United States Patent [19]

Helmrich

[11] **3,785,569**

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[54] **AEROSOL GRENADE**

[75] Inventor: **Ralph Helmrich,** High Bridge, N.J.

[73] Assignee: **Diamond Aerosol Corporation,** Glen Gardner, N.J.

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[52] **U.S. Cl.** **239/337,** 102/65, 169/36, 239/251

[51] **Int. Cl.** **F42b 27/06**

[58] **Field of Search** 169/36; 239/337, 239/251; 102/65, 66

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Primary Examiner—M. Henson Wood, Jr.
Assistant Examiner—Andres Kashnikow
Attorney—Joseph Hirschmann

[57] **ABSTRACT**

An aerosol grenade which spins at a high rate about more than one axis to discharge its fluid contents over a wide area even under windless conditions. The grenade includes a pressurized container, a plurality of discharge nozzles oriented so as to cause the grenade to spin about one of its axes upon discharge of the fluid contents. A fuse mechanism is provided which opens the closure for the pressurized container when a trigger block in the fuse mechanism is subjected to a lateral force upon impact of the grenade. The plane of the discharge nozzles is spaced along the longitudinal axis of the grenade from the center of gravity of the grenade. A spinning ring the plane of which is spaced from the center of the longitudinal axis of the grenade increases the erratic movement of the grenade upon discharge facilitating distribution of the grenade's contents. The grenade is especially useful as a means of distributing tear gas, the rapid and erratic movement preventing throw back by target personnel. A preferred lachrymatory composition employed comprises orthochlorobenzylmalononitrile dissolved in N,N-dimethyl formamide or N,N-dimethyl acetamide.

32 Claims, 11 Drawing Figures

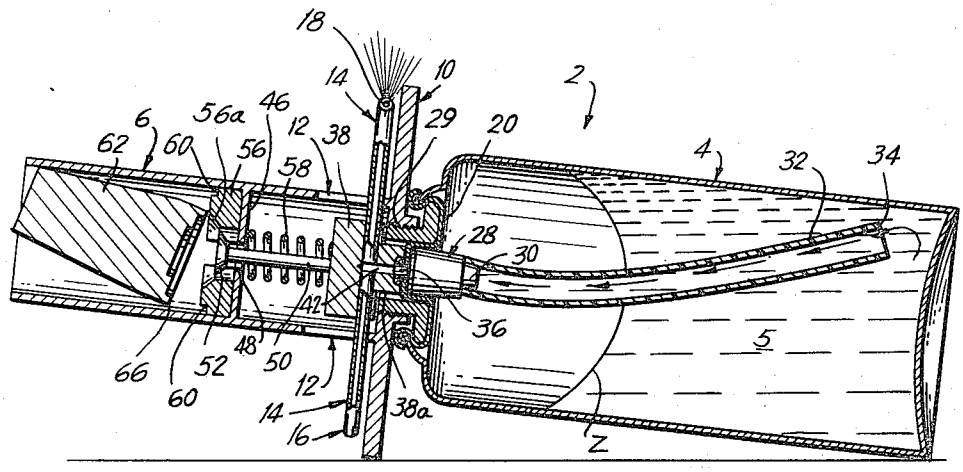


FIG. 1

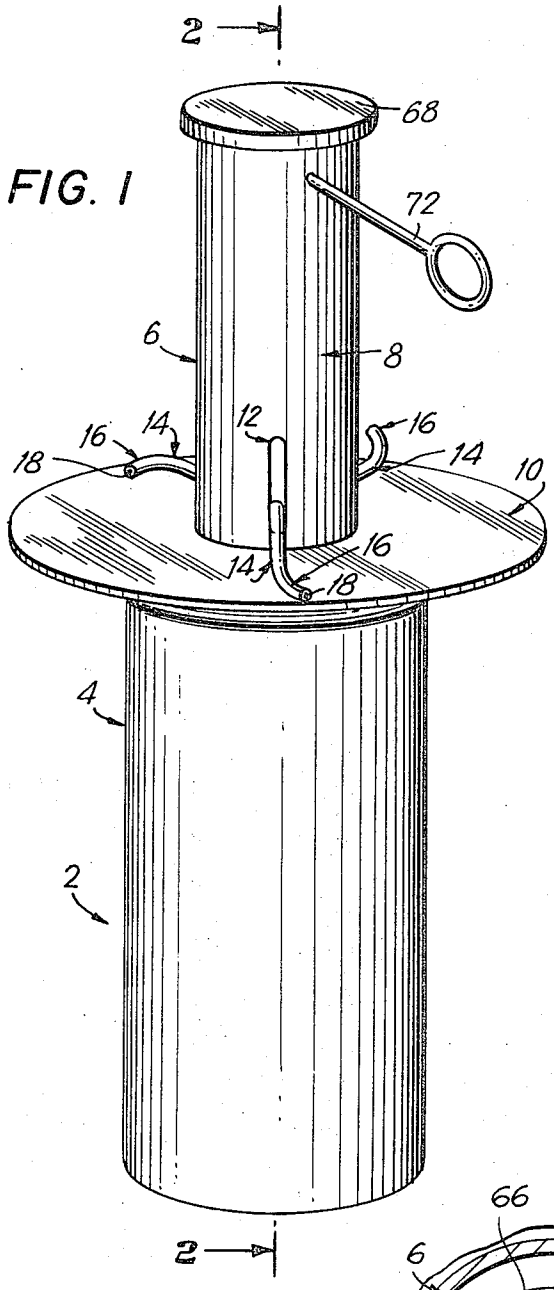
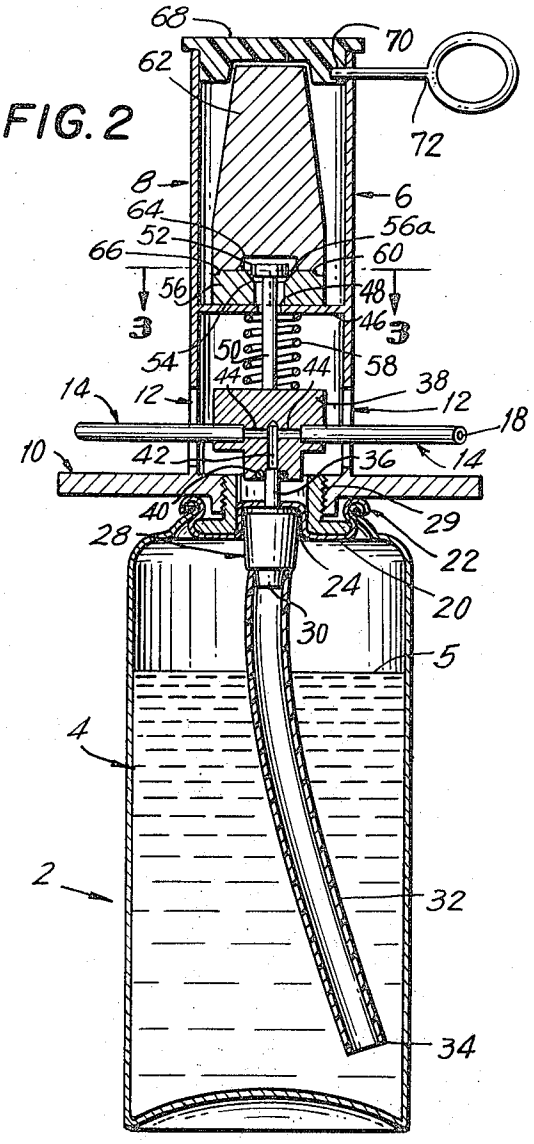


