Jan. 13, 1959 D. G. FAUST 2,868,584

SPRAY SYSTEM

Filed June 28, 1954 3 Sheets-Sheet 1

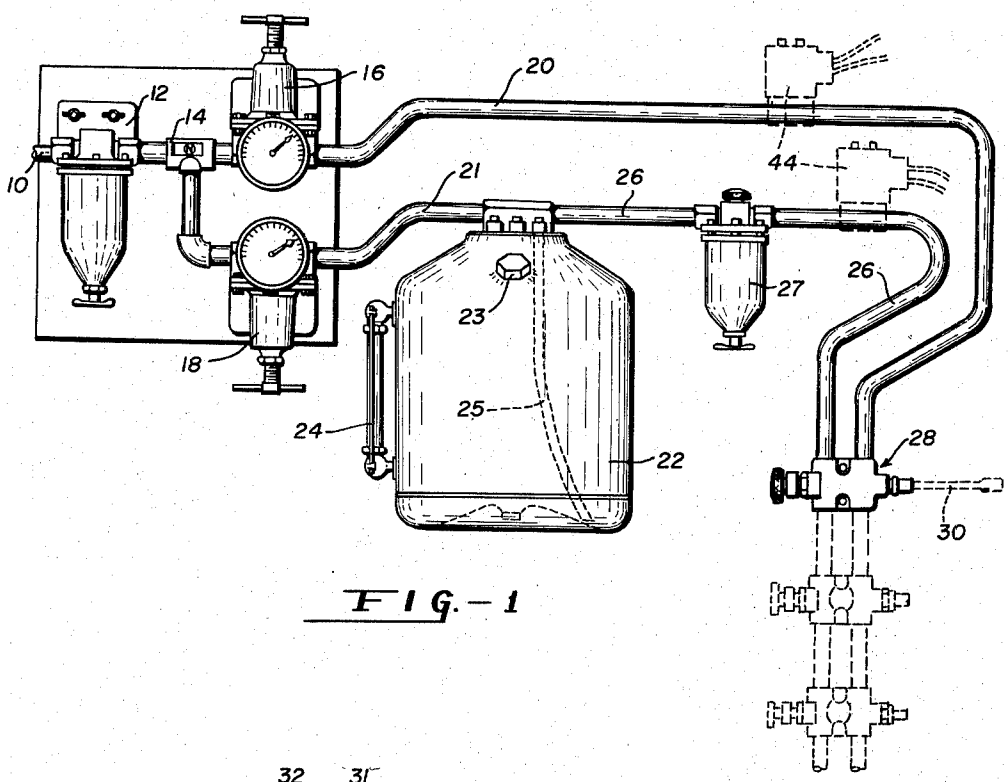


FIG. - 1

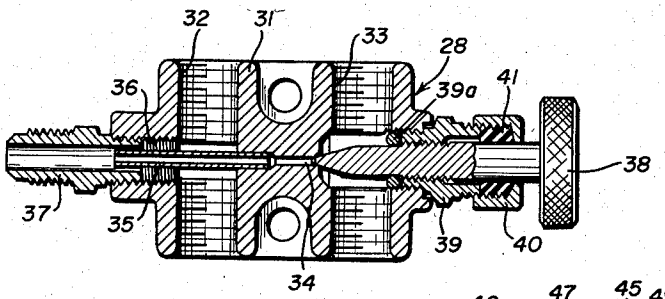


FIG. - 2

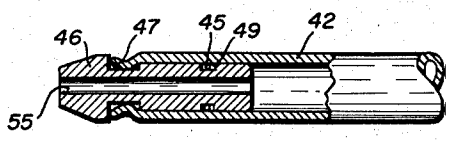


FIG. - 4

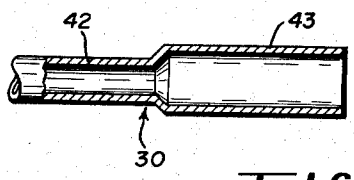


FIG. - 3

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SPRAY SYSTEM

