this invention shown in zone 2A of FIG. 5.

FIG. 3 is a view through a vertical plane as 3A—3B of FIG. 1 of one embodiment, 111, of apparatus according to this invention, the cooperative combination of a circularly moving self-propelled sprinkling irrigating apparatus as 20 and one explosive blast liquid-distributing water assembly 140 according to this invention.

FIG. 4 is a top view of the array of apparatus shown in FIG. 3.

FIG. 5 is a view through a vertical plane as 3A—3B of FIG. 1 of another embodiment of apparatus, 112, according to this invention, the cooperative combination of a circularly moving self-propelled sprinkling irrigating apparatus as 20 and another embodiment of explosive blast liquid distributor water assembly 40 according to this invention.

FIG. 6 is a top view of the apparatus shown in FIG. 5.

FIG. 7 is an enlarged top view of the apparatus shown in zone 7A of FIG. 6 with the nozzle 45 bent in a clockwise direction.

FIG. 8 is an enlarged side view taken along the direction of arrow 8A of FIG. 6 showing, in enlarged view, zone 7A of FIG. 6 with axis of nozzle 45 in the flat vertical plane including longitudinal axes of the collimator tube 43 of the explosive blast liquid distributor assembly 40 and of the chamber 42.

FIG. 9 is a front view of apparatus shown in FIGS. 7 and 8 taken along the direction of arrow 9A in FIG. 7 with the nozzle 45 bent, as seen from above, to approximately its most counterclockwise position.

FIG. 10 is an enlarged top view of apparatus shown in zone 10A of FIG. 4.

FIG. 11 and 12 are diagrammatic representations of two different valve timing mechanisms for the explosive blast liquid distributor assemblies herein described. FIGS. 11 and 8 correspond in respect to array of assembly 60.

FIG. 13 is a plan view of the pattern of operation and water distribution of another embodiment 113 of apparatus according to this invention comprising the cooperative combination of a circularly moving self-propelled sprinkling apparatus 100 and explosive blast liquid distributor water assemblies 140A and 140B according to this invention.

FIG. 14 is a view along the vertical plane 14A—14B of FIG. 13.

FIG. 15 is an enlarged view of zone 15A of FIG. 13.

FIG. 17 is a view through a vertical plane as 17A—17B of another embodiment 114 of apparatus, according to this invention, the cooperative combination of a circularly moving self-propelled sprinkling apparatus, as 20, and another embodiment of explosive blast liquid distributor water assembly 240 according to this invention.

FIG. 16 is a top view of the array of apparatus shown in FIG. 17.

FIG. 18 is a plan view of the pattern of operation and water distribution of embodiment 114.

FIG. 19 is a diagrammatic representation of the gas volume control assembly 92.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Broadly, the apparatus of this invention comprises the cooperative combination of a self-propelled rotary sprinkling irrigating apparatus (as 20 or 100) and an explosive blast liquid-distributing water system assembly (as 40, 140 or 240) for operation on a square field, 31.

In one embodiment, 112, of this invention, shown in FIGS. 5, 6 and 2 the self-propelled sprinkling irrigating apparatus as assembly 20 hereinbelow described is about 1,600 feet in length and is composed of a plurality of radially spaced-apart wheeled stations supporting a string of pipe that extends radially and horizontally from a central pivot point, as 30. An assembly 40 is supported at the radial end of assembly 20 and is operatively connected thereto.

In another embodiment, 113, of the invention, shown in FIGS. 13, 14 and 15, a relatively short (50—150 feet long) length of horizontally extending pipe 102 pivotally supported at its center on a wheeled station 103 is provided with an upper supporting frame 104. Frame 104 of assembly 100 supports an assembly 104A and 140AB (identical to 140) at each end of the pipe 102 and operatively connected thereto. Other embodiments 111 and 114 are also described hereinbelow.

The apparatus 20 is a rotary self-propelled sprinkling irrigation apparatus, generally as shown in U.S. Pat. No. 2,604,359 and driven by hydraulic power, but may be electrically

powered as in U.S. Pat. No. 1,419,925; includes a central water supply pipe 30 and a generally horizontally extending water distributing pipe 24 operatively and pivotally connected to the central supply pipe and movable around the central supply pipe as a vertical axis; a plurality of movable stations 21A, 21B, 21C and 21D are disposed at spaced positions along the distributing pipe and a plurality of discharge nozzles are spaced along the distributing pipe 24 for spraying water on to the land as the distributing pipe moves around the central water supply pipe; each of the stations as 21D comprise a pair of wheels as 23A and 23B rotatably and operatively connected to a vertically extending tower as 23C. A cable system as 25 comprises longitudinally extending upper tower cables as 26 and diagonally extending vertical cables as 27 that extend in a vertical plane and lengthwise horizontally extending cables as 28A and 28B and diagonal horizontal cables as 29A and 29B that extend in diagonal horizontal cables as 29A and 29B that extend diagonal planes between the towers and the pipe 24. Each of the towers as 23A are supported on the ground contacting support therefor, as wheels 23B and 23C, and are provided with a motor operatively connected to the wheels and to a position-sensitive power control source and in operation travels in a circular path about the central pivot pipe; counterclockwise being regarded as forward in the below description.

In the combination of apparatus 111 shown in FIGS. 3 and 4 the explosive blast liquid-distributing assembly 140 is in part attached to and supported on the portion of pipe 24 radial to terminal station as 21D of the apparatus 20 and in part supported by and attached to the tower 23A and in part supported on a carriage assembly 76 thereof.

The explosive blast liquid distributing assembly 40 comprises a water discharge assembly 41, an ignition and timing control subassembly system 50, a nozzle-positioning subassembly 60 and a frame subassembly 70 in operative combination.

The water discharge assembly 41 comprises a vertically extending cylindrical hollow combustion chamber 42, a collimator tube 43, a nozzle control valve 44, a nozzle assembly 45.

The combustion chamber 42 assembly is a hollow vertically extending rigid circular cylindrical chamber rounded at its upper and lower ends and connected at its bottom through a discharge opening therein to a collimator tube 43 by a smoothly rounded elbow. Valves 126, 121 and other valves shown in FIG. 11 in box indicated as 11B are supported on the outer cylinder wall of chamber 42 and form timing valve assembly 119A.

