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Feb. 10, 1970 R. S. STANSBURY ET AL 3,494,423

AIRBORNE FIRE SUPPRESSION SYSTEM

Filed March 5, 1968 6 Sheets-Sheet 1

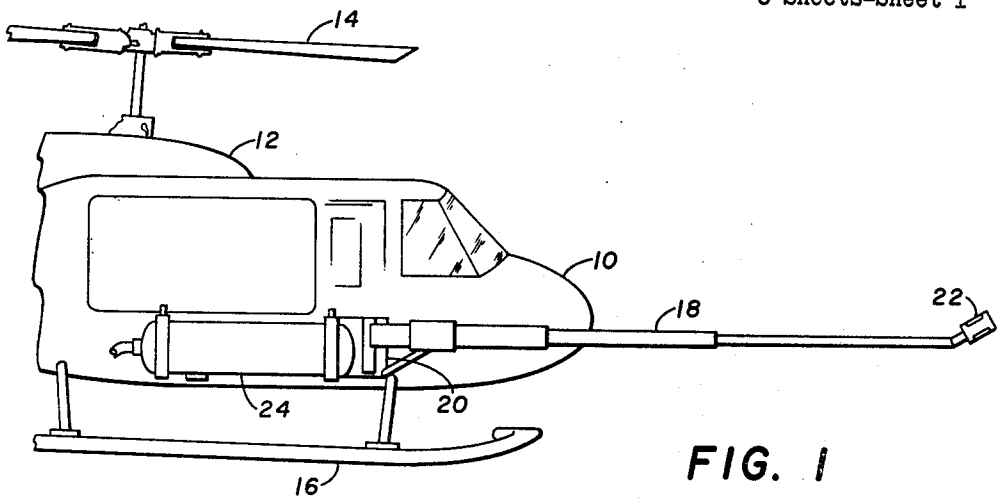


FIG. 1

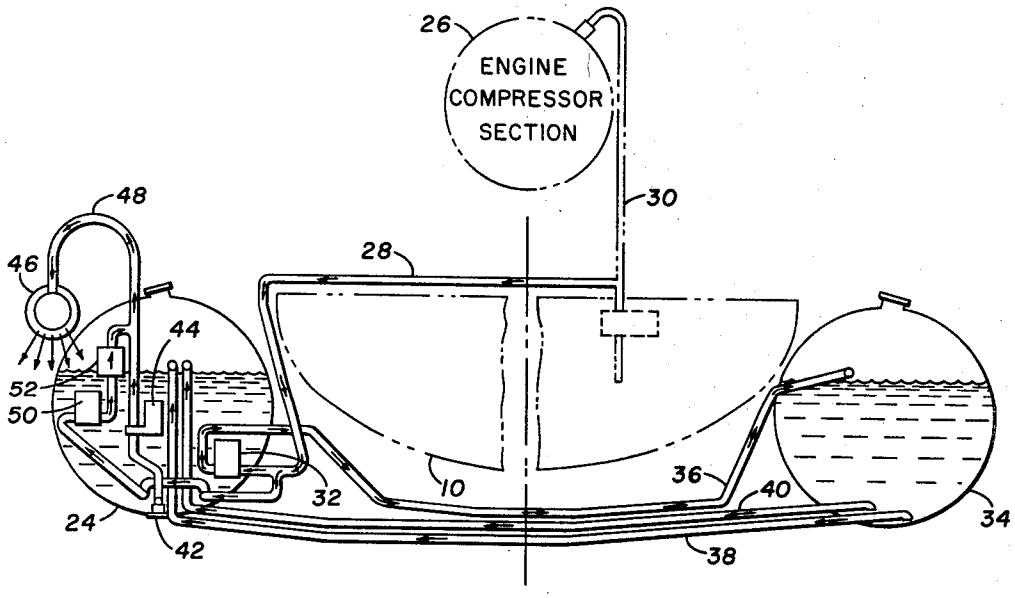