FIG. 2



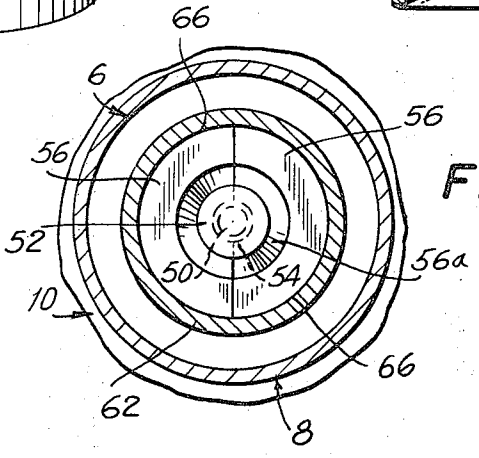


FIG. 3

FIG. 5

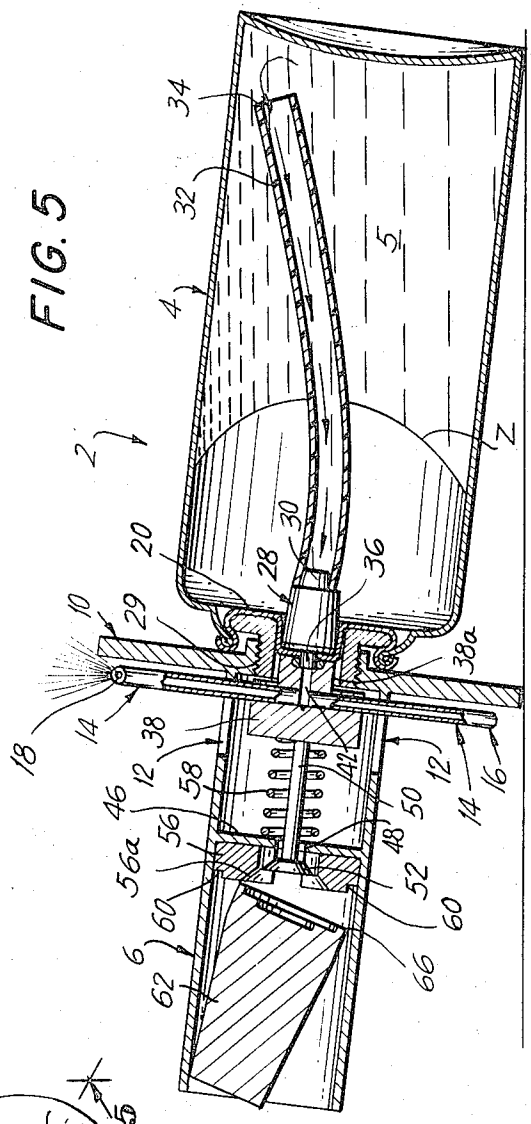


FIG. 4

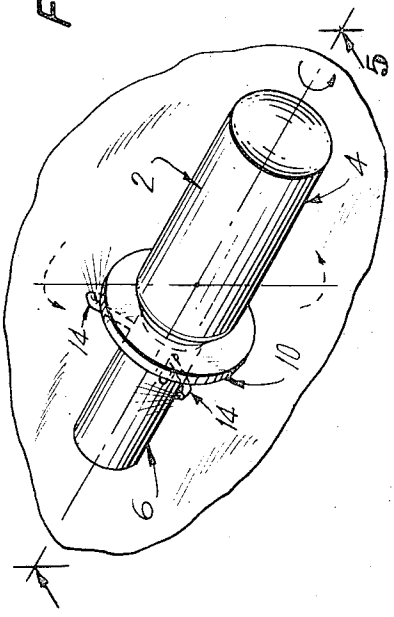


FIG. 6

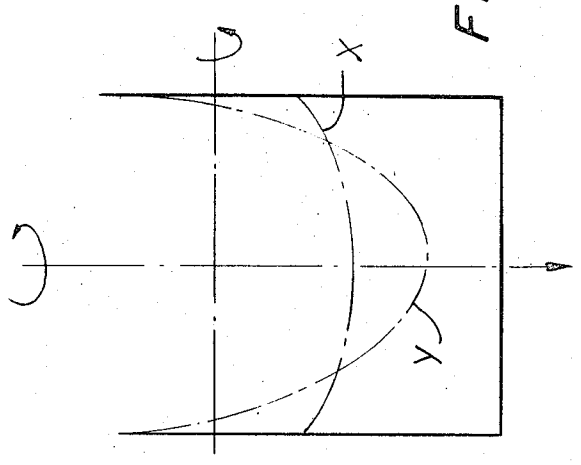


FIG. 7

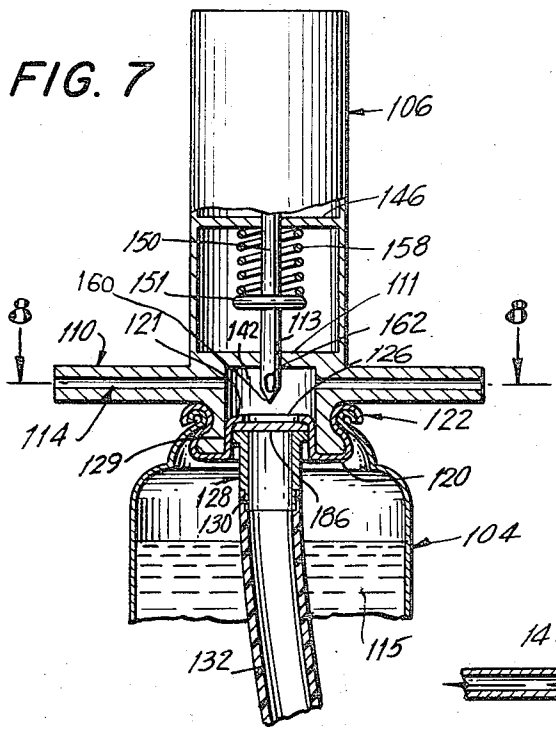
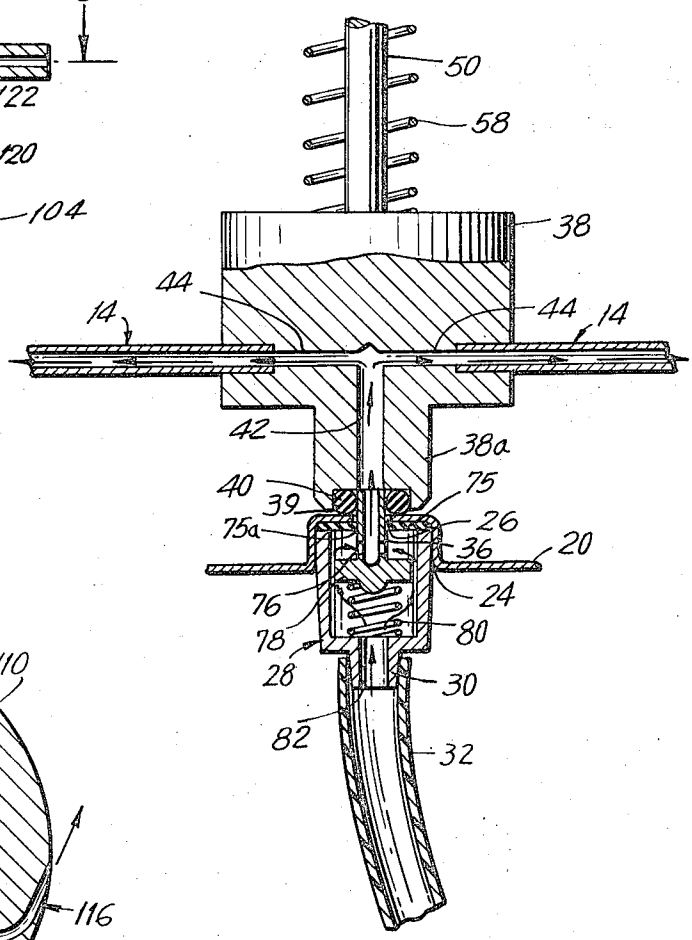