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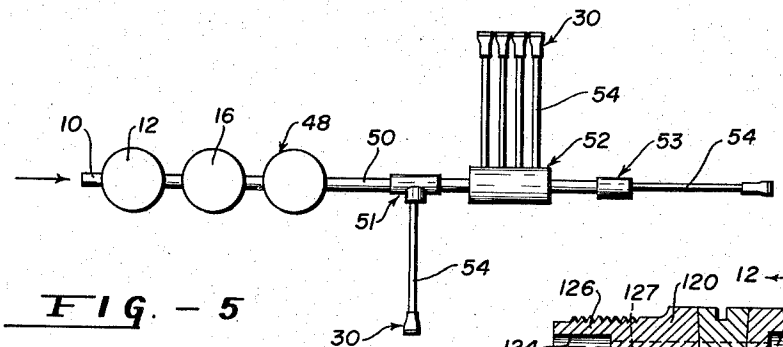


FIG. - 5

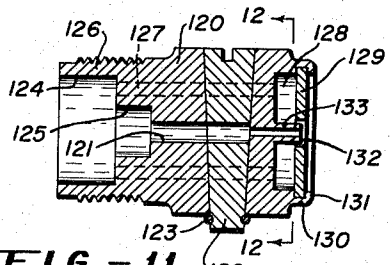


FIG. - 11

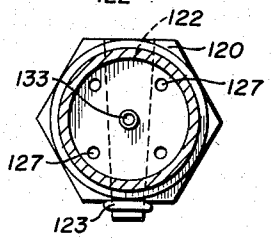


FIG. - 12

FIG. - 6

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SPRAY SYSTEM

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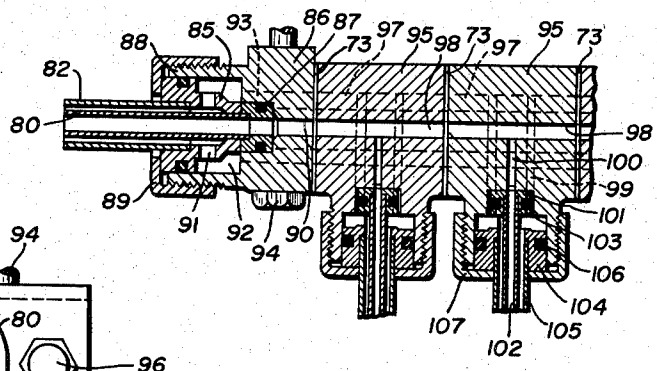