FIG. 2

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6 Sheets-Sheet 2

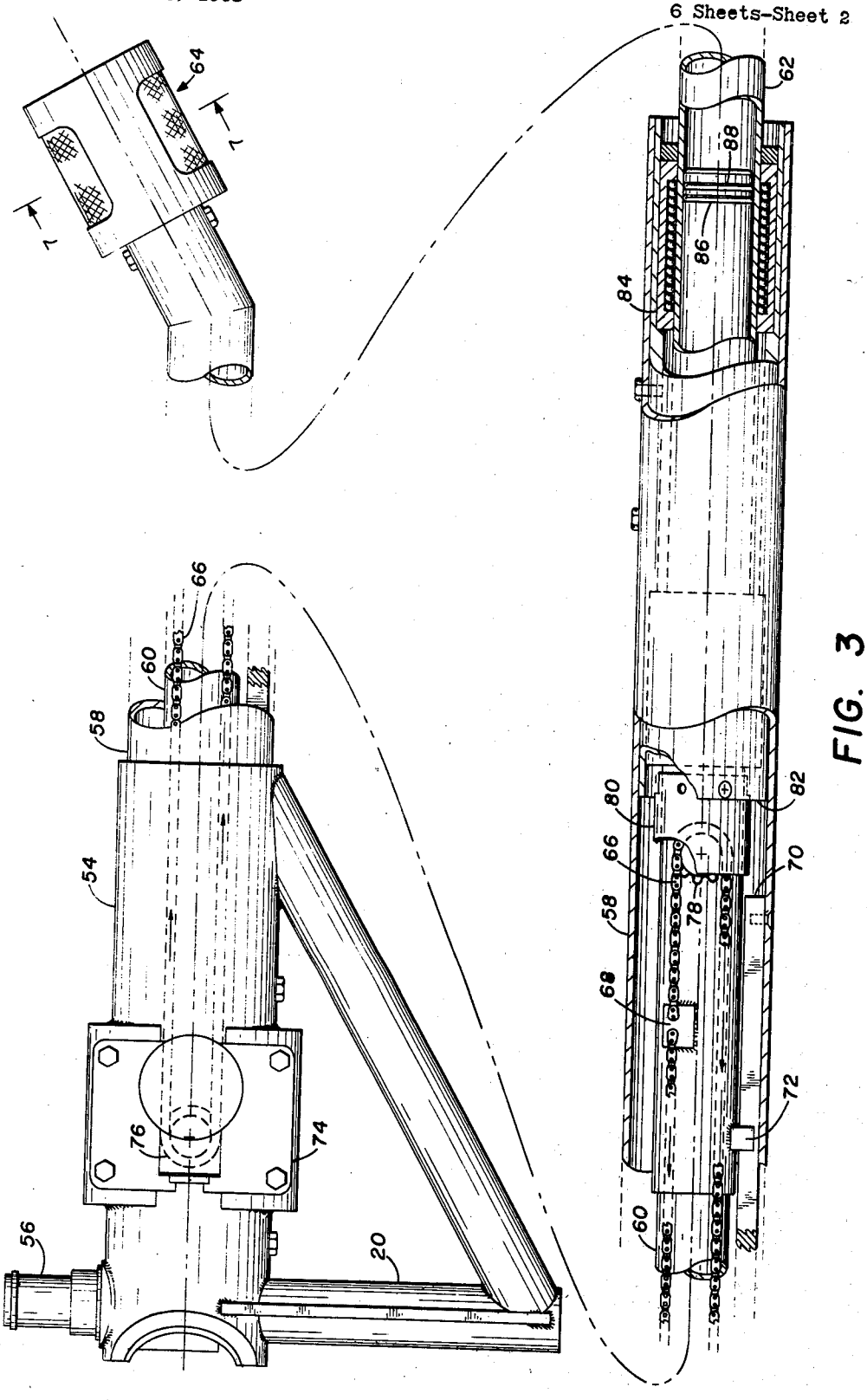


FIG. 3

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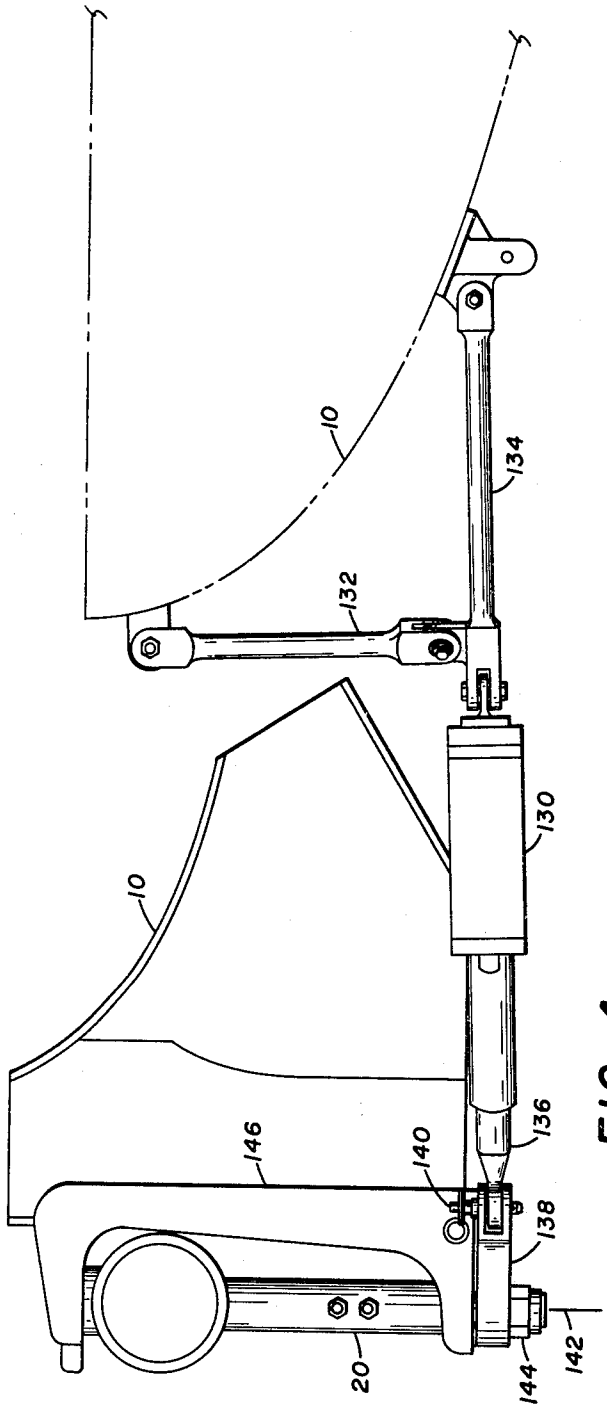