FIG. 9



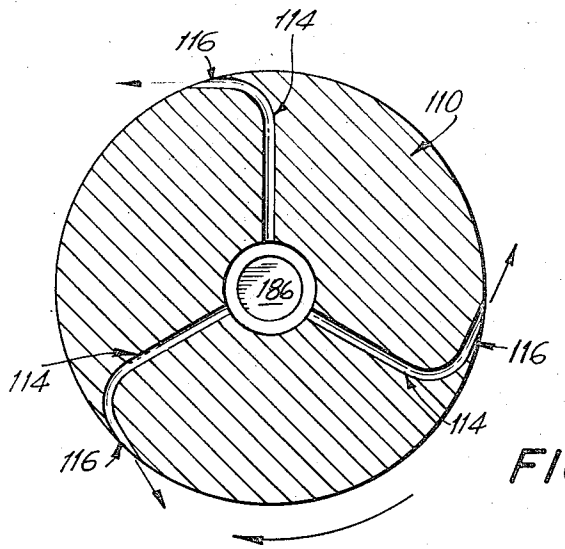


FIG. 8

FIG. 10

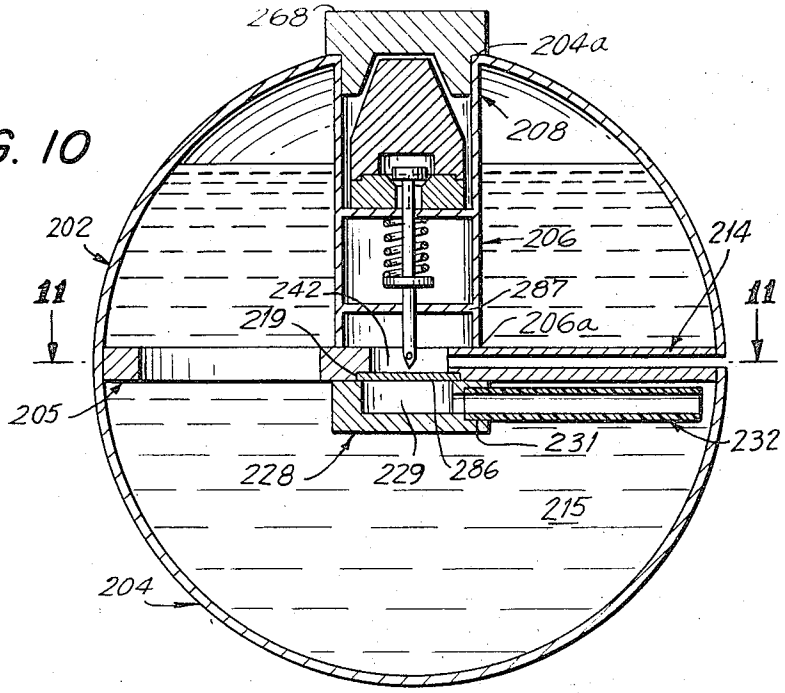
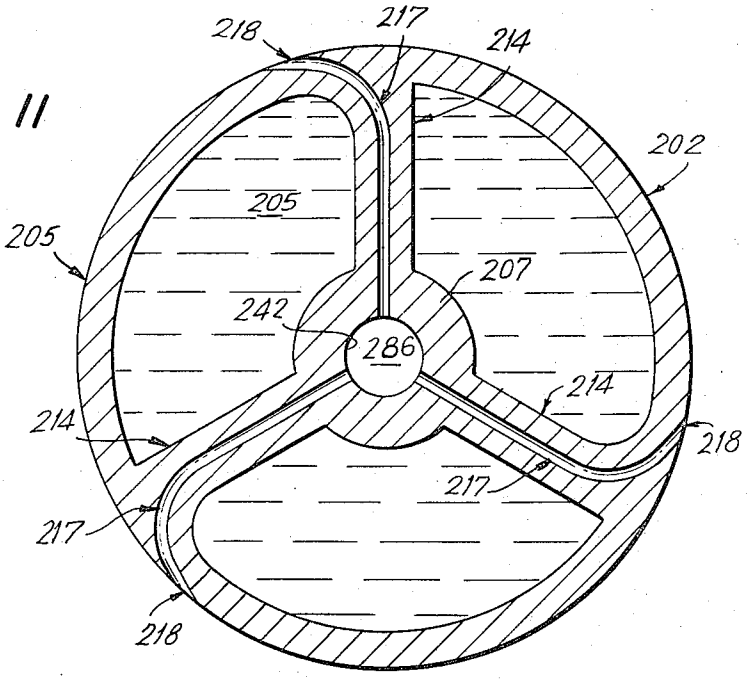

268
204a
208
202
206
214
11
242
287
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206a
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232
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229
286
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204

FIG. 11


218
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AEROSOL GRENADE

BACKGROUND OF THE INVENTION

The present invention relates to a pressurized aerosol dispenser for the distribution of fluids in aerosol form including liquids, gases and powdered material. In particular, this invention is concerned with an aerosol type grenade utilized to dispense such fluids rapidly over a wide area. An important aspect of this invention is an aerosol grenade which is capable of rapidly dispensing fluids over a wide area and which during its discharge of the fluids is caused to move about at a high rate of speed in an erratic manner. This invention is particularly concerned with an aerosol grenade for dispensing non-toxic physically-incapacitating agents, such as tear gases and the like, for crowd control rapidly over a wide area. While the invention is primarily concerned with the distribution of incapacitating agents such as tear gas, the aerosol dispenser of the present invention can be utilized for discharge and distribution of other chemicals, dyes, insecticides, and any other fluid commonly dispensed by conventional aerosols.

It is a well-known fact that the utilization of aerosol dispensers for distributing fluids such as liquids, gases, or finely-divided powdered material has been enormous in recent years. For many applications, it is particularly desirable that the material that is dispensed be distributed rapidly over a wide area. Distribution of materials over a wide area is oftentimes made difficult by the lack of any wind so that the material dispensed from the container tends to remain in the immediate area of the container.

Tear gas grenades presently employed by law enforcement agencies and the armed forces dispense the incapacitating agent by means of a chemical reaction which generates a considerable amount of heat. One of the many disadvantages of such a weapon is, while it is discharging, which is often over a period of a half a minute to a minute or more, it can be picked up and thrown back at the law enforcement officials by the individuals at which it was originally thrown. This hazard exists principally for two reasons: first, the presently employed grenades discharge over an undesirably long period of time, and secondly, once they are thrown and land, they lie at rest.

Another very serious disadvantage of grenades presently employed is that they burn at fairly high temperatures and thus constitute a fire hazard.

While one of the easiest ways to increase the rate of discharge of the incapacitating agents of grenades operating by chemical reaction is to increase the temperature at which they burn, this greatly increases the fire hazard of such weapons. The amount of heat which conventional tear gas grenades generate is also undesirable in many cases where, for example, it is desired merely to control a crowd of disorderly persons and not to harm them physically other than through the temporary action of the incapacitating agent. When high temperature burning grenades are employed, the target personnel could be inadvertently burned or otherwise harmed by such grenades. Of course, if the reaction temperature is lowered, the discharge time is extended and this increases the probability that the device will be thrown back at the law enforcement agents employing the device. Furthermore, utilization of the chemically activated grenades which burn upon discharge presents a very significant hazard in transporting and storing

such devices, particularly in bulk quantities because of the incendiary hazard which they constitute.

Known aerosol dispensers as well as conventional tear gas grenades are generally ineffective for distributing the agent dispensed over a large area under conditions of no wind.

While some prior tear gas grenades have been devices utilizing multiple chemical charges which explode during discharge in order to cause the grenade to jump about erratically to make it difficult to throw the grenade back, these devices are very complex and constitute additional fire hazards, are not always reliable, and increase the danger of permanent physical harm to personnel whom it is only desired to temporarily incapacitate.

