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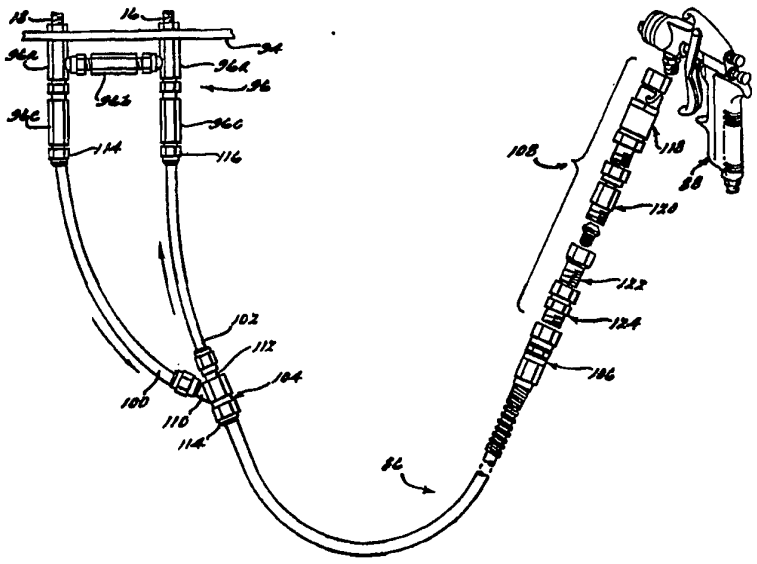

(57) Abstract

A recirculating paint supply system (10) supplies single or multiple paint coatings to paint spray stations (1, 2, 3) arranged in parallel or series relation, each station (1, 2, 3) including manually operated flexible monoline and coaxial conduits (86) to supply paint to a spray gun (88). In one aspect of the invention, the fluid connectors inhibit paint build up which might otherwise contaminate the paint line and include a unique quick disconnect ball valve (118) to inhibit paint splash back, a ball valve (32) having a unique seal (74) for the ball (64), a compression seal arrangement (98) in a flow enabling/disabling H-connector (96), a Y-shaped connector (212) to mix two paint coatings, and a Y-shaped connector (104) to interconnect the supply (100) and recirculating (102) lines to rows of spray stations. In another aspect, unexpected benefits are found from the selective use of glass-filled nylon and stainless steeel components in the fluid connectors.

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PAINT SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a paint system including a flexible conduit or hose arrangement to supply a liquid coating composition from a paint supply system to a spray gun. More particularly, this invention relates to fluid connectors for the paint system.

As those familiar with the prior art will appreciate, in previous paint supply systems, a base coat of paint is applied at a first station and then the article, such as an automobile body, is conveyed to a new station where a clear coat paint is applied, the clear coat paint adding the feeling of depth to the paint. The ability to apply a clear coat and a base coat at the same time would provide a dramatic reduction in the cost of painting the car in the sense that half of the spray booths could be eliminated or deactivated and therefore half of the equipment and half of the manpower could be eliminated from the painting operation.

Additionally, the modern factory is typically spread out and paint booths are not localized in one area or arranged so as to be parallel to one another. As a result, the use of a series connection between paint booths requires extensive tubing, particularly when the paint must be supplied to opposite sides of each booth. Accordingly, it would be desirable to minimize the number of lines needed to supply paint in a paint system and the cost associated with these lines.

A continuing problem associated with the spray application of liquid paints is the presence of foreign particulate matter in the liquid paint supply which causes imperfections on the surfaces of the article being spray painted, frequently necessitating a refinishing or repainting thereof. Such foreign particulate matter, sometimes referred to as "seeds," or "strings," or "snotters" are formed in many instances as a result of an agglomeration of the paint constituents during standing or

recirculation of the liquid paint necessitating removal prior to discharge through the spray nozzle. The foregoing problem is particularly pronounced in recirculating type liquid paint systems, although they are present in direct line systems as well.

Recirculating paint supply systems conventionally comprise a mixing tank equipped with suitable agitation for maintaining the liquid coating composition uniformly mixed and a pump for transferring the liquid coating composition under a desired pressure to a manually manipulable supply conduit connected to the spray nozzle. A suitable return hose is provided for returning the excess quantity of paint back to the mixing tank for recirculation and to keep the paint in suspension. Typical of such a system is the recirculating paint supply system shown in United States Patent No. 5,060,861, the specification of which is incorporated herein by reference. In this paint supply system, the supply and return hoses are interconnected by suitable fluid fittings so as to form a single conduit having coaxial passages for supplying and returning the liquid composition.

This and like paint systems typically will utilize many different fittings, connectors and coupling arrangements to complete the necessary fluid interconnections. Such fittings are often generally made of metal which can result in the conduit being relatively heavy. However, the paint supply hoses or unitized fluid conduit, and the associated fluid fittings, should be as light as possible to reduce operator fatigue and enable the operator to manipulate the position of the spray gun.

Seals and filters are also included in the paint supply line to seal the interconnections as well as to remove particulate matter from the paint being provided to the spray gun. In spite of the seals and filters, foreign matter can still be present. For example, the quick connectors used for the spray gun tend to create spit at

the quick disconnect upon disconnecting which is generally not noticeable but, when dry, will cause leakage and contamination to occur. Further, to prevent leakage, it is known to cover the threaded sections of fluid fittings with pipe dope and then assemble the fittings. While this arrangement works well in many fluid sealing applications, it has several disadvantages. First, a pipe fitter must be called to assemble or disassemble the unit, which can be an inconvenience. Further, exposed threads create voids in the joint between the components which causes paint to accumulate and generates paint particles (dirt, etc.) that will be sent downstream and end up on the car, resulting in the need to rebuff and/or repaint the car.

Various flow control devices or paint restrictors are also used with paint supply systems. In many cases such prior art constructions have been handicapped by their tendency to become plugged over periods of use, necessitating frequent replacement and/or downtime to permit cleaning to restore them to proper operating conditions. The build up of deposits in such flow regulators cause a progressive decrease in the pressure of the liquid coating composition supplied to the spray nozzle, thereby resulting in variations in the quality and thickness of the coating, thus detracting from their use.

Moreover, a flow control device must include an element that moves relative to its valve body in order to change the flow rate. For example, a conventional ball valve has a rotatable ball member through which fluid can flow and seal portions positioned at the opposing upstream and downstream faces of the ball to inhibit flow therearound. Extended use of the valve member in one flow position can result in paint coagulating in voids formed around the seal portions. When the ball member is rotated, paint portions can break loose, thus detracting its use. Paint flakes, particles and dirt can result from the mating

of fluid connector members, notwithstanding a seal being positioned to prevent flow around mated portions.

Accordingly, it would be desirable to limit or replace the use of threaded fittings with compression fittings, or those that use only pressure, thereby eliminating voids which tend to cause the paint to accumulate.

SUMMARY OF THE INVENTION

The benefits and advantages of the present invention are obtained in recirculating paint supply system that has a substantially flexible recirculating fluid conduit connected at one end to a spray gun and at its other end to supply and return lines of a paint supply.

To selectively connect and disconnect the supply and return lines of the paint system to the supply and return hoses of the recirculating conduit, a series of ball valves are interconnected to form an H-shaped fluid connector assembly. According to an exemplary embodiment of this invention, a funnel shaped seal is sandwiched between mating frustoconical surfaces of the interconnected ends of the valves whereby to form a compression seal. Additionally, the interior surfaces of the valves which contact the paint composition are comprised of stainless steel. or other suitable metal, that is resistant to attack by the paint.

According to a preferred embodiment of the paint system of the present invention, the discharge end of the recirculating fluid conduit has a fluid fitting secured thereto. In an exemplary embodiment, helical convolutions having a predetermined pitch width extend radially outward from the fitting, and a guard for protecting the outer periphery of the conduit and providing strain relief to conduit is secured to the helical convolutions. The fluid fitting includes a rotatable coupling nut, and the guard includes a wire helically coiled to form a generally cylindrical member that encircles an axial portion of the

conduit and extends axially away from the fitting. A portion of the wire helix has the same predetermined pitch width as and threadably engages the convolutions, coupling rotation of the nut tending to tighten the engagement of the coil with the convolutions.

According to another preferred embodiment of the paint system of the present invention, particularly applicable for the manual spray application of liquid coating compositions, a quick disconnect connector assembly is provided to enable the rapid connection and disconnection of the fluid conduit and prevent unwanted spit of paint during the connection or disconnection to the spray gun. The quick disconnect connector assembly comprises a valve body having a bore, a tubular fluid conduit which is inserted into the bore, a seal element having a passage positioned in the bore, and a closure member normally engaged with the seal for sealing the passage and movable from sealed engagement by the inward insertion of the fluid conduit. The fluid conduit and the seal passage are dimensioned such that the forward end portion of the fluid conduit is adapted to establish sealing engagement with the wall of the seal passage both when the fluid conduit has been partially inserted into the passage but prior to engaging the closure member, during which time no flow is permitted through the connector assembly, and also when fully inserted into the passage, whereby to move the closure member from its flow preventing engagement with the seal.

According to another preferred embodiment, a flow control device of the present invention comprises a valve body having opposite end portions and a bore extending between the end portions, a closure member, including a rotatable ball member in the bore and having a passageway therethrough, for selectively opening and closing the bore to permit and prevent flow through the bore, and seal means, operating to encapsulate the ball member, for

sealing the bore to prevent unwanted fluid leakage. The seal operates to eliminate voids in which paint could collect and break free to contaminate the paint system during rotation of the ball.

Further, certain of the connection elements provided in the flexible recirculating conduit are comprised of a suitably configured polymeric material which combines strength and functional relationships and decreases weight, the material preferably being of a glass-filled nylon. Importantly, the fluid connection elements connecting the supply to the inlet end of the conduit are comprised of stainless steel.

The present invention overcomes many of the problems and disadvantages associated with prior art constructions, providing simple, economical yet durable devices which can be directly connected to the fluid inlet of a conventional spray gun and is easily manipulable by an operator. Significantly, flakes and other particles which could interfere with the quality of the painted surface are inhibited and possibly eliminated.

Additional benefits and advantages of the present invention will become apparent upon a reading of the description of the preferred embodiments taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of a multiple spray station arrangement of a recirculating liquid paint coating composition supply system embodying the invention.

FIG. 2 is a view taken along line 2 - 2 of FIG. 1 illustrating a fluid connector assembly connecting a paint supply line to a pair of paint stations according to the invention.

FIG. 3 is a section view of a ball valve fluid connector including a seal arrangement according to this invention.

FIG. 4 is an exploded view, in section, of the seal arrangement shown in FIG. 3.

FIG. 5 is a perspective view of an individual spray station and incorporating a coaxial recirculating conduit for supplying and returning excess liquid paint coating composition to the supply system embodying the invention.

FIG. 6 is an exploded view of an H-shaped fluid connector assembly for selectively connecting or disconnecting the supply system to the recirculating conduit according to this invention.

FIG. 7 is a partly exploded schematic view of the recirculating conduit shown in FIG. 3 and the fluid connectors therefor.

FIG. 8 is an exploded assembly view, in section, of a quick disconnect fluid connector assembly according to this invention.

FIGS. 9(A), 9(B) and 9(C) are side views in section showing the quick disconnect fluid connector assembly of FIG. 8 being connected.

FIG. 10 is a section view of a swivel fluid connector.

FIG. 11 is a section view of a filter fluid connector assembly.

FIG. 12 is a section view of a restrictor fluid connector.

FIG. 13 shows the discharge end portion of the recirculating conduit.

FIG. 14 is a partially exploded section view of the discharge end portion shown in FIG. 13 and illustrates a fluid connector that is terminated to the conduit and a spring guard that is secured to the fluid connector for supporting the conduit and the termination therefor according to this invention.

FIG. 15 is a section view of a Y-shaped fluid coupler for mixing two coating compositions according to this invention.

FIG. 16 illustrates another preferred embodiment of a recirculating paint supply conduit according to this invention, the conduit being particularly useful for mixing two paint coating compositions.

FIG. 17 illustrates another preferred embodiment of a recirculating paint supply system according to this invention, the conduit being particularly useful for mixing two paint coating compositions.

FIGS. 18 - 23 are views of a fluid flow regulator adapted to be connected to a recirculating paint system according to this invention.

FIGS. 24 - 26 are views of a push to connect fluid coupling including a compression seal for a recirculating paint system according to this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and as may best seen in FIG. 1, a multiple station recirculating liquid paint coating composition supply system 10 is illustrated. The supply system illustrated in FIG. 1 illustrates a paint system for recirculating a single paint of a specific color to each of the three spray stations identified at Numbers 1, 2 and 3. In the embodiment shown, each station is in communication with a pressurized liquid coating or paint supply header 12 and a low pressure paint return header 14. It will be appreciated that the spray stations illustrated in FIG. 1 can form a row of separate spray booths to provide for a plurality of different coating compositions and/or different colors. By way of example, each spray station may include twelve different systems to supply twelve different colors of the desired coating composition.

The paint supply system typically includes a supply tank and a supply pump for supplying the liquid coating paint composition under pressure to the supply header. The quantity of paint composition that is supplied but which is in excess of that required at the multiple stations is

returned to the supply via the return header. A supply branch line 16 at each spray station is connected to the supply header 12 and in turn is connected to a shut off valve at the entry to the spray booth whereby to supply paint composition to a desired spray station. A return branch line 18 at each spray station is connected to the paint return header 14 and to a shut off valve at the exit from the spray station whereby to return paint composition via the return header to the supply tank.

According to an important feature of the foregoing arrangement, the spray stations can be connected in series and in parallel. That is, each of the plurality of branches permit selective branch lines to service a line of spray stations at different locations and each station to be provided with a plurality of outlets. Additionally, two branch lines can be used to service opposite sides of a common spray station.

As shown in FIG. 2, according to an important aspect of this invention, a specially configured fluid connector assembly 20 is provided to either supply or return the coating composition to each of two spray stations, such as to stations No. 2 and No. 3. As illustrated, a supply fluid connector assembly 20 comprises a Y-shaped fluid fitting 22 including an inlet port 24 and two outlet ports 26, a generally straight tubular fluid conduit 28 for connecting the inlet port 24 to the supply branch line 16, a pair of angled tubular conduits 30 each having an inlet end connected to one of the outlet ports 26 and an outlet end, and a pair of ball valves 32. The ball valve 32 has an inlet end 34 connected to the outlet end 42 of one of the angled tubular conduits, and an outlet end 36 connected to supply paint composition into the spray station. Each ball valve 32 can be closed to prevent fluid from passing into the spray station, at that location, or opened to permit fluid to pass into the station. When the fluid connector assembly 20 is used to return a paint

composition, the outlet ports 26 would communicate the composition from the stations to the fluid fitting 22 and via the fluid conduit 28 into the paint return header 14.

