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(54) Fluid nozzle assemblies

(57) The invention relates to use of the Coanda effect in directing fluids such as may be used in cutting, spraying and welding tools, and so obviates the need for sophisticated complex mounting arrangements providing for 360 degree movement in three dimensions as are required by fully automated assembly plants. It achieves this by surrounding the outlet nozzle jet with two or more ducts (28) through which a secondary or auxiliary fluid can be delivered while the primary fluid is directed through the outlet nozzle jet. At the outlet end of each duct is provided a vane (32) that has a Coanda effect surface that can direct the flow of the secondary or auxiliary fluid around the surface and thereby direct the primary fluid in the same direction. Direction of the primary fluid can thereby be adjusted by varying the secondary fluid flow and by adjustment of the attitude of any vane (32).

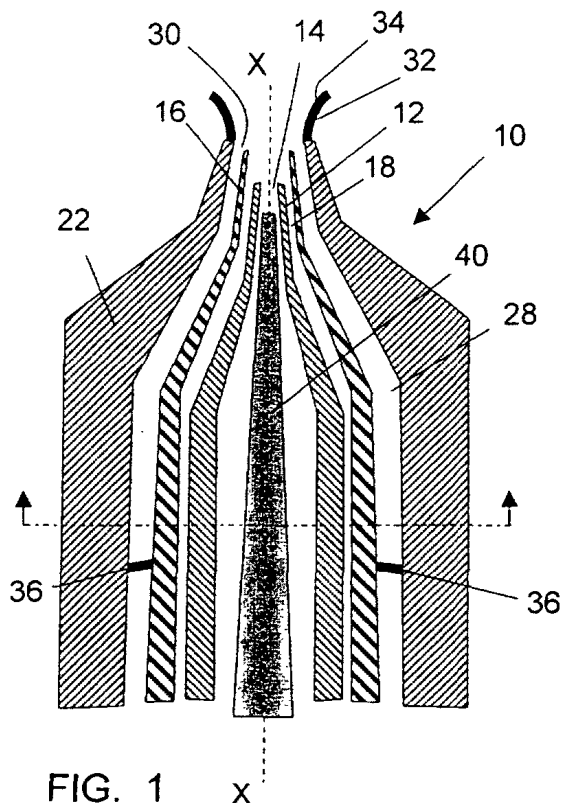


FIG. 1 X

Description

[0001] This invention is concerned with nozzle assemblies for use in directing fluids under high pressure and is especially though not exclusively concerned with such assemblies used in the industrial environment for the purposes of, for example, paint spraying, welding and cutting by the use of oxyacetylene, tools, plasma jet tools and the like, cutting by the use of super high pressure fluids, cleaning and like operations.

[0002] In modern automated systems such as may be used in assembly plants (e.g. vehicle, white goods and the like), the operations of welding, cutting and spray painting are commonly computer controlled on a totally automated assembly line. Each welding or cutting or painting tool is mounted on complex armature arrangements which enable the ultimate nozzle head to be manipulated to whatever position and attitude is required of it to carry out its appropriate function. Movement of each armature needs to be controlled to achieve this.

[0003] A typical vehicle body part, for example, needs to be shaped before it can be welded to other components, and the resultant structure cleaned at each stage as necessary.

[0004] At each stage of the assembly, the welding and cleaning tools need to be computer controlled in order to ensure that the surfaces are properly prepared prior to entry into the paint stage.

[0005] Subsequent to assembly, body parts are then required to be degreased, treated with anti-corrosion coating and then given final paint coatings, all of which require precise computer control of the various welding, cleaning, spraying and painting tools of a fully automated production line to achieve the desired result.

[0006] It is an object of the present invention to reduce the complexity of these systems.

[0007] In addition, high pressure fluid is also used as a cutting/etching medium and for removing unwanted coatings or other materials from surfaces, and in both such uses, a nozzle assembly is required to be physically moved in order to cut or clean as the case may be. In both instances, in the industrial environment, precise positioning of the nozzle assembly is again required and usually by computer controlled arrangements.

