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(54) A method of cleaning industrial components and a jet assembly for use therein.

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Description

This invention relates to cleaning industrial components.

US—A—1573424 and UK—A—2006913 disclose industrial component washing machines in which high kinetic energy jets of cleaning fluid having a selected pattern and orientation are each directed at a corresponding selected portion of a component to be cleaned by a respective jet nozzle which is located with precision.

The use of robots to support and locate jet nozzles used in washing of industrial components has been proposed. In accordance with such proposals, jet assemblies selected from a series of different gripper-held jet assemblies would be used. Each assembly would contain a dedicated jet nozzle designed for a specific type of washing. For example there would be a jet nozzle designed to form the so-called pinpoint jet of washing fluid, that is to say a jet of fluid which has a substantially uniform cross-section throughout its length, for washing blind tapped holes and small oil galleries in engine blocks. Also there would be jet nozzles which form a hollow cone of washing fluid and jet nozzles which form a solid cone of washing fluid for general surface cleaning. Other jet nozzles which form jets of compressed air for drying would also be provided. The robot would be programmed to select the jet assembly to be used, to transport the selected jet assembly to the washing location, to control it for the washing step, and then to return it to the storage location prior to selecting another jet nozzle for another washing or drying step. A considerable amount of the wash cycle time was lost in the changeover operations. A proposal to minimise this loss of time by arranging a number of jet assemblies as a group or cluster carried by a single robot was found to be less satisfactory than expected because of the complex form of the group or cluster and the danger of impact of parts of it with the engine block or other component being washed.

JP—A—58-98154 discloses alteration of the width of a paint spray pattern automatically in correspondence with the shape of an object to be painted by a spray gun carried by a robot, but paint spray apparatus is designed to form a mist of atomised paint which has low kinetic energy and is not suitable for forming a high energy jet of fluid such as is needed for cleaning. GB—A—2001262 discloses a jet nozzle which may be used to form such a low kinetic energy mist of atomised fluid. Although the pattern of the jet can be altered, it cannot be used to form a high kinetic energy hollow cone of fluid because the fluid enters the nozzle chamber in a circumferential direction to form the vortex and without an axial directional component. Also the fluid expands as it enters the chamber so that its speed falls.

According to one aspect of this invention there is provided a method of cleaning industrial components as defined by Claim 1. Claims 2 to 9 refer to preferred features of the method defined by Claim 1.

According to another aspect of this invention there is provided a jet assembly which is suitable for use in the foregoing method and which is defined by Claim 10. Claims 11 to 18 refer to preferred features of the jet assembly defined by Claim 10.

Examples of apparatus in which the present invention is embodied will now be described with reference to the accompanying drawings, of which:—

Figure 1 is a schematic diagram of apparatus for controlling operation of a jet assembly in which this invention is embodied, the jet assembly being shown in cross-section;

Figure 2 is a fragment of the nozzle of the jet assembly shown in Figure 1 illustrating its operation to form a hollow cone;

Figure 3 is a view similar to Figure 2 illustrating operation of the jet assembly to form a pinpoint jet of fluid;

Figure 4 is a view similar to Figures 2 and 3 illustrating operation of the jet assembly to form a full cone of washing fluid;

Figure 5 is a view in perspective of an industrial parts washing machine in which the present invention is embodied;

Figure 6 is a perspective view of robot apparatus incorporated in the machine shown in Figure 5;

Figure 7 is a view in perspective illustrating operation of the robot supported jet assembly shown in Figure 6 to form a pinpoint jet of washing liquid and direct that pinpoint jet at a preselected portion of an industrial component to be cleaned;

Figure 8 is a view similar to Figure 7 but illustrates operation of the jet assembly to form and direct a cone of washing fluid at a respective portion of the component;

Figure 9 is an elevation of another form of jet assembly including a pair of jet nozzles similar to that shown in Figures 2 to 8; and

Figure 10 is a view in perspective of an industrial parts processing installation in which this invention is embodied.

Figure 1 shows a jet assembly 10 comprising a manifold block 11 from which a nozzle 12 projects and to which two hoses 13 and 14 are connected. The nozzle 12 comprises a tubular body having a bore which reduces in diameter in three steps adjacent its end remote from the manifold 11. An annular swirl plate 15 is spigotted into the larger intermediate diameter bore portion 16. The central aperture 17 of the annular swirl plate 15 has a diameter which is smaller than the diameter of the smallest diameter bore portion 18 which forms an opening at the outer end of the nozzle 12. The smaller intermediate diameter bore portion 19 forms a chamber 21 between the swirl plate 15 and the opening 18, the annular end wall of the chamber 21 adjacent the opening 18 tapering towards the opening 18. One end of a tube 22 is spigotted into the central aperture 17 of the annular swirl plate 15. The tube 22 extends through the tubular body of the nozzle 12 and its other end is spigotted into a bore 23 in the manifold block 11. The bore 23 leads to a union 24 to which the hose 14 is connected.

The tube 22 comprises an inner conduit which communicates with the chamber 21. The major part of the tubular body of the nozzle 12, which forms the largest diameter bore portion 25, comprises an outer conduit which surrounds the tube 22 and cooperates therewith to form an annular passage leading around the tube 22 from a passage 26 in the manifold block 11 to the chamber 21, communication between the annular passage and the chamber 21 passed the swirl plate 15 being via spiral passages formed by four helical grooves in the outer cylindrical surface of the swirl plate 15 and the adjacent portions of the bore portion 16. The passage 26 is connected to the hose 13 via a union 27.

Each hose 13, 14 is provided with a flow control valve 20 and with a solenoid shut-off valve 30. The hoses 13 and 14 are connected in parallel to an output of a pump 36 which is a source of washing fluid under pressure. A pressure regulator 37 in each hose 13, 14 between the pump 36 and the respective shut-off valve 30 regulates the pressure upstream of that shut-off valve 30 such that the pressure upstream of the valve 30 in the hose 14 is higher than that upstream of the valve 30 in the hose 13. A supply of compressed air having its own shut-off valve 38 and pressure regulating valve 39 is connected to the hose 14 between the shut-off valve 30 in the hose 14 and the union 24.

Figure 2 shows that the nozzle 12 forms a hollow cone spray when washing fluid is supplied through the annular passage and the spiral passages formed by the swirl plate 15 to the chamber 21, the shut-off valve in the hose 14 being closed so that no fluid is supplied via the tube 22. Flow through the spiral passages imparts a spinning action to the fluid so that it enters the chamber 21 with such a spinning action and with an axial directional component and forms a vortex in the chamber 21 which causes formation of the hollow cone.

Figure 3 shows that a pinpoint jet of washing fluid is formed when washing fluid is supplied to the opening via the tube 22 only, the shut-off valve in the hose 13 being closed so that no washing fluid is supplied by the annular passage and the spiral passages to the chamber 21.

Figure 4 shows that a full cone is formed when washing fluid is supplied by both the tube 22 and the annular passage and the spiral passages to the chamber 21, the two supplies of washing fluid interacting in the chamber 21 to form the full cone. As can be seen from the drawing, the spinning flow that emerges from the spiral passages into the chamber 21 with an axial directional component, spins around the substantially uniform cross-section stream that emerges from the tube 22 in an area of the chamber 21 which has substantially the same cross-sectional area of the four spiral passages. Hence the flow emerges from the spiral passages into the chamber 21 without significant loss in kinetic energy (this is the case also when a hollow cone spray pattern is formed as illustrated in Figure 2). It is necessary to regulate the flows through the two paths by adjustment of the respective flow control valves in order to obtain the optimum spread of the full cone.

A compressed air jet is formed when the shut-off valves 30 in the two hoses 13 and 14 are closed to shut off the supply of washing fluid and the compressed air supply is opened by opening its respective solenoid shut-off valve 38 so that compressed air is supplied through the tube 22 to the opening 18.

When the jet assembly 10 is used to wash an industrial component, such as an engine block, by a method in which this invention is embodied, it may be mounted on an arm of a robot which is programmed to effect a sequence of movements of the arm automatically whereby the jet assembly 10 is located and oriented automatically at each of a programmed sequence of locations and orientations in space, the program being appropriate for the components to be washed and the robot being located adjacent a washing station at which each of a series of the components to be washed is located in turn for washing. In addition to locating and orientating the jet assembly 10, the robot controls operation of the solenoid-operable shut-off valves 30 to effect the required supply of washing fluid to the chamber 21 via the annular passage and the spiral passages, or the tube 22 or both, dependent upon the form of washing fluid jet required for the particular washing operation to be performed in accordance with the program, or to effect closure of the two washing fluid shut-off valves 30 in the hoses 13 and 14 and to open the compressed air supply shut-off valve 38 for the drying steps of the washing cycle.