The collimator tube 43 is a rigid cylindrical tube of uniform cross section along its length and with the axis thereof horizontal and, at its inlet end, intersects the longitudinal vertical axis of the chamber 42. A nozzle control valve 44 at the other, outlet, end (right-hand end as shown in FIGS. 2, 7 and 8) of the collimator tube 43 is operatively connected thereto. The inlet end of a flexible nozzle tube 46 is operatively connected to the outlet of valve assembly 44 and the inlet of nozzle 45 is operatively connected to the outlet end of tube 46. A valve control arm 47 is operatively connected to the normally closed closure element or gate 48 of the valve 44; the gate 48 is movably mounted on the frame 49 of the conventional valve assembly 44 which is normally closed, and opened by assembly 50.

The nozzle 45 is supported on the nozzle-positioning assembly 60 on the nozzle frame assembly 70.

The nozzle frame assembly 70 comprises a horizontal box frame 81 firmly attached to a vertical frame 82, and a carriage assembly 76. The box frame 81 comprises lateral beam member 71, central beam member 72, front beam member 73 and a rear beam member 74, firmly joined together in the form of a hollow box. The vertical frame 82 has the general shape of an inverted "U" having a vertical forward member 83 and a vertical rear member 84 joined to the members 73 and 74 respectively and the horizontal top member 85 joining the tops of the members 83 and 84. A carriage assembly 76 is attached to the bottom of members 73 and 74 below members 83 and 84. That assembly comprises a rigid wheel supporting frame 78 which supports ground contacting wheels 77A and 77B, the wheels are rotatably supported in the frame with their axes parallel to tube 43.

The ignition and timing control subassembly system 50, comprises, in operative combination, a spark plug 51 and a nozzle control valve and timer piston assembly 55 and a spark switch 53, and a timing valve assembly 119A.

The piston assembly 55 comprises a rigid piston shaft 59 in a vertical cylindrical piston casing 57, the upper end of casing 57 is pivotally held by arm 85 of box 81. Piston shaft 59 is movable lengthwise within casing 57 to move outward of that casing 57 and is pivotally joined at its outer end to control arm 47 of valve 44 at the central portion of that arm; a rigid switch contact arm 52 is firmly attached to the lower end of shaft 59. A tension spring 56 is attached to the outer end of arm 47 and to member 85. Hence, the piston shaft 59 moves in opposition to the force of the piston spring 56. The valve 47 is thus normally closed. The spark plug 51 is firmly attached with a combustion tight fit into the top of the combustion chamber 42. Spark timer arm 52 is a rigid horizontally extending ear located on the water discharge control valve piston shaft and movable therewith to contact and actuate the spark switch 53; the spark plug switch is connected to a voltage source 54 so that, on movement of the timer arm 52 into contact with the spark plug switch 53 the voltage 54 is applied to the spark plug 51 to initiate combustion in the combustion chamber 42.

The control valve piston 55 operates on the control valve arm 47 to open the gate valve 44 slightly prior to the spark plug arm 52 contacting and closing the spark plug switch 53 and causing ignition in the combustion chamber 42.

The nozzle-positioning assembly 60 comprises, in operative connection, a rigid L-shaped nozzle-positioning bracket 62 operatively connected to nozzle-positioning drive piston 63, a supplementary positioning oil piston 64, a nozzle clamp 65 and a nozzle-positioning elevator bracket 67. The nozzle 45 is operatively connected to the front end of a flexible watertight nozzle tube 46. The L-shaped nozzle-positioning bracket 62 is formed of a rigid driving arm 61A and a driven arm 61B pivotally supported at a pivot pin 66 therefor on the member 71 of the nozzle frame 70. A spring 75 is attached at one end to the corner whereat member 71 and 74 of the frame 70 join and is attached at its other end to the outer end of the arm 61B to draw it clockwise as shown in FIG. 7. Bracket 67 is supported at end of arm 61B. A nozzle-positioning drive piston 63 has a rigid piston chamber casing therefor 63A firmly yet pivotally fixed on to the frame 70 and a piston shaft 63B extending therefrom is pivotally attached to arm 61A of the bracket 62. Nozzle clamp 65 which is firmly attached to the nozzle 45 is supported in a vertical adjustment sleeve or bracket 67 from which a rigid elevator rod 68 which projects and adjusts vertically and on which (elevator rod) the clamp 65 is firmly attached and supported. A lock screw fixes the portion of rod 68 in bracket 67.

In operation the drive piston 63 is moved by air passing through two-way control valve 91 and timing throttle valve 91T, to slowly move the bracket 62 about its pivot pin 66 and thus over a period of time ranging from 2 to 6 minutes and usually of about 4 minutes, rotates the arm 62 from the extreme clockwise position shown in FIG. 7 to the extreme counterclockwise position thereof shown in FIG. 9. Contact of bracket arm 62 and pin 90A of release valve 90 releases the pressure applied to piston 63 (as shown by the piping diagram of FIG. 11) and then the bracket 62 is returned to its starting position of FIG. 7 by spring 75.

A release valve switch 90 is operatively connected to the piston 63 by a two-way normally open valve 91. After the relatively slow counterclockwise motion of nozzle 45 it is rapidly moved clockwise when the button 90A release valve switch 90 is contacted by the arm 61B when the nozzle has traversed its intended path counterclockwise as shown in FIG. 9.

The elevation of the nozzle is effected by adjustment of elevator rod 68 in the supporting bracket 67.

The nozzle-positioning assembly 60 is located on the nozzle frame 70 as shown in FIGS. 7, 8 and 9. In the position of parts thereshown the actuation of the nozzle piston 63 provides for motion of the nozzle 45 from its clockwise position as shown in FIG. 7 to its counterclockwise position shown in FIG. 9. This travel is performed by overcoming the tension in the spring 75. The controlled motion of the longitudinal axis of nozzle 45 relative to the line of or longitudinal axis of the collimator tube 43 is the method of varying the angle of discharge of the stream of water 115 which is discharged from the nozzle orifice 69 during the operation of the explosive blast liquid-distributing assembly 40 in the combination of apparatus shown in the apparatus 112.

An oil piston 64 may be interposed (as in FIG. 8 and 11) between valve 91 and piston 63 to move the piston 63 more smoothly than by pneumatic power alone. A throttle valve 90T is used in line 90B between valve 91 and piston 63 as well as throttle valve 91T to control the speed of movement of bracket 62 pivotally about pin 66 from position of FIG. 7 to that of FIG. 9.

An air compressor 128 passes compressed air by air line 129 which is attached to and extends along the conduit 24 of the apparatus 20 to air tank 139 located near the chamber 42.