Preferably, the angled tubular conduits 30 have first and second portions 40 and 42 with the first portions 40 extending along a first axis that is generally at an acute angle to the fluid conduit 28 and the second portions 42 extending along a second axis that is generally orthogonal (i.e., perpendicular to) to the fluid conduit 28. Generally, the first and second portions are joined by a curved portion 44 and are disposed at an angle of about 40° - 50°, and preferably at about 45° to one another. When connected to the fluid fitting, the fluid conduits 28 and 30 form a generally Y-shaped configuration. While a T-section is known for the purposes of dividing and/or directing a fluid to and along a path that is generally orthogonal to the supply, it is believed that the 90° change in direction is too abrupt in a paint system and can lead to problems. The Y-shaped configuration of FIG. 2 is believed to enhance constancy of volume flow without paint coagulation and obviate any possible adverse effects that may otherwise interfere with the uniformity of paint flow. While not shown, the Y-shaped fluid connector assembly 20 could be used to return the low pressure paint composition to the return header.

As shown in FIGS. 3 and 4, the ball valve 32 includes a valve body 46 having opposite axial end faces 48 and 50, and a selectively threaded bore 52 extending between its end faces. The following elements are arranged in the bore in the following sequence: a first end fitting 54 adjacent to the end face 48, a Teflon spacer 56, a stainless steel retainer member 58, the spacer and the retainer being threadably connected to the bore, the fluid sealed flow regulator member 38, and a second end fitting 60 adjacent to the end face 50. The first end fitting 54 includes a first portion that is threadably engaged with the bore and

a second portion extending outwardly of the bore, the second end portion including a coupling nut 62 for connecting the ball valve 32 to stainless steel tubing. The second end fitting 60 includes a first portion threadably engaged with the bore and an externally threaded second portion extending from the bore.

The fluid sealed flow regulator member 38 includes a spherical ball 64 rotatably positioned in the bore of the valve body and having a passage 66 extending therethrough, an operating rod 68 extending from the ball and through the valve body, and a handle 70 connected to the operating stem for rotating the ball in the bore whereby to position the passage 66 relative to the bore. An O-ring 72 is provided to seal around the rod 68 where it passes through the valve body.

According to this invention, the valve body 46 is comprised of a polymeric material, such as glass filled nylon. Preferably, the externally threaded first portions of the end fittings are embedded in the polymeric material. Further, except for the elements that must be resilient to complete a seal, it is contemplated that the end fittings, the retainer member and the ball that makes contact with the paint composition be comprised of stainless steel, or other suitable material having a resistance to attack by the paint. It is believed that when the paint is subject to metal contact, paint flakes/particles are inhibited in the paint system downstream of the supply and return.

Importantly, a combination bearing and seal arrangement is provided whereby to seal the ball 64 relative to the bore. Although the use of seals which engage the ball element are known, leakage and paint flakes has oftentimes been a problem. According to this invention, a pair of cylindrical cup-shaped valve seats 74 are adapted to be brought into abutting relation with one another and encapsulate the rotatable spherical ball 64 therebetween. Each valve seat 74 has a flat endwall 76 to

sealingly abut the retainer member 58 or the second end fitting 60, depending on whether the valve seat is upstream or downstream of the ball, and a generally cylindrical wall 78 having an axial mating face 80 and forming a semispherical cavity. The mating faces are axially abutted to form an axial seal without introducing any voids. The outer periphery of the cylindrical wall 78 is adapted to engage the bore to form a seal therewith. The endwall 76 has an opening 82 to pass fluid between the valve seats when ball is positioned so that fluid will pass through its passage 66.

In operation, the valve seats 74 are placed on opposite sides of the ball 64 and axially pressed together, whereby the mating faces 80 are abutted to form a substantially void free axial seal, and the cylindrical walls 78 form a cavity to totally encapsulate the ball 64. This bearing cavity completely encapsulates the ball so that no paint can accumulate in the interface between the ball and the polymeric body of the valve, which material would, when dried, lead to the possibility of paint flakes/particles breaking free during rotation of the ball 64. There are no crevices or threads to collect paint or dirt where it can harden and contaminate later paint jobs.

FIG. 5 is a perspective view, embodying the invention, of an individual spray booth 84 in one of the paint stations and a recirculating conduit 86 used by an operator to direct the liquid paint coating composition from the supply system to a spray gun 88. It is to be understood that the spray booth is not exclusively limited to the supply system and paint station arrangement disclosed.

As shown, a product to be painted such as an automotive vehicle 90, is moved through the spray booth by a conveyor system 92. The walls of the spray booth are formed from rectangularly shaped pads of removable plastic

film so that walls may be cleaned by simply removing the layers of film.

In the embodiment shown, the supply and return lines from the Y-shaped fluid connector assembly 20 enter the spray booth through the ceiling 94 and into an H-shaped connector assembly 96. Of course, the supply and return could enter in a manner other than that shown (e.g., the lines could enter through a wall of the station). The recirculating conduit has one end thereof connected to the supply and return lines of the paint system via the H-shaped connector and its other end connected to the spray gun 88.

According to an important feature of this invention, the components of the spray gun 88 are preferably comprised of a polymeric material whereby to contribute to an overall decrease in the weight of the conduit handled by the operator. Preferably, the polymeric material would be glass filled nylon. However, the spray gun could be comprised of metal.

According to this invention, as shown in FIG. 6, the H-shaped fluid connector assembly 96 is provided for selectively connecting the supply and return branch lines 16 and 18 of the paint supply to the inlet and return ends of the recirculating conduit 86 or interrupting the supply of paint to the recirculating conduit whereby the recirculating conduit 86 may be disconnected for service, cleaning or the like. The H-shaped fluid connector assembly is formed by five valves 96a, 96b and 96c each having an internal construction as described above for the ball valve 32. The valves 96a are of the bulkhead type and each has an externally threaded sleeve portion 96e at one of its ends for completing a fluid connection, respectively, to the supply and return headers 12 and 14 of the paint system, an internally threaded bore at the other of its ends to threadably receive the threaded end portion of a fluid coupler 96d, and a side branch 96f fitted with

a rotatable fluid coupler 96d. The valves 96b and 96c are the same and each has an externally threaded sleeve portion 96g and 96h at its opposite ends. The bypass valve 96b has its opposite sleeve portions 96g and 96h threadably engaged, respectively, with the respective fluid couplers 96d in the side branches of the valves 96a. Each valve 96c has one of its sleeve portions 96g threadably connected with a fluid coupler 96d of a respective valve 96a and the other of its sleeve portions 96h threadably connected to the respective supply and return lines of the recirculating conduit 86, in a manner to be described.

In operation, when the valves 96a and 96c are open and the bypass valve 96b is closed, fluid may flow to and from the paint supply and into the recirculating conduit whereby to communicate to the spray gun 88. If however the valves 96c are closed and the valves 96a and 96b are open, fluid cannot pass into the recirculating conduit 86 whereby the recirculating conduit may be replaced, or removed, if desired.

According to this invention, a hollow funnel-shaped seal member 98 is located between mating conical surfaces formed in the sleeve portion of the valves 96a, 96b or 96c and in the fluid coupler 96d and axially compressed into fluid sealed relation. Preferably, the seal member 98 is comprised of Teflon and includes a cylindrical portion at one end and a conical portion at other second end. The sleeve portion includes an inwardly tapering conical wall and an interior cylindrical wall whereby to form a recess sized to nestingly receive the seal member 98. Coupling rotation of the fluid coupler 96d desirably results in a compression fluid seal between the mating members.

FIG. 7 is a partly exploded schematic view of the recirculating conduit 86 used in the paint supply system, including a pressurized paint supply line for supplying paint to the nozzle of the spray gun 88 in a quantity in excess of that required and a return line for recirculating

excess paint from the spray gun. The recirculating conduit comprises a pair of hoses 100 and 102 arranged coaxially and including an outer hose 100 which forms a supply conduit, an inner hose 102 which forms a return conduit, a Y-shaped coupling 104 attached to the hoses to direct fluid into the passage formed between the hoses 100 and 102, and a fluid fitting 106 secured to the discharge end of the outer hose 100. The coupling 104 includes an inlet end 110 connected in fluid tight relation to the supply branch line 16 via the H-shaped connector assembly 96, a return end 112 connected in fluid tight relation to the return branch line 18 via the H-shaped connector assembly, and an outlet end 114. The fluid fitting 106 is adapted to connect the discharge end of the recirculating conduit 86 with a fluid fitting assembly 108 for connection to the spray gun 88.

The recirculating conduit 86 and the Y-shaped coupling 104 are similar to those disclosed in the aforementioned U. S. Patent No. 5,195,680. Generally, the outer hose 100 is of a composite construction to include outer and inner layers, the outer layer being comprised of a material having high strength and flexibility. A suitably material is a mixture of nylon and polyurethane plastics. The inner layer and the inner hose 102 are comprised of a material which is resistant to attack by the liquid coating compositions in contact therewith, nylon being one suitable material.

The fluid fitting assembly 108 between the spray gun 88 and the fluid fitting 106 at the discharge end of the recirculating conduit comprises, in the following sequence, a quick disconnect fluid coupling assembly 118 which is adapted to be attached to the spray gun, a swivel fluid connector 120, a filter fluid connector 122, and a flow control or restrictor fluid connector 124 which is adapted to be coupled to the fluid fitting 106. According to a particular feature of this invention, it is important that the fluid fittings withstand attack of the liquid coatings

in contact therewith yet be sufficiently light in weight such that total weight of the spray gun, fittings and hose which must be held and maneuvered manually be held to a minimum. According to this invention, this objective is achieved by selective manufacture of the fitting elements of a polymeric material. As will be discussed further hereinbelow, the quick disconnect, the swivel, the filter, the restrictor, and the fluid discharge connector at the end of the hose are selectively comprised of a polymeric material such as glass filled nylon.

As shown best in connection with FIG. 8 and in the coupling sequence illustrated FIGS. 9(A) to 9(C), the quick disconnect fluid coupling assembly 118 includes a centrally bored valve member 126 having a pin 128 extending radially therefrom, and a centrally bored ball valve 130 having a bayonet slot 132 at its forward mating end to interengage with the radial pin to couple the two together. The valve member 126 includes an elongated cylindrical stem 134 having an internally threaded coupling nut 136 rotatably mounted thereto for connection to a threaded end of the spray gun 88 and an axial forward end portion 137 adapted to be inserted into the valve member. The stem 134 has an axial end face 138 which protrudes axially forward of the stem body and a central bore 140 therethrough for passing fluid. The end face 138 is slightly semispherical in shape and is provided with a central aperture 142 and one or more peripherally disposed apertures 144, each aperture communicating with the central bore 140.

The ball valve 130 includes forward and rearward shell portions 146 and 148 which are threadably engaged to form a valve body 150 having a generally cylindrical stepped bore 152 extending centrally between the forward and rearward ends of the body, a pair of seal members 154 and 156 disposed in the bore to seal about the outer periphery of the stem 134 and the bore 152 of the valve body 150, and a closure member in the form of a spherical ball 158

normally biased by a coil spring 160 into engagement with the seal member 156 to prevent fluid from passing through the bore. The forward end of the shell portion 146 forms a cylindrical socket to receive the stem 134 and includes the bayonet slot 132 to engage with the pin 128 during axial insertion of the stem into the valve body. The rearward end of the shell portion 148 includes a conical socket 162 for compression mating with a corresponding conical face on the swivel fluid connector 120.

Preferably, the shell portion 146 is comprised of a metal, such as stainless steel, whereby to endure the forces and wear occasioned during connection and disconnection to the stem 134. To reduce the weight of the conduit system, the shell portion 148 is formed of glass-filled nylon, or other suitable polymeric material not subject to attack by the paint material.

The seal members 154 and 156 are generally planar, circular and have a pair of flat faces, an outer circumference, and a central passage 164 and 166 extending between its respective faces. The seal members 154 and 156 are mounted in the bore 152 in sandwiched relation between the shoulders 168 and 170 formed on the shell portions 146 and 148. The outer diameter of each seal member 154 and 156 is preferably slightly greater than the inner diameter of the bore 152 whereby to provide an interference fit therebetween. When the shell portions 146 and 148 are brought together to assemble the valve body, the seal members 154 and 156 are compressed together to form an axial seal therebetween and a radial seal with the bore 152 of the valve body 150.

Preferably, the confronting faces of the seal members 154 and 156 are formed to include a conical skirt. As shown, the seal member 154 includes a conical skirt 172 which tapers inwardly and into encircling engagement about the entrance to the central passage 166 through the seal member 156. The seal member 156 includes a conical skirt

174 which expands outwardly and into sealing engagement with the inner wall of the bore 152 to complete a 360° sealing engagement therewith. The forward end 176 of the skirt 172 defines a restricted opening of the seal passage that is dimensioned to engage the outer periphery of the stem 134 prior to insertion of the stem into the passage 166 of the seal member 156. During insertion, the forward end 176 centers the stem 134 relative to the passage 166 and is forced against the seal member 156, thus to inhibit any flashback of the high pressure paint.

The closure member 158 is a spherical ball which seats, in part, in the entry to the central passage 166 and against the end face of the seal member 156. The coil spring 160 has its opposite ends disposed against a shoulder 178 of the valve bore and the closure ball 158 whereby to normally axially force the ball into the central passage, thereby compressing the seal material around the passage and forming a fluid seal thereabout.

The central passages 164 and 166 formed by the conical skirt 172 of the seal member 154 or by the wall of the passage through the seal member 156 has a diameter that is slightly less than the outer cross-sectional diameter of the stem 134 whereby to provide a sealed interference fit therebetween upon coupling engagement. Importantly, the stem will engage and seal with the central passages 164 and 166 prior to engaging the closure member.