Although the compressed air supply as described would function to displace washing fluid that had accumulated in the nozzle 12, it may be desirable to provide a form of venting to clear washing fluid from the nozzle 12 for the drying step.

The robot may be adapted to control operation of the nozzle 12 to effect pulsing of the washing fluid jet supply during a washing step if desired.

A supply of compressed air having its own shut-off valve 38A and pressure regulating valve 39A may be connected to the hose 13 between the shut-off valve 30 in the hose 13 and the union 27 instead of or in addition to the supply of compressed air connected to the hose 14. In the latter arrangement, the pattern of the jet of compressed air may be varied automatically if desired by controlled operation of the respective shut-off valves 38 and 38A in much the same way as has been described above with reference to Figures 2, 3 and 4 when the shut-off valves 30 in the hoses

13 and 14 are closed to shut-off the supply of washing fluid.

Automatic operation of the shut-off valves 30, 38 and 38A to effect the required supply of washing fluid or compressed air to the chamber 21 via the annular passage and the spiral passages, or the tube 22 or both, dependent upon the form of fluid jet required for the particular washing or drying operation to be performed in accordance with the program could be under the control of separate control means functionally interlinked with the robot so that the jets are formed in synchronism with the programmed movements effected by the robot, rather than being controlled by the robot itself as described above.

Figure 5 shows an industrial parts washing machine comprising a housing 40 with a loading hatch 41 through which a component to be washed is passed into and withdrawn from a work station within the housing 40. There is a turntable 42 at the work station. A number of fixed jet assemblies 43 are located and orientated with precision around the work station. A robot 44 is provided within the housing 40.

Figure 6 shows the robot 44 in more detail. It carries a jet assembly 45 at the end of its arm. The configuration and construction of each jet assembly 43, 45 is as has been described above as the jet assembly 10 with reference to Figures 1 to 4.

The machine includes a control panel 46 which is interlinked with the robot 44 and which incorporates programmed control means for controlling operation of the fixed jets 43 as well. Conveniently the programmed control means are microprocessors and such microprocessors may be incorporated in the robot 44 as well.

In operation of the machine, a component to be cleaned is conveyed to the loading hatch 41. An automatic door of the hatch 41 is opened to allow the component to be introduced into the interior of the housing 40 and be loaded on the turntable 42. The automatic door of the hatch 41 closes automatically once the component is positioned and locked on the turntable 42. The programmed control means incorporated in the control panel 46 and in the robot 44 select the appropriate robot control program signal and instruct the robot control system to commence the wash cycle.

The robot 44 washes one face and 25% of the top of the work envelope of the component and returns to a safe location within the enclosure 40. The pattern of the jet of fluid directed at the component by the jet assembly 45 and the wash action are controlled directly from the robot microprocessor and are therefore totally integrated into the robot program. Figure 7 shows operation of the jet assembly 45 to direct a pinpoint jet of washing fluid at a selected part of the component. Figure 8 shows the jet assembly 45 directing a cone spray of washing fluid at the component.

The turntable 42 is now indexed through 90° and through this operation the static jet assemblies 43 are operated in accordance with the program of the programmed microprocessors in the control panel 46 to remove gross swarf content from the component.

After indexing through 90°, the robot 44 is instructed to continue the cleaning cycle on the next face and part of the top of the component. This cycle is continued until each side has received a robot wash and the overall component has received four flushes.

A drying cycle then commences, including direction of compressed air by jets 43 and 45 onto the component. The robot 44 operates to effect drying of the nearest face of the component in a similar manner to the washing operation. General drying is effected by operation of blower fans incorporated in the housing 40 whilst the turntable 42 is indexed. After drying is complete, the blow-off fans are stopped, the supply of compressed air to the jet assemblies 43 and the robot jet assembly 45 is stopped by appropriate operation of the compressed air shut-off valves 38. The automatic door of the loading hatch 41 opens and the component is removed.

Figure 9 shows an alternative arrangement in which the present invention is embodied. A manifold 28 carries two nozzles 29 and 31. The construction of each nozzle 29, 31 is substantially similar to the construction of the nozzle 12 described above with reference to Figure 1 and the connections through the manifold 28 of each nozzle 29, 31 to the respective pair of hoses 32 and 33, 34 and 35, are substantially similar to the equivalent connection of the nozzle 12 to the respective pair of hoses 13 and 14 as described above with reference to Figure 1. The axis of the nozzle 31 is oblique to the axis of the nozzle 29 so that jets emitted from the two nozzles 29 and 31 converge. The outer end of the nozzle 29 is further from the manifold 28 than is the outer end of the nozzle 31.

In use of the apparatus shown in Figure 9, the manifold 28 is mounted on the arm of a robot. The washing operation is substantially as described above with reference to operation of the nozzle 12. The arrangement of the two nozzles 29 and 31 increases the scope of the washing operations that can be performed. For example the space between two portions of a surface that can be washed by the jet assembly shown in Figure 9 can be increased by moving the two nozzles 29 and 31 closer to that surface, or can be reduced by moving the nozzles 29 and 31 further away. This is because the jets converge. The nozzle 29 can be effectively shut off so that washing is effected only by the nozzle 31 by bringing the nozzles so close to the surface being washed that the surface abuts the outer end of the nozzle 29.

The jet assemblies described above with reference to Figures 1 to 4 or 9 may be designed so as to be physically and functionally compatible with a machine installation as illustrated in Figure 10 which includes a robot 50 which is arranged to select and locate automatically at a work station 51—54 one of a group of different tools, whereby the jet assembly is one of the group 55 of tools available for automatic selection. For this purpose the jet assembly may be formed with a shank or other suitable connecting and locating means adapted to locate the jet assembly at the work station 51—54 and to connect the jet assembly to a source of fluid pressure of the machine, the jet assembly being usable for various cleaning purposes, e.g. removal of debris or contaminants, such as swarf and oils. The normal coolant/fluid available for use during the operating cycle of the machine could be directed through the jet assembly for such purposes.

Claims

1. A method of cleaning industrial components in which a high kinetic energy jet of cleaning fluid having a selected shape and orientation is directed at a corresponding selected portion of a component being cleaned, the shape and orientation of the jet being predetermined and selected automatically from a range of such shapes and orientations, by a programmed automatic control of flow of the high kinetic energy fluid to and through a jet nozzle (10, 29, 31, 43, 45), to suit the selected portion of the component at which it is directed.

2. A method according to claim 1, wherein the programmed automatic control comprises directing the flow of high kinetic energy fluid to the jet nozzle (10, 29, 31, 43, 45) through either or both of two paths which are each arranged so that the fluid emerges from it with an axial directional component relative to the jet nozzle (10, 29, 31, 43, 45), and causing any fluid which emerges from one of said two paths to do so with a spinning action.

3. A method according to Claim 2, wherein the shape of the high kinetic energy jet of fluid is determined by the choice of the path or paths by which the flow of high kinetic energy fluid is directed to the jet nozzle (10, 29, 31, 43, 45) and by the interaction of the fluid that forms the jet with the structure which defines the respective path.

4. A method according to Claim 1, Claim 2 or Claim 3, in which the programmed automatic control further comprises one or more of the steps of varying the pressure of fluid flow fed to the jet nozzle (10, 29, 31, 43, 45), and of varying the nature of the fluid medium fed to and through the jet nozzle (10, 29, 31, 43, 45).

5. A method according to Claim 1, Claim 2 or Claim 3, wherein operation of the jet nozzle (10, 29, 31, 43, 45) is controlled automatically in accordance with the programme to effect pulsing of the resultant jet of fluid.

6. A method according to any one of Claims 1 to 5, wherein the normal coolant/fluid available for use during the operating cycle of a machine tool is directed through the jet nozzle (10, 29, 31, 43, 45) for cleaning purposes, e.g. removal of debris or contaminants, such as swarf and oil, from a work piece.

7. A method according to any one of Claims 1 to 6, in which a programmed robot (44) locates and orientates the jet nozzle (10, 29, 31, 43, 45) at each of a programmed sequence of locations and orientations relative to the component and flow of fluid under pressure to and through the jet nozzle (10, 29, 31, 43, 45) is controlled automatically so that a jet of fluid is directed at a selected portion of the component by the jet nozzle (10, 29, 31, 43, 45) in synchronism with said programmed sequence.