The conduit 24 of the apparatus 20 (or 102 of apparatus 100) is operatively connected via a check valve 130 to the combustion chamber 42. The water in conduit 24 (or 102) is pressurized by a pump as 138. A reservoir 24A and a constant output pressure valve 24B are in line with check valve 130, so the water feeding into tank 42 is at a constant pressure. Air line 139A passes to valve 126 from tank 139. A source of compressed fuel 137 also passes by line 137A to valve 126 on outer wall of chamber 42. The valve diagram of FIG. 11 illustrates the connections of the valves and lines herebelow referred to in respect to their operation.

Constant air pressure at about 100 p.s.i.g. comes into the timer valve 121 and therethrough into the timing or variable pressure tank 124. The air pressure builds up in the timer tank 124. When its pressures reaches 50 p.s.i.g. air passes constant input pressure valve or regulator 125V (which it reaches by manifold line 124M) via line 125A to the slider 127 and moves the control slider 127 in the valve 126 from its normally closed position to the position thereof for the fuel gas and air to enter into the chamber 42. As the air pressure (100 p.s.i.g.) is substantially greater than the 50 p.s.i.g. pressure of the water in the tank 42, the pressure of the gasses causes the check valve 130 to close. The gas which enters into tank 124 and into the tank chamber 42 is at 100 p.s.i.g: when the pressure in chamber 124 reaches 90 p.s.i.g. as sensed by the pilot valve 131 such pressure is passed by line 131A against the other end of the slider 127, and moves the slider 127, overcoming the opposing pressure previously applied thereto of only 50 p.s.i.g. through valve 125V. This slider movement also serves to pass air to the valve control line 135 and thereby to the piston 57 and causes the shaft 59 thereof to move downward. The spark timer arm 52 then contacts the spark switch 53 and causes ignition at the spark plug 51. On ignition the great pressure in the combustion chamber (about 300 p.s.i.g.) forces the water 37 then in the chamber 42 (as below described) and the collimator tube 43 and the nozzle 45 out therefrom as a stream, 115, that passes through the air for a distance of 100 to 550 feet. The outer portion as 115A of the stream is projected for up to 550 feet the lower portion of the stream 115B extends at different times during the portion of such discharge from 10 to 150 feet from the orifice 69. The stream delivers water relatively evenly over a fanlike area 116 that is shaped generally like the upper portion of an exclamation point. At the surface of the ground in the corner areas, as 33, 34, 35 and 36 peripheral to the circular portion 32 of a field 31 covered by the operation of the apparatus 20 this water reaches the ground in the form of a spray of droplets (not a solid stream as used for hydraulic dredging). Stream 115 length varies with apparatus 111 position in field 31.

After the discharge of the water from the nozzle 45, the exhaust gasses created by the combustion in chamber 42 continue to pass out from orifice 69 for a short time, about 1 to 2 seconds.

When the slider 127 passes air to the piston chamber 57 it also passes it to a purge channel 132 which goes to a purge orifice 133 in the chamber 42: purge line 132 is provided with check valves 134A, 134B and a purge storage chamber 136. Accordingly, when the pressure in the combustion chamber 42 falls from combustion pressures as the combustion or exhaust gas reaches the atmosphere, the purge line air is applied thereinto; the relatively small purge tank 136 drives air into and through the chamber 42 and the collimator tube 43 out through the nozzle 45 and thereby exhausts the combustion gasses from that system. This purge operation is a very brief duration of approximately one to 2 seconds but it is adequately long to effect such purge. Concurrently with the purging, immediately after the drive of water by combustion, the water from the pipe 24 pours through the check valve 130 and again proceeds to fill up the tank 42. When the pressure in the chamber 42 rises to combustion value, the pressure in tank 124V, 131V and 121A are released by pilot relief valves 124V, 131V and 121V respectively. Line 125A pressure is released when pressure in line 131A exceeds that of 125A as 125R opens at a preselected selected pressure less than that of line 131A but more than that of line 125: hence, after combustion, slider 127 is moved by the usual valve spring to the normally closed position in regard to the air and fuel passage therethrough into the chamber 42. This disconnection of such line pressure permits bleeding and/or passage of air from the cylinder 57 and the spring 56 attached to the arm 47 then closes the gate 48 of the valve 44 and the pressure of the water in the chamber 42 builds up after pressure of the purge tank is dissipated (it falls to atmospheric). The water then enters tank 42 and traps the air therein and thereabove and the pressure in tank 42 increases as water enters that tank.

The constant pressure input valve regulator 121I concurrently allows air to pass to timer regulator 121 when the pressure in chamber 42 is below a predetermined value of 30 p.s.i.g.: this starts the timing cycle initiated by passage of air (at constant input pressure) from 121 to volumetric or timer tank 124. The adjustment of valve 121 in view of the capacity of timer tank 124 is such that, by the time that the pressure in the variable pressure timer tank 124 is sufficient to reach 50 p.s.i.g. that the amount of water desired to be located in the tank 42 is again up to the usual level and has a sufficient volume to deliver water to cover the area desired by stream 115 discharged from nozzle 69 as shown in FIGS. 4 and 6 and the size of the combustion chamber 42 which is thereabove is adequate to provide sufficient combustion energy to deliver the liquid water to that area. As above described at that point of reaching of 50 p.s.i.g. pressure in the variable pressure tank 124 the pilot valve 125V permits air to pass therepast moves the slider 127 of the valve 126 into the open position and fuel and air pass into the chamber 42 until, as above described, the pressure in chamber 42 as well as 124 rises to a pressure of about 90 lbs. whereupon the tank 124 is connected by line 131A to the slider 127 and shuts off the further flow of gasses through valve 126 into the chamber 42. During this time of passage of combustion gas into chamber 42 the excess in pressure of the gas over that of the water has closed check valve 130 and prevented further movement of the water into the chamber 42. When the valve 131 moves the slider 127 as above described to cut off the further flow of such combustion gas into the chamber 42 the valve 126 also then passes air into the cylinder 57 for movement of the arm 59 and the spark timer arm 52 and 53 to initiate combustion and repeat the cycle above described. The timer valve 121 is adjustable from 0 to 2 minutes and is usually set at 6 seconds for the process above described.