While various types of aerosol dispensers are known which are intended for distributing chemicals such as insecticides, defumigants, defoiliating agents, etc. over a large area, it is generally necessary that the aerosol dispenser be continuously operated by hand until the contents are fully discharged and as indicated above, under conditions of no wind, these presently known devices are not very effective. It would be highly advantageous if there were an aerosol dispenser available which could be utilized to continuously and rapidly discharge its contents over a wide area without the necessity of holding the aerosol discharge mechanism open by hand. Thus an aerosol dispenser of this type which could be armed by the user, and then thrown, and which upon impact would have means provided for opening and commencing the rapid discharge of the contents over a wide area would be very much desired. For example, provision of means which would cause an aerosol dispenser to move about during its discharge period within the area in which it is desired to disperse the contents would be highly desirable.

Especially in the case of tear gas grenades or similar weapons, it is desirable that they can be armed by the user but only activated to commence discharge of its contents after it is thrown or propelled at the target personnel and has landed in their vicinity. This feature would assure the discharge of the maximum amount of incapacitating agent in the target area. Furthermore, a device capable of discharging its incapacitating agent contents within a very short period of time, such as under ten seconds, would be highly desirable. Furthermore, a grenade or dispenser which can move about erratically and extremely rapidly in the target area would be highly desirable as an effective crowd control weapon.

SUMMARY OF THE INVENTION

According to the present invention, the foregoing difficulties are overcome by the aerosol grenade which I have developed that discharges and disperses a fluid material in aerosol form rapidly over a wide area, without any chemical thermal reaction and effective even under windless atmospheric conditions. The aerosol grenade which I have devised is provided with a plurality of discharge nozzles oriented in such a way, with respect to the body of the aerosol grenade, that upon discharge of the contents, the grenade is caused to spin at a rate of high speed about one or more of its axes. This spinning causes the grenade to move about within the area in which it is desired to distribute the fluid contents of the grenade. This spinning movement of the grenade which is rapid and generally erratic facilitates

the distribution of the discharged fluid over a significantly large area, even under windless conditions, than would otherwise be possible. In the preferred embodiments illustrated in the description which follows, the movement of the grenade during discharge of its contents is caused to be extremely erratic by spacing the discharge nozzles a distance along an axis from the center of the gravity of the container.

The discharge nozzles are oriented so as to cause the aerosol grenade to spin at a high rate of speed about one of its axes and because the nozzles are displaced from the center of gravity, the grenade tends to rotate about an axis transverse to the first axis. This transverse axis is continuously shifting due to the shifting of the center of gravity of the container as the contents of the pressurized container are discharged.

In one of the particularly preferred embodiments of the present invention, the erratic movement of the grenade during discharge is further enhanced by a spinning ring on the grenade, the plane of which is parallel to the axis of the discharge nozzles and displaced from the center of the longitudinal axis of the container so that during discharge, as the container spins about its longitudinal axis, its erratic movement is enhanced by rolling or skittering on the spinning ring.

The fluid material to be discharged is charged with propellant under pressure into an aerosol container provided with an aerosol valve that can be opened by action of a fuse mechanism, or the container is closed by a frangible disc which is pierced by operation of the fuse mechanism when the grenade is activated. Piercing of the frangible member or opening of the aerosol valve places the contents of the aerosol container in communication with a distribution chamber which in turn communicates with the discharge nozzles. The nozzle orifices are oriented more or less tangentially to an imaginary circle of larger diameter than the spinning ring. The nozzles also are spaced along the longitudinal axis from the center of gravity of the grenade.

Preferably the total cross-sectional area of the discharge orifices of the discharge nozzles is equal to one half or less than the area of the opening from the aerosol container in order to produce a high degree of propulsive force to cause a high speed spin of the grenade.

The aerosol grenade dispenser which I have devised is provided with a fusing mechanism for causing opening of the aerosol valve or piercing of the frangible disc of the aerosol container to place the contents of the aerosol container in communication with the discharge chamber and nozzles. The fuse mechanism includes a firing pin structure which is operatively connected to a valve operator for the aerosol valve. In the case of the frangible disc, the operative end of the firing pin comprises a pointed hollow shaft which breaks the frangible disc to place the pressurized container in communication with the discharge chamber and the discharge nozzles. The firing pin is urged towards the sealed opening of the pressurized container by a compression spring, one end of which is in contact with a bulkhead in the fuse body and the other end of which bears on the valve operator, or in the case of the hollow-pointed firing pin, on a ring adjacent the operative end of the firing pin. The firing pin passes through a central aperture in the bulkhead which spans the fuse body and is held away from the valve or frangible disc when the grenade is in the inactive state by means of sear blocks which are held between the preferably bevelled underside of the head of the firing pin and the upper surface of a bulkhead spanning the fuse body by a trigger block. The trigger block is displaced by a lateral force and releases the sear blocks, and thus the firing pin, upon impact of the grenade. As indicated, the underside of the head of the firing pin is preferably bevelled or the edges rounded where they bear on correspondingly bevelled surfaces on the upper inner surfaces of the sear blocks which bear against the underside of the head of the firing pin. The outer peripheries of the sear blocks have a ledge cooperating with an annular lip extending from the base of the cylindrically shaped trigger block which serves to keep the sear blocks against the underside of the firing pin head until the trigger block is displaced laterally upon impact of the grenade. When the trigger is displaced from the sear blocks, the sear blocks are forced outwardly away from underneath the firing pin head by the camming action of the lower edges of the head of the firing pin on the sear blocks. As the firing pin is released by the sear blocks and moved by the spring toward the aerosol container, the aerosol valve opens or, in the case of the frangible disc, it is broken, placing the contents of the aerosol container in communication with the discharge chamber and nozzles.

One of the most useful aspects of this invention is its utilization in a tear gas grenade type of weapon since the material discharged is discharged in aerosol form without any burning, the weapon is safe to use from a fire hazard point of view, does not create the possibility of burning the personnel at whom it is aimed, and rapidly discharges its entire contents while spinning and moving about erratically at a high rate of speed, thus substantially eliminating the possibility that the target personnel can pick up the grenade and throw it back at the law enforcement agents.

In another aspect of my invention, I have found that it is possible to dispense relatively large amounts of the tear gas CS (orthochlorobenzylmalononitrile) by dissolving it in a solvent such N,N-dimethyl formamide and N,N-dimethyl acetamide in which it is readily soluble. A further advantage of these solvents is that they are non-flammable. The solution of CS in the foregoing solvents is charged into the aerosol container with a chlorinated fluorocarbon propellant, such as dichlorodifluoromethane, and the combination is preferably saturated to 150 pounds per square inch at 70°F with carbon dioxide, nitrous oxide or other non-flammable soluble gases.

This results in a great advantage since relatively large amounts of CS can be dispensed from a small-hand-thrown grenade containing 150 ml of liquid whereas to dispense equivalent amounts using known solvents for CS would require containers on the order of one-half gallon or more in size.

Various alternative embodiments are envisioned for my aerosol grenade. Thus the discharge nozzles can be incorporated integrally within the spinning ring. The grenade may be in the form of a spherical container containing the pressurized material in which the discharge nozzles are incorporated in a spoked ring spanning the internal diameter of the sphere. In such case, the discharge nozzles lead through the spokes in the ring and exit generally tangentially at the circumference of the sphere. This will cause the sphere to spin about the central axis. The trigger mechanism and fuse body are connected to the hub of the ring perpendicularly to the plane of the ring.

The spinning action of the grenade of the present invention tends to cause the fluid in the aerosol container to be centrifuged to the section of the aerosol container where the dip tube terminates. This facilitates substantially complete exhaustion of the contents. Thus upon discharge of the grenade of this invention from approximately 95 to 100 percent of the contents of the aerosol container are discharged. Furthermore, this discharge takes place in a very short period of time; in most cases, on the order of five or six seconds.