[0008] The present invention seeks to simplify these systems by providing a nozzle assembly that itself can direct fluid in a desired direction thereby at least reducing the complexity of current fluid delivery systems.

[0009] The present invention provides in one aspect, a fluid directing nozzle assembly comprising a nozzle head or member having an outlet through which a first fluid under pressure is directed in use, a sleeve surrounding said nozzle and defining therewith an annular conduit, spacer elements supporting the sleeve in spaced relationship to the nozzle outlet, and the conduit providing a plurality of separated ducts each having an outlet adjacent the outlet of the nozzle, each duct having a vane associated therewith, each vane being movably mounted on the sleeve and having a Coanda effect surface which is curved outwardly from the direction of said first fluid under pressure issuing from the nozzle outlet, the nozzle member being couplable to a source of said first under pressure and each duct being couplable to a, second, source of fluid under greater pressure than the fluid to be directed through the nozzle outlet.

[0010] In a nozzle assembly according to the present invention, there may be as many or as few ducts as are required to control both the accuracy and the rate of delivery of fluid through the nozzle. Thus, if all that is required of the nozzle assembly is that fluid is directed in one or other of the four possible orthogonal directions, which may be characterised as up, down, left and right, then only four ducts will be required. On the other hand, if linear movement of the fluid, as with a high pressure cutting tool, is all that is required, then it may be sufficient to provide a pair of opposed ducts that can be used to direct the fluid along a single linear path. Other arrangements of ducts can be determined depending upon the degree of accuracy required.

[0011] Each vane is preferably pivotably mounted on the sleeve so that its influence can be varied to adjust the angle at which fluid can be directed from the nozzle. In a further embodiment of the invention, it is also foreseen that each vane is flexible and has a contour that can be varied to change the shape of its Coanda effect surface.

[0012] The present invention further provides in another aspect, a system for directing fluid onto a surface, the system comprising a fluid directing nozzle assembly according to the present invention, a first source of fluid under pressure coupled to the nozzle outlet, a second source of fluid under pressure coupled to said plurality of separated ducts, the second source being arranged to deliver fluid through said ducts at a greater velocity than fluid delivered through the nozzle outlet whereby fluid directed through the ducts experiences a Coanda effect as it exits the ducts to control directing of fluid issuing from the nozzle outlet.

[0013] The nozzle assembly may be adapted to deliver a gaseous fluid through the nozzle outlet, as in the case of the use of the nozzle assembly in for example an oxyacetylene cutting or welding system, where the gas is a mixture of oxygen and acetylene, and the system comprises means for controlling the relative amounts of oxygen and acetylene delivered to the nozzle outlet and the rate of delivery of one or both gases. As a further alternative, a nozzle assembly according to the present invention may be used to direct a plasma jet for the purpose of cutting or welding.

[0014] Alternatively, the nozzle assembly is adapted to deliver a mixture of paint and carrier gas or water under pressure.

[0015] Where the system is intended for use as a cleaning or fluid cutting system, the nozzle assembly may be adapted to deliver water under pressure, and, in the case of a fluid cutting system wherein the cutting fluid, typically oil or water, may be delivered at pressures of 300MPa or greater. In the case of cleaning applications, the nozzle assembly may be

adapted to deliver a mixture of water under pressure and a detergent fluid medium.

[0016] In a system according to the invention the nozzle assembly is preferably mounted to be pivotable on a movable arm such that the nozzle assembly can be moved across a surface to be treated. The movement of any movable arm and of any vane would of course be computer controlled in an automated system. However, the provision of a nozzle assembly according to the present invention would allow for a wider range of coverage of a paint spraying from a single position of the nozzle assembly without the necessity of moving the nozzle assembly itself. Consequently, the mounting the nozzle assembly and therefore of the system can be simplified.