FIG. - 7

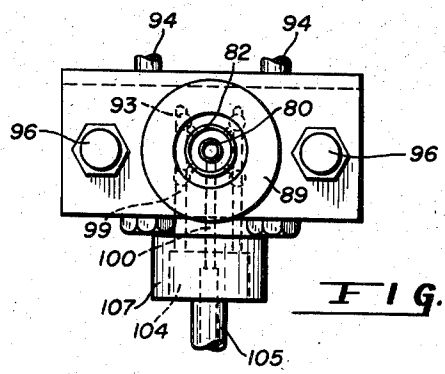


FIG. - 8

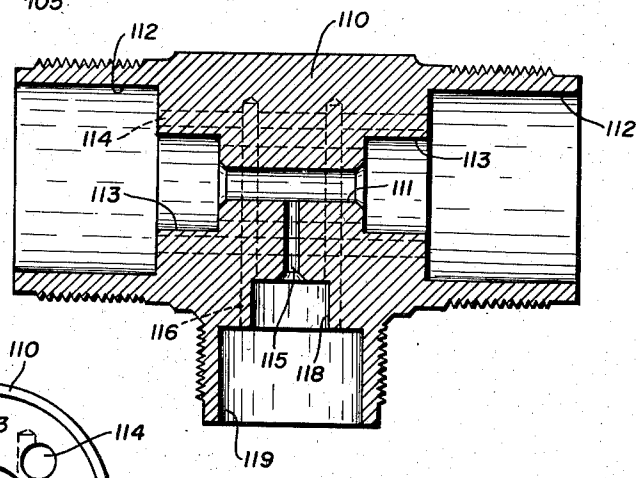


FIG. - 9

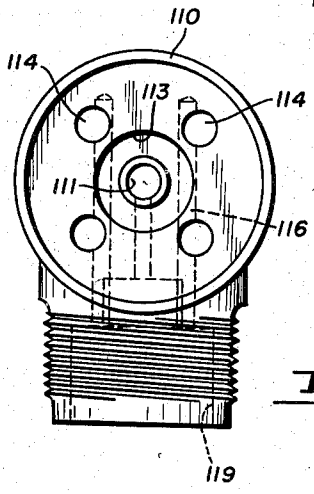


FIG. - 10

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2,868,584

SPRAY SYSTEM

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Application June 28, 1954, Serial No. 439,785

4 Claims. (Cl. 299—86)

This invention relates to spray systems and more particularly to pressurized air-liquid spray systems which provide distribution of a spray or aerosol to multiple point, and which includes means for controlling the spray at the individual points of use.

While many types of spray systems for many different uses have been known, recently interest has grown in oil-air spray systems, especially for use in metal working industries which use cutting, drawing, forging, pressing, and like operations. Common practice in metal cutting dictates the use of a deluge of a mixture of cutting oil and water, in an attempt to cool the cutting tools. Recently, however, there has been considerable interest and investigation in the art of metal cutting, for the purposes of increasing tool life, increasing feeds and cutting speeds, improving finish, and in the overall picture of increasing production and reducing costs.

Investigations in the metal cutting art have followed many paths; studies include various types of cutting compounds, revised tool geometry, and methods of applying cutting compounds. The information collected from the various sources is, to a large extent, conflicting. There does seem, however, to be well substantiated agreement among the authorities that improved tool life, with increased rates of feed and speed, and improved surface finish, is possible by applying cutting oil as a finely divided spray, as compared to the past practice of deluging the tool and work with a free flowing stream of cutting oil composition.

The fundamental theories which underline and support the conclusions that a fine spray application of cutting oil is an improvement in the metal working industry appears to be sound. The principal problems in metal cutting operations are (1) the dissipation of heat resulting from the metal shearing action and (2) the maintenance of a lubricating film between the surfaces of the metal being cut and the cutting tool. Generated heat is inherent in the operation, and cutting or shearing metal cannot be performed without developing considerable heat. Therefore, the best that can be done is to try to rapidly dissipate the heat generated by this shearing or cutting action so as to maintain the cutting portion of the tool at a temperature sufficiently low to prevent damage to the cutting edges.

After the metal has been sheared by the cutting tool, the chip thus produced curls back across the face of the cutting tool. The unit load between this removed metal and the tool face is quite high, obviously, depending on the feed, speed and depth of cut. If no effort is made to lubricate the contacting surfaces of tool and chip, the friction, between these two rubbing surfaces, creates considerable heat, raises the tool tip temperature beyond safe limits, and results, normally, in early tool failure. By providing a suitable lubricant film between the surface of the tool and the metal being worked, this source of heat can be substantially reduced.

The current practices of deluging the work from above fails to apply lubricant to the points of greatest need.

Large quantities of cutting oil from a nozzle are discharged over the tool and the entire work surface, and it is only by a very obscure route that any of the cutting oil reaches the interface between the tool and the removed metal where it is most desired and where it will be most beneficial. The improved techniques of applying cutting oil by a spray directly onto the tool and worked metal assure a greater quantity of the cutting oil contacting the surfaces between the tool and the metal.