FIG. 4

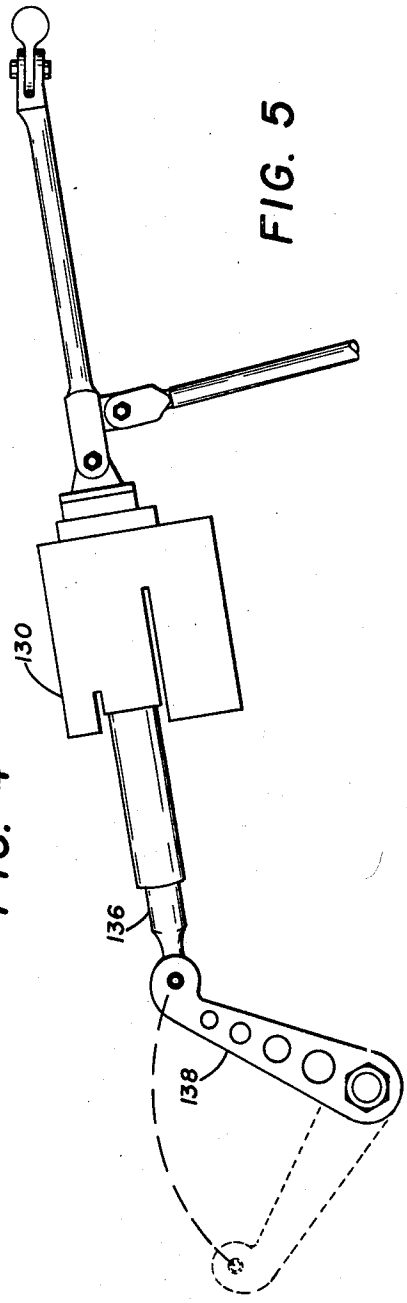


FIG. 5

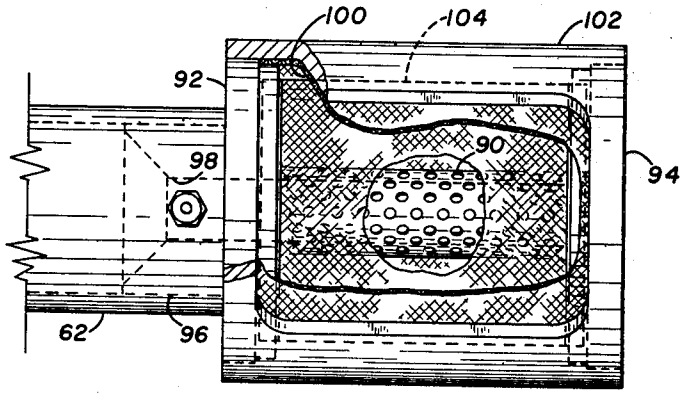


FIG. 6

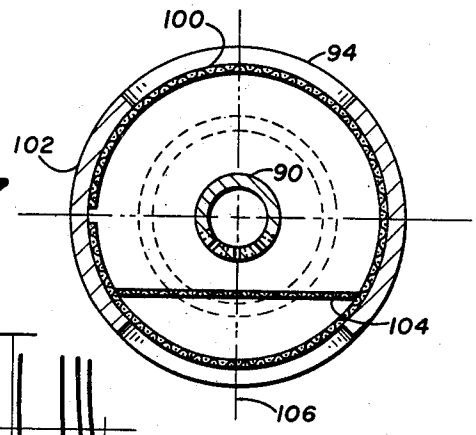


FIG. 7

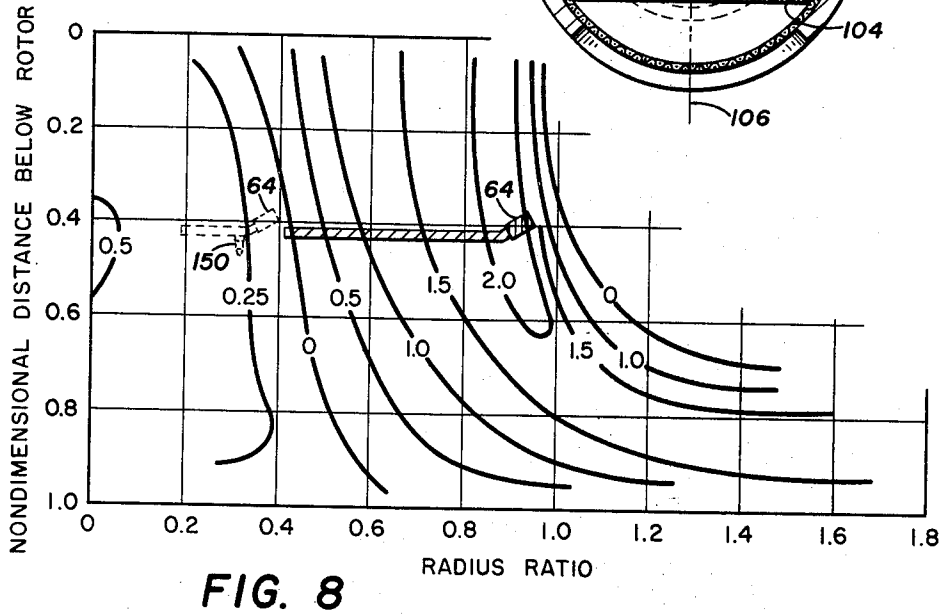


FIG. 8

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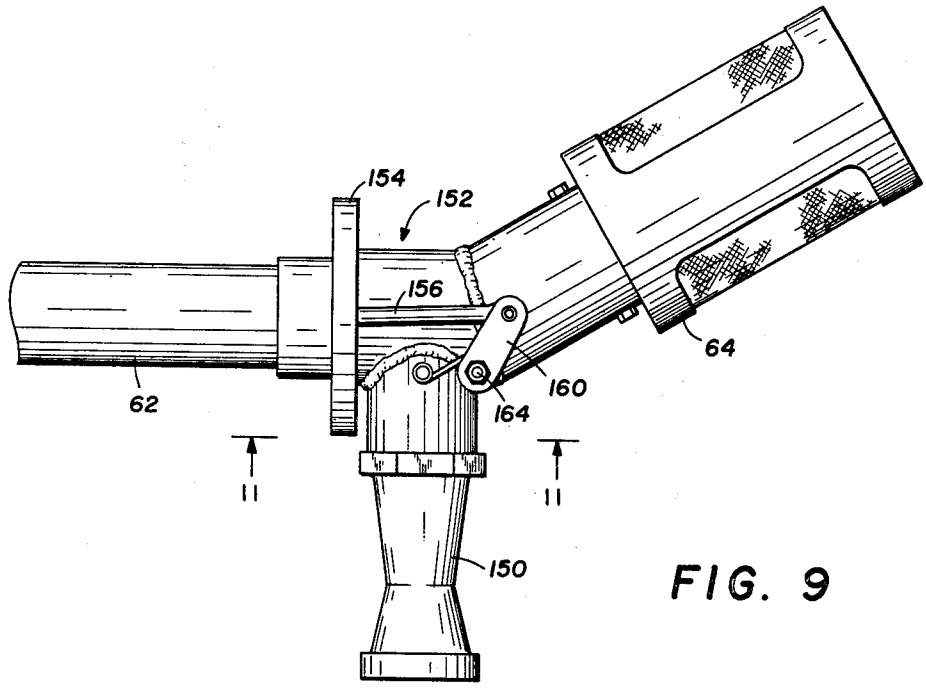