[0017] The present invention further provides in another aspect, a method of delivering a, first, fluid under pressure at a target surface, the method comprising directing the, first, fluid under pressure at the target surface from an outlet nozzle and, as required, directing a second fluid from a second outlet closely adjacent said outlet nozzle alongside the first fluid under pressure, said second outlet being formed as a plurality of ducts around the outlet nozzle and having a vane providing a Coanda effect surface mounted on the outlet of each respective duct to deflect second fluid exiting through a duct away from direction of first fluid exiting from the outlet nozzle and thereby induce first fluid exiting from the outlet nozzle to be deflected in the same direction as the second fluid exiting from the duct, the second fluid, on exit from a duct, being at a greater velocity than the first fluid exiting from the nozzle outlet.

[0018] In carrying out a method according to one embodiment, the first fluid may, as stated above, be a gaseous fluid medium, such as an oxy-acetylene mixture or a plasma jet with the second fluid being air, or, in a second, paint spraying embodiment of the invention, the first fluid is a sprayable paint and the second fluid is air.

[0019] There now follows a detailed description which is to be read with reference to the accompanying drawing of two embodiments of nozzle assemblies according to the present invention, for use in systems according to the present invention and for carrying out methods according to the present invention.

[0020] In the accompanying drawings:

Figure 1 is a diagrammatic exaggerated cross-section of a nozzle assembly which can be used for spraying a mixture of fluids (e.g. paint) onto a surface;

Figure 2 is an end view of the nozzle assembly shown in Figure 1;

Figure 3 is a cross-sectional view taken on the line A - A of Figure 1; and

Figure 4 is a diagrammatic exaggerated illustration of a nozzle assembly which can be used for controlling the direction of water under pressure.

[0021] Referring to Figure 1, the nozzle assembly shown therein generally at 10 is specifically described hereinafter as suitable for use in paint spraying, as an example of directing a fluid medium which has two constituents. It may equally well be useful in principle, and with appropriate modifications to the design, dimensions and materials employed in manufacture of the nozzle assembly, for directing a mixture of gases, such as oxygen and acetylene, as would be used in an oxy-acetylene welding tool or an oxy-acetylene cutting tool.

[0022] The nozzle assembly 10 has a general axis of symmetry X - X and comprises a nozzle member 12 providing an outlet 14 through which fluidised paint under pressure can be pumped from a source thereof under pressure at a target surface when the spraying system of which the nozzle assembly forms a part is in use. The nozzle member is surrounded by a sleeve 16 and defines therewith an annular conduit 18. Spacer elements 20 (Figure 3) support the sleeve in spaced relationship to the nozzle outlet, and sufficiently removed from the nozzle outlet 14 that they have no effect on the flow through the conduit 18. Surrounding the sleeve 16 is an, outer, housing 22 which is spaced from the sleeve by partition walls 24 (Figure 3) which extend along the annular passage 26 defined between the sleeve 16 and the housing. The partition walls 24 extend the length of the housing and sleeve and divide the passage 26 into a plurality of separated ducts 28 each having an outlet 30 adjacent the outlet of the nozzle. In the embodiment shown in Figures 1 to 3, four such ducts are shown though it will be appreciated that in practice and depending upon the intended function of the nozzle assembly, there may be as few as a pair of opposed ducts though for 360 degree control of direction, as described below, a minimum of three ducts is required. If greater control of direction is needed, then more than four ducts can be provided. Each duct has a vane 32 associated therewith, each vane 32 being pivotably and movably mounted on the outer housing 22 and having a Coanda effect surface 34 which is curved outwardly from the direction of said first fluid under pressure issuing from the nozzle outlet 14. The vanes 32 are connected to and controlled by remote means (not shown) which can vary the angle of each vane relative to the direction of flow of fluid through the nozzle assembly. In of for an assembly plant or production line such as a white goods or vehicle assembly line, the remote means will be computer controlled. The nozzle assembly is couplable to a supply of a first component of the first fluid (e.g. paint) to be delivered under pressure to the nozzle outlet 14 while the conduit 18 is couplable to a supply of a second component of the first fluid (e.g. air or water under pressure). The two components are admixed immediately

downstream of the nozzle outlet 14 as is well known.