The surface temperatures at the point of shear of the metal are very high; therefore, the cutting oils which are applied do not provide lubrication in the manner of the lubrication of a bearing, for example. The lubrication of these heated interface surfaces depends upon the instantaneous decomposition or vaporization of these cutting compounds to provide a dry lubricant on the surface of the metal which has just been removed, as well as on the tool face and cutting edges themselves. This reaction or decomposition of the cutting oils is considerably speeded on its way by breaking up the cutting oil into very fine particles, such as a spray, prior to applying it to the heated surfaces. The use of a spray gives two important results: (1) the finely divided liquid particles expose more surface area of the cutting oil to the high temperature metal surfaces, therefore, the reaction between the cutting oil and these hot surfaces occurs more rapidly, and a heavier layer of dry lubricant is built up between the surfaces, and (2) a higher rate of heat extraction from the work surface and the cutting tool is possible because these finely divided particles of cutting oil, with more surface exposed to the heated metal surfaces, will decompose or vaporize at a much more rapid rate, since the heat of vaporization must come from the work piece and the cutting tool. The greater the heat extraction, of course, the lower the temperature of the work piece, and more important, the lower the tool temperature.

According to the present invention there is provided a spray system which utilizes a central liquid feed reservoir and common air line to supply a plurality of spaced spray nozzles or outlets. The spray system provides an individual spray control for each outlet, as well as a general control for the overall system. The simplified system includes a positive pressure liquid supply, which permits substantial adjustment of individual outlets. The spray system permits the use of water or water soluble oils, as well as petroleum base oils, and other liquids, and further permits such liquids to be dispensed as a very fine spray or aerosol. The individual outlets are very sensitive to control so that very fine adjustments may be accomplished at each individual outlet to provide the desired spray.

Included among the objects and advantages of the present invention is a simplified, aerosol spray system, having a central pressurized liquid supply reservoir for feeding multiple outlets or spray nozzles, and which provides a sensitive control for adjusting individual outlet nozzles. The invention, furthermore, provides a spray system which is controllable for providing various types of sprays at various individual points of use. The invention includes a novel piping system and corresponding fittings, including spray nozzles, for utilizing the piping system to produce a series of spray or aerosol streams from the central liquid dispenser and central air pressure line. Novel valve means are provided to control the spray issuing from individual nozzles without disturbing the operation of other outlets along the line. The spray system is adapted to utilize water, water soluble compounds, oils and similar types of compounds, which may be desired as a spray or aerosol.

These and other objects and advantages of the inven-

tion will be apparent from the following description and appended illustrations, in which:

Figure 1 is a general layout of a pressure system according to the invention, including a central liquid dispenser, interconnecting piping, and individual spray nozzles;

Figure 2 is a cross sectional view of a control valve for individual spray nozzles along the lines;

Figure 3 is a cross sectional view of a nozzle for utilizing the spray system of the invention;

Figure 4 is a cross sectional view of a modified nozzle or nozzle tip according to the invention;

Figure 5 is a schematic view of a modified spray system utilizing a concentric pipe in a pipe for transporting two fluids which are used to form the aerosol or spray;

Figure 6 is a cross sectional view of a central liquid reservoir with an integral pressure regulator for use in the pipe in a pipe system;

Figure 7 is a cross sectional view showing the details of a connector and a multiple T takeoff for a pipe in a pipe system;

Figure 8 is an end elevation view of the device of Figure 7;

Figure 9 is a cross sectional view of an individual T takeoff for the pipe in a pipe system;

Figure 10 is an end elevation of the device of Figure 9 illustrating the position of the various passages in the takeoff from the pipe in a pipe system;

Figure 11 is a cross sectional view of a modified spray nozzle; and

Figure 12 is an end elevation of the device of Figure 11 taken along section line 12—12.