During coupling, the stem 134 is axially inserted into the front mating end of the valve body 150 and the pin 128 engaged with the slot 132 in the socket thereof, twisted, and progressively inserted. The forward end portion 137 of the stem 134, when inserted, will be successively engaged with the seal members 154 and 156 to seal against leakage, during which time the closure ball 158 is forced against the seal member 156 to prevent fluid passage. Ultimately, upon complete interengagement between the pin 128 and the slot 132, the end face 138 of the stem 134 will engage and

axially force the closure ball 158 away from fluid preventing closing relation with the seal member 156. In FIG. 9(A), the forward end portion 137 of the stem 134 has been axially inserted into the bore 152 by an amount sufficient to engage the conical skirt 172 of the seal member 154, whereby to be in sealing engagement therewith, and to force the forward end 176 of the skirt against the seal member 156. The penetration of the stem 134 is such that a fluid seal is formed therebetween but the stem does not engage with the closure ball 158, which remains biased against and in sealing relation against the rearward end face of the seal member 156.

In FIG. 9(B), the forward end portion of the stem 134 has been inserted into the bore 152 by an amount sufficient to penetrate into the central passage 166 of the seal member 156. The outer periphery of the stem establishes sealing engagement with the seal member 156, without disturbing the sealing engagement between the closure ball 158 and end face of the seal member 156. The stem is also in sealed engagement with the conical skirt 172.

In FIG. 9(C), the axial end face 138 of the stem 134 has reached and driven the closure ball 158 axially rearward from its engagement with the end face of the seal member 156 whereby fluid is permitted to pass through the valve body 150, through the apertures 144 in the end face 138, and through the central bore 140 of the stem 134. The closure ball 158 would then be seated in the central aperture 142 formed in the axial end face 138. Importantly, during withdrawal, the controlled sealing engagement between the stem 134 and the seal members 154 and 156 allows gradual reseating of the closure ball 158 against the end face of the seal member 156 and into the central passage 166 whereby to inhibit paint from splashing outwardly.

FIGS. 10, 11 and 12 disclose, respectively, details of the swivel fluid connector, the filter fluid connector and

the restrictor valve. The swivel fluid connector 120 includes a body 180 having a bore extending between forward and rearward portions thereof, and a rotatable coupling nut 182 on the forward portion to couple to the quick disconnect fluid coupling assembly 118. The rearward portion is externally threaded and has an internal conical wall 184 to form a portion of a compression connection when connected to the filter fluid connector 122. Preferably, the body 180 is comprised of a suitable polymeric material, such as glass filled nylon. Desirably, the swivel fluid connector 120 allows the recirculating conduit 86 to rotate relative to the spray gun 88 and prevent forces from distorting the integrity of the recirculating conduit. Depending on the application, the coupling nut 182 may either be of a polymeric material, or metal, such as stainless steel.

The filter fluid connector 122 is similar to that disclosed in United States Patent No. 4,442,003, the teachings of which are incorporated herein by reference. Generally, the filter fluid connector 122 includes a thimble-shaped filter element 186 which is captivated between first and second ferrules 188 and 190, the first ferrule 188 being externally threaded for attachment to the restrictor fluid connector 124 and the filter element being affixed to the second ferrule 190. Importantly, however, the ferrule 188 is comprised of glass filled nylon and the ferrule 190 is comprised of stainless steel.

The restrictor fluid connector 124 is similar to that disclosed in U. S. Patent No. 4,106,699, the teachings of which are incorporated herein by reference, and also in the aforementioned United States Patent No. 5,060,861. The restrictor fluid connector 124 includes a centrally bored fluid housing 192, a coupling nut 194 mounted to the forward end portion of the housing for attachment to the ferrule 190 of the filter fluid connector 122, and a flow plate 196 and adjustable flow restrictor 198 secured in the

bore of the fluid housing 192. Importantly, however, the fluid housing 192 is comprised of glass filled nylon.

Turning to FIG. 13, according to an important feature of this invention, the discharge end of the recirculating conduit 86 includes a flexible strain relieved termination, including the fluid fitting 106 that is terminated to the outer hose 100 of the recirculating conduit, and a helical coil sheath 200 to engage the fluid fitting and supportingly encircle the outer periphery of the recirculating conduit. Preferably, the fluid fitting 106 comprises a pair of fluid housings 202 and 204 which are threadably engaged to form the fitting. The fluid housing 202 includes a forward end portion onto which is mounted an internally threaded coupling nut 206 to connect to the restrictor fluid connector 124 and an externally threaded rearward end portion to threadably connect to the fluid housing 204. The fluid housing 204 includes a rearward end portion 208 to which the outer and inner supply and return hoses 100 and 102 of the recirculating conduit 86 are secured. Preferably the fluid housings 202 and 204 are comprised of glass filled nylon.

According to this invention, the rearward end portion 208 of the fluid housing 204 is externally threaded or formed to include helical convolutions 210 that extend radially outward therefrom with the sense of the convolutions (or thread) being opposite to the helical sense of the internal thread formed in the coupling nut 206. Further, according to this invention, the coil sheath 200 is formed by a wire that is helically coiled into an axially elongated cylinder and the helically coiled wire is threadably engaged within the grooves of the convolutions 210 formed on the fluid housing. As configured, coupling rotation of the coupling nut 206 on the fluid fitting 106 tends to tighten the threaded connection between the coils of the sheath and the helical grooves formed by the external thread.

Further, according to this invention, the forward end of the fluid fitting 106, enclosed by the coupling nut 206, is generally conically shaped. As such, the mated relation results in a compression fit.

FIGS. 15 - 17 illustrate preferred embodiments of a paint system according to this invention in which two paint coatings are applied at the same time. According to these embodiments a pair of respective coaxial recirculating conduits 86a and 86b are connected, respectively, at their supply end to a paint coating source to supply same under pressure to the discharge end of the conduit. For example, the first recirculating conduit 86a could recirculate a clear coat paint and the second recirculating conduit 86b could recirculate a base paint. A unique Y-shaped fluid connector 212 operates to receive the flow of paint composition from each of the two recirculating conduits, mix the flows into one, and supply this mixed flow to the spray gun 88.

Referring to FIG. 15, the Y-shaped fluid connector 212 includes two inlets 214, an outlet 216, a central chamber 218 for receiving the two coatings from the inlets 214, and a nylon mixing element 220 in the chamber for mixing the two coatings. A check valve 222 is positioned at each inlet to allow the base coat or clear coat to flow from the inlet to the outlet but not to flow into to other inlet. A slot 224 in the check valve 222 permits fluid to flow through the check valve when the fluid is being discharged from the recirculating conduit. The nylon mixing element 220 comprises a generally axial fin formed (i.e., twisted) helically about its axis. The fin rotates about its axis to mix the paints together as the clear coat and base coat are received in the chamber.

The recirculating conduits 86a and 86b preferably include a restrictor fluid connector 124, as described above. As shown in the paint system of FIG. 16, a single restrictor connector is positioned at the outlet (i.e.

discharge) end of the Y-shaped connector whereby to restrict the flow of paint to the spray gun. Alternatively, as shown in the paint system of FIG. 17, two restrictor connectors are provided, one for each inlet to the Y-shaped connector. The restrictor fluid connector would advantageously permit the user to vary the amount of either paint composition being supplied to the mixer.

It is believed that the fluid connectors, which connect the paint supply to the conduits, need to have their inner components of stainless steel, although the outer shell still may be made of glass-filled nylon or metal. It is believed that making the components from stainless steel results in less degradation of the paint of those surfaces that contact the paint. Although not shown, it is to be understood that in certain applications the coaxial recirculating (i.e., the hose within a hose) conduit described above could be replaced with four separate conduits.

Referring now to FIGS. 18 - 23, according to another important feature of this invention, a paint flow regulator 226 for use in recirculating liquid coating composition systems is adapted to provide a specific flow of a single coating material to the spray gun 88. The flow regulator 226 assures a continuous supply of a uniform liquid coating to the nozzle of the spray gun 88 at an adjustable desired pressure.

The flow regulator 226 includes a first and second housing 228 and 230 having respective mating faces 232 and 234 and forming respective chambers 236 and 238, inlet and return lines 240 and 242 communicating with the chamber 236 formed in the housing 228, an outlet line 244 communicating with the mating face 232, a fluid passage 246 extending between the flow chamber 236 and the mating face 232, and a diaphragm 248 and a gasket 250, the housings being combinable whereby the outer periphery of the diaphragm 248 and the gasket 250 are compressed between the mating faces

232 and 234 and the diaphragm isolates the chambers 236 and 238 from one another. A series of fluid recesses 252 arranged into the shape of a crucifix are formed in the front mating face 232 with one fluid recess 252 thereof being in direct fluid communication with the outlet line 244. The crucifix has its center located on the passage 246 and the respective recesses extend radially outwardly from the axis of the passage. The inlet and return lines 240 and 242 terminate in a conventional fluid connector and the outlet line 244 terminates in a conventional quick connect fluid connector.

Flow is regulated, in part, by an elastomeric seal 254 having a through bore 256 and mounted in the flow chamber 236 for sealing the entrance to the passage 246 and an axial push rod 258 mounted for axial movement in the bore 256 and in the passage 246. The push rod 258 has a shaped head 260 disposed in the flow chamber 236 and movable into sealing engagement with the wall of the through bore 256, a drive shoulder 262 positionable in the passage adjacent to the mating face 232, and a threaded forward end 264 extending through the diaphragm 248 and into the chamber 238. The cross-section of the drive shoulder 262 and the passage 246 adjacent the front mating face 232 are substantially the same whereby the drive shoulder 262 will inhibit flow from the flow chamber 236. Access to the flow chamber 236 is afforded by a plug 266 threadably secured in a bore formed in the housing 228.

Preferably the housings 228 and 230 and the plug 266 are comprised of a polymeric material, such as glass filled nylon. To form a complementary transition between the polymeric material of the housing 228 and to transmit force, flat annular washers 268 and 270 are located between the mating face 232 and the diaphragm 248, the washer 268 being of polymeric material and abutted against the mating face 232 and the washer 270 being of a suitable metal and abutted against the diaphragm.

Movement of the push rod 258 is controlled, in part, by a flat circular force plate 272 disposed in the chamber 238, an axial flow control plunger 274 extending through a wall of the housing 230 into the chamber 238 to engage the force plate 272, a flat polymeric annular washer 276 in the chamber 238 and abutted against the diaphragm 248, and a cylindrical coil spring 278. The coil spring 278 is comprised of flat coils and has its opposite axial ends abutted, respectively, against the annular washer 276 and the force plate 272. The forward end 264 of the push rod 258 is provided with a cap 280 which engages the washer 276, the cap 280 and the drive shoulder 262 operating to clamp the washers 268, 270 and 276 and the diaphragm 248 together. The flow control plunger 274 is threadably engaged with the housing 230 and adapted to be incrementally advanced into and outward of the chamber 238, the inward advance of the flow control plunger 274 increasing the spring force acting on the washer 276 (and thus the fluid pressure needed to overcome the spring load).

The operation of the flow regulator 226 is shown in sequence in FIGS. 20-22. Fluid flow is regulated through the flow regulator 226 by the axial reciprocation of the push rod 258 within the passage 246. During operation, the flow chamber 236 continuously receives and recirculates a high volume of liquid paint whereby to maintain the liquid constituents therein in the form of a substantially uniform dispersion. The paint is introduced into the flow chamber 236 through one sidewall of the flow chamber such that the paint will impinge on an apertured turbulizer sleeve 267 extending from the plug 266 and against an opposite sidewall to develop a swirling action to maintain the paint constituents uniformly dispersed.

Initially, as shown in FIG. 20, the coil spring 278 normally biases the polymeric washer 268 against the mating face 232, thereby resulting in the washer 268 forcing the

drive shoulder 262 of the push rod 258 into position in closing relation with the outlet of the passage 246. Pressurized liquid is then introduced into the flow chamber 236 via the inlet line 240. If the fluid pressure is lower than the spring force, the drive shoulder 262 will not move but will act to prevent fluid from flowing through the passage 246. The fluid will return to the supply via the return line 242.

As shown in FIG. 21, as the fluid pressure increases, the force acting on the head 260 of the push rod 258 will exceed the spring force, thereby driving the drive shoulder 262 of the push rod towards the second housing 230 and the washer 268 from covering relation against the mating face 232 and with the recesses 252. Fluid is allowed to communicate via the recess 252a and to the outlet line 244. Excess fluid will return will return to the supply via the return line 242.

Finally, as shown in FIG. 22 should the pressure increase to a level that the fluid force acting on the head 260 is greater than the spring force, the head 260 will move into seated relation with the wall of the through bore 256 of the seal 254 mounted in the fluid chamber 236. In this condition, the push rod 258 will prevent fluid from passing through the passage 246 and the fluid will return to the supply via the return line 242.

According to another feature of this invention, a push to connect fluid coupling 282 is shown in FIGS. 24-25. In this fluid coupling, a cylindrical fluid conduit 284 has an end portion 286 adapted to be inserted into a fluid connector 288, whereby to be simultaneously releasably gripped, axially positioned and sealed. As shown, the fluid connector 288 comprises a housing 290 having an annular shoulder 292 leading into a stepped bore 294, an annular lock ring 296 and an annular O-ring 298 located in the bore 294, and a tubular unlock sleeve 300 mounted to the shoulder. The lock ring 296 and the O-ring 298 are

mounted in respective annular grooves formed in the stepped bore 294 and each operates to radially engage the outer periphery of the conduit 284 to inhibit its unwanted release. The lock ring 296 has a plurality of radially inwardly directed spring tines 302 which are adapted to engage the end portion 286 and lock the conduit 284 in the bore 294. The tines 302 deflect radially outwardly upon engagement with the fluid conduit 284 and direct the end portion 286 towards the O-ring 298 and the end 285 of the conduit towards an endwall of the bore 294. The unlock sleeve 300 includes a pair of axially spaced collars 304 and 306 which engage opposite axial faces of the annular shoulder 292, the collars being axially spaced to permit axial captivated movement of the unlock sleeve 300 relative to the housing 290.

To effectuate release, the unlock sleeve 300 is forced axially inwardly of the stepped bore 294 whereby the conical end face of the collar 306 engages and drives the spring tines 302 radially outwardly. The collar 304 prevents excess inward axial movement of the unlock sleeve 300 into the stepped bore, such movement as could overstress the spring tines 302, or possibly cause the collar 306 to be locked between the O-ring 298 and the deflectable ends of the tines 302. In this regard, the wall between the annular groove receiving the lock ring 296 and the O-ring 298 is tapered and serves to support the tines 302 during their deflection.