As indicated, the grenade of this invention is particularly useful as a tear gas grenade, but is generally suitable for rapidly dispensing fluid materials in aerosol form over large, oftentimes inaccessible, areas even under windless conditions because of the rapid and erratic motion about the target area imparted to the grenade as its contents are being discharged.

BRIEF DESCRIPTION OF THE DRAWING

In the accompanying drawing which forms a part of the specification:

FIG. 1 is a perspective view in elevation of the aerosol grenade of this invention;

FIG. 2 is a vertical section taken along line 2—2 of FIG. 1 showing the parts of the grendade with the valve in the closed position;

FIG. 3 is a horizontal section taken along 3—3 of FIG. 2;

FIG. 4 is a perspective view on a smaller scale illustrating the rotation of the grenade of this invention about both the longitudinal and transverse axes thereof when the pressurized contents of the grenade are being discharged;

FIG. 5 is a sectional view to FIG. 2 but showing the condition of the parts of the grenade during discharge of the contents and after the device has been triggered;

FIG. 6 shows the meniscus of the liquid during the spinning of the grenade during discharge;

FIG. 7 is a partial vertical section of an alternative embodiment of the grenade of this invention;

FIG. 8 is a sectional view along line 8—8 of FIG. 7;

FIG. 9 is an enlarged sectional view showing the operation of the valve and discharge mechanism of the embodiments of FIGS. 1 through 6;

FIG. 10 is a sectional view of another embodiment of the grenade of this invention; and

FIG. 11 is a sectional view along line 11—11 of FIG. 10.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring in greater detail to the accompanying drawing, representative embodiments of the aerosol grenade according to my invention are illustrated. An especially preferred embodiment is illustrated in FIGS. 1 through 6 and FIG. 9.

In this embodiment, the aerosol grenade is indicated generally at 2. A conventional type of aerosol container is indicated at 4. The fuse body 6, having a cylindrical wall 8, is formed integrally with a spinning ring 10. Vertical slots 12 in the wall 8 of the fuse body 6 accomodate the extensions of a plurality of nozzles, three in the device illustrated. The nozzles 14 have ends 16 which are curved so that the orifices 18 thereof are generally directed tangentially of the circumference of the spinning ring 10.

The aerosol container 4 is closed by the top 20 which is crimped to the sides of the can 4 in a conventional manner as indicated at 22. The raised central portion 24 of the top has a centrally located aperture 26 therein and is crimped in the usual manner to hold the body 28 of a conventional aerosol valve. The threaded annular collar 29 is secured on the top 20 of the aerosol container 4 by the annular flange thereof which extends under the crimp 22. The fuse body 6 is then in turn secured to the top of the aerosol container 4 by the internal threads of the spinning ring 10 which is formed integrally with the fuse body 6. The lower portion of the valve body 28 has a central neck 30 to which dip tube 32 is frictionally secured. The end of the dip tube is indicated at 34. The valve stem 36 of the aerosol valve is force-fitted into the recess 39 in the lower portion 38*a* (FIG. 5) of the valve operator 38. An annular seal 40 is retained within the recess 39 and forms a fluid-tight seal between the valve stem 36 and the valve operator 38. In communication with the upper end of the valve stem 36 is the central vertical passage 42 in the valve operator 38. Extending laterally from the end of the passage 42 are equally angularly spaced lateral passages 44. Connected to the sides of the valve operator 38 and in communication with the lateral passages 44 are the three discharge nozzles 14.

Within and transverse of the fuse body 6 is bulkhead 46 having a central opening 48 therein. A firing pin 50 extends through the opening 48 in the bulkhead 46. The lower end of the firing pin 50 is connected to the upper surface of the valve actuator 38. A spring 58 is compressed between the lower surface of the bulkhead 46 and the top surface of the valve operator 38, thus biasing the valve operator 38 and valve stem 36 downwardly towards the container 4.

The firing pin 50, when the grenade is not in the discharge position, prevents the valve operator 38 from being moved towards the valve container 4 by two or more arcuate sear blocks 56 held under the head 52 of the pin 50 by trigger block 62. The lower edges of head 52 of the pin 50 are rounded or bevelled as shown at 54. The upper internal edges of the sear blocks 56 are correspondingly bevelled as shown at 56*a*. The upper outer edges of the sear blocks are annularly notched as shown at 60.

The trigger block 62 is generally cylindrically shaped and has an opening 64 in the base thereof to accommodate the head 52 of the firing pin 50. The edge of the base of the trigger block 62 has an annular flange or lip 66 extending axially thereof which lip 66 cooperates with the notched edges 60 of the sear blocks 56 to hold the sear blocks against the lower surface 54 of the firing pin 52. To assure that the trigger 62 does not release the sear blocks 56 accidentally, the end of the fuse body 6 is closed by a safety cap 68, the recessed portion of lower surface of which prevents accidental displacement of trigger 62. The outer edges of the cap frictionally engage the internal surfaces of the end portion of the upper wall 8. The cap 68 is further secured to the fuse body 6 by a safety pin 72 which passes through an aperture 74 in the wall 8 and into a notch 70 in the side of the safety cap 68.

Details of a conventional aerosol valve which may be utilized in this embodiment are shown in greater detail in FIG. 9. The valve body 28 is crimped in place by the central portion 24 of the top 20 of the aerosol container 4. The valve stem 36 passes through the central

aperture 26 in the top 20 of the aerosol container 4. Secured between the top of the valve body 28 and the top 20 of the dispenser is a flexible gasket 75 having a central opening 75a. The lower portion of the valve stem 36 has lateral ports 76 which are closed by the central walls defining the opening 75a of the gasket 75 when the valve is in the closed position, i.e., when the valve stem 36 is in the raised position shown in FIG. 2. In the open valve position shown in FIG. 9, the valve stem 36 has been pushed downwardly by the valve operator 38 after the firing pin 50 has been released by the sear blocks 56 allowing the spring 58 to push the valve operator 38 downwardly. The valve stem 36 is connected to valve cone 78 which is normally urged upward by the spring 78 which is of lesser strength than the spring 58. As the valve stem 36 and the valve cone 78 are pushed downwardly by the valve operator 38, the lateral ports 76 pass below the gasket 75 and thus place the interior of the hollow valve stem 36 in communication with the pressurized contents of the container which are forced upward through the dip tube 32 through the passage 82 in the necked portion 30 of the valve body 28. From the passage 82, the fluid flows through the hollow internal portion of the valve body 28 around the perimeter of the cone valve 78, through the ports 76 into the valve stem 36, to the central passage 42 in the valve operator 38 and is distributed into the plurality of lateral passages 44 in the valve operator 38 and thence to the discharge nozzles 14.

As shown in FIG. 5, the trigger block 62 has by lateral force been tilted, thus disengaging the annular lip 66 from the annular notches 60 of the sear blocks 66. The downward force of the spring 58 on the valve operator 38, and in turn on the firing pin 50 forces the sear blocks outward and away from the firing pin head 52 through the camming action of the surface 54 of the firing pin head 52 acting on the corresponding bevelled surface 56a of the sear blocks. This allows the valve operator 38 to move downwardly, opening the aerosol valve by moving the valve stem 36 downward so that the ports 76 move below the gasket 75. As the aerosol valve opens, the fluid 5 is discharged through the nozzles 14, as already described. As the fluid is discharged from the nozzles, a propulsive force is released causing the grenade to spin about its longitudinal axis and roll on the spinning ring 10. Since the nozzles are spaced from the center of gravity of the grenade and the spinning ring 10 from the longitudinal center of the grenade, this combination causes the grenade to also rotate about a tranverse axis. This tendency to spin about two different axes causes the grenade to skitter about in a very erratic manner, especially on rough surfaces. Furthermore, as the grenade is discharging, the amount of fluid 5 in container 4 is constantly changing thereby changing the center of gravity of the grenade and thus shifting the transverse axis about which the grenade rotates, accentuating the erratic motion of the grenade. This "double spin" of the grenade also facilitates its rapid dicharge. As shown in FIG. 6, the Y curve represents the shape of the meniscus of the fluid 5 if the spin of the grenade were only about its longitudinal axis. The X curve shows the shape of the meniscus of the fluid 5 when the grenade is spun about both the longitudinal and transverse axes. The Z curve in FIG. 5, similar to curve X of FIG. 6, shows the approximate shape of the meniscus of the liquid as the grenade spins about both axes. This assures that most of the fluid will be forced up the dip tube 32 and thereby assures that a very high percentage of the fluid will be discharged from the container.