8. A method according to Claim 7, wherein the automatic control of fluid flow to and through the jet nozzle (10, 29, 31, 43, 45) is effected by the robot (44) in accordance with the programme.

9. A method according to Claim 4 or any one of Claims 5 to 8 when appended to Claim 4, wherein a supply (36) of washing fluid to and through the jet nozzle (10, 29, 31, 43, 45) is shut off automatically after a washing phase and a source of compressed air is connected to the jet nozzle (10, 29, 31, 43, 45) so that a jet of compressed air is directed at the component by the jet nozzle (10, 29, 31, 43, 45) for a drying phase.

10. A jet assembly (10, 43, 45) suitable for use in performing a method according to any one of Claims 1 to 9, the jet assembly (10, 43, 45) comprising a nozzle (12, 29, 31) with an opening (18) at one end and forming a chamber (21) which communicates with the opening (18) and which has a cross-section which is larger than the cross-section of the opening (18); an inner conduit (22) having a cross-section smaller than the cross-section of the opening (18), communicating with the chamber (21) opposite the opening (18) and being arranged so as to form a jet of cleaning fluid under pressure which has a substantially uniform cross-section and to direct that jet substantially coaxially through the opening (18); an outer conduit surrounding the inner conduit (22) and cooperating therewith to form an annular passage leading around the inner conduit (22) to the chamber (21), and swirl means (15) in the annular passage configured to coact with a high kinetic flow of fluid under pressure to the chamber (21) through the annular passage whereby to impart a significant axial directional component and a spinning action to such fluid as it enters the chamber (21) and thereby to form a vortex in the chamber (21).

11. A jet assembly (10, 43, 45) according to Claim 10, wherein the annular passage is connected to one source of fluid under pressure via one shut off valve (30) and the inner conduit (22) is connected to another source of fluid under pressure via another shut off valve (30).

12. A jet assembly (10, 43, 45) according to Claim 11, wherein the pressure of fluid in the other source is higher than that of fluid in said one source.

13. A jet assembly (10, 43, 45) according to Claim 11 or Claim 12, wherein the inner conduit (22) is also connected to a source of compressed air via a further shut off valve (38).

14. A jet assembly (10, 43, 45) according to any one of Claims 11 to 13 when appended to Claim 7,

wherein operation of the shut off valves (30, 38) is controlled automatically in accordance with the programmed sequence by operation of the programmed robot (44) which carries the jet assembly (10, 43, 45).

15. A jet assembly (10, 43, 45) according to any one of Claims 10 to 14, which is designed so as to be physically and functionally compatible with a machine which is arranged to select and locate automatically at a work station (51—54) one of a group (55) of different tools, whereby the jet assembly (10, 43, 45) is one of the group (55) of tools available for automatic selection.

16. A jet assembly (10, 43, 45) according to any one of Claims 10 to 15, wherein the range of patterns of jet of washing fluid comprises a hollow cone, a solid cone and a so-called "pin-point" pattern which is a stream of fluid which maintains a substantially uniform cross-section for a significant travel from the jet nozzle by which it is directed.

17. A jet assembly (10, 43, 45) according to Claim 16, wherein a solid cone pattern of jet of washing fluid is formed by combining a hollow cone pattern of jet of washing fluid with a "pin-point" pattern of jet of washing fluid.

18. A jet assembly according to any one of Claims 10 to 17, comprising two such nozzles (29 and 31) mounted on a manifold (28) which is adapted to be carried by a robot, each nozzle (29, 31) being adapted to emit a jet of fluid through the opening (18) at its end remote from the manifold (28), the opening (18) of one of the nozzles (29, 31) being spaced further from the manifold (28) than the opening (18) of the other and the axis of the opening (18) of one of the nozzles (29, 31) being oblique to the axis of opening (18) of the other nozzle (29, 31).

Patentansprüche

1. Verfahren zum Reinigen industrieller Teile, bei dem ein Reinigungsfluidstrahl hoher kinetischer Energie mit einer ausgewählten Form und Richtung auf einen korrespondierenden ausgewählten Abschnitt eines zu reinigenden Teiles gerichtet wird, wobei die Form und die Richtung des Strahls vorbestimmt und aus einem Vorrat an Formen und Richtungen ausgewählt wird durch eine programmierte automatische Steuerung des Fluidflusses hoher kinetischer Energie zu und durch eine Strahldüse (19, 29, 31, 43, 45), um den Fluß dem ausgewählten Abschnitt des Teils anzupassen, auf das er gerichtet ist.

2. Verfahren nach Anspruch 1, bei dem die programmgesteuerte automatische Steuerung folgende Schritte umfaßt:

der Fluidfluß hoher kinetischer Energie zu der Strahldüse (10, 29, 31, 43, 45) wird durch einen oder beide von zwei Wegen geleitet, die beide so angeordnet sind, daß das Fluid aus ihnen mit einer axialen Richtungskomponente relativ zur Strahldüse (10, 29, 31, 43, 45) austritt, und

es wird veranlaßt, daß alles aus einem der beiden Wege austretende Fluid in eine Drehbewegung versetzt wird.

3. Verfahren nach Anspruch 2, bei dem die Form des Fluidstrahls hoher kinetischer Energie durch die Wahl des Weges oder der Wege, durch die der Fluidfluß hoher kinetischer Energie auf die Strahldüse (10, 29, 31, 43, 45) gerichtet ist, und durch die Wechselwirkung des den Strahl formenden Fluids mit der den zugehörigen Weg bildenden Struktur vorbestimmt ist.

4. Verfahren nach Anspruch 1, Anspruch 2 oder Anspruch 3, bei dem die programmgesteuerte automatische Steuerung einen oder mehrere der folgenden Verfahrensschritt umfaßt:

Ändern des Drucks der Strahldüse (10, 29, 31, 43, 45) zugeführten Fluids und Ändern der Art des Fluidmediums, das zu der und durch die Strahldüse (10, 29, 31, 43, 45) geführt wird.

5. Verfahren nach Anspruch 1, Anspruch 2 oder Anspruch 3, bei dem die Tätigkeit der Strahldüse (10, 29, 31, 43, 45) automatisch in Übereinstimmung mit dem Programm geregelt wird, um ein Pulsieren des resultierenden Fluidstrahls zu bewirken.

6. Verfahren nach einem der Ansprüche 1 bis 5, bei dem normales, für die Verwendung in den Arbeitszyklen einer Werkzeugmaschine zur Verfügung stehendes Kühlmittel/Fluid durch die Strahldüse (10, 29, 31, 43, 45) zu Reinigungszwecken geleitet wird, z.B. zur Beseitigung von Abfall oder Verunreinigungen wie Späne oder Öl von einem Werkstück.

7. Verfahren nach einem der Ansprüche 1 bis 6, bei dem ein programmgesteuerter Roboter (44) die Strahldüse (10, 29, 31, 43, 45) auf jede von mehreren in einer Programmabfolge festgelegten Positionen und Richtungen relativ zum Teil einstellt, und bei dem der Druckfluidfluß zu und durch die Strahldüse (10, 29, 31, 43, 45) automatisch derart gesteuert wird, daß ein Fluidstrahl in Synchronisierung mit der Programmabfolge durch die Strahldüse (10, 29, 31, 43, 45) auf einen ausgewählten Abschnitt des Teils gerichtet wird.

8. Verfahren nach Anspruch 7, bei dem die automatische Steuerung des Fluidflusses zu der und durch die Strahldüse (10, 29, 31, 43, 45) durch den Roboter (44) in Übereinstimmung mit dem Programm bewirkt wird.

9. Verfahren nach Anspruch 4 oder einem der Ansprüche 5 bis 8 in Zusammenhang mit Anspruch 4, bei dem nach einer Waschphase eine Waschfluidzufuhr (36) zu der und durch die Strahldüse (10, 29, 31, 43, 45) automatisch abgesperrt und eine Druckluftquelle mit der Strahldüse (10, 29, 31, 43, 45) verbunden wird, um in einer Trocknungsphase einen Druckluftstrahl durch die Strahldüse (10, 29, 31, 43, 45) auf das Teil zu richten.