In the system illustrated in Figure 1, compressed air from a primary air supply line 10 is filtered by means of an air filter 12. The filtered primary air is divided by means of a T 14, part of which passes through an upper regulator 16 and part through a lower regulator 18. The upper regulator 16 controls the air pressure in a secondary air supply line 20, and lower regulator 18 controls secondary air pressure in line 21 leading to a central liquid supply tank 22. The liquid supply tank 22 includes a filler plug 23, a sight glass 24, to ascertain the level of the liquid in the tank, and a feed supply line 25 which extends to the bottom of the tank for withdrawing liquid from supply tank 22. Air under pressure, introduced into the supply tank by means of conduit 21, forces liquid from the tank 22 through supply line 25 into central feed line 26. As the spray outlets of the system are quite small, the liquid issuing from the tank is preferably filtered, as by a filter 27 in the line, to aid in preventing clogged outlets by foreign matter. The air line, and the companion liquid line 26 are extended along a prescribed route, and at the point of first use, a mixing and adjusting valve 28 is inserted across the lines to mix liquid and air for exhausting as an aerosol through a spray nozzle 30.

The mixing valve 28, shown in detail in Figure 2, comprises a body 31 having an air passage 32 and a liquid passage 33 extending therethrough. The air passage 32 and the liquid passage 33 are internally threaded on each end thereof so that the valve may be inserted into the air line and the liquid line. When assembled in the lines, the valve provides a passage for the air and liquid therethrough. The passages extending through the valve will, under normal conditions, provide passage of substantially full flow of the fluid through the lines. A lateral passage 34 extends between the liquid passage 33 and the air passage 32, and a tube 35 secured into the passage 34 extends the passage through the air passage 32 and exhausts into a lateral air outlet 36. The side outlet 36 is threaded to accommodate a connector 37 to which is attached a spray nozzle. A needle valve assembly 38 is secured to the valve by means of a valve gland 39 and a packing nut 40. A packing ring 41, secured in place by the packing nut 40, is provided to prevent leakage through the needle valve assembly. The needle valve 38 passes through the liquid passage 33 and seats in the end of the lateral passage 34 forming therewith a controlled outlet orifice for liquid. A retaining ring 39*a* prevents accidental removal of the needle.

A spray nozzle, suitable for use with the spray system, is illustrated in detail in Figures 3 and 4. The nozzle of Figure 3 comprises a main tube 42 and a flatten section or orifice 43 of the tube. The tube 42 is substantially smaller than the air passage 32. The flattened end provides a smaller cross sectional outlet than the tube 42, so that the nozzle provides the principal restriction to the air flow from each branch or lateral line. The nozzle orifice 43 may be varied in size to meet individual requirements, and provides means for controlling the amount of air exhausted at each outlet. The spray at each individual outlet is adjusted by controlling the amount of liquid and air issuing from each nozzle.

In Figure 4, a modified nozzle tip is illustrated. In this modification, a nozzle tip 46 is telescoped into a nozzle tube 42. The end of the tube 42 is rolled into a groove 47 near the end of the tip 46 thereby securing the parts together. To prevent leakage between the tube 42 and tip 46 an O ring seal 45 is seated in an annular groove 49 in the tip 46. A passage 55 through the tip 46 exhausts the mixture of liquid and air in the tube 42. The size of the passage and the velocity of the mixture determines the type of spray issuing from each such nozzle.

A mixture of liquid and air passes through the nozzle or nozzle tip, and being under pressure and moving at a relatively high velocity the mixture breaks up into a spray. To produce a spray, the mixture must exhaust from the system at a velocity sufficient to break up the globs or masses of liquid intermixed with air in tube 42. The nozzle and nozzle tips constrict the nozzle tube 42 thereby increasing the velocity of the mixture as it exhausts from the nozzle tube. The pressure in the air line of the system must, obviously, be maintained sufficiently high to provide a sufficient velocity of air to form a spray or aerosol.

In using the system, primary air is filtered, and the air pressure in the central air line 20 is adjusted to the desired pressure. The pressure of the air entering into the central liquid supply tank 22 is adjusted to suit the conditions of use. At each individual station or outlet, the mixing valve 28 is opened to dispense the amount of liquid required for the desired spray. The individual outlets may thus be adjusted independently to provide a spray to suit the requirements of individual points of application.