While the above description constitutes the preferred embodiment of the invention, it will be appreciated that the invention is susceptible to modification, variation, and change without departing from the proper scope or fair meaning of the accompanying claims.

CLAIMS

What is Claimed is:

1. In a recirculating paint supplying system of the type including a first and a second paint station, a supply conduit for supplying pressurized liquid coating to each paint station, a return conduit for returning excess low pressure liquid coating from each station, a first connector for connecting the supply conduit to the paint stations, and a second connector for connecting the paint stations to the return conduit, the improvement wherein said first connector comprises a fluid fitting having a first part in fluid communication with a pair of second parts, a first fluid line having one of its ends connected to said supply conduit and the other of its ends connected to the first part, a pair of second fluid lines each having one of its ends connected to a respective of said paint stations and the other of its ends connected to a respective of said second parts, each said second fluid line having a first end portion extending generally orthogonally to the first fluid line and a second end portion extending generally at an acute angle to the first fluid line.

2. The recirculating paint supplying system as claimed in Claim 1 wherein the first end portion is disposed at an angle of about 45° to the second end portion and to said first fluid line whereby to provide a generally smooth 90° transition for the coating in flowing between the first fluid line and the paint stations.

3. The recirculating paint supplying system as claimed in Claim 2 and further comprising closure means, associated with said second fluid lines, for closing fluid

communication between said supply conduit and said paint stations.

4. The recirculating paint supplying system as claimed in Claim 3 wherein said closure means comprises a flow control device in the second end portion of each said second fluid line, said flow control devices being operable independently of one another.

5. The recirculating paint supplying system as claimed in Claim 1 wherein said second connector comprises a first connector and said return conduit extends between said first and second rows, said first connector having its first fluid line connected to said return conduit and its respective second fluid lines connected to a respective first paint station in said first row and a second paint station in said second row.

6. In a recirculating paint supply system or the like including a pressurized conduit having a first end and a second end for receiving and supplying a liquid coating composition to a spray nozzle in an amount in excess of that required and for returning the excess coating composition to a supply tank, the improvement comprising;

flow preventing means, including a valve body fitted to the first end of said conduit, for preventing fluid flow from said conduit;

flow enabling means, extending from said spray nozzle and insertable in said valve body, for enabling the liquid coating to communicate to said nozzle; and

connecting means for connecting said valve body to said spray nozzle,

said flow preventing means being normally operable to prevent fluid from passing from said conduit to said spray nozzle when said valve body is disconnected from said spray nozzle and comprising a fluid seal mounted in said valve

body, said seal having opposite axial end faces and a central passage extending between said end faces, and a closure member normally forced into sealing engagement with one of the end faces of said seal and the seal passage for preventing flow through said valve body, and

said flow enabling means being operable to first establish sealing engagement with the wall of said passage during axial insertion and thereafter to engage and move said closure member from engagement with said seal, fluid flow being enabled substantially simultaneously with said closure member being forced from engagement with said one end face.

7. The recirculating paint supply system as claimed in Claim 6 wherein said flow enabling means comprises a cylindrical stem having an end face adapted to engage and force said closure member from engagement with the seal, said stem having an inlet for receiving said fluid and an outlet for discharging said liquid coating.

8. The recirculating paint supply system as claimed in Claim 6 wherein said valve body is comprised of a polymeric material.

9. The recirculating paint supply system as claimed in Claim 8 wherein said polymeric material comprises glass filled nylon.

10. The recirculating paint supply system as claimed in Claim 6 wherein said connecting means comprises swivel means for allowing relative rotation between the valve body and the spray nozzle, flow restrictor means for adjusting the volume rate of flow from the valve body to the spray nozzle, and filter means for filtering the liquid coating passing between said valve body and said spray nozzle

whereby to prevent particles in the coating from reaching the spray nozzle.

11. The recirculating paint supply system as claimed in Claim 6 wherein said connecting means comprises swivel means, including a body portion comprised of a polymeric material, for allowing relative rotation between the conduit and the spray nozzle.

12. The recirculating paint supply system as claimed in Claim 6 wherein said connecting means comprises flow control means, including a body portion comprised of polymeric material, for restricting and adjusting the rate of liquid coating passing between the conduit and the spray nozzle.

13. The recirculating paint supply system as claimed in Claim 6 wherein said connecting means comprises filter means, including a body portion comprised of polymeric material, for filtering the liquid coating passing between the conduit and the spray nozzle.

14. In a paint system of the type including a spray nozzle; first and second fluid conduits, each terminated by a respective end fitting, for passing a liquid coating; and connecting means for connecting the end fittings to the nozzle, the improvement wherein said connecting means comprises

a Y-shaped fitting having first and second inlet ends each for receiving a liquid coating from a respective of said conduits, a chamber for receiving the two coatings, means in said chamber for mixing the liquid coatings, and an outlet end for dispensing the mixture to the nozzle;

first means for connecting said inlet ends to the respective end fittings, said first means including check valve means for preventing the coating entering into one of

said inlet ends from passing through the other of said inlet ends;

second means for connecting said outlet end to the nozzle; and

restrictor means, disposed between said end fittings and said spray nozzle, for adjusting the volume rate of flow to said spray nozzle.

15. The paint system as claimed in Claim 14 wherein the means for mixing the coatings comprises a generally axial fin formed helically and disposed for rotation in said chamber.

16. The paint system as claimed in Claim 14 wherein said second means includes said restrictor means, and said restrictor means comprises a flow restrictor valve connected to said outlet end.

17. The paint system as claimed in Claim 14 wherein said first means includes said restrictor means, and said restrictor means comprises a flow restrictor valve connected to each respective inlet end.

18. The paint system as claimed in Claim 14 wherein said connecting means further comprises a swivel connector means between each said end fitting and said Y-shaped fitting, for enabling the fluid conduits to rotate relative to the Y-shaped fitting.

19. The paint system as claimed in Claim 14 wherein at least one of said fluid conduits includes a first hose to supply liquid coating to the end fitting of said conduit, and a second hose to return excess liquid coating from the end fitting, said first and second hoses being generally coaxial to one another.

20. The paint system as claimed in Claim 19 wherein each of said fluid conduits includes supply and return hoses arranged coaxially.

21. The paint system as claimed in Claim 14 wherein said Y-shaped fitting includes a Y-shaped body comprised of a polymeric material.

22. The paint system as claimed in Claim 21 wherein said polymeric material is glass filled nylon.

23. In a paint supply system or the like including an axially elongated tubular conduit having a first end for receiving a liquid coating from a paint supply and a second end, and coupling means for coupling the second end of said conduit to the nozzle of a paint spray gun whereby to communicate liquid coating thereto, the improvement wherein said coupling means comprises:

first connector means for protecting the second end portion of said conduit from strain occasioned from the conduit bending relative to its axis and communicating liquid coating from the second end, said connector means including a first fluid connector connected to the second end of said conduit and having a first and a second body portion,

second connector means, including a second fluid connector having a first and a second body portion, for connecting to the spray gun, and

third connector means for connecting said first fluid connector to said second fluid connector, said third connector means comprising:

swivel means, including a first and a second body portion, for allowing relative rotation between the first and second fluid connectors,

flow control means, including a first and a second body portion, for restricting and adjusting the rate of

liquid coating passing between said first and second fluid connectors, and

filter means, including a first and a second body portion, for filtering the liquid coating passing between said first and second fluid connectors whereby to prevent particles in the coating from reaching the spray nozzle,

each of said first body portions being comprised of a polymeric material.

24. The paint supply system as claimed in Claim 23 wherein said polymeric material is glass filled nylon.

25. The paint supply system as claimed in Claim 23 wherein each of said second body portions is comprised of a metal.

26. The paint supply system as claimed in Claim 25 wherein said metal is a stainless steel.

27. In a recirculating paint supply system or the like including a pressurized conduit having a first end for supplying a liquid coating composition to a spray nozzle in an amount in excess of that required and a return conduit connected to said first end for returning the excess coating composition to a supply tank, and a fitting for interconnecting a forward end portion of the conduit with the spray gun, the improvement comprising

strain relief means for inhibiting bending forces from straining the connection, said strain relief means comprising

said fitting including a forward mating portion for completing a fluid interconnection and an externally threaded rearward backshell portion 38, and

an axially elongated wire sheath formed at least in part by a wire being coiled into a helix, the coils of the helix being threadably engaged with the backshell.

28. In a quick disconnect connector assembly of the type including first and second fluid connectors which mate with one another, said first connector including an elongated tubular conduit having a central bore for passing fluid and said second connector including an axial bore for receiving the forward end portion of said conduit, an annular seal member in said bore for sealing the mated connection, said seal having an axial passage extending between opposite end faces, and a closure member removably engaged with one of said end faces and seated in said passage for normally preventing fluid flow through said passage and movable therefrom by the forward end of said first conduit whereby to permit flow to pass through the passage, the improvement wherein

said tubular conduit and said passage are dimensioned such that the forward end portion of said conduit is adapted to establish sealing engagement with the wall of said passage both when the conduit has been partially inserted into the passage but prior to engaging the closure member during which time no flow is permitted through the connector assembly and also when fully inserted into said passage whereby to move the closure member from flow preventing engagement with the one end face and permit flow to communicate with said central bore.

29. The quick disconnect connector assembly as claimed in Claim 28 wherein said closure member comprises a spherical ball, and further comprising bias means for biasing the ball against said one end face.

30. The quick disconnect connector assembly as claimed in Claim 29 wherein said tubular conduit includes

a nonplanar end face extending forwardly of the conduit, the end face including a central opening for seating and positioning the ball and a fluid passage for communicating fluid to said central bore extending therethrough.

31. The quick disconnect connector assembly as claimed in Claim 30 wherein a frustoconical skirt extends from the other end face of said seal whereby to engage the bore and form a central recess, and further comprising a second seal member positioned in sealed engagement with said other end face of the first seal member, said second seal member having a conical skirt extending into said recess to center the forward end of the conduit with the passage and seal around the forward end of said conduit prior to entry of the forward end portion into said passage.

32. A quick disconnect fitting assembly for releasably connecting a pair of fluid fittings to one another for fluid communication therebetween, said assembly comprising:

a cylindrical conduit on a first of said fittings for passing fluid, said conduit having a central bore and an apertured forward end communicating with said bore,

socket means on the second of said fittings for receiving the forward end portion of said conduit when inserted longitudinally inwardly into said socket means,

a seal member for providing a fluid tight connection between engaging portions of said forward end portion and said second fluid fitting both when the forward end portion is partially inserted or fully inserted in said second fluid fitting, and

a normally closed flow closure element adapted to engage the seal and prevent fluid flow when the closure element is in a first position and movable by the forward

end of said first fluid fitting and into a second position and permit fluid flow,

the seal member being in sealing engagement with the forward end portion both when the forward end portion is in its partially inserted position but before the end portion reaches the closure element in its flow preventing first position and also after reaching its fully inserted position and the closure element is moved to the second position for permitting fluid flow.

33. In a quick disconnect fluid connector assembly of the type including first and second members, and means operating between the members for connecting the members together whereby to pass fluid therebetween, said first member being in the form of an elongated tubular conduit, and said second member including a housing having axial bore means formed therein for receiving said conduit at a first end and providing a fluid path at a second end, and elastomeric sealing means, disposed in said bore means, for providing a fluid seal between said conduit and said housing, said seal means including a first annular seal member having forward and rearward axial end faces and an axial passage extending between said end faces, and a closure member normally biased into sealing engagement with the rearward end face for preventing fluid flow and movable therefrom for permitting flow, the improvement wherein

the cross-section of said conduit and of the inner wall of said axial passage are like-shaped and dimensioned such that the wall of said passage engages the outer periphery of the conduit and provides a tight interference fit therewith, and

the forward end portion of said conduit is dimensioned to first make sealing contact with the passage wall of said seal without engaging the closure member and then while maintaining sealing engagement with the passage wall to axially move the closure member from its sealing engagement

with said rearward end face and permit fluid communication between the members.

34. The fluid connector assembly as claimed in Claim 33 wherein said seal means includes a second annular seal member positioned in sealed relation against the first annular seal member and said housing, said second annular seal member including means for centering the forward end portion of said conduit with the entry to said passage while establishing an initial fluid sealed engagement therewith.

35. The fluid connector assembly as claimed in Claim 33 wherein said bore means includes an inner wall, said seal means includes a second annular seal member positioned in sealed relation with said inner wall, and first and second frusto-conical skirts disposed in nested relation, the first skirt extending from the first seal member and into sealing engagement with the inner wall of said bore means, and the second skirt extending from the second seal into generally centered relation with the entry to said passage.

36. The fluid connector assembly as claimed in Claim 33 wherein said conduit includes a non-planar end face having a central seat for engaging said closure member, and passage means adjacent to said seat for passing fluid; and said closure member comprises a spherical ball, a spherical segment of said ball being received in said seat when the conduit is driven thereagainst.

37. The fluid connector assembly as claimed in Claim 33 wherein said housing comprises a first housing member for receiving said conduit at a first end, a second housing member comprised of a polymeric material for receiving said

closure member, and connecting means for connecting the housing members together.

38. The fluid connector assembly as claimed in Claim 37 wherein said seal means comprises a first and a second annular seal member, and said bore means comprises said first housing member having a first shoulder for engaging the first seal member and said second housing member having a second shoulder for engaging the second seal member, said shoulders operating to compress the seal members together and against the inner wall of the bore.

39. In combination, a fluid conduit having an end, and a fluid fitting having a rearward end portion secured to the conduit and a forward end portion, the improvement comprising helical convolutions having a predetermined pitch width extending radially outward from said rearward end portion; and guard means, secured to said helical convolutions and extending axially from said fitting, for protecting the outer periphery of the conduit and providing strain relief to the securement.

40. The combination as claimed in Claim 39 wherein said fluid fitting comprises a shell which includes an outer periphery upon which said convolutions are formed, and said guard means includes a wire helically coiled into a generally cylindrical form, the portion of the wire helix adapted to engage the convolutions having the same predetermined pitch width as the convolutions.

41. The combination as claimed in Claim 39 wherein a coupling nut is rotatably mounted to the forward end portion of said fluid fitting, said coupling nut being adapted to couple to a mating fitting by rotation in a sense opposite to that for coupling the coil to said convolutions.