10. Strahlvorrichtung (10, 43, 45) zur Durchführung eines Verfahrens nach einem der Ansprüche 1 bis 9, umfassend eine Düse (12, 29, 31) mit einer Öffnung (18) an einem Ende und einer mit der Öffnung (18) verbundenen Kammer (21), die einen größeren Durchmesser als

die Öffnung (18) aufweist.

einen einen kleineren Durchmesser als die Öffnung (18) aufweisenden inneren Kanal (22), der gegenüber der Öffnung (18) mit der Kammer (21) verbunden und so angeordnet ist, daß er einen Reinigungsdruckfluidstrahl mit einem im wesentlichen gleichförmigen Querschnitt erzeugt und diesen Strahl im wesentlichen koaxial durch die Öffnung (18) leitet;

einen äußeren Kanal, der den inneren Kanal (22) umgibt und mit diesem zur Bildung eines ringförmigen Durchgangs zusammenwirkt, der um den inneren Kanal (22) herum in die Kammer (21) führt und

in dem ringförmigen Durchgang angeordnete Drallmittel (15), die zum Zusammenwirken mit einem mit einer hohen kinetischen Energie durch den ringförmigen Durchgang in die Kammer (21) strömenden Druckmittelfluid ausgebildet sind, wodurch diesem Fluid zum Bilden eines Wirbels in der Kammer (21) beim Eintritt in die Kammer (21) eine starke axiale Richtungskomponente und eine Drallbewegung erteilt wird.

11. Strahlvorrichtung (10, 43, 45) nach Anspruch 10, bei der der ringförmige Durchgang mit einer Druckfluidquelle über ein Absperrventil (30) verbunden ist und bei dem der innere Kanal (22) mit einer anderen Druckfluidquelle über ein anderes Absperrventil (30) verbunden ist.

12. Strahlvorrichtung (10, 43, 45) nach Anspruch 11, bei der der Druck des Fluids in der anderen Quelle höher ist als in den einen Quelle.

13. Strahlvorrichtung (10, 43, 45) nach Anspruch 11 oder 12, bei der der innere Kanal (22) zusätzlich mit einer Druckluftquelle über eine weiteres Absperrventil (38) verbunden ist.

14. Strahlvorrichtung (10, 43, 45) nach einem der Ansprüche 11 bis 13 in Zusammenhang mit Anspruch 7, bei der die Tätigkeit der Absperrventile (30, 38) automatisch in Übereinstimmung mit dem Programmablauf durch die Tätigkeit des programmgesteuerten Roboters (44) gesteuert wird, der die Strahlvorrichtung (10, 43, 45) trägt.

15. Strahlvorrichtung (10, 43, 45) nach einem der Ansprüche 10 bis 14, die so gestaltet ist, daß sie physisch und funktional kompatibel mit einer Maschine ist, die an einer Arbeitsstations (51—54) automatisch ein Werkzeug aus einer Gruppe (55) verschiedener Werkzeuge auswählt und positioniert, wobei die Strahlvorrichtung (10, 43, 45) als ein Werkzeug aus der Gruppe (55) von Werkzeugen für die automatische Auswahl zur Verfügung steht.

16. Strahlvorrichtung (10, 43, 45) nach einem der Ansprüche 10 bis 15, bei der der Vorrat an Strahlmustern des Reinigungsfluids ein hohles konisches, ein massiv-konisches und ein sogenanntes Nadelstrahlmuster umfaßt, in dem der Fluidstrahl nach seinem Austritt aus der Strahldüse noch über eine wesentliche Strecke einen im wesentlichen gleichförmigen Querschnitt beibehält.

17. Strahlvorrichtung (10, 43, 45) nach Anspruch 16, bei der das massiv-konische Strahlmuster des Reinigungsfluids aus der Kombination eines hohlen konischen Strahlmusters des Reinigungsfluids mit einem Nadelstrahlmuster des Reinigungsfluids geformt wird.

18. Strahlvorrichtung nach einem der Ansprüche 10 bis 17, umfasend zwei auf einem für die Aufnahme von einem Roboter geeigneten Verteiler (28) montierte Strahldüsen (29 und 31), wobei jede Strahldüse (29, 31) durch die Öffnung (18) an ihrem von dem Verteiler (28) fernen Ende einen Fluidstrahl emittieren kann, und wobei die Öffnung (18) einer der Strahldüsen (29, 31) weiter von dem Verteiler (28) entfernt ist als die Öffnung (18) der anderen Düse (29, 31), und wobei die Achse der Öffnung (18) einer der Düsen (29, 31) relativ zur Achse der Öffnung (18) der anderen Düse (29, 31) geneigt ist.

Revendications

1. Procédé pour le nettoyage de composants industriels, dans lequel on dirige un jet de fluide de nettoyage, ayant une énergie cinétique élevée et une forme et une orientation sélectionnées, sur une partie sélectionnée correspondante d'un composant que l'on nettoie, la forme et l'orientation du jet étant prédéterminées et sélectionnées automatiquement, parmi une gamme de ces formes et orientations, par une commande automatique programmée du débit du fluide à énergie cinétique élevée allant vers une buse (10, 29, 31, 43, 45) du jet et traversant celle-ci, pour s'adapter à la partie sélectionnée du composant sur lequel est dirigé le jet.

2. Procédé conforme à la revendication 1, dans lequel la commande automatique programmée comprend les étapes qui consistent à diriger le flux de fluide à énergie cinétique élevée vers la buse (10, 29, 31, 43, 45) du jet à travers l'un ou l'autre ou chacun de deux trajets qui sont disposés chacun de façon que le fluide sorte de ce trajet avec une composante directionnelle axiale par rapport à la buse (10, 29, 31, 43, 45) du jet, et à donner à tout fluide sortant de l'un des deux trajets un effet de rotation.

3. Procédé conforme à la revendication 2, dans lequel la forme du jet de fluide à énergie cinétique élevée est déterminée par le choix du trajet ou des trajets à travers lequel ou lesquels on conduit le fluid de fluide à énergie cinétique élevée vers la buse (10, 29, 31, 43, 45) du jet, et par l'interaction entre le fluide qui forme le jet et la structure qui définit le trajet respectif.

4. Procédé conforme à l'une des revendications 1, 2 ou 3, dans lequel la commande automatique programmée comprend en outre une ou plusieurs des étapes qui consistent à faire varier la pression du flux de fluide amené à la buse (10, 29, 31, 43, 45) du jet, et à faire varier la nature du milieu fluide qui est amené à la buse (10, 29, 31, 43, 45) du jet et la traverse.

5. Procédé conforme à l'une des revendications 1, 2 ou 3, dans lequel le fonctionnement de la buse (10, 29, 31, 43, 45) du jet est commandé automatiquement conformément au programme pour produire une pulsation du jet de fluide obtenu.

6. Procédé conforme à l'une quelconque des

revendications 1 à 5, dans lequel on fait passer le liquide de refroidissement/fluide normal disponible pour être utilisé au cours du cycle de fonctionnement d'une machine outil, à travers la buse (10, 29, 31, 43, 45) du jet en vue d'un nettoyage, par exemple l'enlèvement de débris ou de produits contaminants, tels que limaille ou huile, d'une ébauche.

7. Procédé conforme à l'une quelconque des revendications 1 à 6, dans lequel un robot (44) programmé place et oriente la buse (10, 29, 31, 43, 45) du jet en chacune des localisations et orientations d'une séquence programmée de celles-ci par rapport au composant, et dans lequel le flux de fluide sous pression allant vers la buse (10, 29, 31, 43, 45) du jet et la traversant est commandé automatiquement de façon à diriger au moyen de la buse (10, 29, 31, 43, 45) du jet, un jet de fluide sur une partie sélectionnée du composant en synchronisme avec ladite séquence programmée.

8. Procédé conformé à la revendication 7, dans lequel la commande automatique du flux de fluide allant vers la buse (10, 29, 31, 43, 45) du jet et la traversant est réalisée par le robot (44) conformément au programme.

9. Procédé conforme à la revendication 4 ou à l'une quelconque des revendications 5 à 8 lorsqu'elles dépendent de la revendication 4, dans lequel ou coupe automatiquement, après une phase de lavage, une alimentation (36) en fluide de lavage allant vers la buse (10, 29, 31, 43, 45) du jet et la traversant, et dans lequel on relie une source d'air comprimé à la buse (10, 29, 31, 43, 45) du jet de façon à diriger un jet d'air comprimé sur le composant au moyen de la buse (10, 29, 31, 43, 45) du jet pour une phase de séchage.