[0023] The function of the ducts 28 is to permit air under pressure to flow therethrough to influence the direction of the fluid mixture emanating from the nozzle assembly. To this end, the supply of air through one or more of the ducts 28 is under greater pressure than the fluid mixture so that it exhausts from the or each duct 28 at a greater velocity than the fluid mixture from the nozzle assembly.

[0024] We have found by experiment that it is possible to influence the direction of a primary fluid flow by generating a secondary flow of fluid between the primary fluid flow and a Coanda effect surface, where the secondary fluid flow is caused to have a higher velocity than that of the primary fluid flow.

[0025] In all aspects of the present invention, we have also determined from experiment that a number of curvatures can be adopted for the Coanda surface but that an optimum curvature for the Coanda surface is that of a section of a logarithmic spiral, which has a polar equation given by

$$r = ae^{b\theta}$$

or by the cartesian co-ordinates

$$x = r \cos \theta = a \cos \theta e^{b\theta}$$

$$y = r \sin \theta = a \sin \theta e^{b\theta}$$

where r is the radius of the curve and a and b are constants.

[0026] In carrying out experiments, we have also determined that it is possible to effect a 30 degree vectoring of the primary fluid flow when the ratio of pressure of the secondary flow to that of the primary flow is between about 1.6 and 2.0.

[0027] To control fluid flow through the ducts, gates 36 can be provided in the ducts 28, the position of the gates being remotely controllable between a first position in which the associated duct 28 is fully open and a second position in which the duct is fully closed. By adjusting the position of any gate, it is possible to control both the pressure and the rate of flow of the secondary flow.

[0028] By way of explanation, and referring to Figure 1, a supply of paint can be considered as being delivered via the nozzle outlet 14 and admixed with air under pressure delivered via the conduit 18. If then, a supply of air under pressure is coupled via the left hand duct 28, with the gate 36 fully open, that air supply, providing a secondary flow, is entrained by the Coanda effect to follow the curvature of the surface 34 of the associated vane 32 and is directed upwardly and to the left viewing Figure 1. The resultant pressure gradient caused by this deflection then causes the fluid mixture from the outlet 14 and conduit 18 also to be deflected in the same direction as the secondary fluid.

[0029] By varying the pressure of the air delivered via the duct 28, the angle of deflection of the main fluid flow through the main outlet can be varied without moving the nozzle assembly. In consequence, it is possible to employ a nozzle assembly according to the present invention for spraying curved surfaces where previously it would have been necessary to physically move the nozzle assembly.

[0030] The quantity of paint delivered through the outlet 14 can also be varied by positioning a needle valve member 40 in the outlet 14, the needle valve member being of varying thickness so that it can be moved along the axis X - X to restrict the outlet 14.

[0031] Where a nozzle assembly similar to that described with reference to Figures 1 to 3 is used as the cutting or welding tip of an oxyacetylene tool or a plasma jet, it will be appreciated that the position of the cutting or welding tip of the flame or jet can be similarly varied by ducting air through one or other of the ducts 28.

[0032] Referring now to Figure 4, there is shown therein a nozzle assembly according to the present invention which is designed for directing a single fluid, such as water, under pressure. This assembly is similar to that of Figures 1 to 3 except that it excludes the conduit 18.

[0033] In carrying out a method according to the invention, water under pressure, which for a water jet cutting tool may be a very high pressure, is conventionally ejected through a nozzle outlet 50 of a nozzle member 52, similar to outlet 14 of nozzle member 12 of Figure 1. The nozzle member 52 is coaxial with an outer housing 54 which is mounted in spaced relationship to the nozzle member 52 by a plurality of partitions (not shown) similar to the partitions 24 of the embodiment of Figure 1. A plurality of vanes 56 is mounted on the outlet end of the housing 54 and these are adjustable in the same manner as those described with reference to the embodiment of Figures 1 to 3, and will therefore not be

further described. Each of the ducts is also provided with a gate 58 for varying and controlling flow of water/air as the case may be through that duct to control the direction of the primary fluid flow through the nozzle outlet 50.