In FIGS. 7 and 8, there is shown an alternative embodiment of the aerosol grenade of the present invention.

The discharge mechanism, instead of a conventional aerosol valve, comprises a frangible disc 186 and the discharge nozzles 114 are incorporated in the structure of the spinning ring 110.

The aerosol container is indicated at 104 containing fluid 115. The top 120 is crimped to the wall of the container 104 at 122. The crimping operation also serves to connect the spinning ring 110, which is integral with the fuse body 106, to the aerosol container by gripping the depending circular flange 129 of the spinning ring structure between the crimp 122 and central portion 124 of the top 120.

The raised central portion 124 of the top 120 grips the annular neck structure 128. Frangible disc 186 is retained between the top of the neck structure 128 and the annular edge 121 which extends inwardly as shown and defines the central opening 126 in the top 120.

The dip tube 132 is force-fitted over the lower end 130 of the annular neck 128.

The firing pin 150 passes through the central opening in the bulkhead 146 as in the previous embodiment. The lowermost portion of the firing pin 150 in this case is hollow and has a chisel point 160 and lateral ports 162. To the firing pin 150 there is fixed a retaining ring 151 for spring 158. The compression spring 158 exerts its force between the lower surface of the bulkhead 146 and the top of the ring 151. The lower part of the firing pin 150 passes through an aperture 113 in the lower bulkhead 111 and projects into a central chamber 142 of the spinning ring 110. The chamber 142 communicates with the discharge nozzles 114 formed integrally in the ring 110 as best shown in FIG. 8, and, when the disc 186 is pierced, with the interior of aerosol container 104.

In FIG. 7, the position of the parts is shown in the inactive state. When the grenade is thrown and the trigger mechanism actuated as in the previous embodiment, the spring 158 acting against the bulkhead 146 and the ring 151 forces the firing pin 150 downwardly, the chisel point 160 breaks through the frangible disc 186, placing the pressurized contents of container 104 in communication with the discharge nozzles 114 through the dip tube 132. The fluid 115 to be dispersed flows upwards through the dip tube 132, through the opening in the frangible disc 186 into chamber 142 and through discharge nozzles 114 which are formed interiorly of the spinning ring 110. The ends 116 of the nozzles 114 are curved as shown at the periphery of the spinning ring 110 so that the discharge occurs generally tangentially of the edge of the spinning ring 110. In the case where disc 186 is not shattered by the firing pin 150 but merely pierced by the end 160 thereof, the fluid 115 will flow into the chamber 142 by way of the lateral ports 162 and the hollow interior of the pin 150, and then into the discharge nozzles 114.

A further embodiment of the invention is illustrated in FIGS. 10 and 11 wherein the aerosol grenade 202 is in the form of a spherical body. The aerosol container 204 may be formed of metal and encloses all the elements of the grenade. An opening 204a accomodates fuse body 206 which is generally similar in construction

to the fuse structure of the embodiment shown in FIGS. 7 and 8. Running perpendicularly to the fuse body **206** and across the diameter of the spherical container **204**, is a spoked ring member **205** having the cross section as shown in FIG. **11**. The base **206***a* of the fuse body is fixed to the hub **207** of the ring **205**. The central portion of the hub **207** is open and also defines a portion of the chamber **242**. The spokes of the ring comprise the nozzles **214** which lead from the hub **207** to the ring to the edge of the ring. The conduits **217** of the nozzles **214** are in open communication with the chamber **242**. The outer portions of the conduits **217** are curved up to their ends **218** in such manner that the fluid is discharged generally tangentially to the circumference of the ring **205**. This tangential discharge will cause the grenade to spin about its central axis which runs perpendicular to the ring **205**.

An annular adaptor body **228** is secured to the underside of the hub **207**. A frangible disc **286** is set in annular recess **219** on the underside of the hub **207** and is retained in place by the inner edges of the walls of the annular adaptor body **228**. one side of the annular adaptor body **228** is provided with a port **231** into which the dip tube **232** is force-fitted.

The fluid material contained within the sphere is indicated at **215**.

The fuse body **206** is secured to the upper side of the hub **207** as shown, the upper portions of the wall **208** in fluid-tight engagement with the edge of the circular opening **204***a* in the sphere **204**. The base **206***a* of the fuse body **206** likewise is in fluid-tight seal with the upper surface of the hub **207**. The lower portion of the firing pin passes through an opening in the lower bulkhead **287** running transversely across the fuse body **206**. The outer end of the fuse body **206** is enclosed by the safety cap **268** which frictionally engages the interior walls of the body **206**. As in the previous embodiments, the safety cap **268** is removed prior to throwing the grenade and the grenade upon impact is activated as the firing pin is released by the sear blocks when the trigger block is subjected to a lateral force. The firing pin pierces the frangible disc **286** which previously isolated the pressurized contents of the sphere. The pressurized fluid material **215** then flows through the dip tube **232** into the chamber **229** within the annular adaptor body **228**, into the chamber **242** defined by the inner wall of the hub **207**, the lower wall **206***a* of the fuse body **206** and the bulkhead **287** of the fuse body, out through the conduits **217** of the nozzles **214**, exiting the orifices **218** generally tangentially of the ring **205**. As indicated, the grenade spins about the axis which is perpendicular to hub of the ring at a high rate of speed. This spin tends to centrifuge the fluid material **215** to the sides of the sphere adjacent the ring and the end of the dip tube **232**, thus facilitating substantially complete discharge of the fluid **215**. Because the center of the gravity of the sphere is not at the geometric center of the sphere, the sphere will tend to spin about additional axes.

The rate of spin is especially high with this embodiment because the spherical shape of the device greatly reduces the frictional contact of the grenade with the surface on which it lands.

The frangible discs utilized in the grenades of this invention may be comprised of suitable materials known to the art. By way of exemplification, pyrrolytic graphite and ceramic discs are mentioned.

As indicated, the aerosol grenade or dispenser of the present invention is suitable for dispensing any fluid material normally dispensed by aerosols such as fine powders, insecticides, dye markers, smoke signals, fire extinguishing agents, luminescent materials, and the like, especially where it is desired to distribute the aerosol dispensed material over a large area. The grenade of the present invention is particularly suitable for dispensing materials in areas which might be otherwise inaccessible. The aerosol dispenser of this invention can be thrown, or propelled by grenade launcher, into the target area and the discharge does not commence until the grenade strikes an object that causes a lateral force to be exerted on the trigger block to release the firing pin.

As indicated, a particularly preferred use of the grenade of this invention is as a weapon to render persons temporarily incapacitated by substances such as lachrymating agents, nerve gases, and the like. It is especially advantageous where it is desirable to avoid permanent injury to target individuals. Furthermore, it is a particular advantage of the grenade of this invention that no incendiary hazard is presented and at the same time the possibility of throw back is eliminated for all practical purposes.