10. Système de jet (10, 43, 45) adapté à être utilisé pour la mise en oeuvre d'un procédé conforme à l'une quelconque des revendications 1 à 9, le système de jet (10, 43, 45) comprenant une buse (12, 29, 31), munie à une extrémité d'une ouverture (18) et formant une chambre (21) qui communique avec l'ouverture (18) et dont la section est plus grande que la section de l'ouverture (18); un conduit intérieur (22) dont la section est plus petite que celle de l'ouverture (18), qui communique avec la chambre (21) à l'opposé de l'ouverture (18), et qui est disposé de façon à former un jet de fluide de nettoyage sous pression ayant une section sensiblement uniforme, et à diriger ce jet à travers l'ouverture (18) sensiblement dans l'axe de celle-ci; un conduit extérieur entourant le conduit intérieur (22) et coopérant avec lui pour former autour du conduit (22) un passage annulaire qui mène à la chambre (21), et des moyens pour provoquer un tourbillonnement (15) placés dans le passage annulaire et conformés de manière à coopérer avec une flux à énergie cinétique élevée de fluide sous pression traversant le passage annulaire et allant vers la chambre (21), de façon à communiquer à ce fluide quand il pénètre dans la chambre (21) une composante directionnelle axiale importante et un effet de rotation, et à former ainsi un vortex dans la chambre (21).

11. Système de jet (10, 43, 45) conforme à la revendication 10, dans lequel le passage annulaire est relié à une source de fluide sous pression par l'intermédiaire d'une vanne de fermeture (30), et le conduit intérieur (22) est relié à une autre source de fluide sous pression par l'intermédiaire d'une autre vanne de fermeture (30).

12. Système de jet (10, 43, 45) conforme à la revendication 11, dans lequel la pression de fluide dans l'autre source est plus élevée que celle du fluide dans la première source.

13. Système de jet (10, 43, 45) conforme àl'une des revendications 11 ou 12, dans lequel le conduit intérieur (22) est également relié à une source d'air comprimé par l'intermédiaire d'une autre vanne de fermeture (38).

14. Système de jet (10, 43, 45) conforme à l'une quelconque des revendications 11 à 13, quand elles dépendent de la revendication 7, dans lequel le fonctionnement des vannes de fermeture (30, 38) est commandé automatiquement conformément à la séquence programmée par le robot programmé (44) qui porte le système de jet (10, 43, 45).

15. Système de jet (10, 43, 45) conforme à l'une quelconque des revendications 10 à 14, qui est réalisé de façon à être physiquement et fonctionnellement compatible avec une machine destinée à sélectionner et à placer automatiquement à un emplacement de travail (51—54) un outil choisi parmi un groupe (55) d'outils différents, de façon que le système de jet (10, 43, 45) soit l'un des outils du groupe (55) disponibles pour la sélection automatique.

16. Système de jet (10, 43, 45) conforme à l'une quelconque des revendications 10 à 15, dans lequel la gamme des formes de jet de fluide de lavage comprend un cone creux, un cone solide et une forme dite "de précision" qui est un flux de fluide gardant une section sensiblement uniforme pendant un trajet important à partir de la buse du jet par laquelle il est dirigé.

17. Système de jet (10, 43, 45) conforme à la revendication 16, dans lequel une forme en cone solide du jet de fluide de lavage est obtenue en combinant une forme en cone creux du jet de fluide de lavage et une forme "de précision" de ce jet.

18. Système de jet conforme à l'une quelconque des revendications 10 à 17, comprenant deux buses (29, 31) montées sur un collecteur (28) destiné à être porté par un robot, chaque buse (29, 31) étant destinée à projeter un jet de fluide par l'ouverture (18) située à celle de ses extrémités qui est à l'opposé du collecteur (28), l'ouverture (18) de l'une des buses (29, 31) étant plus éloignée du collecteur (28) que l'ouverture (18) de l'autre, et l'axe de l'ouverture (18) de l'une des buses (29, 31) étant oblique par rapport à l'axe de l'ouverture (18) de l'autre buse (29, 31).

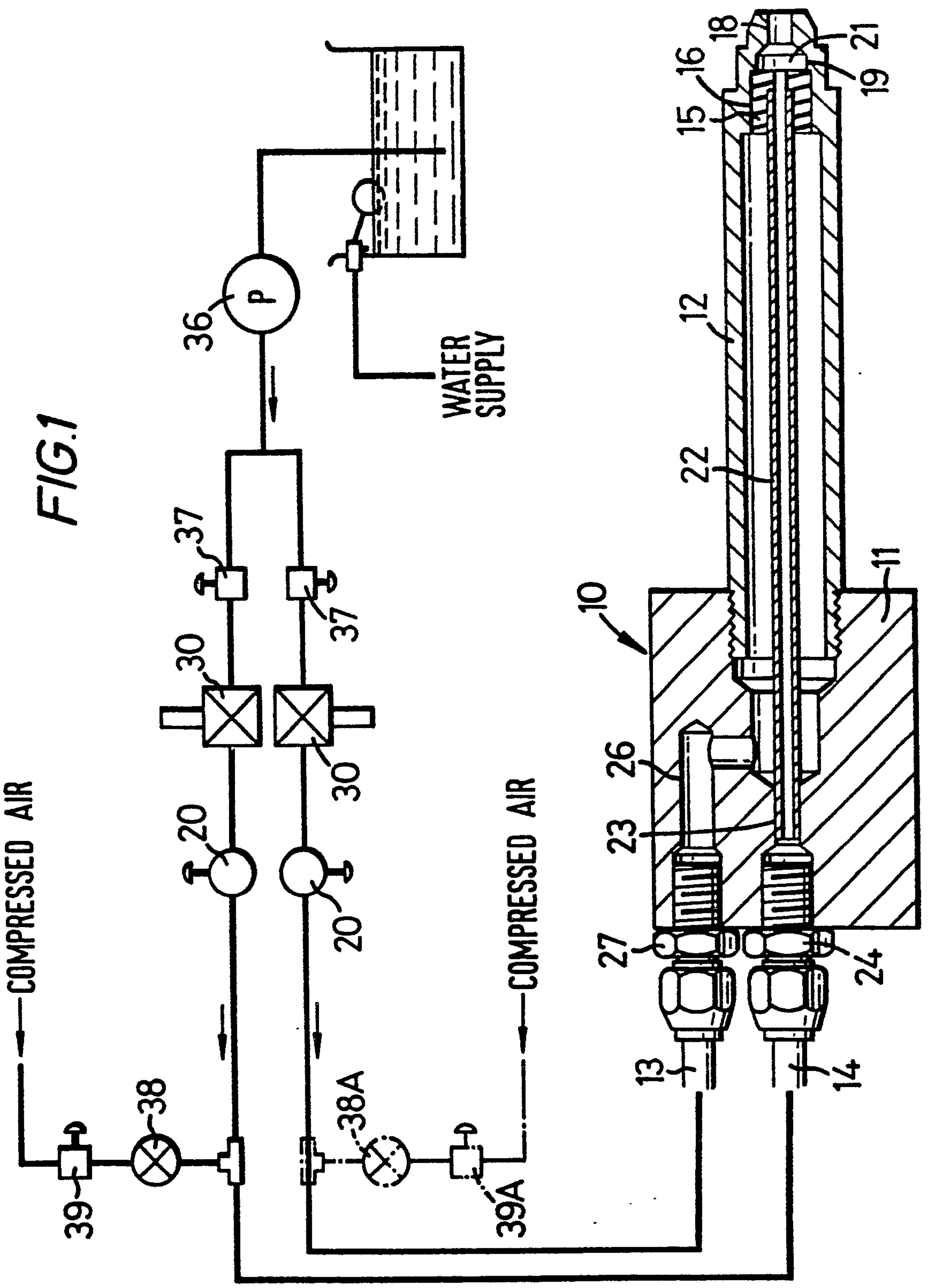
COMPRESSED AIR
COMPRESSED AIR
WATER SUPPLY
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FIG.1