5 Claims

1. A fluid directing nozzle assembly comprising a nozzle member having an outlet through which a first fluid under pressure is directed in use, a sleeve surrounding said nozzle and defining therewith an annular conduit, spacers elements supporting the sleeve in spaced relationship to the nozzle outlet, and the conduit providing a plurality of separated ducts each having an outlet adjacent the outlet of the nozzle, each duct having a vane associated therewith, each vane being movably mounted on the sleeve and having a Coanda effect surface which is curved outwardly from the direction of said first fluid under pressure issuing from the nozzle outlet, the nozzle member being couplable to a source of said first under pressure and each duct being couplable to a, second, source of fluid under greater pressure than the fluid to be directed through the nozzle outlet.
2. A nozzle assembly according to claim 1 wherein each vane is flexible and has a contour that can be varied to change the shape of its Coanda effect surface.
3. A system for directing fluid onto a surface, the system comprising a fluid directing nozzle assembly according to claim 1 or claim 2, a first source of fluid under pressure coupled to the nozzle outlet, a second source of fluid under pressure coupled to said plurality of separated ducts, the second source being arranged to deliver fluid through said ducts at a greater velocity than fluid delivered through the nozzle outlet whereby fluid directed through the ducts experiences a Coanda effect as it exits the ducts to control directing of fluid issuing from the nozzle outlet.
4. A system according to claim 3 wherein each vane is independently movable to vary the effect on fluid from the second source flowing over the Coanda effect surface and thereby vary the direction at which fluid issuing from the nozzle outlet can be directed.
5. A system according to claim 3 or claim 4 wherein the fluid is a mixture of oxygen and acetylene, and the system comprises means for controlling the relative amounts of oxygen and acetylene delivered to the nozzle outlet and the rate of delivery of one or both gases.
6. A system according to claim 3 or claim 4 wherein the nozzle assembly is adapted to deliver a mixture of paint and carrier gas under pressure.
7. A system according to claim 3 or claim 4 wherein the nozzle assembly is adapted to deliver a mixture of paint and water under pressure.
8. A system according to claim 3 or claim 4 wherein the nozzle assembly is adapted to deliver water under pressure.
9. A system according to any one of claims 5 to 8 wherein the nozzle assembly is mounted to be pivotable on a movable arm such that the nozzle assembly can be moved across a surface to be treated.
10. A method of delivering a, first, fluid under pressure at a target surface, the method comprising directing the, first, fluid under pressure at the target surface from an outlet nozzle and, as required, directing a second fluid from a second outlet closely adjacent said outlet nozzle alongside the first fluid under pressure, said second outlet being formed as a plurality of ducts around the outlet nozzle and having a vane providing a Coanda effect surface mounted on the outlet of each respective duct to deflect second fluid exiting through a duct away from direction of first fluid exiting from the outlet nozzle and thereby induce first fluid exiting from the outlet nozzle to be deflected in the same direction as the second fluid exiting from the duct, the second fluid, on exit from a duct, being at a greater velocity than the first fluid exiting from the nozzle outlet.