42. The combination as claimed in Claim 39 wherein said fluid fitting is comprised of a polymeric material.

43. The combination as claimed in Claim 42 wherein said polymeric material is glass filled nylon.

44. The combination as claimed in Claim 41 wherein said fitting comprises first and a second housing members, said coupling nut being mounted on said first housing member, and said second housing member including said rearward end portion, and said fluid conduit comprises an outer and an inner hose arranged generally coaxially whereby to define outer an inner fluid passages, said outer hose being secured to said rearward end portion.

45. The combination as claimed in Claim 44 wherein the forward end portion of said first housing member is generally frusto-conical and adapted to complete a compression seal with a like shaped frusto-conical socket formed in a mating member.

46. In a fluid coupling of the type having a fluid conduit and a fluid fitting, said fitting including a backshell secured to one end of the conduit and a coupling mechanism formed with helical thread for threadable connection to a mateable fitting, the improvement comprising helical convolutions of predetermined pitch width being formed on the outer periphery of said backshell and by a wire coiled into a cylindrical tube sized to encircle the outer periphery of said conduit, the convolutions of said wire coil threadably engaging with the convolutions of said backshell and the tube extending from said backshell a predetermined amount to support the conduit.

47. The fluid coupling as claimed in Claim 46 wherein said coupling mechanism comprises a coupling nut mounted for rotation in a first direction to effect threadable engagement, and the convolutions of said coils threadably engage with the convolutions of said backshell by rotation in a second direction opposite to the first direction.

48. A fluid control assembly, comprising

connector means, including a first and a second connector and a bypass connector, for selectively establishing and interrupting fluid flow between a fluid supply and a fluid return, said first connector being connected to said supply and having a connector portion connected to an inlet port on said bypass connector, and said second connector being connected to said return and having a connector portion connected to an outlet port on said bypass connector, and

seal means, operating between said ports and said connector portions, for compression sealing the connection, the seal means comprising each said port and respective connector portions being formed with complementary frustoconical mating faces, and a resilient seal member having a frustoconical skirt sandwiched between said mating faces, the skirt being complementary to said mating faces and operable to undergo axial compression and seal the mating faces.

49. The fluid control assembly as claimed in Claim 48 wherein the frustoconical mating faces on said connector portion and said port are concave and convex and the frustoconical mating face of said connector portion tapers rearwardly and inwardly and into a cylindrical recess rearwardly of its frustoconical mating face, and a cylindrical body extends from the skirt of said seal member, the cylindrical body being received in said

cylindrical recess to center its frustoconical skirt with said mating faces.

50. A compression sealed fluid fitting, comprising mateable first and second fluid fittings, and a funnel-shaped seal of polymeric material to seal the interface between fittings when mated, said seal including a cylindrical body and a conical skirt extending outwardly from the body, said first fluid fitting having a cylindrical recess sized to receive said body and a conical face to seat said skirt, and said second fluid fitting including a conical mating face adapted to engage and force the skirt against the conical face of said first fluid fitting.

51. A ball valve for a liquid paint, comprising

a valve body having opposite end portions and a bore extending between said portions,

closure means, including a ball member rotatably mounted in said bore and having a passageway therethrough, for selectively positioning said passageway with said bore to permit and prevent flow through the bore, and

seal means, operating to encapsulate said ball member and eliminate paint collecting voids, for sealing the bore to prevent unwanted fluid leakage.

52. The ball valve as claimed in Claim 51 wherein said seal means includes a pair of cup members that have end faces which are axially abutted with one another to form an axial fluid seal and a cavity that encloses the ball member.

53. The ball valve as claimed in Claim 52 wherein each said cup member has a peripheral wall dimensioned to engage and form a fluid seal with the wall of said bore and an endwall having a central aperture, the apertures and

said passageway being adapted to align with one another whereby to pass fluid through the bore when the ball member is in a first position and nonaligned with one another whereby to prevent fluid passage through the bore when the ball member is in a second position.

54. A method of connecting a fluid conduit to the nozzle of a spray gun such that during connection and disconnection excess liquid does not escape from the conduit, the steps of the method comprising

connecting a fluid fitting to said spray gun, said fitting including a cylindrical stem having an outer periphery and a fluid passage,

connecting a valve body to the discharge end of said conduit, said body having a bore extending between said end faces for passing said liquid to said fluid passage,

positioning an annular seal between the end faces of said body and in sealed relation with the wall of said bore, said seal having a central passage extending between first and second end faces thereof and the cross-section of said passage being less than the cross-section of said outer periphery,

biasing a closure member against the first end face to prevent fluid passage through said bore,

inserting the stem into the central passage through the second end face whereby the outer periphery is brought into sealed engagement with the seal wall but spaced from the closure member,

continuing the insertion until the stem engages the closure member, and

forcing the closure member from engagement with the first end face to enable fluid flow through the fluid passage.

55. In a push to connect fluid coupling of the type including a tubular conduit adapted to convey fluid and a

complementary connector housing having an axially extending stepped bore for receiving an end portion of said conduit at a first end and providing a fluid path at a second end, the improvement wherein:

said connector housing is comprised of a polymeric material and includes an annular shoulder at said first end, said annular shoulder defining first and second end faces, respectively, facing axially outwardly and inwardly of said bore;

said stepped bore includes a first and a second annular groove with a conical wall therebetween, said first groove being adjacent to said first end and said second groove being adjacent to said second end;

an annular spring ring and an annular seal ring mounted, respectively, in said first and said second annular groove for engaging the outer periphery of and locking the end portion of said conduit when said conduit is inserted in said bore,

said spring ring having a plurality of spring tines converging radially inwardly to form a conical throat for grippingly engaging the outer periphery of said end portion, said spring tines directing the end of said conduit towards said seal ring and said conical wall limiting the outward radial deflection of the spring tines; and

a tubular sleeve having a radial shoulder adjacent said first end for engaging said first face and an annular collar adjacent said second end, said tubular sleeve being mounted to said annular shoulder for axial movement thereto and said annular collar being mounted for axial movement towards and into engagement with the spring tines whereby to deflect the tines radially outwardly towards said annular wall and release the conduit from gripped relation.

56. A flow regulator for use in a paint recirculating system, comprising:

a housing comprised of polymeric material and including a fluid chamber, said housing an inlet, an outlet, a return, and an axial passage communicating with said chamber;

flow control means, including a push rod movable between a first, second and third position, for selectively controlling fluid flow from said chamber, said push rod permitting fluid to communicate between the inlet and the return when in any of said positions, and preventing fluid to communicate through said passage and to said outlet when in either said first and said third positions, and permitting fluid to communicate between said inlet and return only when in said first and third positions; and

flow regulator means, connected to said push rod and responsive to the pressure in said chamber, for regulating the movement of said push rod between said positions.

57. The flow regulator as claimed in Claim 56 wherein

said housing comprises a first and second housing portion each having a mating face and combinable at said mating faces, said first housing portion including said chamber, and said passage extending between an inlet in the chamber and an outlet opening on the mating face of said first housing;

said push rod comprises a head and a drive shoulder; and

said flow control means further comprises:

closure means, connected to said drive shoulder, for closing the outlet from the passage when the push rod is in said first position and movable from closing relation when the push rod is in said second and said third position; and

seal means, disposed in said chamber adjacent inlet leading into said passage and engageable by said head, for sealing the inlet to the passage when the push rod is in said third position.

58. In a paint spray apparatus of the type including a spray nozzle, a recirculating paint supply system for supplying a liquid coating composition to the spray nozzle in an amount in excess of that required, and a flow control device in the recirculating supply system for regulating the amount of paint supplied to the spray nozzle, an improved flow control device comprising:

a housing formed with an internal flow chamber having spaced first and second walls, an inlet and a return port connectible to a supply of pressurized paint for introducing paint into the chamber through the first wall such that the paint will impinge on the second wall in a swirling action to maintain the paint constituents uniformly dispersed, and an outlet passage having a first end opening in said chamber and a second end connectible in fluid relation to the spray nozzle;

flow control means, including a push rod movably mounted in said passage between a first, a second and a third position, for selectively controlling the flow of paint outwardly of said second end, said push rod preventing fluid to flow to the spray nozzle when in said first and third positions and permitting fluid to flow to the spray nozzle only in said second position; and

flow regulator means, including a spring, for inhibiting movement of the push rod in response to the pressure of the fluid supplied to the chamber.

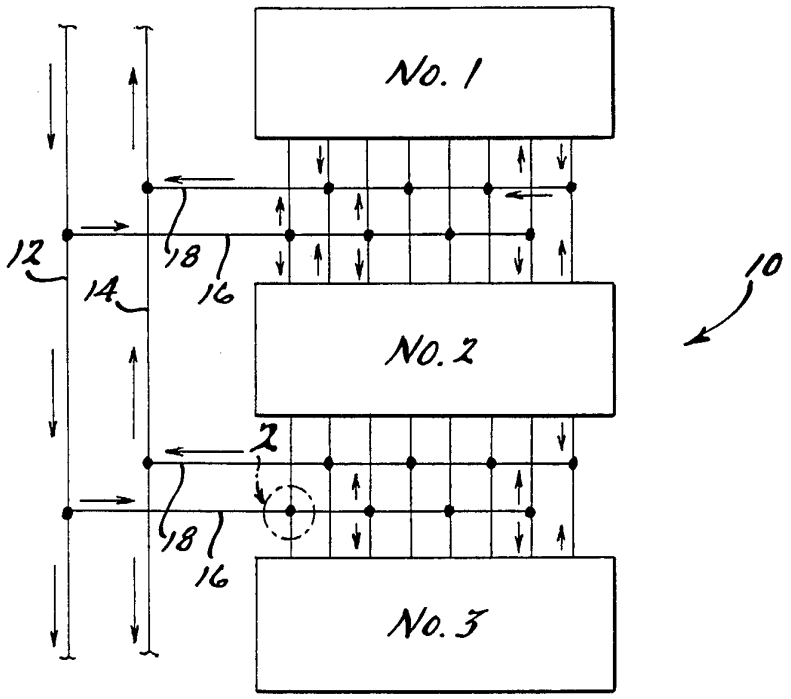
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Fig. 1.

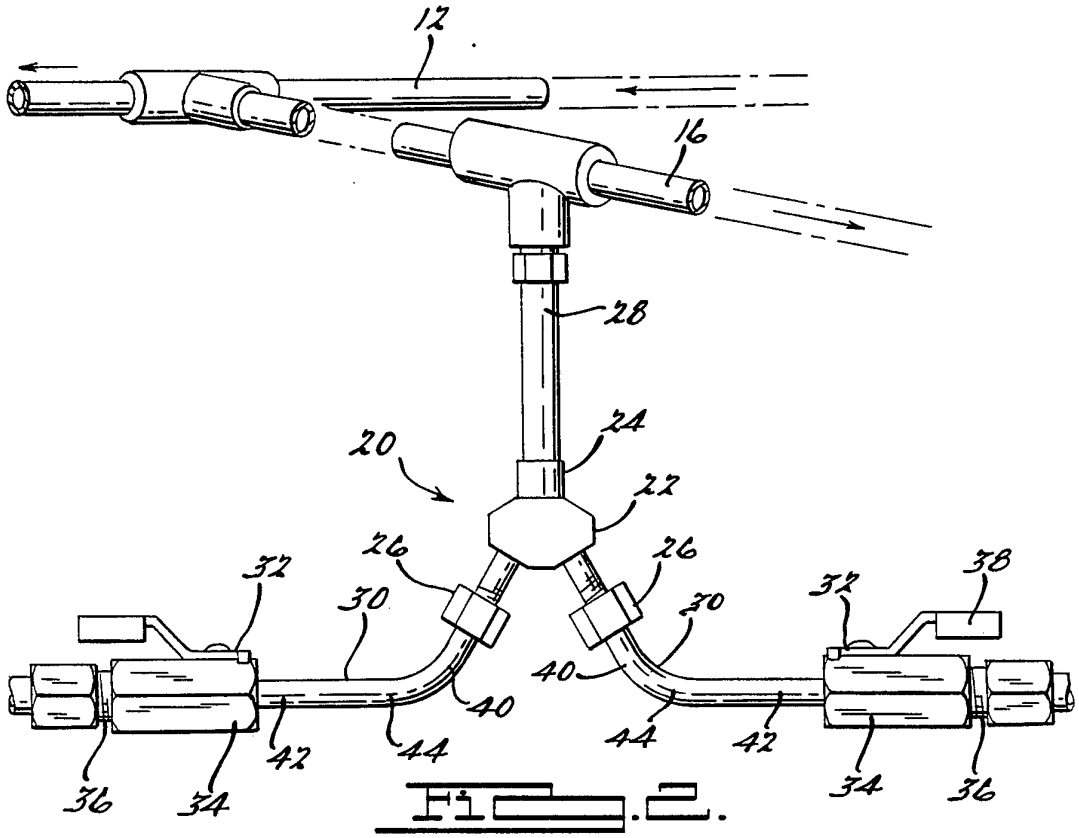
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Fig. 2.