Solenoid valves 44, in the central air and liquid supply line, may be utilized for stopping and starting the entire spray system. The solenoid valves may be connected so as to be actuated by the machine controller. In this manner, the spray will only operate when the machine is operating, and eliminates the need for manually starting and stopping the spray system independently of starting and stopping of the machine.

In the modified system illustrated in Figure 5, a primary air supply line 10 is passed through an air filter 12 into a pressure regulator 16, and then into a unitary regulator-liquid supply reservoir 48. A concentric pipe in a pipe conduit 50 transports air and liquid separately from the supply reservoir 48 to a single T fitting 51, a multiple T fitting 52 and a straight line fitting 53. From each outlet of the fittings, a tube 54 extends to a nozzle 30 which may be directed to the point of application of the spray.

The regulator-tank 48, Fig. 6, comprises a body 56 having a passage 57 therethrough. The inlet 58 of the passage 57 is threaded to accommodate an air line from the pressure regulator 16, and the outlet exhausts through an exteriorly threaded annular opening 59. A small lateral passage 60 intersects air passage 57 and extends upwardly in the body 56. A valve seating cage 61 is se-

cured in the upper end of the passage **60**, and the cage **61** is seated against an O-ring seal **62** to prevent leakage between the cage and the body. A spring loaded ball **63** seats against the valve seat of the cage and provides means for closing the passage **60**. A bonnet **64** is secured to the body **56** by means of a threaded clamp ring **65**. A flexible diaphragm **66**, backed by a lower spring rest **67**, is sealed between the bonnet **64** and the body **56**. An adjusting spring **68** is supported on the lower spring rest **67** and extends into an adjusting screw **69** threaded in the bonnet. A valve stem **70** extends through the diaphragm **66** and is secured to the lower spring rest **67**. The stem **70** has an extension **71** which normally rests on the ball **63**. The force of the spring acting on the ball regulates the pressure of the air passing through passage **72** into the reservoir **74**. The lateral bore **72** through the body **56** extends from the regulator assembly to a liquid reservoir **74** mounted beneath the body **56**. The reservoir is secured to the body by means of a clamp ring **75**, and the reservoir seats against a gasket **76** to form a tight enclosure. A supply tube **77** extends from the body to about the bottom of the reservoir for conducting liquid from the reservoir to the spray system. The tube is interconnected with a passage **78** which exhausts centerwise of the annular air outlet **59**. A ball check valve **79** prevents liquid from flowing back from the liquid conduit into the reservoir and thereby maintains liquid in the passage **78** for immediate flow. The bore **78** exhausts into a liquid conduit **80** which is sealed in a tube connector **81** which fits within an enlarged outlet of the bore **78**. The connector **81** is sealed in the enlarged outlet to prevent leakage by means of an O-ring seal **84**. An air conduit **82** is sealed in a tube connector **81***a*, and is retained in place by means of a clamp ring **83**. An O-ring seal **84***a* between the connector **81***a* and the outlet **59** prevents leakage from the connection. The unitary regulator-reservoir provides means for regulating the pressure of the central fluid supply which flows in conduit **80**, and, also, provides a means for introducing liquid into the center pipe and air into the outer pipe of a pipe-in-pipe conduit.