FIG. 2

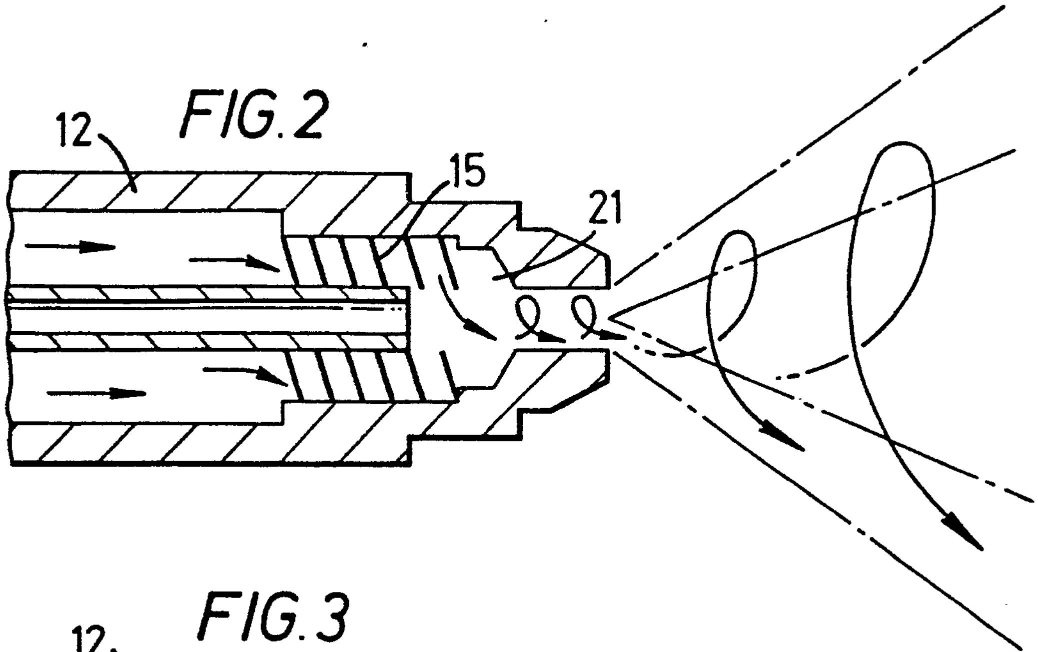


FIG. 3

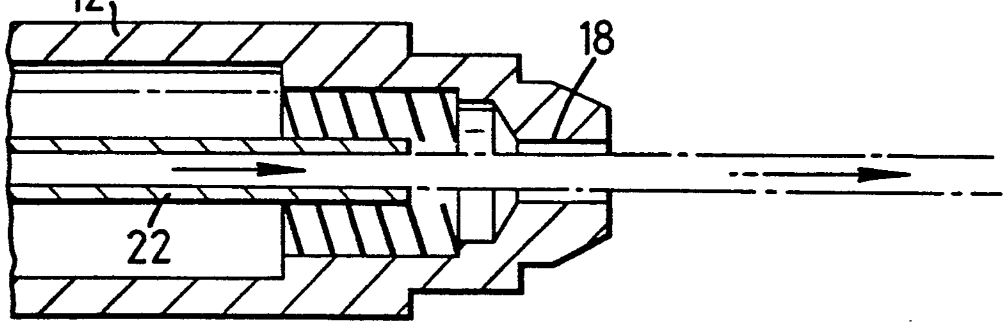
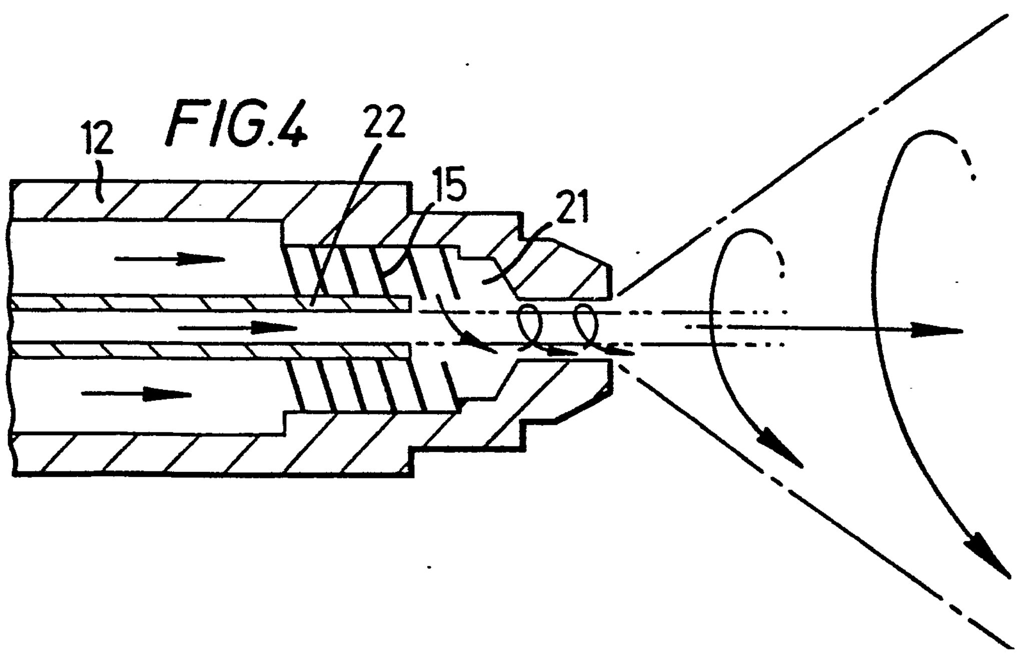