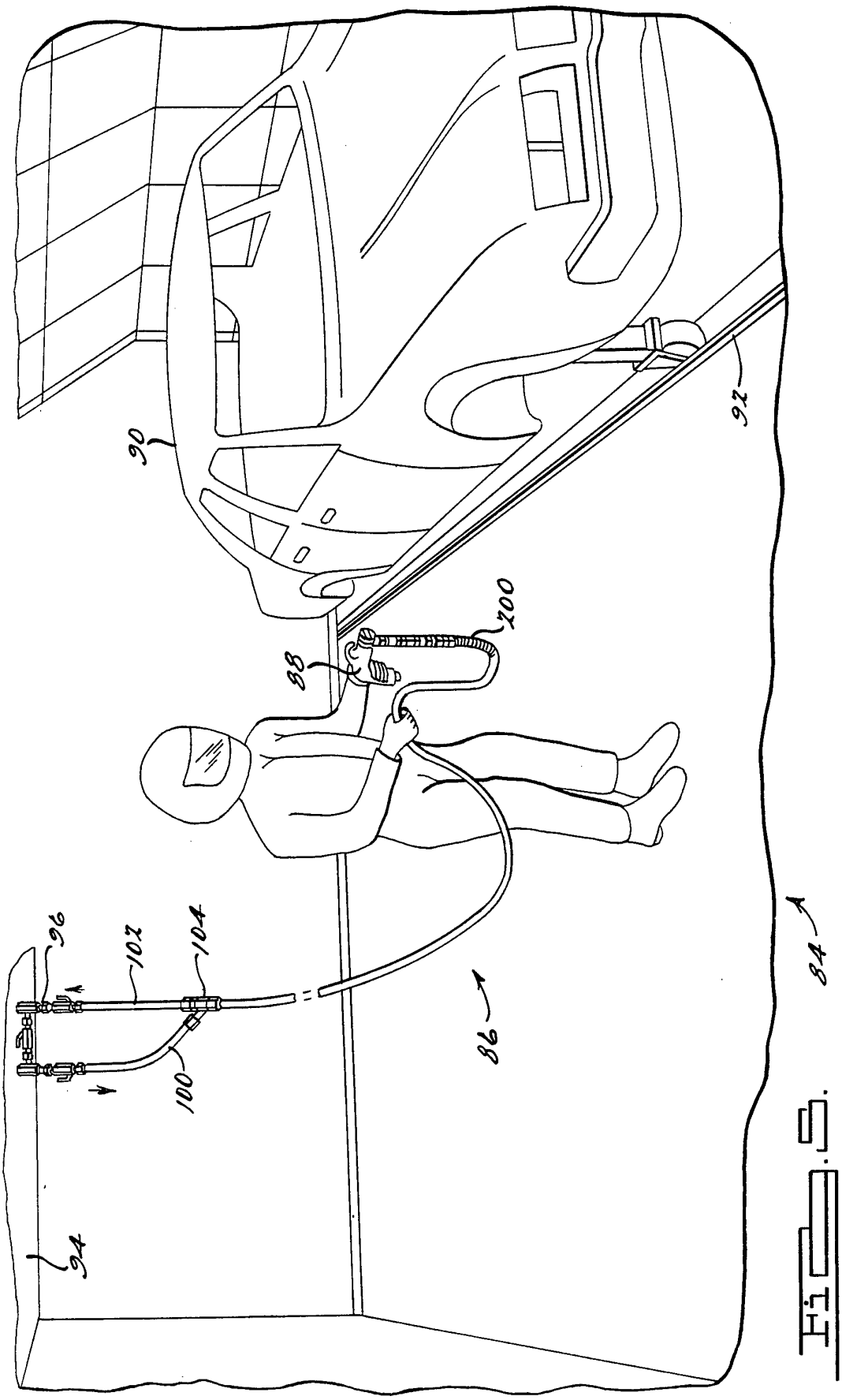

Fig. 5.

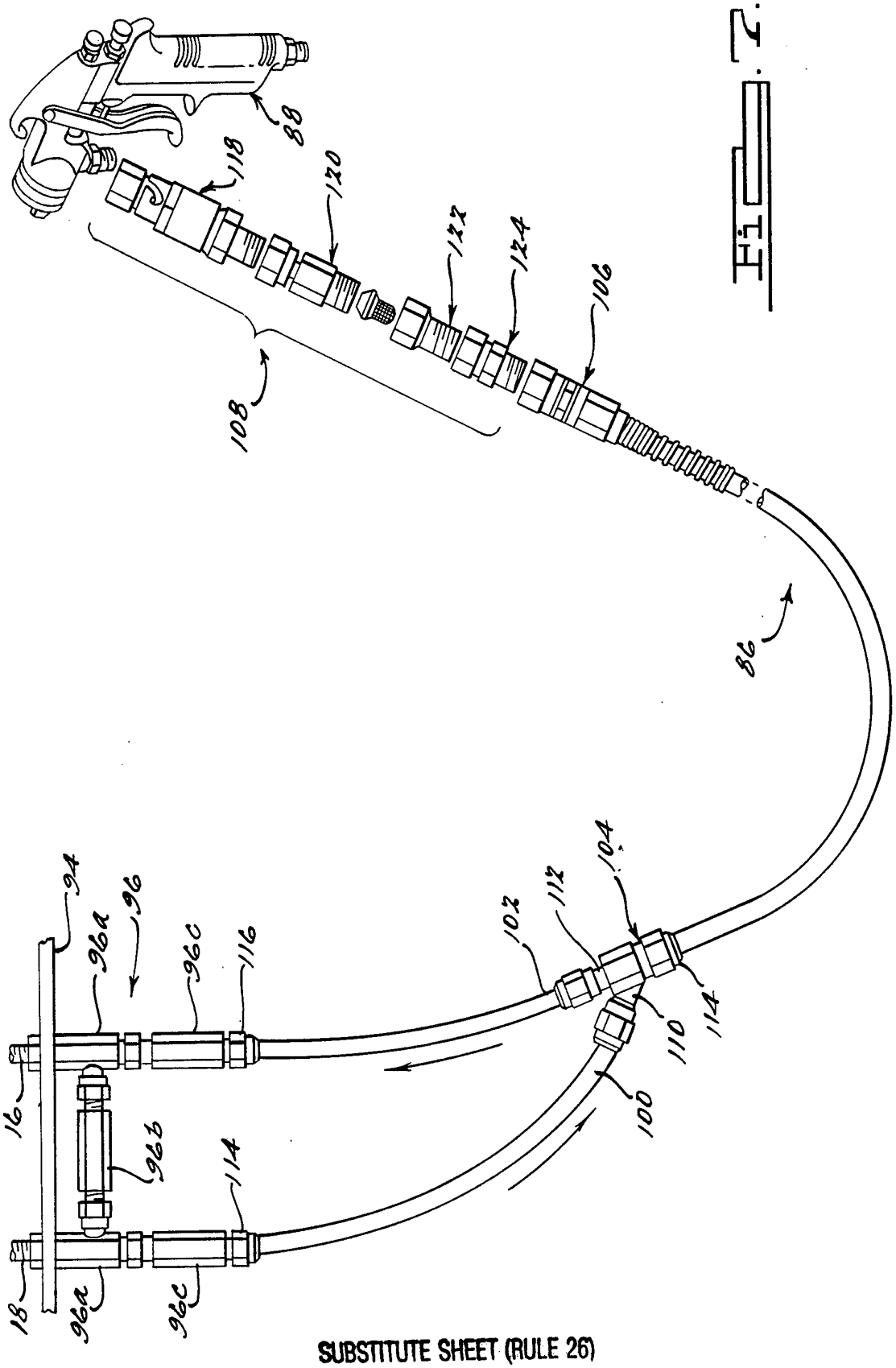
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FIG. 7.

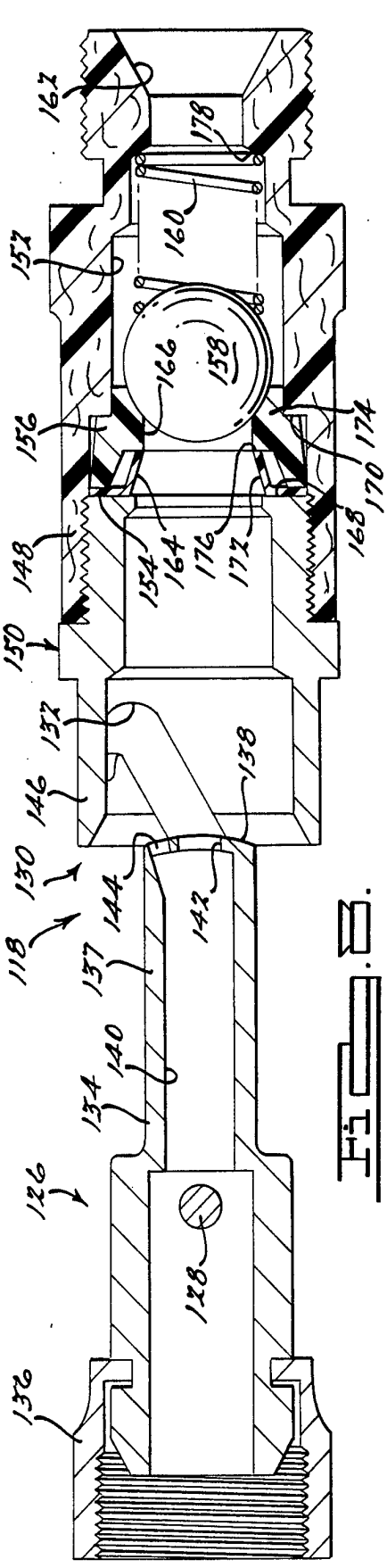

FIG. 8.

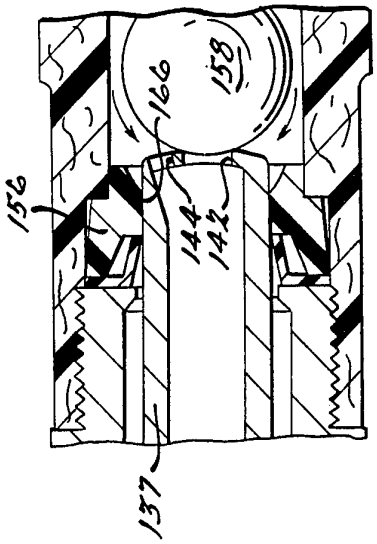

FIG. 9(C).

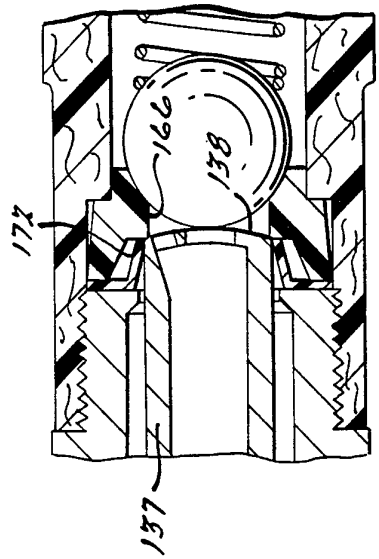

FIG. 9(B).

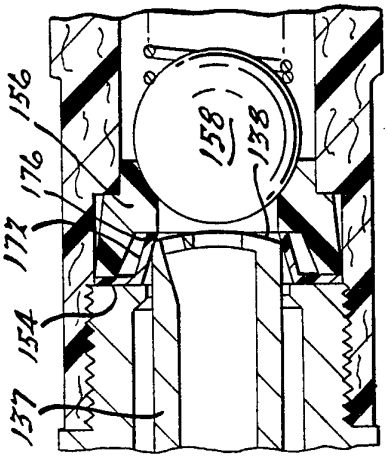

FIG. 9(A).

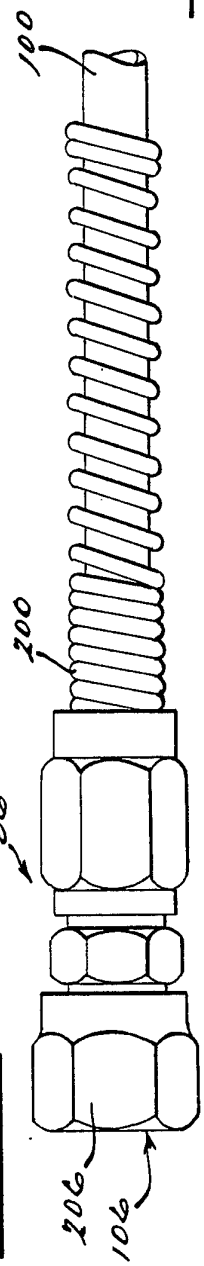

FIG. 13.

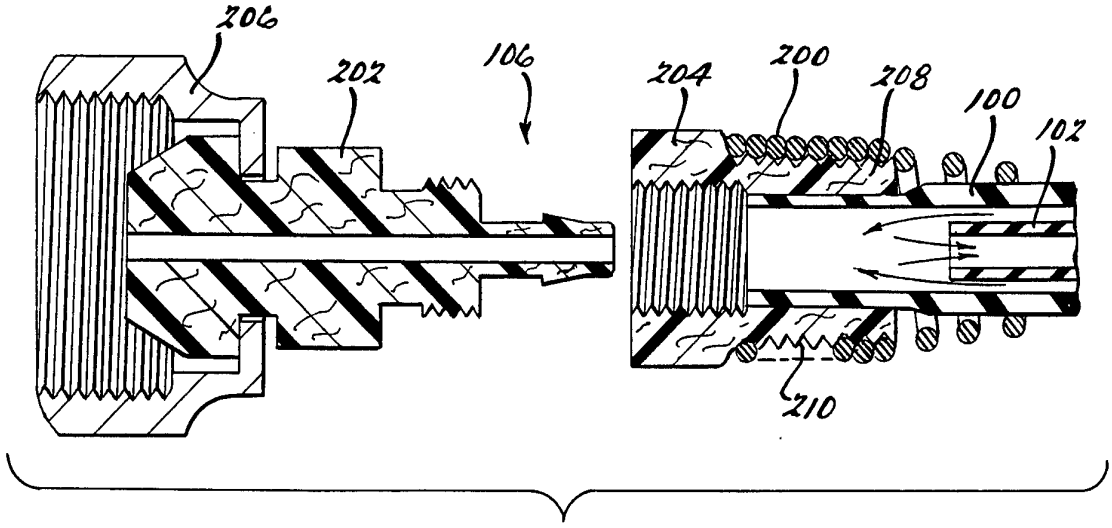
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Fig. 14.

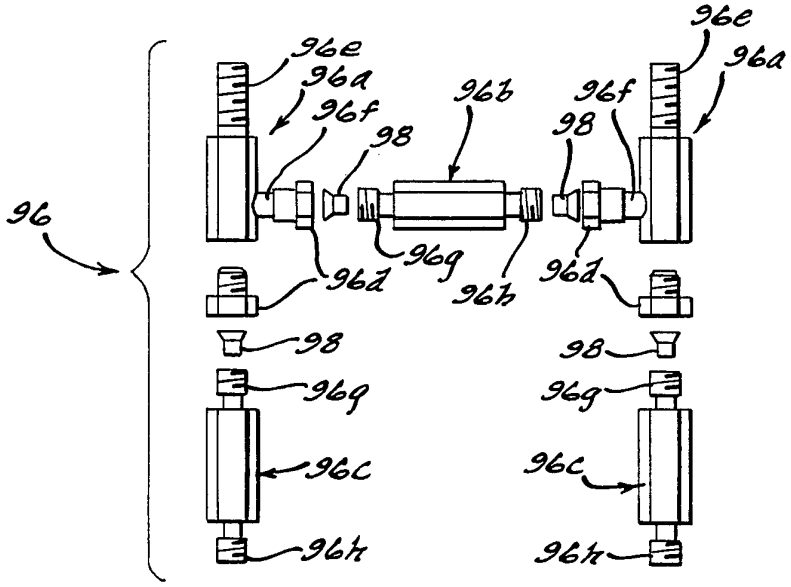
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Fig. 6.