A commonly employed non-lethal irritant used in tear gas grenades in the past has been CS which is orthochlorobenzylmalononitrile. The recommended solvent for use with CS has been trioctylphosphate; however, the solubility of CS in this solvent is only on the order of about 5 percent and thus impractically large hand grenades would be required to dispense approximately only 20 grams of CS. I have found that a particularly satisfactory solvent for CS is N,N-dimethyl formamide or N,N-dimethyl acetamide and further that a particularly suitable composition for utilization in a tear gas grenade according to the present invention is as follows:

	% by weight
CS	10
Dimethyl Formamide	20
Propellant 12 (Dichlorodifluoromethane) Saturated to 150 psig at 70°F with CO_2	70

Another suitable composition for utilization in a tear gas grenade of the present invention consists of CS–2 which is CS mixed with finely divided silica and an anticaking agent having diameters of 5 microns or less and being essentially insoluble in the propellant.

A representative formulation using CS–2 is:

	% by weight
CS–2	10
Propellant 12 (Dichlorodifluoromethane) Saturated to 150 psig at 70°F. with CO_2	90

In general, the solvent system should have a high degree of solvency with low toxicity and operable over a range of at least 0°F to 120°F. It is desirable that the solvent and propellant be mutually soluble to a degree to promote atomization. Most of the halogenated hydrocarbons commonly employed as aerosol propellants are suitable and are available under the Freon trademark.

As indicated, in the case of both the spherical grenade and the longitudinal grenade, the centrifugal force generated by the spinning of the grenade serves to keep the contained fluid in the aerosol container in

that portion of the container in which the end of the dip tube terminates. In the case of the generally cylindrical embodiment, the placement of rolling or spin ring at the end of the grenade away from the bottom of the aerosol container facilitates this as described above by tilting the container to its bottom end. In the case of the spherical grenade, the fluid is forced to the wall of the container near the diameter traversed by the spoked ring.

I have found that particularly on a rough surface the spinning forces will cause the grenade to bounce about making throw back all the more difficult. In most cases, the aerosol grenade will rotate on the order of several hundred rpm and the cloud formed by the rapid discharge from the multiple nozzles of the rapidly moving grenade causes it to appear merely as a blur to target personnel.

On a perfectly smooth surface, in the case of the cylindrically shaped grenade having the diameters described below, the grenade will move within an area having a radius of approximately 10 feet; however, this area is considerably larger in the case of irregular rough surfaces. In the absence of wind, the dispersion of the discharged material will cover an area of up to 40 feet in diameter. With the presence of wind and on rough surfaces, the area is very much larger.

I have found that it is preferred that the aerosol dispenser be charged at a pressure of at least 100 lbs. per square inch in order to assure rapid discharge with enough reactive power to propel the grenade about as the material is discharged.

While the disclosed fuse mechanism for activating the aerosol valve or piercing the sealed disc is particularly preferred, it is obvious that other known types of fuses or trigger devices can be readily adapted to the structure of my grenade. For example, various trigger release devices utilizing time delay systems, barometric pressure, hydrostatic pressure, or accoustics may be utilized.

An additional advantage of the aerosol tear gas grenade of my invention over the chemical reaction grenade of the prior art is that it can be refilled and reused readily. The only part other than the charged contents themselves which may require replacement are the safety cap and trigger block if these are lost during the utilization of the grenade.

In order to obtain a high degree of reaction force from the nozzles upon discharge, it is preferred that the total area of the aerosol valve orifices and channels which place the aerosol container in communication with the discharge nozzles have a cross sectional area significantly greater than, and preferably at least twice that of the total area of the cross sections of the discharge nozzles. It is desired that the greatest pressure drop take place at the nozzle orifices, and that pressure drops in the system between the container and nozzles be minimized.

A tear gas grenade according to the present invention embracing the embodiment described in FIGS. **1** through **6** and FIG. **9**, and charged with the CS composition described comprised an aerosol container can of approximately 4½ inches in length with outside diameter of 2⅛ inches. The liquid contents of the container are approximately 150 ml. The con-tainer is charged with the CS composition and propellant as described above at a pressure of 150 pounds per square inch. Three discharge nozzles each having orifices of approximately 0.062 inches internal diameter were employed. The individual discharge nozzles extend approximately 1¼ inches from the longitudinal axis. The plane of the nozzles is approximately 1¾ inches from the center of the grenade along the longitudinal axis. The spinning ring is placed approximately 4½ inches from the base of the container and the plane of the nozzles approximately 5½ inches from the container base. The nozzles are about 2 inches from the top of the fuse body. The center of gravity of the device prior to discharge is approximately 1½ inches below the nozzle plane. The rolling ring has a diameter of approximately 3 inches. Upon discharge, the contents of the aerosol can were exhausted in approximately 5 or 6 seconds.

It is apparent that these specifications may be varied within fairly broad ranges by those skilled in the art on a simple trial and error basis. It is essential, however, that the pressure drop at the nozzles be sufficient to rotate the grenade rapidly to provide adequate movement for effective distribution and to hinder throw back. At least 100 rpm is preferred.

The cylindrical embodiment of the grenade is particularly preferred as an anti-personnel weapon. The spinning ring should be placed off center in order to achieve a high degree of spin about the transverse axis. As mentioned above, since the center of gravity of the device is constantly changing as the contents are discharged, the erratic movement is accentuated because the transverse axis about which the device is spinning is constantly moving along the longitudinal axis of the device.

In lieu of the individual nozzle or nozzles incorporated in the spinning ring as described above, other variations are possible which will provide for high speed spinning about the longitudinal axis of the device and rapid discharge of the contents. For example, turbine arrangement having vanes distributed uniformly about the perimeter directing the discharge contents in very large number of tangential streams could be employed.

The aerosol grenade of my invention provides for the rapid discharge of fluid material over a large area remote from the user. The high speed spinning motions which can be very erratic facilitate the distribution of the contents and serve to prevent throw back in the case of its use as a personnel control weapon.

While the invention has been explained by a detailed description of certain specific embodiments, it is understood that various modifications and substitutions can be made in any of them within the scope of the appended claims which are intended to also include equivalents of such embodiments.

What is claimed is:

1. An aerosol grenade container for storing a fluid to be discharged together with a propellant for such fluid under pressure, closure means sealing said container prior to discharge of said fluid, said discharge nozzle extending laterally of an axis of said container, an exit orifice for said nozzle, said exit orifice oriented in the direction so that upon discharge of said fluid from said grenade said grenade is caused to spin about said axis, and fuse means operable to open said closure means upon impact of said grenade, to thereby place the interior of said container in communication with said discharge nozzle.

2. An aerosol grenade as claimed in claim **1** wherein the plane of said nozzle is spaced from the center of

gravity of said grenade with its contents along said first axis.

3. An aerosol grenade as claimed in claim 1 wherein said closure means comprises an aerosol valve.

4. An aerosol grenade as claimed in Claim 1 wherein said closure means comprises a frangible disc, said fusing means including a firing pin with a mounted end which pierces said frangible disc.

5. An aerosol grenade as claimed in claim 1 wherein the fluid to be discharged comprises orthochlorobenzylmalononitrile dissolved in N,N-dimethyl formamide or N,N-dimethyl acetamide.

6. An aerosol grenade container for storing a fluid to be discharged together with a propellant for such fluid under pressure, closure means pressure sealing said container prior to discharge of said fluid, a plurality of discharge nozzles extending laterally of an axis of said container, exit orifices for said nozzles, said exit orifices oriented in the direction so that upon discharge of said fluid from said grenade said grenade is caused to spin about said first axis, and fuse means operable to open said closure means upon impact of said grenade, to thereby place the interior of said container in communication with said discharge nozzles.

7. An aerosol grenade as claimed in claim 6 wherein the plane of said nozzles is spaced from the center of gravity of said grenade with its contents along said first axis.