FIG. 4



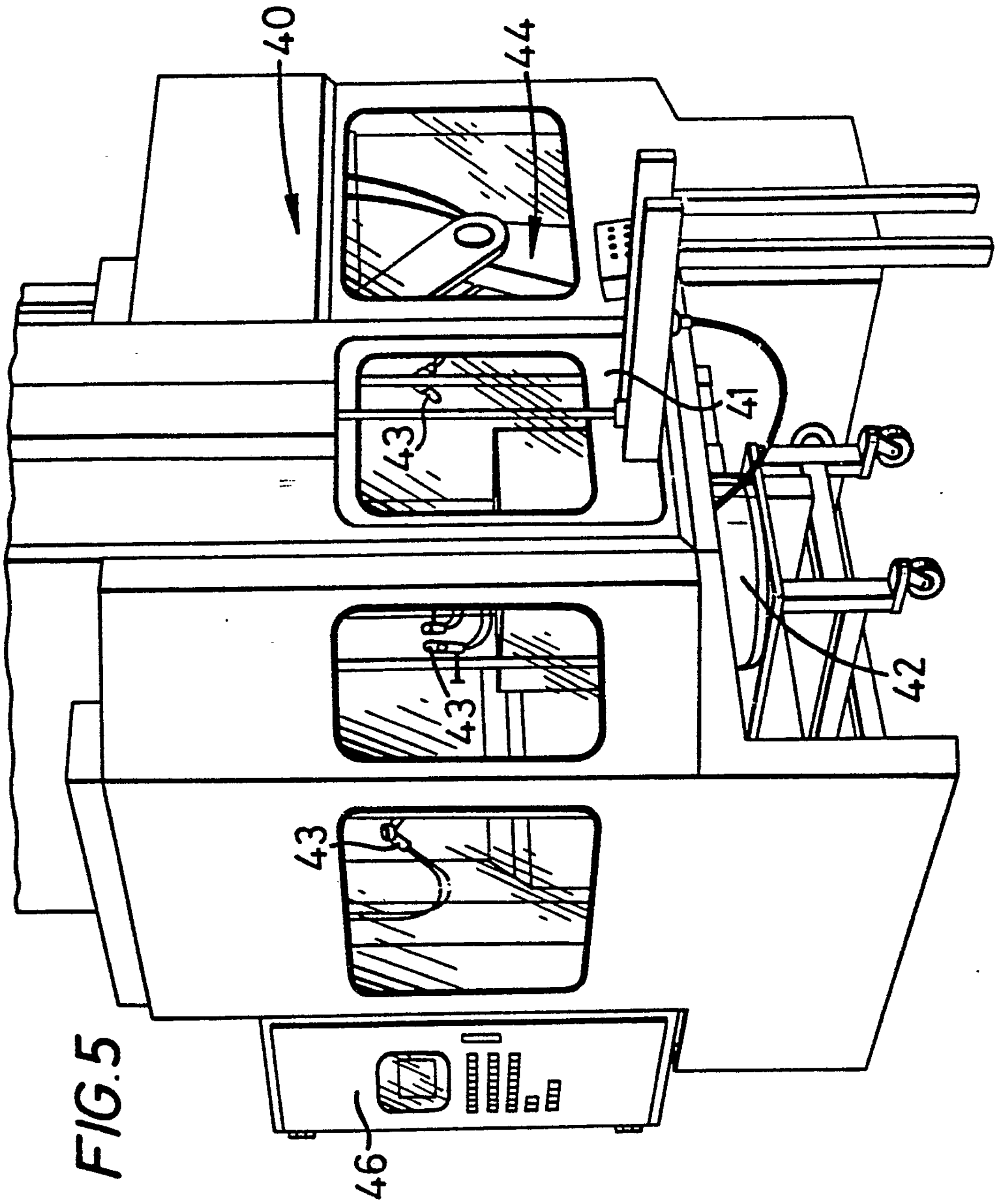


FIG.5

FIG.6

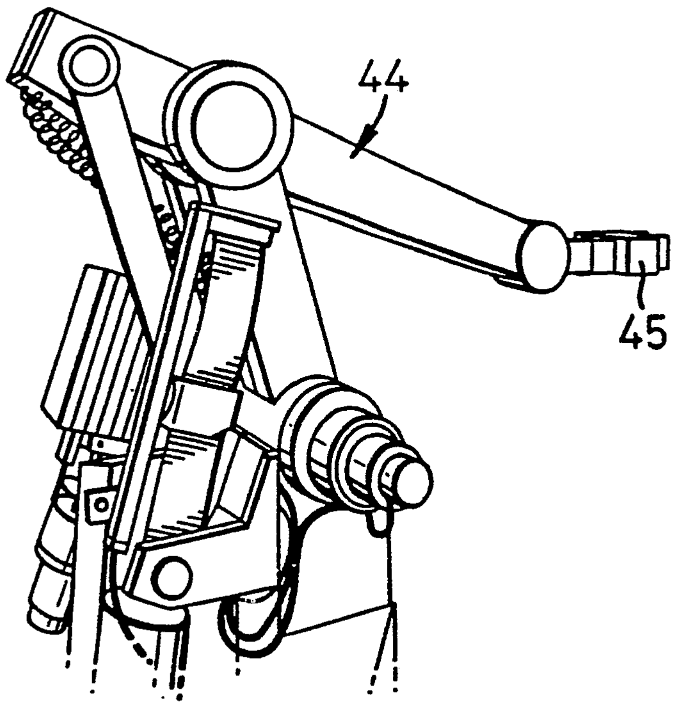


FIG.7

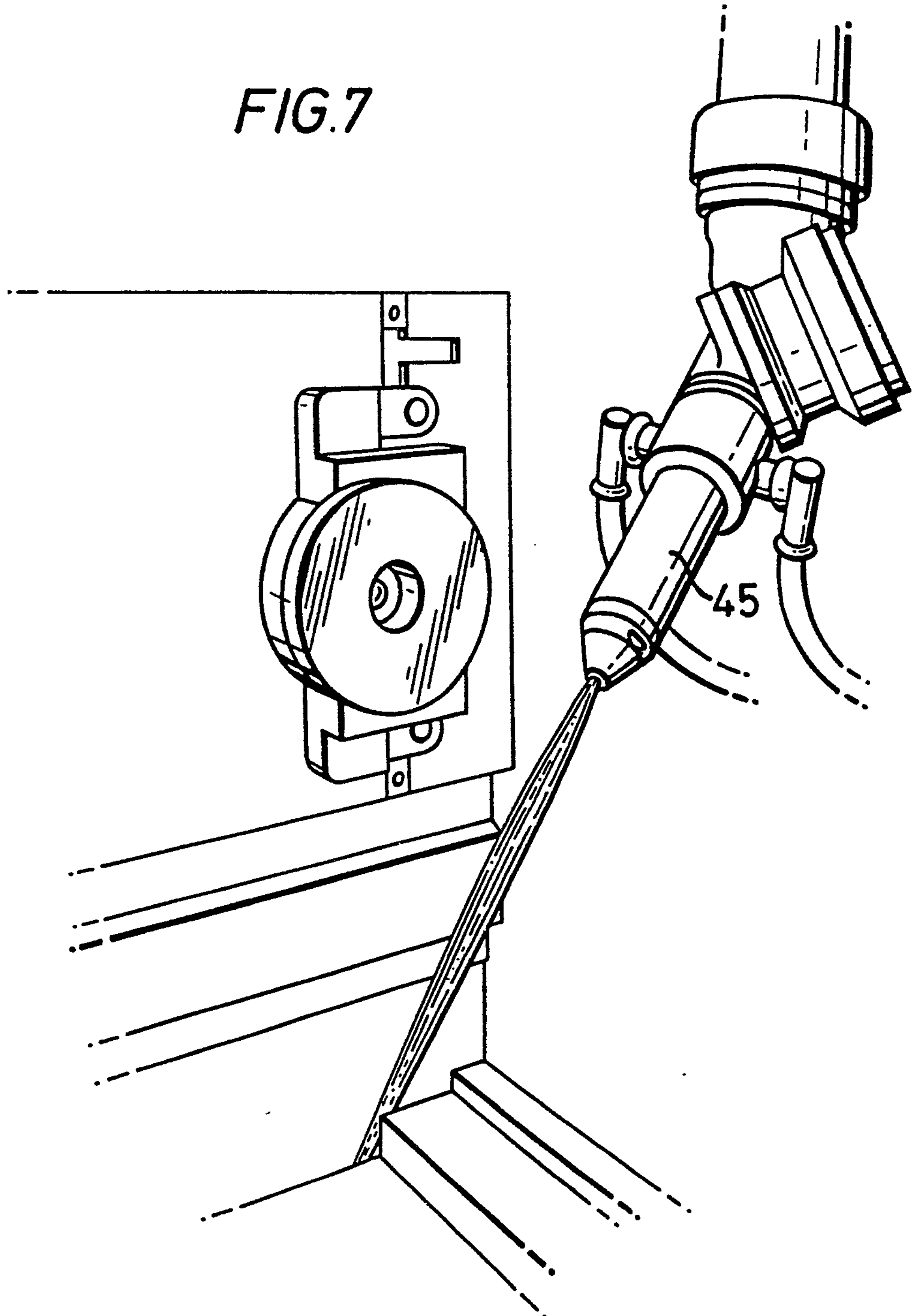
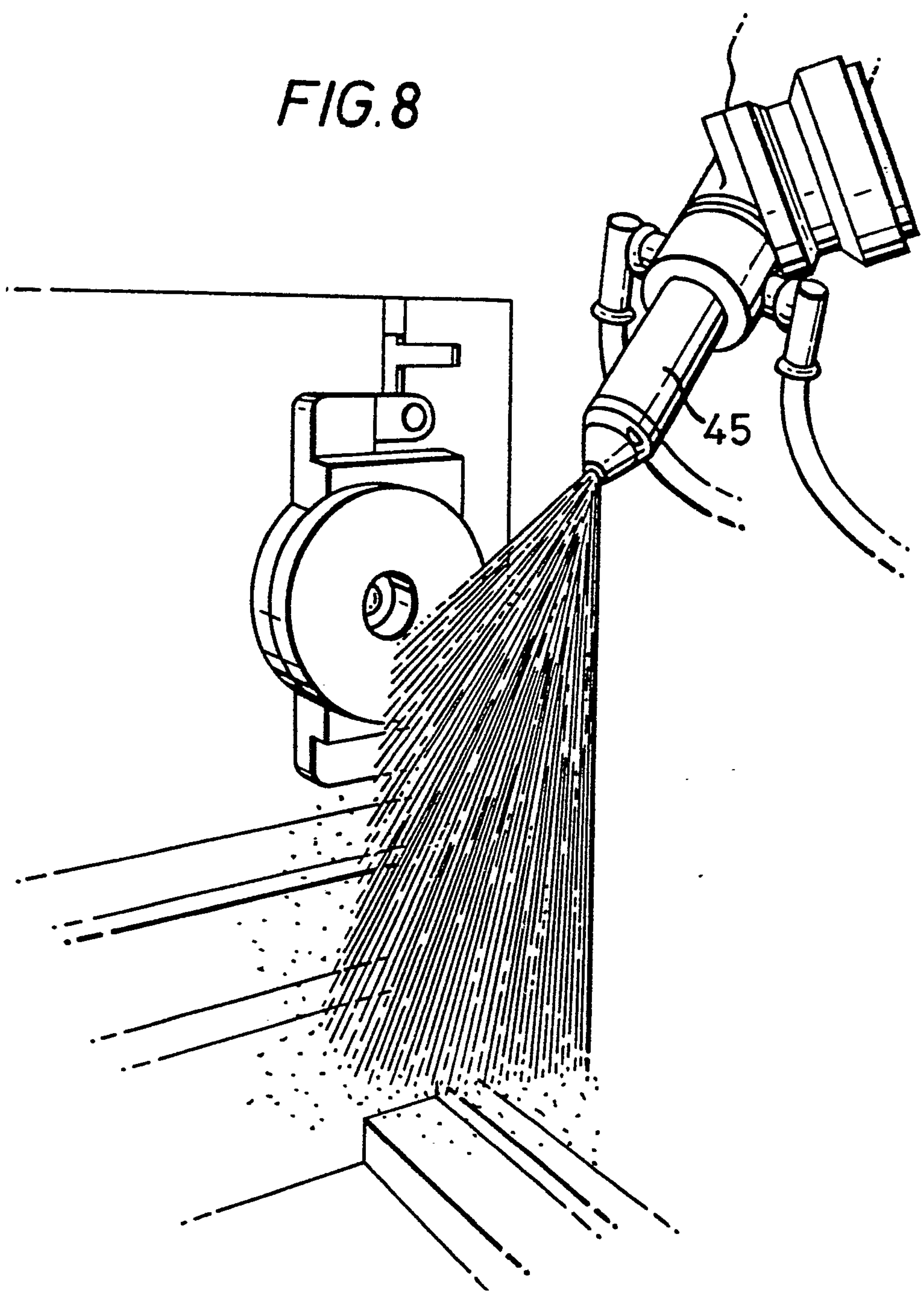