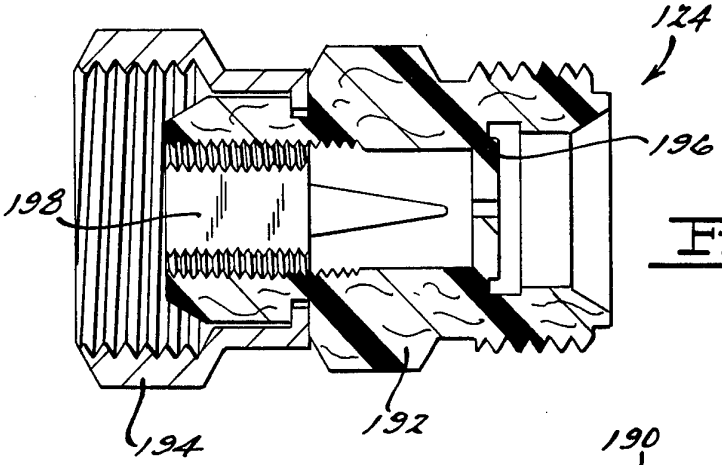


Fig. 12.

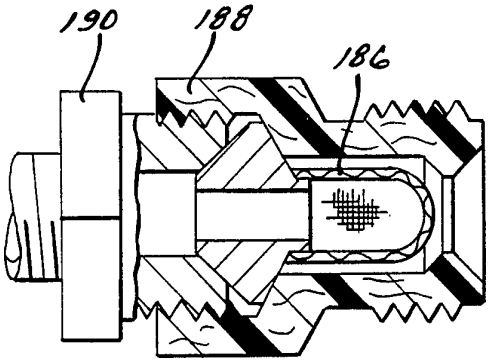
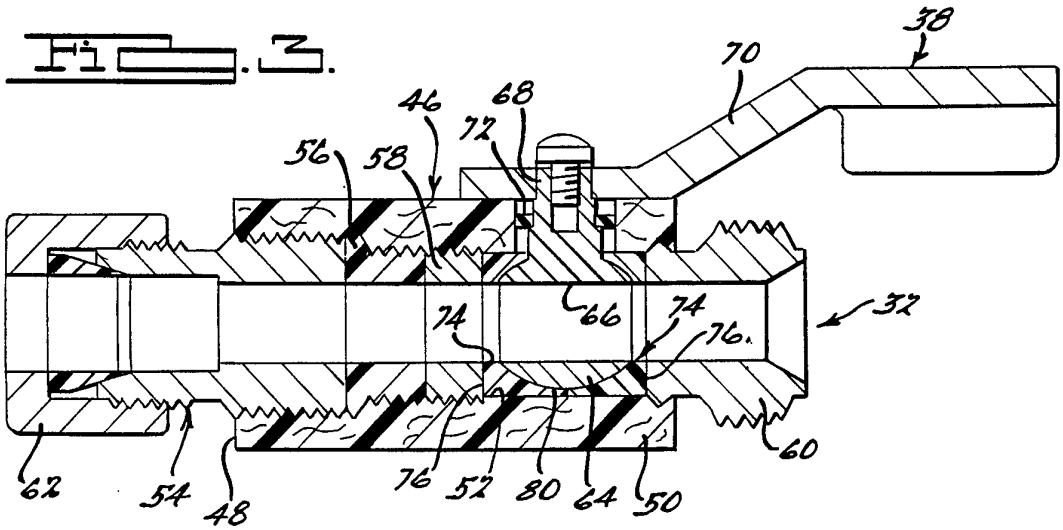


Fig. 11.

Fig. 3.



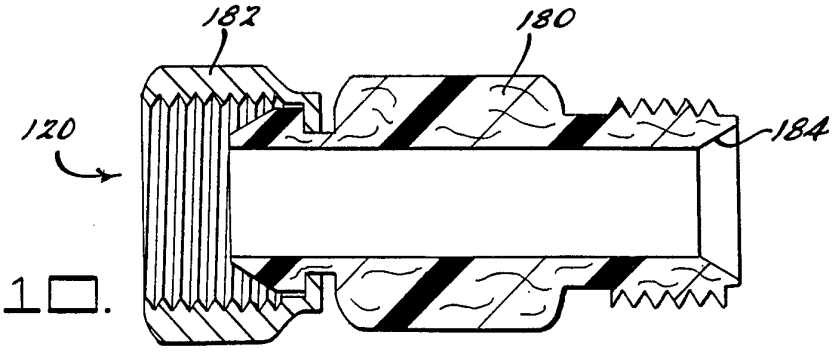


Fig. 10.

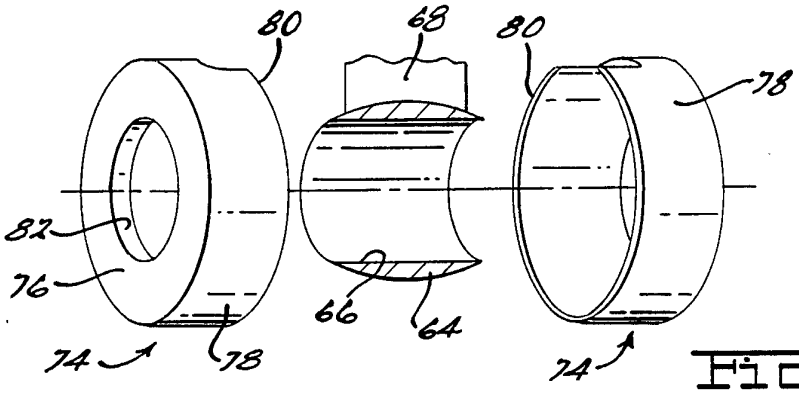


Fig. 14.

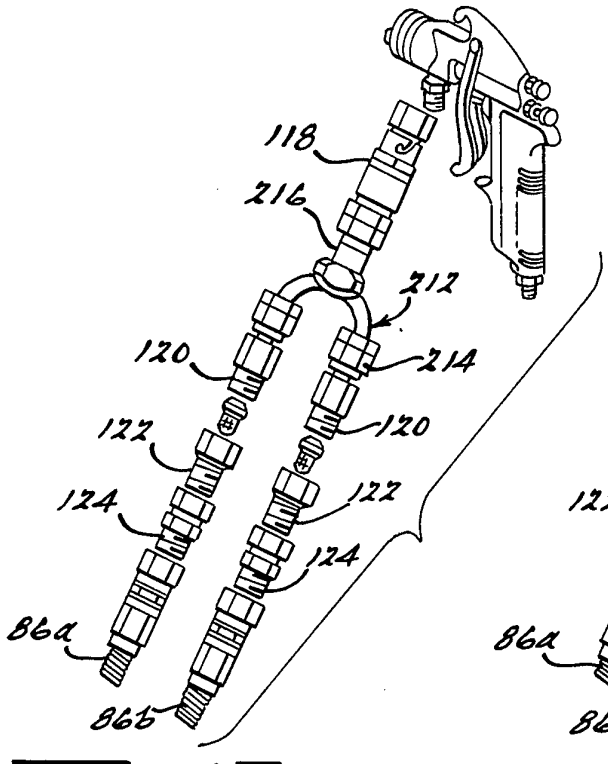


Fig. 17.

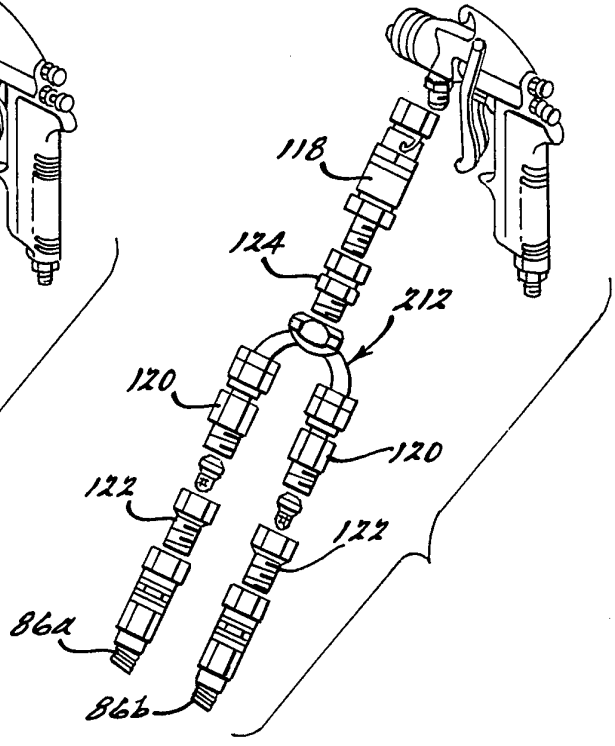


Fig. 16.

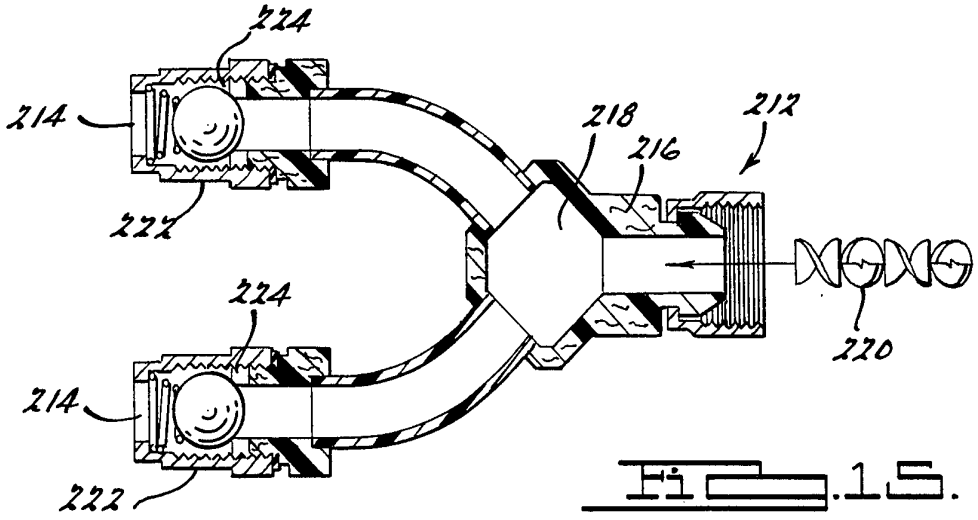


Fig. 15.

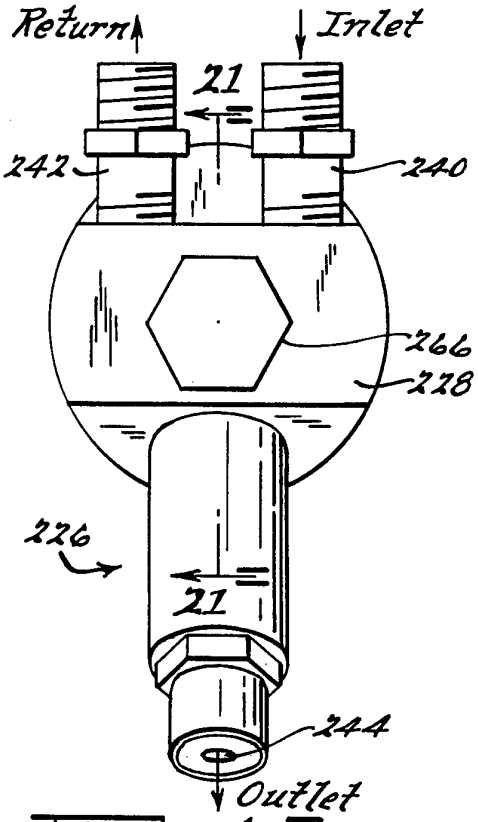


Fig. 19.

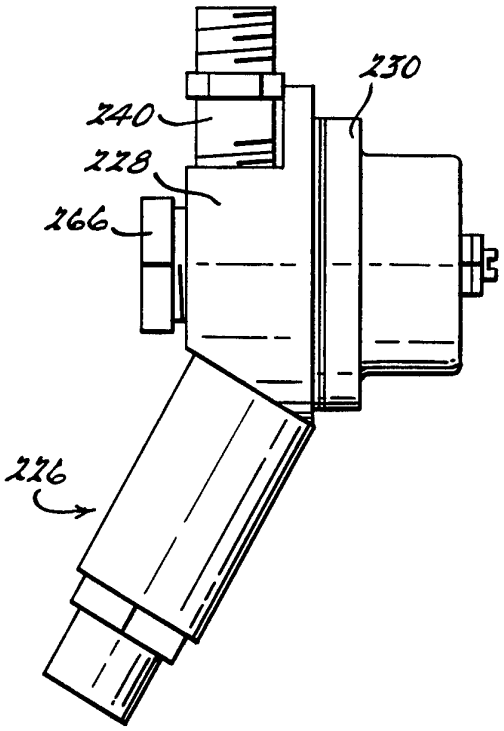


Fig. 18.

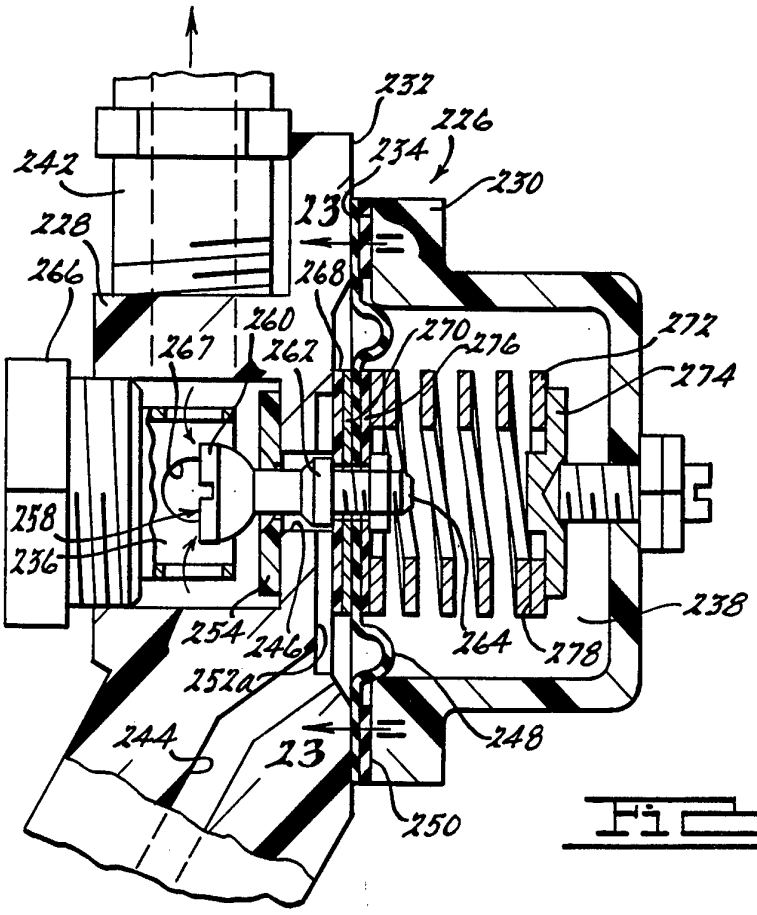


Fig. 20.