Accordingly, in operation of the apparatus 112 the chamber 42 thus provides for containing explosions which, within a period of about 1½ seconds in each period, (depending upon

the valve arrangements it might have a range of from 1 to 5 seconds) purge the water added to the pipe section 43 through the nozzle 45 and provide for a trajectory of the water so discharged by the explosion in chamber 42 for a distance of up to about 550 feet. The explosion energy is varied to vary the trajectory of such water and that water is distributed on the ground with a pattern that is somewhat egg-shaped with the wide shape of the egg-shaped pattern at the wider distance with a maximum 30-foot width when there is over 150 lbs. of pressure developed by each explosion. Standard nozzles are available as brought out in the L. R. Nelson Manufacturing Company catalog (L. R. Nelson Manufacturing Company, Inc., Irrigation Division for No. BG 693) for trajectories of up to 590 ft. The embodiment 111 herein provides for a recharge time of tube 43 and chamber 42 of about 6 seconds with 40-lb. pressure in the pipe 24. Pressure in chamber 42 automatically actuates water supply cutoff. Each time there is such a water purge 25 to 30 gallons are distributed at a distance of from 20 to 300 ft. distance from the nozzle 45. It is within the scope of the invention that the distance traversed will be proportional to the proximity of the longitudinal axis of the conduit 24 of the apparatus 20 or the like length of the beam supporting the nozzle to the diagonal corner-to-corner axes of the field so that at the positions where the field corners are to be sprayed the distance of the purge trajectory may be varied according to the width of the sector remaining between the circle of the irrigator and the square boundary of square field then to be covered or irrigated. This distance will be proportional to the energy of the explosion for that purge or series of purges which will be, in turn, controlled by the angle of the beam relative to the length and/or width or diagonal axis of the field. One way of controlling this distance is to have the amount of open angle of the valves supplying the gas to the explosion system to vary for the particular series of purges then to be made with the angle of the "beam" with the width or length of the field. It is within the scope of the invention that pressures of the 350 p.s.i. will be easily obtained so that 600-feet feet trajectory distance can be obtained. Nevertheless with only 300-feet trajectory only about 24 acres in a section are not covered using (in 112 or 111) a standard irrigating machine the length of which is about 1,320 feet long from pivot 30 to end of pipe 24 in a square field with a 2,640-foot long edge as 39A of 31.

As shown in FIGS. 9 and 11, arm 52 that actuates the ignition switch 53 that actuate the spark plug 51 for the explosion chamber 42 does not actuate switch 53 until after the valve 44 to the nozzle 45 has first been opened by its crank arm 47. The arm 47 that controls the nozzle valve 45 is actuated by the same shaft 59 as supports the arm 52 and the timing thereby provides for a "flattening out" of the pressure in the explosion chamber 42 by opening the valve 44 to the nozzle 45 prior to the combustion explosion occurring in the chamber 42. Accordingly, the force given to the water as it is ejected on each purge from the nozzle 45 is at a more even rate than it would be without such avoidance of a short peak pressure; this also avoids excessively high mechanical strain on the walls of chamber 42 and tube 43. The slow rate of movement of the nozzle and the very slow (about 1 mile an hour) movement of the peripheral supporting station as 21D on a circular irrigation system as 20 provides that, at each period of time during which the liquid is purged (that is for the substantially 1½-to 2-second period) while the nozzle is in fact to a slight degree moving, it is moving so slowly in radial as well as translational motion that, for practical purposes, it can be regarded during that 1- to 2-second period as stationary.

The explosion, purge and fill cycle repeats automatically each 6 to 15 seconds while the nozzle slowly moves in one direction. The nozzle moves slowly counterclockwise as shown in sequence of FIGS. 7, 8 and 9 and then snaps back to position of FIG. 7 on release of pressure to cylinder 63 automatically to start again: the nozzle moves at a rate of about 4 minutes per each such cycle, the rate dependent upon and arranged to cover the sector in the total generally triangular and arcuate portion of the square field otherwise not irrigated by distribution from the irrigator as 20 moving in a circular path about its center pivot and possibly not covered by action of the apparatus shown herein acting on adjacent similar sectors as 116' and 116'' and 116''' in the field 31 corners as 33, 34, 35 and 36. Such series of adjacent sectors usually cover such corner areas completely.

In another embodiment of timing valve assembly shown in FIG. 12 the timing valve assembly is, as below described, free of connection to or pressure measurement within the container 42. In that timing valve assembly a valve 201 is attached to the end of the line 24 and is attached through a normally open pneumatic valve 202 connected via line 204 and a check valve 203 to the bottom of the combustion chamber 42. The line 204 is connected by tee 205 to the collimator tube 43 and the valve 244 is a normally closed valve with a pneumatic line 245 attached thereto for control thereof.

The airline 210 is attached through the tee 211 to a regulator valve 212 and adjustable timer valve 223 to the timer tank 124 which feeds into regulator valves 213, 214 and 215. These valves are set for opening at different pressures, valve 215 opens at 50 p.s.i.g. pressure, valve 214 opens at 100 p.s.i.g. pressure and valve 213 is pilot that opens at 115 p.s.i.g. pressure. When, after combustion and discharge of water from the chamber 42 through tee 205 and line 43, water comes from the line 24 through the line 204, valve 201, 202 and 203 and tee 205 and enters the tank 42. The air used to purge the exhaust gasses is trapped and compressed by the incoming water: the amount of water that enters chamber 42 is determined and limited by the volume of that air remaining after compression thereof by the water. The timer value 223 operates through the valve 216 to move the slider 217 to the left and thereby the air line from tee (or "T") 211 passes air in the line 218 past check valve 219 and 220 into the tank 42; concurrently the air passing along line 218 also passes to the normally closed two-position valve 221 and provides for passage of gas from source 222 through check valve 224 into the chamber 42. This passage of gas to chamber 42 continues until the pressure in the tank has reached the pressure of the gas, i.e. about 120 p.s.i.g. The timer valve continues to pass air into the tank 124 at a fixed rate.