FIG. 9

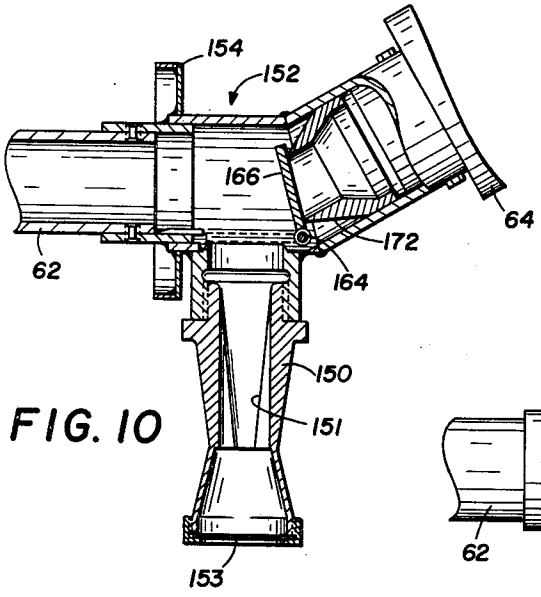


FIG. 10

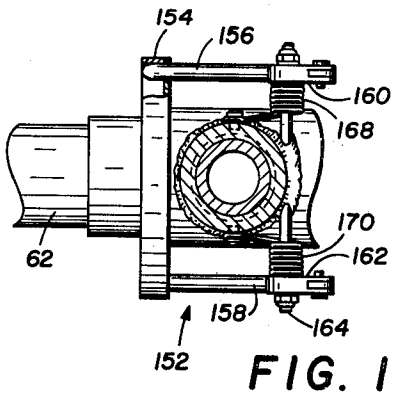


FIG. 11

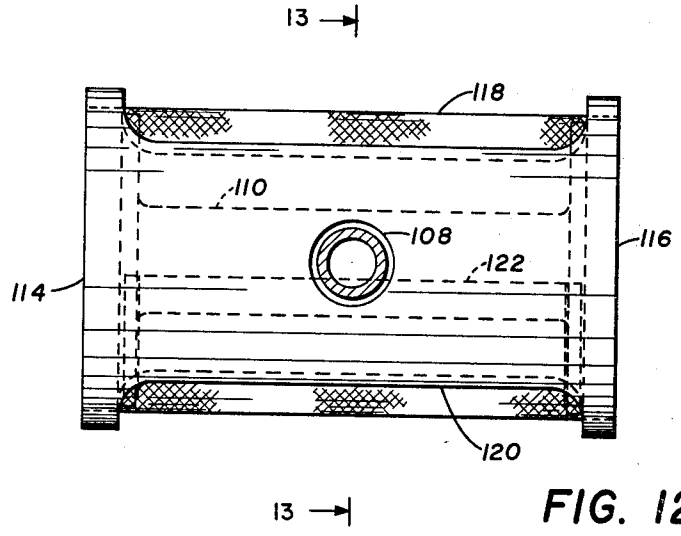


FIG. 12

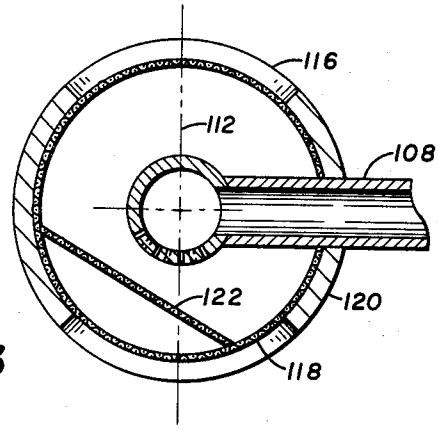


FIG. 13

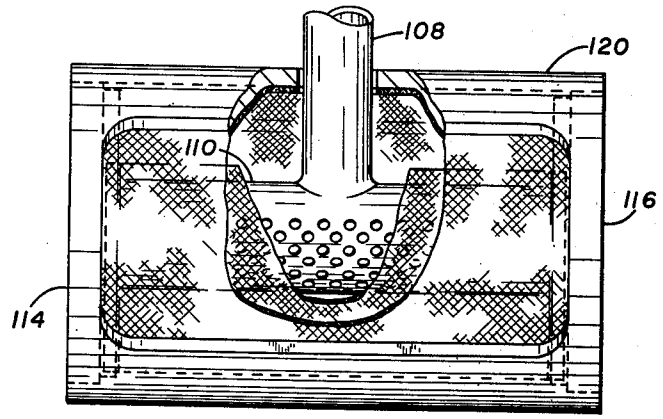


FIG. 14

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Patented Feb. 10, 1970

3,494,423

AIRBORNE FIRE SUPPRESSION SYSTEM

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Int. Cl. A62c 3/00
U.S. Cl. 169—2 23 Claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for airborne fire suppression by means of a fire retardant chemical foam directed to a desired area of a fire scene from an extendable boom rotationally mounted to an airframe. A dispersion-type nozzle attached to the extendable boom causing a mixing of the fire retardant material with rotor downwash to create a foaming mixture. The fire retardant material is supplied to the extendable boom at relatively low pressures from one or more storage tanks and dispersed by the nozzle into the rotor downwash at an angle adapted to the downwash pattern to provide accurate fire pattern control.

BACKGROUND OF THE INVENTION

This invention relates to airborne fire fighting, and more particularly relates to a low pressure fire suppression system employing rotor downwash to distribute a fire retardant chemical for effective fire control.

Aircraft accidents often occurs in remote areas not accessible to normal ground fire fighting equipment. In such situations an airborne system is highly desirable because first, it can reach the scene, and second, the response time to arrive at the fire is minimized. Wherever response time is a critical factor, such as in aircraft and automotive accidents, an airborne fire fighting system is superior to the usual ground based equipment.

Presently available airborne fire fighting systems usually operate at high pressures, around 3000 p.s.i., supplied from high pressure nitrogen cylinders. In such systems, the high pressure is required to adequately foam the fire retardant material for maximum effectiveness in fire suppression. These high pressure systems create a safety hazard in that the pressure vessels are always a potential "bomb" if ruptured. In military applications the "bomb" hazard is extremely critical.

Another shortcoming of the high pressure airborne fire fighting system lies in its method of use. One design provides a fixed nozzle mounted within close proximity of the aircraft fuselage, thereby necessitating a dangerously close approach to the configuration. Another design is carried by the helicopter as an external sling load. The helicopter carries this system to the accident scene and releases the package near the fire. Fire fighters are then landed to operate the equipment to either suppress the fire for removal of trapped victims or fire fighting. Considerable time delay is involved before the fire fighters begin to operate the equipment.