Fig. 2.3.

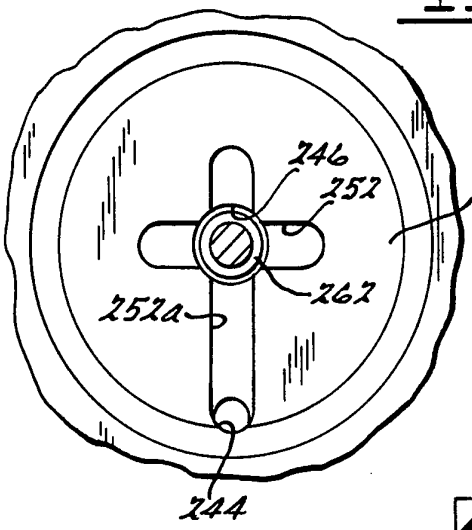
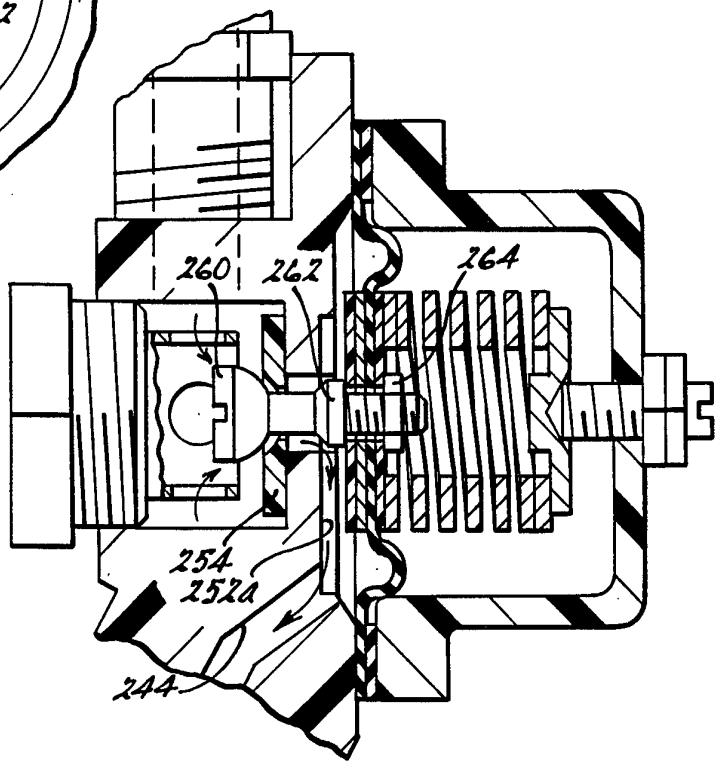


Fig. 2.1.



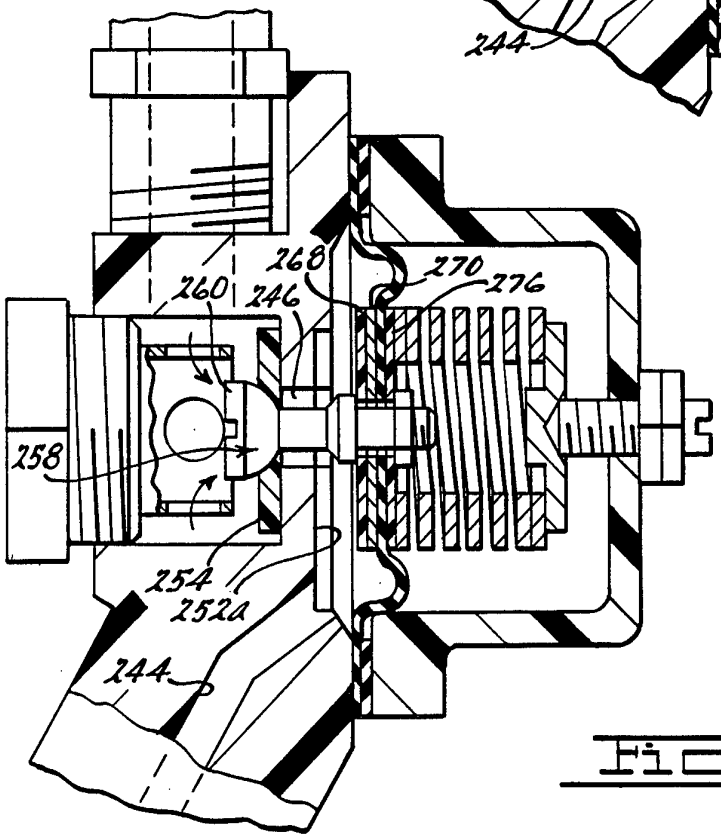


Fig. 2.2.

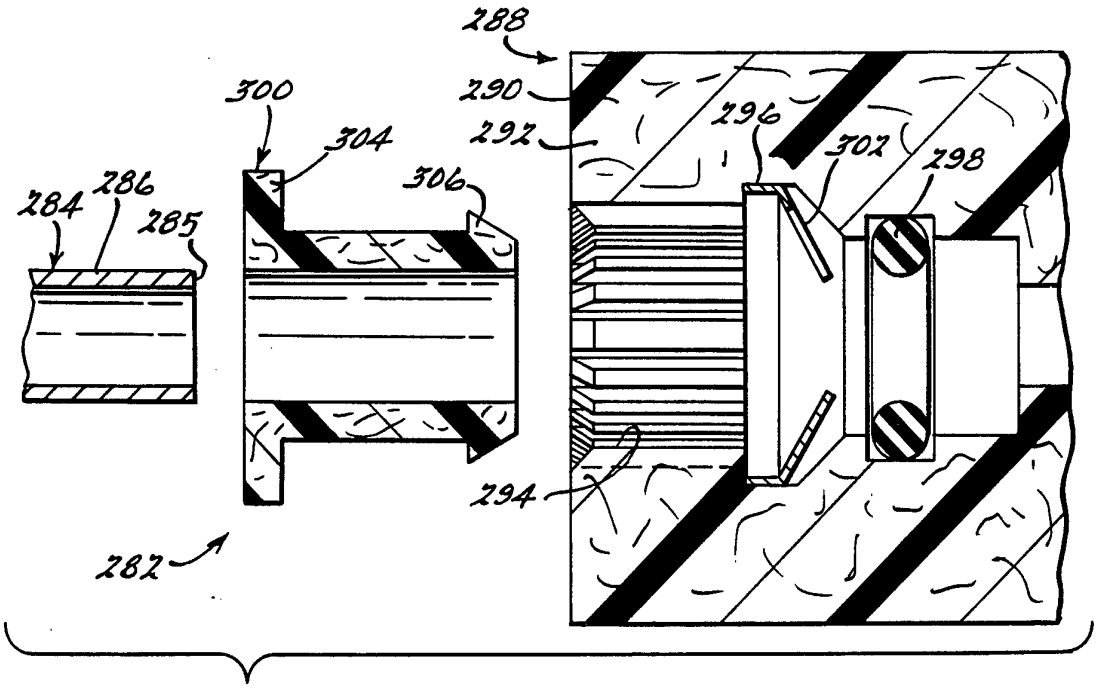


Fig. 24.

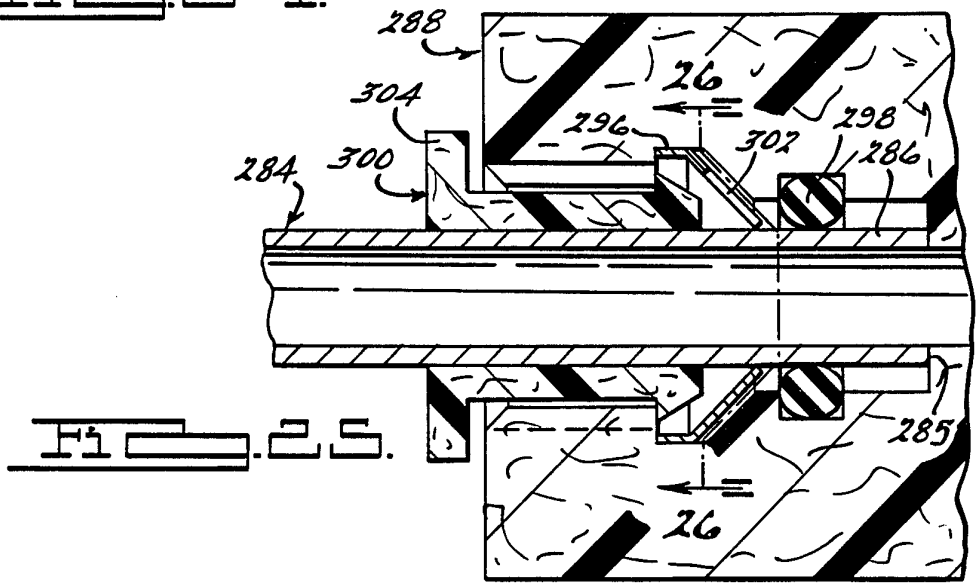


Fig. 25.

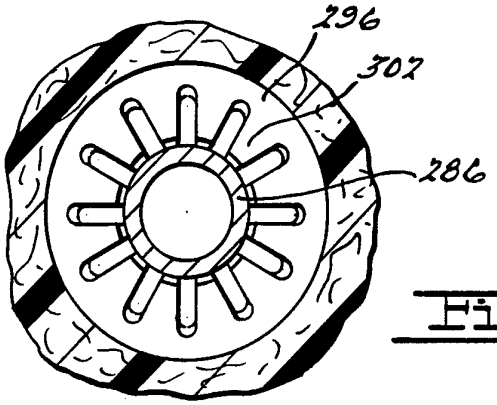


Fig. 26.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/13688

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :Please See Extra Sheet.
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,060,861 (HOLT) 29 October 1991, see entire document.	6-13, 20, 23-27, 44, 45, 54
Y	US, A, 4,114,853 (MEDVICK) 19 September 1978, see entire document.	6-13, 54
Y	US, A, 1,489,310 (CRITCHLOW) 08 April 1924, see entire document.	6-13, 54
Y	US, A, 2,513,081 (CLARK ET AL) 27 June 1950, see entire document.	14-22
Y	US, A, 4,760,956 (MANSFIELD) 02 August 1988, Figure 4, element 255.	14-22
Y	US, A, 3,606,170 (HOFFMAN ET AL.) 20 September 1971, Figure 5, element 56.	14-22

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 FEBRUARY 1995	07 MAR 1995

Name and mailing address of the ISA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	KAREN B. MERRITT
Facsimile No. (703) 305-3230	Telephone No. (703) 308-1113

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/13688

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,106,699 (HOLT) 15 August 1978, Figures 1 and 2.	14-22
X --- Y	US, A, 5,143,409 (LALIKOS) 01 September 1992, Figure 4.	39, 40, 42, 43, 46 --- 23-27, 41, 44, 45, 47
Y	US, A, 5,286,068 (WIEBE) 15 February 1994, Figure 2.	41, 44, 45, 47
X	US, A, 3,230,964 (DEBROTNIC ET AL.) 25 January 1966, see entire document.	28-30, 32, 33, 36, 37
X --- Y	US, A, 1,794,955 (GORDON) 03 March 1931, Figure 2.	50 --- 48, 49
X --- Y	US, A, 3,720,373 (LEVEY) 13 March 1973, Figures 5 and 3.	56-58 --- 48, 49
X	US, A, 4,573,498 (LUDWIG) 04 March 1986, column 1, line 58 - column 2, line 11, Figure 1.	51-53
X	US, A, 5,248,168 (CHICHESTER ET AL.) 28 September 1993, see entire document.	55
A	US, A, 5,195,680 (HOLT) 23 March 1993, see entire document.	1-5
A	US, A, 1,133,320 (ROCKWOOD) 30 March 1915, note G.	48-50
A	US, A, 3,083,725 (MOEN) 02 April 1963, note 12 and 13.	51-53
A	US, A, 4,979,765 (BARTHOLOMEW) 25 December 1990, Figures 1 and 2.	55

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/13688

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/13688

A. CLASSIFICATION OF SUBJECT MATTER:
IPC (6):

B05B 7/04, 9/01, 13/00; F16K 5/06; F16L 19/00, 29/02, 35/00, 37/12

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

239/124, 399, 533.1, 569, 587.1; 251/149.6, 315.01; 285/114, 332.2, 340; 137/599.1

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

239/124, 127, 304, 399, 419.3, 533.1, 569, 583, 587.1, 588; 251/149.6, 149.7, 315.01, 316; 285/114, 308, 319, 332.2, 340, 354; 137/599.1, 861

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING
This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-5, drawn to a recirculating paint supplying system and the arrangement of the fluid lines.
Group II, claims 6-13 and 54, drawn to a recirculating paint supplying system and the valved connection between a spray nozzle having flow enabling means and a conduit having flow preventing means.
Group III, claims 14-22, drawn to a paint system including a chamber for receiving two coatings.
Group IV, claims 23-27 and 39-47, drawn to a paint supply system of fluid conduit including strain protecting first connector means and swivel means.
Group V, claims 28-38 , drawn to a quick disconnect connector assembly.
Group VI, claims 48-50, drawn to a connector means and seal means.
Group VII, claims 51-53, drawn to a ball valve.
Group VIII, claim 55, drawn to a push to connect fluid coupling having a spring ring with spring tines.
Group IX, claims 56-58, drawn to a flow regulator used in a paint recirculatingsystem.

The inventions listed as Groups I-IX do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: The special technical feature of each of the above Groups (as mentioned in the above description of what the claims are drawn to) is unique to that group, not present in any other group, and thus unity of invention is lacking.