To provide for a lateral takeoff for a pipe-in-a-pipe conduit system, the fittings illustrated in Figures 7 through 10 may be used. In the multiple T fitting illustrated in Figure 7, a fitting **85** is secured to the liquid conduit **80**. The air conduit **82** is secured into the large bore of the fitting **85**. The fitting seats into a connector body **86**, and is sealed therein by means of an O-ring seal **87** around the small end and an O-ring seal **88** around the large end of the fitting. A clamp ring **89** secures the fitting **85** into the body **86**. The liquid pipe **80** communicates with a passage **90**, and the air conduit exhausts through a plurality of lateral ports **91** in the fitting **85** into an annular space **92** in body **86**. Multiple passages **93** provide an air passage from the annular space **92** through the body **86**. A pair of bolts **94** provide means for securing the connector body to a mounting panel or the like. A series of lateral outlet T's are secured together and to the connector body **86**. When the pipe-in-pipe conduit is to be extended beyond the multiple T's, another connector **86** is placed on the opposite end, and the assembly is secured together by means of bolts **96** which pass through the entire assembly. Gaskets **73** are provided between each body to prevent leakage. The T **95** has a series of passages **97** passing therethrough which align with the four passages **93** through the connector body **86**, and, also, has a central liquid passage **98** which aligns with liquid passage **90** in the connector body **86**. A series of lateral passages **99** intersect the four passages **97** in the T body. The lateral passages **99** are substantially smaller than the passages **97** through the body, and provide a reduced flow of air from the main passages. A small lateral liquid passage **100** intersects the liquid passage **98**, and the lateral passage **100** being substantially smaller than the main liquid passage provides a reduced flow of liquid from the main passage. A connector **101**, sealed to the end of a small liquid tube **102**, is secured in the side outlet of the T body **95**. An O-ring seal **103** prevents leaking of the connection. A connector **104** sealed to a small air conduit **105**, is secured in the body **95** and an O-ring seal **106** prevents leakage of the connection. The connector unit is removably secured to the body **95** by means of a threaded clamp ring **107**. The small lateral pipe-in-pipe conduits are then conducted to a point of use, where a nozzle or nozzle tip may be attached to the end thereof to provide a spray or aerosol.

An adjustable spray nozzle for use with the pipe-in-pipe conduit is illustrated in Figures 11 and 12. In this modification, a body **120** has a centrally aligned liquid passage **121** therethrough. A tapered plug valve **122**, retained in the body **120** by a retaining ring **123**, provides a control for the flow of fluid through the nozzle. The inlet end of the spray nozzle **120** includes an annular space **124** adapted to accommodate a fitting for a lateral air conduit **105**, e. g., fitting **104**. A smaller annular space **125**, internal of space **124**, is adapted to accommodate a fitting, e. g., fitting **101**, for a lateral liquid conduit **102**. External threads **126** are provided to engage a clamp ring **107** for securing the connector unit to the body **120**. A series of passages **127** interconnect annular space **124** with an annular outlet space **128** and provide an air passage through the body **120**. The annular space **128** is substantially closed by a disk **129** which is secured in place in an annular rabbet **130** by rolling or spinning the edge **131** thereover. The disk has a centrally aligned aperture **132**, which is slightly larger than a tubular outlet **133** for the liquid passage **121**. The tubular outlet **133** extends a short distance into the aperture **132**. Liquid and air exhausting through the aperture **132** above a critical velocity forms a spray or aerosol.

The single T connector, illustrated in Figures 9 and 10, is similar in construction to the multiple connector of Figure 7, except that it is a single outlet, and is useful in a pipe-in-pipe spray system where the individual nozzles of the system must be dispersed over a substantial distance along the course of the conduits. The single T comprises a body **110** having a liquid passage **111** centrally therethrough. Each end of the passage is enlarged to an annular space **112** and a smaller annular space **113**. A pipe-in-pipe connector, as described in Figure 7 may be utilized with the single T.

A fitting **85** is sealed to an air conduit **82** and a liquid conduit **80**. The fitting is secured into the annular spaces **112** and **113** at both ends of the T. A clamp ring **89** retains the fitting in position in the body **110**. O-ring seals **88** and **87** are used to prevent leakage of the connector units. Annular spaces **112** are interconnected by a series of passages **114**. A series of lateral passages **116** intersect the passages **114** and provide means supplying air into a lateral outlet. A small lateral liquid passage **115** intersects liquid passage **111** and extends to a lateral annular space **118**. A tube connector **101** sealed to a tube **102** seats in the space **118**, illustrated for a similar lateral outlet for the multiple T of Fig. 7. A fitting **104**, sealed to a tube **105** seats in space **119**. The O-ring seals to prevent leakage and the clamp ring **107** complete the connection for the lateral outlet. A spray nozzle as illustrated in Figs. 11 and 12 may be used for forming a spray at the desired point.