In accordance with the present invention, a supply of fire retardant material, under relatively low pressure, is connected to an extendable boom mounted to the hard points of a helicopter. Immediately upon arrival at a fire scene, the helicopter pilot swings the boom into position and the fire retardant material flows through the extendable boom to suppress the fire. Simultaneously, rescue personnel are rappelled from the helicopter and proceed immediately to the crash while the pilot clears an entrance and exit path by manipulation of the extendable boom. The rescue personnel are protected from backfires as these are easily visible and controlled by the helicopter pilot, and in addition, they are free to complete their rescue

mission not hampered by bulky and unwieldly high pressure hoses. By means of the controllable boom and variations of helicopter altitude, a wide variety of different chemical dispersion patterns can be effected to assure adequate coverage of the rescue personnel. In addition, the extendable boom allows the pilot to position his aircraft away from the fire itself, thereby reducing a fire hazard to the helicopter.

In accordance with a specific embodiment of the invention, a dispersion-type nozzle mixes the helicopter rotor downwash with a fire retardant material to create a foam dispersed on a fire. The nozzle mounts at the outboard end of an extendable boom rotatably mounted to a helicopter hard point. Low pressure air, on the order of 50 p.s.i., from the helicopter engine compressor pressurizes two storage tanks to deliver the fire retardant material through the extendable boom to the nozzle. For cold weather operation, bleed air from the engine compressor is connected to the boom to maintain the system at a proper operating temperature.

An object of the present invention is to provide a low pressure fire suppression system. Another object of the invention is to provide a fire suppression system for minimizing the elapsed time before beginning actual fire fighting. A further object of this invention is to provide a fire suppression system wherein helicopter rotor downwash mixes with a fire retardant material to create a foaming mixture. Still another object of this invention is to provide a fire suppression system wherein rotor downwash distributes a fire retardant chemical to a fire. Other objects and advantages of the invention will be apparent from the following description of a preferred embodiment, from the claims, and from the accompanying drawings illustrative of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is an illustration, partially cut away, of a helicopter mounted low pressure fire fighting system in accordance with this invention;

FIGURE 2 is a schematic of a pressurizing and fluid piping arrangement;

FIGURE 3 is a detailed view, partially cut away and partially in section, showing the extendable boom and dispersion-type nozzle;

FIGURE 4 is a front view of a boom azimuth control system;

FIGURE 5 is a top view of the system of FIGURE 4;

FIGURE 6 is a bottom view, partially cut away, of the nozzle of FIGURE 3;

FIGURE 7 is a sectional view of the nozzle of FIGURE 3 taken along the line **7—7**;

FIGURE 8 shows the pressure distribution pattern for a rotor helicopter one radius above ground;

FIGURE 9 is a plan view of the extendable boom, partially cut away, showing a dual nozzle system;

FIGURE 10 is a cross section of the dual nozzle system of FIGURE 9 showing the selector valve mechanism;

FIGURE 11 is a view along line **11—11** of FIGURE 9;

FIGURE 12 is a plan view of an alternate embodiment of a dispersion-type nozzle;

FIGURE 13 is a sectional view of the nozzle of FIGURE 12 taken along the line **13—13**; and

FIGURE 14 is a bottom view, partially in section, of the nozzle of FIGURE 12.

DESCRIPTION OF A PREFERRED EMBODIMENT

With reference to FIGURE 1, the helicopter shown comprises an elongated fuselage or hull **10** having a pylon **12** housing an engine and associated gearing required to rotate a lifting rotor **14** about a vertical axis.

The tail portion is cut away for simplicity; it includes an anti-torque rotor in accordance with standard single rotor helicopter design. A skid-type landing gear **16** is provided for supporting the helicopter.

Attached to hard points on the pilot's side of the fuselage **10** is an extendable boom **18** mounted to rotate in azimuth and supported by a bracket **20**. At the outboard end of the boom **18** there is attached a nozzle **22** at an angle with respect to the boom center line which takes full advantage of the helicopter rotor downwash distribution pattern. Also attached to the fuselage **10** is a storage tank **24** with a similar storage tank (not shown) mounted on the opposite side. These storage tanks contain a liquid fire retarding chemical such as a six percent aqueous solution of the fire extinguishing agent known as "Light Water," marketed by the 3M Company and identified by the code FC–194. Where space is available, the storage tanks are mounted in the aft section of the cabin, thereby maintaining the fire retardant chemical at cabin temperature.

The fire retardant material flows from the storage tanks to the boom **18** by a piping arrangement shown schematically in FIGURE 2. Bleed air from the compressor section **26** of the helicopter's turbine engine pressurizes the system at approximately 50 p.s.i. by means of a line **28** connected to a tee in the cabin heater line **30**. Where the helicopter engine does not include a compressor section, a low pressure pump would be employed to supply the necessary air pressure. A solenoid operated pressurizing valve **32** controls the bleed air flow into the storage tanks **24** and **34** by means of a line **36** opening into the tank **34**. Pressurizing the tank **34** forces the fire retardant liquid therein through pipes **38** and **40** into the storage tank **24**. Fluid in the tank **24** is discharged therefrom through a sump **42** upon opening a foam discharge valve **44**. Opening the valve **44** permits the fire retardant liquid to enter the boom nozzle assembly **46** (shown schematically) by means of a connecting line **48**.

After an application of the fire retardant material, the pipe **48** and boom nozzle combination **46** are purged with bleed air controlled by a de-icing valve **50** and a check valve **52**. Since the compressor section bleed air is relatively hot, on the order of 400° F., the air passing through valve **50** not only purges the line **48** and boom nozzle assembly **46**, but also maintains it at a de-icing temperature to permit operation of the system in intermediate weather conditions. Where a pump supplies the pressurizing air, an air heater is located upstream of the valve **50** to preheat the purge air.

The helicopter pilot controls the extendable boom **18** to dispense the fire retardant liquid anywhere in the outer third of the rotor downwash. As shown in FIGURE 3, the extendable boom includes a support section **54** welded to the bracket **20**. A housing tube **58** mates with the section **54** to form the basic or retracted boom length. Concentrically mounted within the housing tube **58** is a supply tube **60** having a hose fitting **56** at one end and extending approximately the length of the housing tube. The hose fitting **56** has a flexible hose (not shown) coupled thereto and to the storage tank **24**. An extension tube **62**, concentrically mounted with respect to the tubes **58** and **60**, terminates at a nozzle **64** canted at about 30° with respect to the boom center line.