When the pressure of tank 124 reaches 100 p.s.i.g. (a) the pilot valve 214 opens and via line 214A moves the slider 217 of valve 216 to the right. So moving slider 217 to the right (as shown in FIG. 12) permits bleeding valve 221 to return to closed position, (b) the normally closed bleed valve 25 is then automatically opened and air passes through the line 226 to check valve 220 but not into the chamber 42 until it is at the same or lower pressure, while (c) normally open valve 202 is closed during air passage through the line 226 by passage of air through the lines 227 and 245 which closes the valve assembly 245 and opens the valve 244 and then moves arm 52 to close switch 53 and initiate combustion. Such combustion produces gasses that drive the water out of the chamber 42. When the water 42 passes out of the chamber tee 205 check valve 203 closes. The valve 223 contains air between 100 and 115 p.s.i.g. and maintains the slider 217 in precombustion position; after combustion valve 225 passes air as a purge through tank 42. The timer tank 124 is so set that this passage of air from the purge tank is of relatively short duration [although it provides enough air to clear out the tank as a purge]. When the pressure in the tank 124 later reaches 115 lbs. per square inch valve 213 opens and the timer valve 233 is released, and the timer valve 233 bleeds out the air therefrom and from tank 124; with the tank 124 exhausted, the slider 217 returns to its normal position and the 45 p.s.i.g. regulator 216 also bleeds out so that the slider 217 returns to its normal position and the pressure in the lines 218 is relieved and also at the valve 221 via a bleed therein.

The system is then ready to initiate another cycle with the timing controlled by the setting on the timer 223. More particularly the water from source 24 passes through the normally open valve 202 and enters the tank 42 while the normally

closed valve 244 is closed. This filling of the tank 42 will occur only to that point at which the air which previously filled the system during the purge thereof is compressed to a predetermined value of about 4 to 1. The water stays at this level and can stay there for some time when the machine is shut off; when the timer 223 (and 124) again actuates valves 225 and 216 gas and air pass into the chamber 42 via valves 219, 220, 221, 224 and 216 and the pressure reaches a predetermined value in tank 124; inasmuch as the volume is fixed the chamber 42 receives a predetermined weight of such gas when valves 98 and 99 are fully open as in position shown in FIG. 1 for the apparatus 112 in field 31.

An accessory water tank 42A is supplied by line 24 of apparatus 20, line 24 has substantially constant pressure as its volume is large relative to the usual gentle and constant sprinkling discharge action of the outlets as 24B and 24C thereon. This is typical of apparatus 100 as well as of apparatus 20 in the embodiments of apparatus herein shown. Line 24 is supplied by pump 30A which has a constant output pressure assisted by a constant pressure output valve as 30B if needed. Line 24 passes water to accessory water tank 42A by constant input pressure valve 42B. Tank 42A supplies tank 42 by constant output pressure value 201 and check valve 203. The tank 42A is accordingly filled during discharge of tank 42 and improves the smoothness of operation of assembly 40. Tank 42A has approximately the same capacity as tank 42 and is supported near thereto as on the terminal station of apparatus 20. In embodiments 111—114 apparatus 40 (as well as 140 and 240) does not interfere with the water pressure in the associated sprinkler assembly, as 20, because the pressure in such system as 20 is not required to be higher than usual and the water distribution from the sprays of apparatus as 20 is not affected by the use of a unit as 40 (or 140 or 240) therewith although the water pump, as 30A connected to the conduit as 24 of the apparatus 111 requires a sufficiently high capacity to cover the 27 percent (=21 78 ×100) greater area coverage by water provided by the apparatuses as 111, 112, 114 of this invention than is required for the coverage of the circular area 31 alone.

A gas volume control assembly 92 is located at and near the central water supply pipe 30 and is there operatively connected thereto and is located in part at and is operatively connected to ignition and timing control subassembly 50 adjacent chamber 42 of assembly 40.

Assembly 92 comprises a gas volume control cam 37 firmly attached at its center to the vertical portion 38A of a sturdy elbow pipe 38. Pipe 38 is in the shape of an upside-down "L" the top portion of which, 38B, is operatively connected to line 24 of apparatus 40 and the bottom portion, 38A, of which is rotatably attached to and coaxial with the central water supply pipe 30 which is vertical. The cam 37 has the same peripheral shape as the shape of the field 31 in which the apparatus as 111 operates. The cam is shaped like a square and is flat on its top and bottom and is rigid and its vertical edges or sides are smooth. The cam is firmly located on the vertical portion 38A of the elbow pipe 38 so that the vertical edges or sides of the cam as 37A, 37B, 37C and 37D parallel the corresponding edges 39A, 39B, 39C and 39D of the field 31 and the cam top surface is horizontal when axis of pipe 24 is parallel to a field edge as 39C.

A spring-loaded piston positioning sensing sleeve 94 is supported on bracket 92A which is firmly located on pipe 30 and slidably supports a cam edge sensing arm 93 near to the pipe portion 38A. Sensing arm 93 is a rigid straight arm that is coaxial with and reciprocatable within sleeve 94 and lies in a plane parallel to the top of cam 37 and slightly therebelow.

FIG. 19 is a diagrammatic view of the components and relations of the gas volume control assembly 92, the cam 37 thereof being shown in isometric view, the sensing sleeve 94 being shown broken away in part.

The cam edge sensing arm 93, at one sensing end thereof (93A), slidably and continuously contacts one edge as (37D in FIG. 19) of the cam 37 and is a cam follower with a roller. A spring-loaded throttle valve 99 in the outlet line 137A of the gas supply to the combustion chamber 42 and a similar spring-loaded throttle valve 98 in the outlet line 139A of the high-pressure air supply to the combustion chamber 42 are controlled by an adjustable bleeder valve 96 which is operatively connected to those valves by a line 97 carried on the pipe 24 of assembly 20. An adjustable bleeder valve 96 is also firmly supported on the rigid bracket 92A and firmly located thereby relative to the cam sensing arm 93 and is operatively connected to the air supply 139. The control end 93B of the arm 93 is pivotally connected to a rigid control arm 95 which is operatively connected to and controls the bleeder valve 96. The pneumatic line 97 is supported by the conduit pipe 24 and operatively connected to throttle valves 98 and 99 adjacent combustion chamber 42. Accordingly, the cam 37 is sensitive to the positioning of the conduit 24 relative to the outline of the field 31 and controls the amount of gas at high pressure and air at high pressure passed into the combustion chamber 42 is a manner controlled by the position of the assembly 20 and, concurrently, the distance of the assembly 40 from the edges as 39A, 39B of the field 31 in which the apparatus as 40 and 112 is located. The valve 96 is arranged so that the valves 98 and 99 are full open when the apparatus as 112 is arranged in the position as shown in FIG. 1 whereat there is the maximum distance from the center of the apparatus 112, i.e from the central water supply pipe 30 to the very corner as 33A of corner area as 33, as shown in FIG. 1 and that the valves 98 and 99 are closed, as shown in FIG. 19, when the circular area as 32 is substantially tangent to the edge of the field in which the apparatus as 112 is operating. Thereby the combustion force in the operation of the assembly 40 is varied according to the position of the assembly 40 in the field to provide maximum power when needed and to shut off the power to that explosive blast liquid-distributing assembly when such is not necessary.