FIG. 8



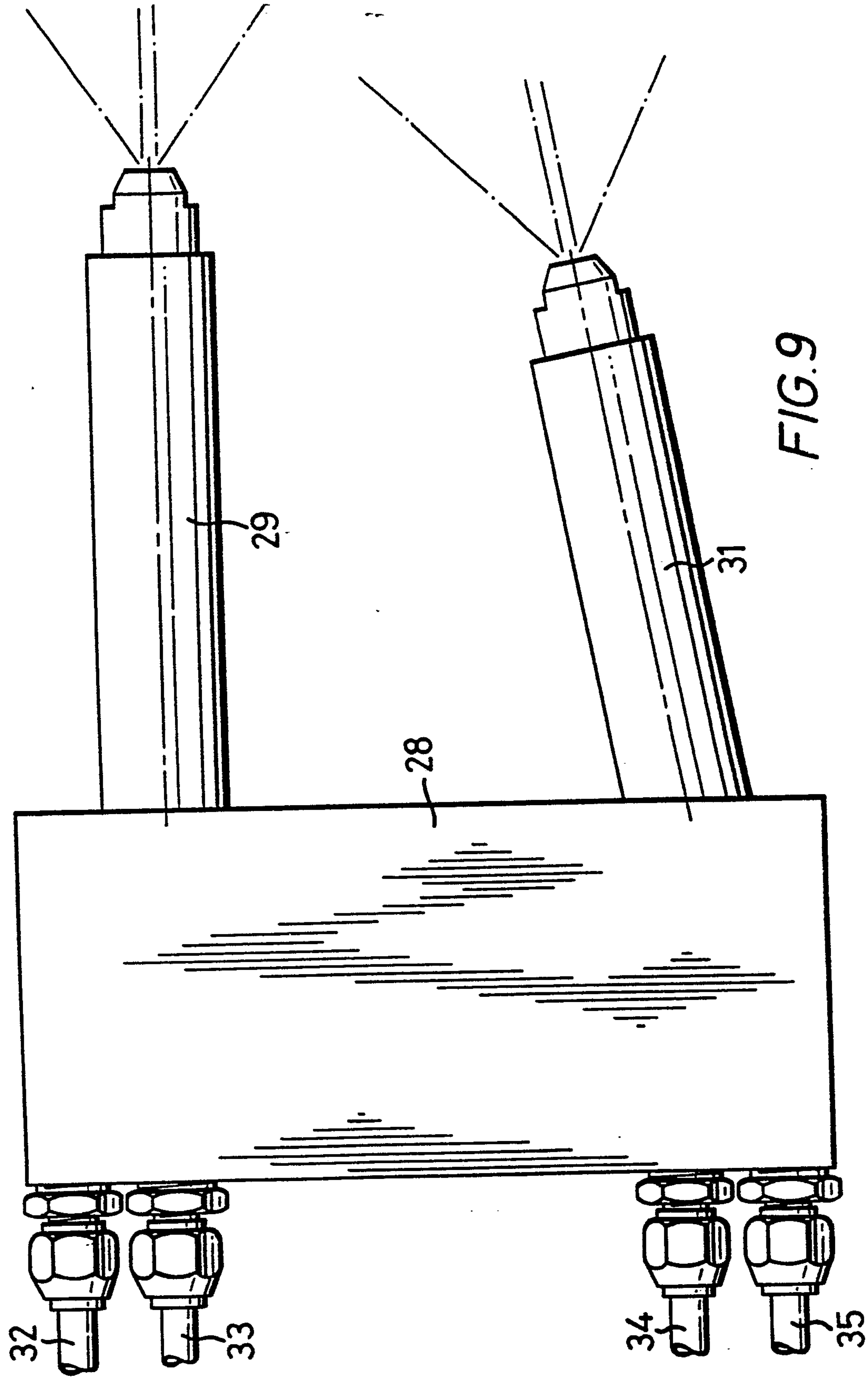


FIG.9

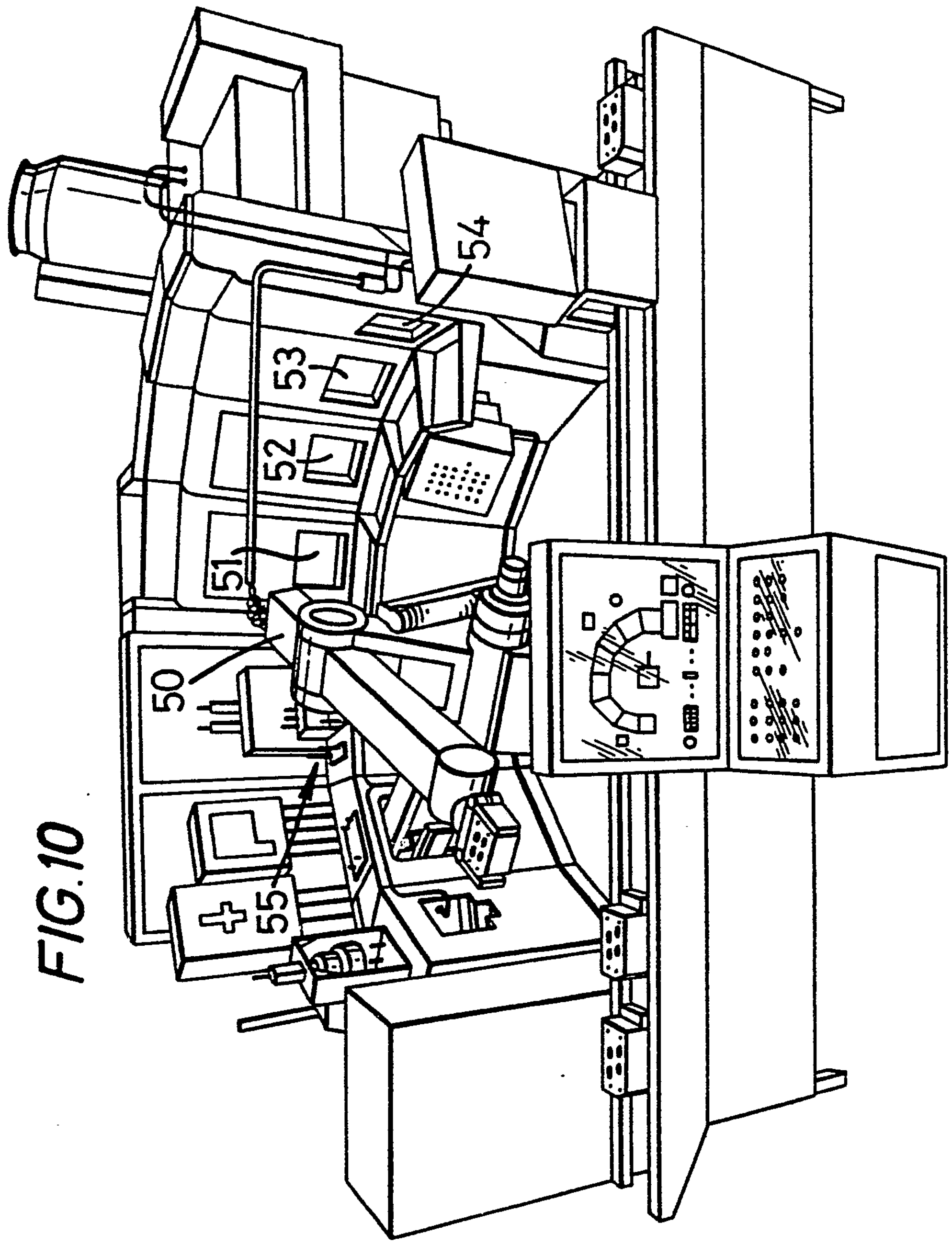


FIG.10