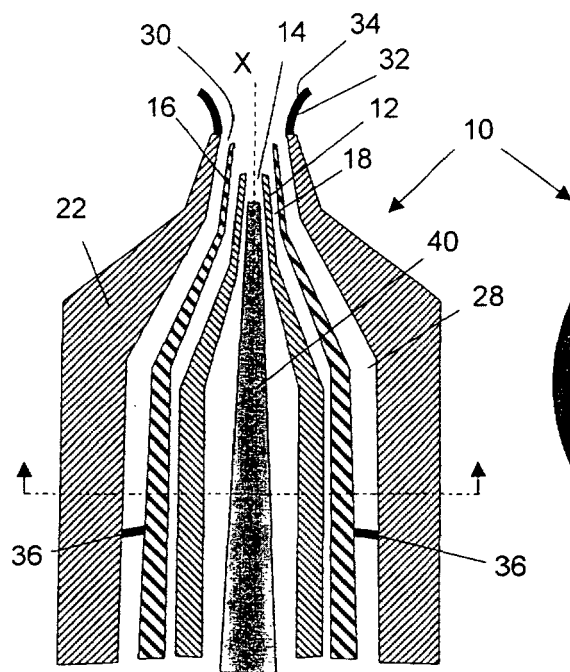


FIG. 1

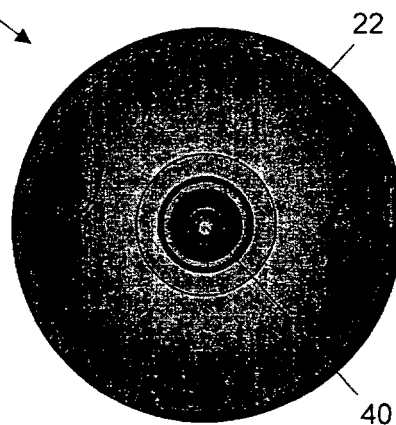


FIG. 2

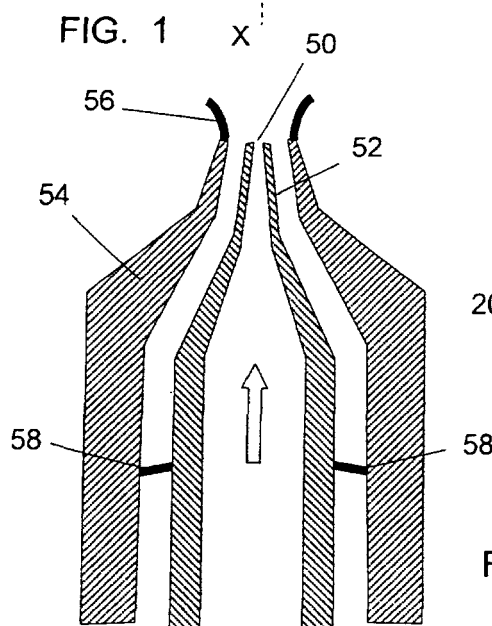


FIG. 4

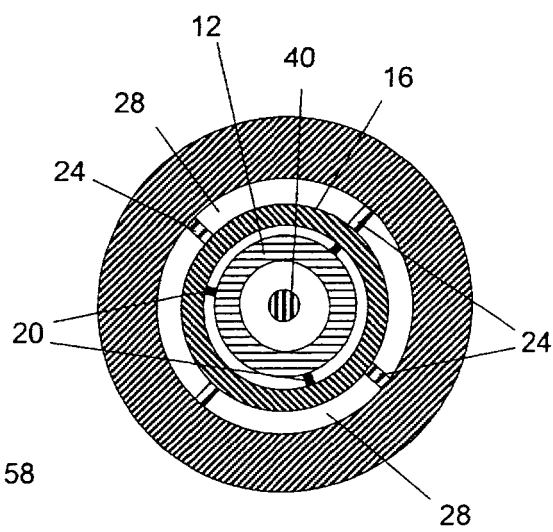


FIG. 3



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 27 0005

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 2 613 995 A (REINHOLD CHARLES) 14 October 1952 (1952-10-14) * column 4, line 62 - column 5, line 4; figures 3,4 *	1	B05B7/06 B05B7/08
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A	DE 24 21 401 A1 (J.H. BENECKE GMBH, 3001 VINNHORST; J.H. BENECKE GMBH, 3000 HANNOVER; J) 13 November 1975 (1975-11-13) * page 2, line 3 - line 15; figures 1a,1b *	1,10	
A	DATABASE WPI Section PQ, Week 198335 Derwent Publications Ltd., London, GB; Class Q49, AN 1983-751682 XP002342991 & SU 968 296 A (KHARK AVIATION INST) 23 October 1982 (1982-10-23) * abstract *	10	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B05B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 1 September 2005	Examiner Brévier, F
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 27 0005

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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01-09-2005

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