In the combination of apparatus 111 shown in FIGS. 3 and 4 the liquid explosive blast liquid-distributing assembly 140 comprises a water discharge assembly 140 and ignition system 150 and a frame assembly 170.

The assembly as 140 and system 150 are mounted on the frame assembly 197.

The frame assembly 197 comprises a radial frame 170 and a main frame assembly 118.

Assemblies 140, 150 and 170 are, respectively, identical with the water discharge assembly 40 and ignition and timing control subassembly system 50 and frame 70 of the apparatus 40 and the parts of assembly 140 are referred to by referant numbers that are 100 units higher than the referent numeral applied to the corresponding part of assembly 40 on the frame assembly 170. The explosive blast liquid-distributing assembly, 140, is mounted with the nozzle, 145, in fixed position relative to and in line with, (i.e. the axis of nozzle, 145, in the same vertical plane as) the longitudinal axis of collimator tube, 143, and there is no motion of the nozzle 145 with respect to the collimator tube 143 as provided for in assembly 40.

Frame 118 is rigid and extends the full length of assembly 140. Frame assembly 118 comprises rigid front and rear members 118A and 118B and central member 118C and a lateral member 118D. The front end of the members 118A and 118B are firmly joined to frame 170 by rigid members 118E and 118F. Members 118A—118F are firmly joined together and supported pivotally about a vertical axis 118G through hinges 118H holding 142 to 142A on station 21D.

A nozzle-positioning piston assembly 160 comprises the throttle valve 190B, valve 190 and piston assembly 163 corresponding to elements 91, 90 and 163 of assembly 60. (There is no element such as 62 in assembly 160.) The positioning piston 163 is firmly attached to the member 118B and serves to position it relative to the terminal station frame as 21D in a manner similar to that of the nozzle-positioning assembly 60 and the release valve 190A is attached to frame of terminal tower 21D. A spring 175 is attached to frame 21D and to a distant portion of frame 118.

The nozzle- and frame-positioning cylinder 163 of the explosive blast liquid-distributing assembly 140 is located, as shown in FIGS. 3, 4 and 10 adjacent to the combustion chamber 142 (identical in structure to the combustion chamber 42 above described for the explosive blast liquid-distributing assembly 40). The operation of the nozzle- and frame-positioning assembly 160 of the explosive blast liquid-distributing assembly 140 is to a great degree the same as that of nozzle position subassembly 60 of the explosive blast liquid-distributing assembly 40 with the exception that the frame and nozzle- and frame-positioning subassembly 160 is arranged so that the explosive blast liquid-distributing assembly 140 rotates as a unit about the vertical longitudinal axis of the hinges on chamber 142 and the thrust of the discharge from the nozzle 145 (identical in structure and function to the nozzle 45 of assembly 40) is passed, without any change of direction, directly to the support for the combustion chamber 142.

The pressure in piston 63 extending its shaft is cut off on contact of member 118C with valve pin 190A. That contact releases the pressure applied to 163, and with the movement of the apparatus 111 counterclockwise as shown in FIGS. 4 and 10, the assembly 140 moves to a clockwise position of pipe 24. However the frame 118 may be locked to the frame of station 21D. The control of the combustion process in assembly 140 is the same as above described for assembly 40 to spray areas as 116, 116' and 116''.

Apparatus 113 is also designed for covering with irrigation liquid a square area as 31: it comprises, in operative combination, a self-propelled rotary sprinkling irrigating apparatus as 100 and a dual explosive blast liquid-distributing water system assembly, that explosive blast liquid-distributing assembly comprising two water discharge assemblies as 119B, and one ignition and timing control subassembly as 119A. Apparatus 100 is one as in U.S. Pat. No. 1,068,797. The self-propelled sprinkling irrigating apparatus 100 comprises a length of horizontally extending pipe 102 which forms a liquid conduit and which is pivotally supported near its center on a movable station 103, one explosive blast liquid-distributing waster assembly as 40A (and 40B) is firmly located at each end thereof. The same timing assembly 119A (shown in zone 14A of FIG. 12) is used to fire simultaneously duplicate water distribution assemblies 40A and 40B, each like assembly 119B (shown in zone 14B of FIG. 12) except as below described.

Each water discharge assembly 40A and 40B is attached to frame 104 and each comprises a vertically extending hollow combustion chamber as 42, a collimator tube as 43, a nozzle control valve as 45, and a nozzle connection near to the bottom of the combustion chamber connected to the collimator tube at one end thereof, the collimator tube being connected at its other end to the nozzle control valve 44, the nozzle control valve interposed between said collimator tube and said nozzle; such valve connection is shown in FIG. 12. Each such nozzle frame assembly comprising a rigid frame 70 with a nozzle timing means as 55 thereon, said timing means operatively attached to its nozzle valve 44 for opening and closing said valve; only one of the timing means has ignition switch actuation means as 52 operatively attached thereto, that one ignition switch means being connected to both of the combustion chambers for assemblies 40A and 40B. A separate inlet for combustion fuel and air to each said combustion chamber is automatically and operatively attached thereto, via tee valves 40F and 40G respectively of FIG. 12. The liquid conduit 102 in such self-propelled irrigating apparatus operatively connects to the combustion chamber of each of assemblies 40A and 40B through a valve assembly as shown in FIG. 12.

Embodiment 114 comprises a separate movable carriage support 270 with an explosive blast liquid-distributing water assembly 240 located thereon in operative combination with a circularly movable self-propelled sprinkler irrigating apparatus.

A rigid connecting assembly 299 extends between the movable carriage support 270 and the self-propelled rotary sprinkling irrigation apparatus 220A and is firmly connected to both and maintains the frame of the carriage and the nozzle of the explosive blast liquid-distributing water assembly in predetermined fixed alignment relative to the length of the liquid conduit 24 of the self-propelled rotary sprinkling irrigation apparatus 220. The explosive blast liquid-distributing water assembly 240 is identical to explosive blast liquid-distributing water assembly 140 and is supported on frame 270 as apparatus 140 is attached to frame 170. However, in embodiment of apparatus 114 the frame 270 is completely and movably supported on its own wheels rather than on apparatus 220 and a combustible fuel supply and an air supply are provided on the carriage support 270.