8. An aerosol grenade as claimed in claim 6 wherein said grenade has a circular spinning ring in a plane perpendicular to said axis.

9. An aerosol grenade as claimed in claim 6 wherein said nozzles are equally angularly spaced from each other.

10. An aerosol grenade as claimed in claim 7 wherein said container is in the shape of a sphere, and wherein said fuse means comprises a hollow fuse body disposed within the sphere, said body having enclosed side walls, a bulkhead transverse to said walls spanning the interior of said fuse body and having a centrally located aperture therein, a firing pin passing through said aperture in said bulkhead, means at one end of said firing pin to open said closure means upon axial movement of said pin towards said closure means, biasing means between said bulkhead and said means at said one end of the firing pin urging said pin towards said closure means, a head on the opposite end of said firing pin, and releasable trigger means holding said head away from said bulkhead to prevent unwanted movement of said pin towards said closure means, said trigger means releasing said head when subjected to a lateral force upon impact of said grenade to thereby cause the opening of said closure means.

11. An aerosol grenade as claimed in claim 10 wherein said trigger means comprises sear blocks having a bevelled surface cooperating with the lower surface of said head, said sear blocks being releasably held against said pin between said head and bulkhead by a trigger block, sad trigger block releasing said sear blocks when subjected to a lateral force upon impact of said grenade.

12. An aerosol grenade as claimed in claim 11 wherein said trigger block has an annular lip projecting therefrom which releasably engages a corresponding annular ledge in said sear blocks to hold said sear blocks against said head, said lip and ledges becoming disengaged when said trigger block is subjected to a lateral force upon impact of said grenade, and said sear blocks releasing said pin due to the camming action of said pin on said sear blocks.

13. An aerosol grenade as claimed in claim 8 wherein said spinning ring is spaced from the center of said axis.

14. An aerosol grenade as claimed in claim 8 wherein said nozzles are formed within the body of said spinning ring.

15. An aerosol grenade as claimed in claim 13 wherein said nozzles are formed within the body of said spinning ring.

16. An aerosol grenade as claimed in claim 14 wherein said nozzles are equally angularly spaced from each other.

17. An aerosol grenade as claimed in claim 15 wherein said nozzles are equally angularly spaced from each other.

18. An aerosol grenade container for storing a fluid to be dis-charged together with a propellant for such fluid under pressure, closure means pressure sealing said container prior to discharge of said fluid, a plurality of discharge nozzles extending laterally of an axis of said container, wherein the plane of said nozzles is spaced from the center of gravity of said grenade along said first axis, exit orifices for said nozzles, said exit orifices oriented in the direction so that upon discharge of said fluid from said grenade said grenade is caused to spin about said axis, a circular spinning ring in a plane perpendicular to said axis, and fuse means operable to open said closure means upon impact of said grenade, to thereby place the interior of said container in communication with said discharge nozzles.

19. An aerosol grenade as claimed in claim 18 wherein said nozzles are equally angularly spaced from each other and said spinning ring is spaced from the center of said first-mentioned axis of said grenade whereby upon discharge of said fluid from said grenade, said grenade will tend to spin also about a second axis transverse to said first axis.

20. An aerosol grenade as claimed in claim 18 wherein said fuse means comprises a hollow fuse body, said body having enclosed side walls, a bulkhead transverse to said walls spanning the interior of said fuse body and having a centrally located aperture therein, a firing pin passing through said aperture in said bulkhead, means at the inner end of said firing pin to open said closure means upon axial movement of said pin towards said closure means, biasing means between said bulkhead and said means at said inner end of the firing pin urging said pin towards said closure means, a head at the second end of said firing pin, and releasable trigger means holding said head away from said bulkhead to prevent unwanted movement of said pin towards said closure means, said trigger means releasing said head when subjected to a lateral force to thereby cause the opening of said closure means.

21. An aerosol grenade as claimed in claim 19 wherein as said fluid is discharged from said grenade the center of gravity continuously changes causing said transverse axis to move along said first axis threby causing the motion of said grenade to be erratic.

22. An aerosol grenade as claimed in calim 21 wherein said nozzles are integrally formed within the body of said spinning ring.

23. An aerosol grenade as claimed in claim 20 wherein said grenade has three discharge nozzles.

24. An aerosol grenade as claimed in claim 20 wherein the fluid to be discharged comprises orthochlorobenzylmalononitrile dissolved in N,N-dimethyl formamide or N,N-dimethyl acetamide.

25. An aerosol grenade as claimed in claim 23 wherein said closure means comprises an aerosol valve.

26. An aerosol grenade as claimed in cliam 23 wherein aid closure means comprises a frangible disc.

27. An aerosol grenade container for storing a fluid to be discharged together with a propellant for such fluid under pressure, closure means sealing said container prior to discharge of said fluid, a plurality of discharge nozzles extending laterally of a first axis of said container, equally angularly spaced from each other, wherein the plane of said nozzles is spaced from the center of gravity of said grenade along said first axis, exit orifices for said nozzles, said exit orifices oriented in the direction so that upon discharge of said fluid from said grenade said grenade is caused to spin about said first axis, a circular spinning ring in a plane perpendicular to said first axis, fuse means operable to open said closure means upon impact of said grenade, to thereby place the interior of said container in communication with said discharge nozzles, said fuse means comprising a hollow fuse body, said body having enclosed side walls, a bulkhead transverse to said walls spanning the interior of said fuse body and having a centrally located aperture therein, a firing pin passing through said aperture in said bulkhead, means at one end of said firing pin to open said closure means upon axial movement of said pin towards said closure means, biasing means between said bulkhead and said means at said one end of the firing pin urging said pin towards said closure means, a head at the outer end of said firing pin, and releasable trigger means holding said head away from said bulkhead to prevent unwanted movement of said pin towards said closure means, said trigger means releasing said head when subjected to a lateral force upon impact of said grenade to thereby cause the opening of said closure means.

28. A grenade as claimed in claim 27 wherein said trigger means comprises sear blocks having a bevelled surface cooperating with the lower surface of said head, said sear blocks being releasably held against said pin between said head and bulkhead by a trigger block, said trigger block releasing said sear blocks when subjected to a lateral force upon impact of said grenade.

29. A grenade as claimed in claim 28 wherein said trigger block has an annular lip projecting therefrom which releasably engages a corresponding annular ledge in said sear blocks to hold said sear blocks against said head, said lip and ledges becoming disengaged when said trigger block is subjected to a lateral force upon impact of said grenade, and said sear blocks releasing said pin due to the camming action of said pin on said sear blocks.

30. An aerosol grenade container for storing a fluid under pressure, said container having a discharge valve for said fluid and preventing a curvilinear surface in a plane angularly disposed with respect to the central axis of the container and upon which it is capable of rolling, and a plurality of discharge nozzles communicating with the interior of the container when said valve is opened and dimensioned and arranged in the plane of such surface to direct high velocity streams of said fluid in substantially tangential directions to said surface to cause spinning of the container and render capture for throw-back difficult after it has landed.

31. A grenade container according to claim 30, wherein the container is in the form of a spherical shell having therein a spider structure in whose arms the nozzles and the passageways from the valve to the nozzles are embodied, the discharge orifices of the nozzles being located on the surface of the spherical shell.

32. A grenade container according to claim 3 wherein the discharge valve is disposed within the spherical shell, and means operable to form outside the shell for opening the valve to effect discharge of the contents of the container.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,785,569 Dated January 15, 1975

Inventor(s) Ralph Helmrich

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 37, "larger" should read -- smaller --.

Claim 30, line 3, "preventing" should read -- presenting --.

Claim 32, line 1, "claim 3" should read -- claim 30 --; and in line 3 of the claim, the words "to form" should read -- from --.

Signed and Sealed this

thirtieth Day of December 1975

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

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