The extension tube **62** is positioned from a fully retracted position to a fully extended position by means of a drive chain **66** attached to a tab **68**. A rail **70**, bolted to the housing tube **58**, and a guide **72** maintained the tube **62** in proper orientation throughout its movement. To position the tube **62**, a motor **74** is energized and rotates a sprocket **76** engaging the chain **66**. Rotating the sprocket **76** causes the chain **66** to exert a pulling force on the tab **68** from either the left or right, depending on whether the tube **62** is being retracted or extended. The chain **66** also engages a sprocket **78** assembled to a bracket **80** which in turn is bolted to a bearing tube **82**. The bearing tube **82** fits into the housing tube **58** and is bolted thereto; it contains a front bearing **84** and a rear bearing (not shown) which support the extension tube **62** and the supply tube **60**. A pair of O-ring seals **86**, **88** provide a watertight seal between the outer diameter of the supply tube **60** and the inner diameter of the extension tube **62**.

An important feature of the fire suppression system of this invention is its ability to suppress and control fires over varying types of terrain. Obstructions will always be a problem while applying the chemical foam. The controllable boom allows the helicopter pilot to position his craft to clear tail rotor obstructions and still dispense the chemical in the rotor downwash where it will be most effective. In addition to extension control, the boom is also controllable in azimuth from a position forward to a position at about 80°.

Control of the boom **18** in azimuth is accomplished by means of a linear actuator **130**, referring to FIGURES 4 and 5, coupled to the hard points of the fuselage **10** by means of linkages **132**, **134**. The extendable shaft **136** of the actuator **130** connects to a positioning arm **138** by means of a quick release pin **140**. Energizing the actuator **130** rotates the positioning arm **138** about an axis **142**, thereby rotating the bracket **20** attached to the arm **138** by means of a nut **144**. The bracket **20** is rotatably mounted in a support **146** attached to the fuselage **10**. To simplify the preparation of FIGURE 4, the fuselage **10** is shown in two different planes; the bracket **146** is attached to the fuselage **10** at points somewhat aft of the linkages **132**, **134**. As best shown in FIGURE 5, the linear actuator **130** positions the arm **138** through an angle of approximately 80° with the outer limit shown in dotted outlines. Boom azimuth control permits the helicopter pilot additional flexibility in positioning his craft at a fire scene.

In operation, as the helicopter approaches a fire scene the pilot actuates the motor **74**, and the chain **66** extends the tube **62** to the desired area of the rotor downwash pattern. He also energizes the linear actuator **130** to rotate the boom as necessary to permit safe operation of the helicopter. When the boom has been extended and positioned where desired, the pilot de-energizes the valve **50** and pressurizes the tank **24** and **34** by opening the valve **32**. The fire retardant liquid flows from the tanks **24** and **34** through a flexible hose (not shown) to the supply tube **60** by means of the fitting **56**. Fluid discharged from the supply tube **60** travels through the extension tube **62** to the nozzle **64** to be dispersed as a foam on the fire.

The nozzle **64**, referring to FIGURE 6, includes an apertured distribution pipe **90** with flanges **92** and **94** on opposite ends thereof. A chamfered pipe **96** at the flange **92** has a passage **98** that channels the fire retardant fluid from the extension tube **62** into the distribution pipe **90**. A cylindrical screen **100** encircles the pipe **90** and fits between the flanges **92** and **94**. A cover **102** partially encloses the cylindrical screen **100**, as shown in FIGURE **7**, to form an aspirator-type passage around the pipe **90**. Approximately half way between the apertures of the pipe **90** and the cylindrical screen **100** a flat screen **104** is positioned in grooves in the flanges **92** and **94**.

The fire retardant chemical from the storage tanks **24** and **34** is channeled through the pipe **96** into the pipe **90** and discharged therefrom as a plurality of small streams. The stream size depends on the aperture sizes in the pipe **90**; these can be either all of one uniform size or graded with smaller apertures displaced from the vertical axis **106**. For purposes of illustration, the apertures shown in FIGURES 6 and 7 are of a uniform diameter. The streams emitting from the pipe **90** are dispersed as droplets when contacting the screen **104** and by mixture with the rotor downwash passing through the upper portion of the cylindrical screen **100**. As the air droplet mixture passing through the screen **104** contacts the lower portion of the cylindrical screen **100** a foaming

action takes place. Thus, as the fire retardant liquid leaves the nozzle **64**, it is in the form of a fire fighting foam having characteristics similar to a foam produced by high pressure systems.

In addition to foaming the fire retardant liquid, the rotor downwash also carries the foam to the fire. The high volume, high velocity air under the rotor very effectively carries the foam down and forward for application on the fire as directed by the pilot for effective fire suppression. This pattern distribution is controlled by locating the nozzle **64** in selected areas of the rotor downwash. Referring to FIGURE 8, there is shown a pressure distribution profile for the downwash from a helicopter rotor with the rotor radius ratio plotted on the horizontal axis and distance below the rotor plotted on the vertical axis. The curves of FIGURE 8 are for a helicopter hovering at an altitude equal to one rotor radius. Note that the downwash pressure reaches a maximum at a radius ratio of about 0.9. In this general area the air moves down and away from the helicopter and the foam dispensed from the nozzle **64** will be carried away from the helicopter. Thus, by extending the nozzle **64** at a radius ratio of about 0.9, the pilot is able to position his craft a greater distance from the fire for increased safety. To position the nozzle **64** at the desired pressure contour, the helicopter pilot extends the tube **62** by energizing the motor **74**. As a simple expedient, a series of markers can be painted on the tube **62** to indicate to the pilot the boom extension length.

It will also be noted that at a radius ratio of about 0.9 the pressure distribution curves are not vertical when they pass the nozzle **64**, assuming the boom is attached as shown in FIGURE 1. At this point the air currents are moving at an angle of approximately 30° from the vertical. Thus, by angularly displacing the nozzle **64** from the boom center line, air passes through the nozzle **64** at close to a right angle. Of course, if the boom is mounted closer to the rotor, that is, at the top of the fuselage **10**, a straight through type of nozzle-boom construction may be used.