A fuel tank 301 for containing combustible liquid fuel and a pump 302 for passing it from the tank to the combustion tank 242, an air compressor 303 and air tank 304 are firmly attached to support 270. The air compressor 303 is operatively connected to electric power passed thereto from electric power lines carried on a pipe as 24 used to power the electric motors on an electrically powered self-propelled rotary irrigation system as in Heine U.S. Pat. No. 1,419,925 or by any other power lines available near to the pivot point 30.

Accessory water tanks 305, 306 may be carried on the apparatus 220 as well as tank 307 carried on frame 270 adjacent to the tank 242 to even out the water flow to tank 242. Tanks 305, 306 and 307 are connected in series and to the water line 24 and valves as 201 and 202 as shown for tank 42A in FIG. 12.

Frame 270 comprises a radial frame assembly as 170 and a central frame assembly as 118, an A-frame 298 and a central carriage assembly 276 which is attached to the central member of frame 270: assembly 276 is attached to and below front and rear members thereof (corresponding to members 118A and 118B of assembly 197). Assembly 276 comprises a rigid wheel supporting frame 278 (corresponding in structure to frame 78) to which are operatively attached ground-contacting wheels 277A and 277B (corresponding in structure to wheels 77A and 77B). The bottom of a vertical A-frame 298 is attached to the central end of frame 270. The chamber 242 of explosive blast liquid-distributing water assembly 240 is in part supported on frame 270 as is assembly 140 on frame 170 (and station 21D) with chamber 242 attached to frame 298, frame 240 is firmly attached to assembly 270.

The self-propelled liquid sprinkler irrigating apparatus 220A preferred for this combination is electrically powered comprising an electric generator power source 271 passing energy to each of the motors on the stations 221A—D of the system 220A, and a conduit 224A. Water under pressure is supplied to the conduit 224A and sprayed on the ground while the conduit is rotated by circular movement of the towers. The motor on each tower is driven by electrical power passed along conduit 224A by electrically insulated conduits which extend to assembly 240 units 302 and 303.

A rigid mechanical connection assembly 299 between the apparatus 220A and assembly 240 is comprised of a pair of rigid straight angle iron bridging arms 289A, 289B, 289C and 289D. Arms 289A and 289B are attached to the assembly 220A and the assembly 240 and are in turn trussed by the rigid straight angle iron bridging arms 289C and 289D. One end of arm 289C is connected to element 289B near to conduit 224A and the other to the radial end of rigid frame 270. One end of element 289A is attached to conduit 224A of apparatus 220A at a point spaced apart from the point of attachment thereto of element 289B and the other element of 289A is attached to frame 270 at a point spaced away from the attachment thereto of element 289B. One end of each of arms 289A and 289B is pivotally yet firmly attached to pipe 224A of the apparatus 220A at spaced apart points on each side of station 221D and the other to a set of spaced apart points on the rigid frame 270. Elements 289D and 289B are pivotally joined near their centers. Thereby the frame 270 is kept in alignment and parallel array to the direction of longitudinal axis of pipe 224A of apparatus 220A. The collimator tube 243 of the apparatus 240 (which collimator tube corresponds exactly to the colli-

mator tube 43 of assembly 40) is arranged with its longitudinal axis parallel to the longitudinal axis or length of the frame 270 and in the center thereof as shown in FIG. 16. The nozzle of the assembly 240 projects radially from the frame 240. The connector assembly 299 maintains the axis of the collimator tube 243 parallel to the axis of the tube 224A of apparatus 220A. The terminal end of conduit 224A is operatively connected to the combustion chamber 242 of the assembly 240 by a flexible line extending from the terminal end of conduit 224A to an accessory water tank such as 305, 306 and 307 and then, in series, to a regulator valve as 201 in FIG. 12 to and through a normally closed valve as 202 and a check valve as 203 of FIG. 12 into the combustion chamber 242.

In one embodiment of apparatus 112 dimensions and details are as follows:

Combustion chamber 42 is 54 inches high and has an 8-inch internal diameter; tube 43 is 11 feet long and has a 6-inch internal diameter from the central longitudinal axis of combustion chamber 42 to the gate of valve 44; nozzle 45 is a 1 ⅝ inch 9200-R-type of L. R. Nelson Manufacturing Co. Peoria, Illinois (Bulletin BG 693); valve 223 of FIG. 12 and valve 121 of FIG. 11 is a two-way pilot-operated valve 0 3092 of Schrader Manufacturing Co., Wake Forest, North Carolina, Catalogue Val-1 page 21 (type 44435–3000 as per page 25 thereof); and valve 126 of FIGS. 11 and 12 is a four-way three-position mark 420 valve series, 1/2 N.P.T., valve type 9, double-pilot externally piloted, type 44921–3000 as set out in Schrader Catalogue Val-1 page 25. While the timing valve assemblies in the ignition and timing control subassembly systems of FIGS. 11 and 12 are shown for pneumatic control such systems could be electrically controlled by use of conventional electrical equivalents thereof especially in apparatus 240 in combination with an electrically powered circular irrigator as 220A and the process of this invention includes the use of electrical valve and timing components therefor.

The pressure during discharge of water from chamber 42 and nozzle 45 is 250 p.s.i.g. when the apparatus 112 is oriented with the longitudinal axis of its water conduit pipe 24 of the mobile sprinkling apparatus as 20 extending from the center of the field as 31, i.e. from the central pipe 30, towards the corner thereof, as in FIG. 1. FIGS. 7, 8 and 9 are pictorial in character and dimensions may be approximated therefrom. By the operation of apparatus as 111, 112, 113 or 114 above described, the large square area 31 may be completely covered by the total of the series of sprinkling actions of each of the sprays, as 115, to the totality of each of the series of adjacent and sometimes overlapping incremental sectors of area as 116, 116'' and 116''' in the areas peripheral to such circular area as is covered by the sprinkling action of the rotary sprinkling apparatus (as 20, 220A or 102) used in conjunction therewith. Apparatus 220A may be structurally the same as 20 yet electrically powered as in U.S. Pat. No. 1,419,925.