In the systems described, the air line and liquid line, whether they are parallel lines or concentric pipe-in-pipe lines, are extended together from the central control position to the various points of use. Individual spray nozzles are connected across the two lines so as to provide a spray at any desired point. When the system is extended as far as desired, the ends of the two tubes are blocked off. The pipe-in-pipe system is valuable for equipment where space is at a premium and the complicity of a dual pipe lead for the air and liquid and a series of mixing valves would be too cumbersome. The pipe-in-pipe system is also valuble in machines where

the spray system is built in as part of the original equipment, whereby the individual spray stations may be preset at the point of need.

While the invention has been illustrated by specific examples, there is no intent to limit the invention to the precise details shown, except insofar as set forth in the following claims.

I claim:

1. A spray system comprising a compressed air conduit and a companion pressurized fluid conduit, spaced mixing means interconnecting said companion conduits at intervals along the extent thereof for admixing a portion of the flows therethrough, said mixing means including a body having extending therethrough a fluid passage and an air passage spaced therefrom, a small lateral bore of variable dimensions extending from said fluid passage to a small fluid tube to provide a lateral lead for a small flow of liquid, a small lateral passageway of fixed dimensions extending from said air passage to a concentric air tube around said small fluid tube, and nozzle means for mixing substantially an equal portion of air from each said mixing means with a variable portion of fluid from said small lateral tubes to form a spray of air and liquid.

2. A mixing valve for connection across a pressurized gas conduit and a pressurized liquid conduit for forming a spray from a portion of the flows in said conduits comprising a body, a liquid passage extending through said body adapted for connection in said liquid conduit, an air passage extending through said body for connection in said gas conduit, a needle valve in said body intersecting said liquid passage adapted to release a portion of liquid from said liquid passage, a lateral outlet orifice of fixed dimensions for releasing a portion of the gas passing through said gas passage, a small bore extending from said valve to said gas passage, and a tube extending through said air passage from said bore and terminating in said gas outlet orifice whereby a variable amount of liquid is admixed and dispensed with gas issuing from said outlet.

3. An adjustable, multiple spray system comprising a first conduit for air under an independently controlled pressure, a second conduit for liquid under an independently controlled pressure, spaced mixing means interconnecting said first and second conduits at intervals along their extent for admixing a portion of the flows therethrough, each said mixing means including a body having a fluid passageway therethrough and a separate air passageway therethrough, a lateral bore communicating with the fluid passageway at one end and a fluid tube at the other to provide a small lateral flow of fluid from said fluid passageway, means for varying said lateral bore for varying the fluid flow therethrough, said lateral bore communicating with a fluid tube, a second lateral bore communicating with said air passageway and terminating at about the end of said fluid tube in air and fluid mixing relation, and a nozzle means interconnected with each said mixing means for mixing a portion of air with a variable portion of fluid to form a spray of air and fluid.

4. An adjustable, multiple spray system comprising a first conduit for air under an independently controlled pressure, a second conduit for liquid under an independently controlled pressure, spaced mixing means interconnecting said first and second conduits at intervals along their extent for admixing a portion of the flows therethrough, each said mixing means including a body having a fluid passage and a separate air passageway therethrough and forming a continuation of the respective passageways, a lateral bore communicating with the fluid passageway at one end and a fluid tube at the other to provide a flow of a portion of the fluid in said fluid passageway, valve means operable in said lateral bore for varying the fluid flow therethrough, a second lateral bore communicating with said air passageway and terminating at about the end of the fluid tube in air and fluid mixing relation, and nozzle means interconnected with each said mixing means for mixing a portion of air from each said mixing means with a variable portion of fluid to form a spray of air and fluid.

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