Referring to FIGURES 9–11, there is shown an alternate nozzle arrangement including the dispersion-type nozzle **64** and a high volume dump nozzle **150**. The nozzles **64** and **150** extend from a two-way valve **152** that is attached to the end of the extension tube **62**. Where desired, the housing of the valve **152** comprises two sections, one at approximately 30° relative to the other, to place the nozzle **64** in the most advantageous position in the downwash pattern for maximum foam dispersion.

As best shown in FIGURE 10, the dump nozzle **150** includes a venturi section **151** terminating in a foaming screen **153**. A fire retardant fluid flowing through the venturi section **151** strikes the screen **153** and is discharged from the nozzle as a foam and droplet spray.

The operating mechanism of the valve **152** includes a guide ring **154** welded to the valve housing. This guide ring has two passages for positioning control rods **156** and **158**. As the extension tube **62** is retracted into the housing tube **58**, the control rods **156** and **158** are pushed forward toward the nozzle **64**, thereby rotating lever arms **160** and **162** clockwise. Clockwise rotation of the lever arms **160** and **162** imparts a rotating motion to a shaft **164** and a butterfly valve **166** pinned to the shaft. The lever arms **160** and **162** are biased to hold the butterfly valve **166** in a horizontal position (shown in dotted outline in FIGURE 10) by means of springs **168** and **170**.

As explained previously, the helicopter pilot positions the nozzle **64** to distribute a fire retardant chemical on a fire scene to permit rescue of personnel from the crashed vehicle. After the rescue has been accomplished, there usually remains "hard to get to" fires which if left to burn will in time reignite the suppressed areas. With the embodiment shown in FIGURES 9–11, the pilot maintains flow through the extension tube **62** and simultaneously fully retracts the boom. This actuates the control rods **156** and **158** to rotate the butterfly valve **166** from a horizontal position to a substantially vertical position against a valve seat **172**. The flow of fire retardant chemicals now passes through the dump nozzle **150** at a relatively high volume. Since the boom is fully retracted, the foam and droplet spray from the nozzle **150** will be dispersed into the downwash pattern in an area where the contour lines are substantially vertical (shown dotted in a typical position in FIGURE 6). This enables the helicopter pilot to direct the high volume flow accurately to the hard to get to fires. Note, however, that the boom can be extended, if desired, and the chemical flow will continue to flow from the nozzle **150**. Fluid flowing through the extension tube **62** and impinging on the butterfly valve **166**, when it is against the valve seat **172**, as shown in FIGURE 10, produces a force sufficient to overcome that produced by the springs **168** and **170**. Thus, the butterfly valve **166** will remain against the valve seat **172** so long as flow continues through the nozzle **150**. Of course, if the pilot wishes to re-establish flow through the nozzle **64**, he merely interrupts flow through the extension tube **62** and the butterfly valve **166** closes off the dump valve **150**.

In addition to controlling the dispersion pattern by positioning the boom in the rotor downwash, the pattern can be controlled by modification of the nozzle **64**. Referring to FIGURES 12–14, there is shown an alternate embodiment of the nozzle **64** wherein the fluid enters the distribution pipe at the side as opposed to the end. Fluid from the extension tube **62** enters the nozzle through a pipe **108** at a right angle to a distribution pipe **110**. The distribution pipe **110** has an array of apertures displaced along its longitudinal axis with the center of the aperture spread rotated approximately 30° from the vertical axis **112**. Flanges **114** and **116** cap the ends of the distribution pipe **110** and includes shoulders to position a cylindrical screen **118**. A cover **120** covers both sides of the cylindrical screen **118** in a manner best shown in FIGURE 13. A flat screen **122**, tilted at 30° to the horizontal, is positioned between the aperture array and the cylindrical screen **118**.

Operation of the nozzle of FIGURES 12–14 is similar to the nozzle of FIGURES 6 and 7. Downwash from the helicopter rotor passes through the upper exposed portion of the cylindrical screen **118** and mixes with streams of the fire retardant fluid emitting from the apertures in the pipe **110**. This air-fluid mixture impinges on the flat screen **122** creating a coarse foam that passes through to the lower exposed portion of the cylindrical screen **118**. A fire suppressing foam develops as the air-fluid mixture passes through the screen **118**. Although the straight through nozzle of FIGURES 6 and 7 will cut a path of any desired width by merely rotating the boom through a few degrees of azimuth, for some application the right angle nozzle of FIGURES 12–14 may be preferred. Whichever nozzle is used, the foam is dispersed into the pressure distribution pattern shown in FIGURE 8 at a selected rotor radius between 0.4 and 0.9.

In a typical fire rescue mission using the system described, the helicopter pilot swings the extendable boom into position prior to hovering at the crash scene. The fire retardant material is sprayed from the boom nozzle to commence suppressing the fire as soon as the helicopter comes to a proper hovering position. Simultaneously, aeromedical rescue men are rappelled from the helicopter and proceed immediately into the conflagration while the helicopter pilot clears an entrance and exit path. The rescue men are protected from backfires by the helicopter pilot who is in a position to view the entire scene and adjust the boom azimuth and extension. The helicopter pilot, using the controllable boom and variations of helicopter altitude, can effect a wide variety of different chemical dispersions to assure adequate coverage to protect the rescue and rescued personnel.

Although an extendable boom has been described herein for optimum positioning of the nozzle **22** in the rotor downwash pattern, a fixed length boom may be employed

with some helicopters. On smaller craft where shorter rotor radii are encountered, a short fixed length boom is satisfactory as the boom length would not hinder the normal operation of the helicopter. The length of the fixed boom is calculated to insure the nozzle 22 is generally in a preferred area of the downwash pattern at all azimuth positions.

While only preferred embodiments of the invention, together with modifications thereof, have been described in detail herein and shown in the accompanying drawings, it will be evident that various further modifications are possible without departing from the scope of the invention.

What is claimed is:

1. An aircraft mounted airborne fire suppression system for dispensing into a downwash pattern a fire retardant material from a storage container comprising:
   - a tubular boom attached by a pivot to said aircaft,
   - control means actuatable from the aircraft pilot position to locate said tubular boom in azimuth about said pivot to preselected areas of said downwash pattern generated by said aircraft,
   - a nozzle at the outboard end of said tubular boom to disperse the fire retardant material as a foam and droplet spray in a desired pattern, and
   - means for transferring said fire retardant material from said storage container to said nozzle through said tubular boom.