I claim:

1. Apparatus for covering with irrigation liquid a square area, said apparatus comprising, in operative combination, a self-propelled rotary sprinkling irrigating apparatus and an explosive blast liquid-distributing water system assembly, said explosive blast liquid-distributing assembly comprising a water discharge assembly, an ignition and timing control subassembly, and a nozzle frame subassembly in operative combination,

the explosive blast liquid-distributor water assembly comprising a vertically extending hollow combustion chamber, a collimator tube, a nozzle control valve, and a nozzle connection near to the bottom of the combustion chamber connected to the collimator tube at one end thereof, said collimator tube being connected at its other end to a nozzle control valve said nozzle control valve interposed between said collimator tube and said nozzle,

said nozzle frame assembly comprising a rigid frame with a timing means thereon, said timing means operatively attached to said nozzle valve for opening and closing said valve, and said timing means having ignition switch actuation means operatively attached thereto and said ignition switch means being connected to said combustion chamber, an inlet for combustion fuel to said combustion chamber and automatically and operatively attached thereto,

a liquid conduit in said self-propelled rotary sprinkling irrigating apparatus, said conduit operatively connected to said combustion chamber.

2. Apparatus as in claim 1 wherein the self-propelled rotary sprinkling irrigation apparatus is one composed of a plurality of radially spaced-apart stations supporting a string of pipe which forms said liquid conduit and extends radially and horizontally from a central pivot point and wherein the explosive blast liquid-distributing water assembly is supported on the terminal radially located station.

3. Apparatus as in claim 1, wherein the self-propelled sprinkling irrigating apparatus comprises a length of horizontally extending pipe which forms said liquid conduit and which is pivotally supported near its center on a movable station and wherein an explosive blast liquid-distributing water assembly is located at both ends thereof.

4. Apparatus as in claim 1 comprising also a separate movable support means and said explosive blast liquid-distributing water assembly is located thereon, and a source of compressed air is located thereon and a source of combustible fuel is located thereon, rigid means between said movable support means and said self-propelled rotary sprinkling irrigation apparatus and connected to both whereby said nozzle of said explosive blast liquid-distributing water assembly is maintained in fixed alignment relative to said liquid conduit of said self-propelled rotary sprinkling irrigation apparatus.

5. Apparatus as in claim 2 wherein the collimator tube axis and the nozzle are fixedly located with respect to each other and the longitudinal axis of the collimator tube is pivotally supported on the self-propelled rotary sprinkling irrigating apparatus.

6. Apparatus as in claim 2 wherein the explosive blast liquid-distributing assembly comprises a collimating tube and a nozzle, the longitudinal axis of the nozzle being movable relative to the longitudinal axis of the collimator tube.

7. Apparatus as in claim 3 wherein the collimator tube axis and the nozzle are fixedly located with respect to each other and the longitudinal axis of the collimator tube is pivotally supported on the self-propelled rotary sprinkling irrigating apparatus.

8. Apparatus as in claim 3 wherein the collimator tube axis and the nozzle are fixedly located with respect to each other and the longitudinal axis of the collimator tube is pivotally supported on the self-propelled rotary sprinkling irrigating apparatus.

9. Apparatus as in claim 5 comprising variable valve means operatively connected to said inlet for combustion fuel, a position-indicating means operatively connected to said self-propelled rotary sprinkling irrigating apparatus and to said variable valve means.

10. An explosive blast liquid-distributing water assembly comprising a vertically extending hollow combustion chamber, a collimator tube, a nozzle frame assembly, a nozzle control valve and a nozzle and a timing valve assembly in an ignition and timing control subassembly,

the bottom of the combustion chamber being connected near to its bottom to one end of the collimator tube, the other end of said collimator tube being connected to a nozzle control valve, said nozzle control valve operatively connecting said collimator tube and said nozzle,

said nozzle frame assembly comprising a rigid frame with a nozzle valve control means supported thereon and operatively attached to said nozzle valve for opening and closing said nozzle valve, said ignition and timing control subassembly comprising ignition means operatively connected to a spark means in said combustion chamber, gas-containing means and air-containing means each operatively connected to said combustion chamber by gas inlet

valve means and air inlet valve means, respectively, means controlling the volume of water passing from a water source to said combustion chamber, gas inlet valve timing means operatively attached to said air inlet valve means and to said nozzle valve control means, valve means operatively connected to said combustion chamber automatically closing said water source off from said combustion chamber on actuation of said ignition means, gas purge means operatively connected to said combustion chamber, and valve means automatically connecting said purge means to said combustion chamber, said gas inlet valve timing means being operatively connected to said ignition means.

11. Apparatus as in claim 10 wherein said gas inlet valve timing means is a pneumatic timing means.

12. Apparatus as in claim 10 wherein said gas inlet valve timing means is an electrical timing means.

13. A process for covering with irrigation liquid an area bounded by straight edges, said process including the steps of continuously passing a portion of a stream of water at one level of pressure to a circular area of ground within said area covered by straight edges and intermittently applying increased pressure to successive separate portions of water from said stream and jetting said separate portions to the radially elongated successively neighboring sectors of ground of said area of ground bounded by straight edges beyond said circular area of ground and adjacent to the said edges of said area as a spray.

14. Process as in claim 13 wherein said area bounded by straight edges is a square area.

15. Process as in claim 14 wherein each of the successive portions of water is first confined in a combustion chamber with a combustible mixture thereabove and then said combustible mixture is ignited and pressure is developed in that combustion chamber in excess of said one level of pressure and said jetted water is delivered to the ground free of any substantial horizontal motion transverse to the path thereof.

16. Process as in claim 15 wherein the pressure in said chamber is relieved prior to ignition of said combustible mixture.

17. Process as in claim 16 wherein said jet extends radially from 200 to 300 feet from the said circular area.

18. Process as in claim 16 wherein each of such said jet portions contains from 20 to 30 gallons and such process is repeated in a period of from 2 to 6 seconds while the nozzle is substantially stationary.

19. Process as in claim 15 wherein the chamber is automatically purged subsequent to each combustion therein and the combustible mixture is passed to the combustion chamber for an automatically predetermined period of time.

20. Process as in claim 15 wherein the energy of the jet is varied dependent on the position of the direction of the jet relative to the edges of said area and is proportional to the distance of said edge from the periphery of said circular area.

21. Process as in claim 19 wherein the period of time of passing of the combustible mixture to the combustion chamber is initiated in response to the pressure change in the combustion chamber on combustion therein.

22. Process as in claim 19 wherein each period of time of passage of the combustion gas into said combustion chamber is determined by an automatically timed repetitive cycle each initiated by the said combustion and the period of time for adding of water to the combustion chamber is controlled automatically for repetitive action responsive to the pressure in said chamber.