2. An airborne fire suppression system as set forth in claim 1 wherein said aircraft is of the type having an engine compressor section and said transfer means includes means for pressurizing said container with bleed air from said compressor section.

3. An airborne fire suppression system as set forth in claim 2 wherein the bleed air pressurizes the container at fifty pounds per square inch.

4. An airborne fire suppression system as set forth in claim 1 wherein said nozzle includes means for directing the fire retardant material in a pattern having a center at an angle of approximately 30 degrees from the center line of said tubular boom.

5. An airborne fire suppression system as set forth in claim 4 wherein said nozzle includes first and second foam screens arranged to mix the aircraft downwash with the fire retardant material to create a foaming spray in a desired pattern.

6. An airborne fire suppression system as set forth in claim 1 including a second nozzle at the outboard end of said tubular boom for high volume dispersion of said fire retardant material, and
   - means for selecting between said first and second nozzles for dispensing said fire retardant material.

7. A fire suppression system for an aircraft having a downwash pattern comprising:
   - container means for storing a fire retardant material,
   - a variable length boom attacked at a pivot to said aircraft,
   - first control means for varying the length of said boom to preselected areas of said downwash pattern,
   - second control means for positioning said boom about said pivot in azimuth to preselected areas of said downwash pattern,
   - a nozzle at the outboard end of said variable length boom for dispensing the fire retardant material as a foam and droplet spray into said downwash pattern, and
   - means for connecting said container means to the inboard end of said variable length boom.

8. A fire suppression system as set forth in claim 7 wherein said aircraft is of the type having an engine compressor section and including means for purging the boom and nozzle with heated air from said engine compressor to maintain said boom and nozzle in a ready operating condition.

9. A fire suppression system as set forth in claim 8 including means for pressurizing said container from said engine compressor section to deliver the fire retardant material from said container to said nozzle.

10. A fire suppression system as set forth in claim 9 including means for mounting said nozzle at an angle of approximately 30 degrees from the center line of said variable length boom.

11. A fire suppression system as set forth in claim 10 wherein said nozzle includes first and second foaming screens arranged to mix the downwash with the fire retardant material to create a foaming spray from said nozzle.

12. A fire suppression and fire fighting system borne by an aircraft generating a downwash pattern comprising:
   - a tubular boom attached to said aircraft and pilot controllable to preselected areas of said downwash pattern generated by the aircraft.
   - a dispersion type nozzle at the outboard end of said tubular boom to disperse the fire retardant material as a foam and droplet spray at an angle adapted to said downwash pattern,
   - a dump nozzle also attached to the outboard end of said tubular boom immediately preceding said dispersion type nozzle to dispense large amounts of the fire retardant material in a concentrated area,
   - valve means for directing the fire retardant material through one of said nozzles exclusive of the other, and
   - means for transferring said fire retardant material from said storage container to said nozzles through said tubular boom.

13. A fire suppression and fire fighting system as set forth in claim 12 wherein said tubular boom includes a stationary section and an extendable section and said valve means operates to direct flow through said dump nozzle when fully retracting the extendable section.

14. A fire suppression and fire fighting system as set forth in claim 13 wherein said valve means includes means responsive to the flow of fluid through said dump nozzle to maintain said valve means in the position established by retracting said extendable section.

15. A low pressure nozzle for a fire suppression system, said nozzle mounted at the outboard end of a pressurized boom, comprising:
   - a distribution pipe in communication with the outboard end of said boom and including a series of apertures arranged in a desired discharge pattern,
   - a first foaming screen positioned from said distribution pipe, and
   - a second foaming screen enclosing said first screen and said distribution pipe.

16. A low pressure nozzle for a fire suppression system as set forth in claim 15 wherein the center of the aperture pattern in said distribution pipe is displaced approximately 30 degrees from the vertical.

17. A low pressure nozzle for a fire suppression system as set forth in claim 15 wherein said aperture pattern includes a series of first size apertures at the center surrounded by smaller second size apertures.

18. A method of dispersing a fire retardant material from an aircraft having a downwash pattern comprising:
   - pressurizing a container of said fire retardant material to deliver said material through a tubular boom to be discharged from a nozzle at the outboard end of said boom,
   - positioning said tubular boom in azimuth about a pivot point to locate the nozzle in a preselected area of the downwash pattern, and
   - controlling the flow of said fire retardant material from the pressurized container through said nozzle to dispense said material as a foam and droplet spray in a desired pattern.

19. The method of dispersing a fire retardant material as set forth in claim 18 including heating said ex-

tendable boom and nozzle to maintain them at a ready operating condition.

20. The method of dispersing a fire retardant material as set forth in claim **18** including purging said extendable boom and nozzle with hot air.

21. A method of dispensing a fire retardant material from an airaraft having a downwash pattern comprising:

pressurizing a container of said fire retardant material to deliver said material through a variable length boom to be discharged from a nozzle at the outboard end of said boom,

varying the length of said tubular boom to a preselected area of said downwash pattern,

positioning said boom in azimuth about a pivot point to a preselected area of said downwash pattern, and

controlling the flow of said fire retardant material from said pressurized container to said nozzle to dispense said material as a foam and droplet spray by means of said downwash pattern.

22. The method of dispersing a fire retardant material as set forth in claim **21** including purging said extendable boom and nozzle with heated air to evaporate any residue of the fire retardant material and maintain said boom and nozzle in a ready operating condition.

23. A method of dispersing a fire retardant material as set forth in claim **21** including the step of mixing the fire retardant material with the aircraft downwash when discharged from a dispersion type nozzle to create a foaming fire retardant spray in a desired pattern.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,494,423 Dated February 10, 1970

Inventor(s) Richard S. Stansbury and Darwin E. Broman

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

Col. 1, assignment to Bell Aerospace Corporation as recorded on Reel 2341 Frame 728 does not show.
Col. 1, line 32, "occurs" should be --occur--.
Col. 1, line 52, "configuration" should be --conflagration--.
Col. 1, line 61, "pressure" should be --pressures--.
Col. 4, line 33, "outlines" should be --outline--.
Col. 6, line 68, after "boom" insert --in both--.
Col. 7, line 55, "attacked" should be --attached--.

SIGNED AND
SEALED
JUL 28 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents