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# (54) A COUPLING APPARATUS

(57) The present disclosure provides an apparatus (11) for coupling a tool (15) to a machine (10). The machine (10) comprises a machine fluid circuit and the tool (15) comprises a tool fluid circuit and tool engagement means (25). The apparatus (11) comprises a coupler (34) and a fluid connection arrangement (35) configured to direct fluid through the coupler (34). The coupler (34) is configured to engage with the tool engagement means (25) such that the tool (15) is mounted to the machine (10) and the fluid connection arrangement (35) fluidly connects the tool fluid circuit to the machine fluid circuit through the coupler (34).

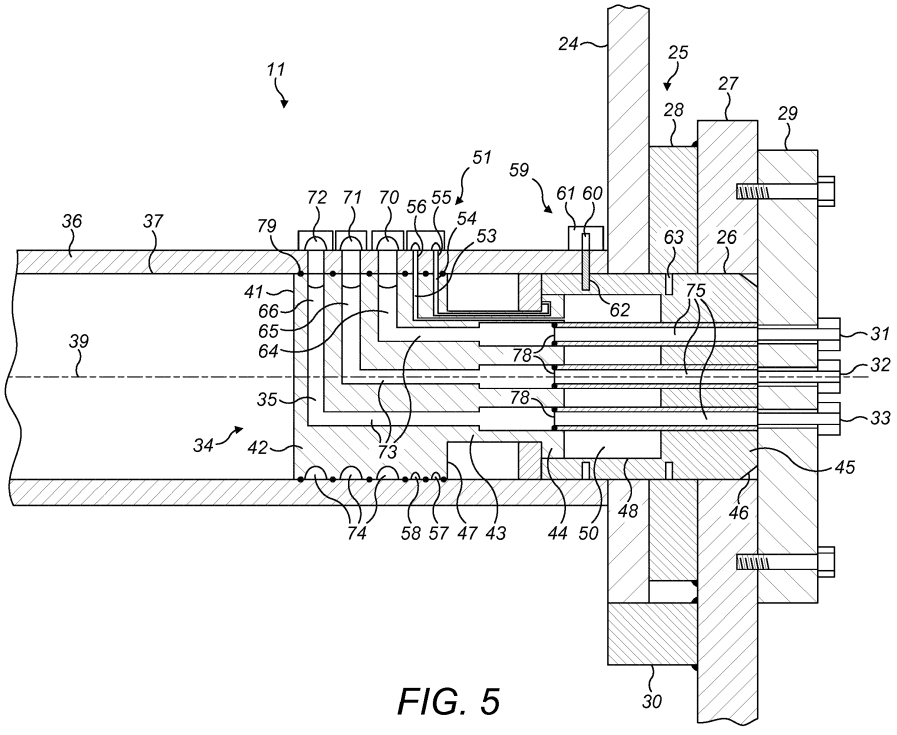


FIG. 5

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## Description

### Technical Field

**[0001]** This disclosure is directed towards an apparatus for coupling a tool to a machine. The apparatus may be particularly suitable for coupling a tool requiring fluid, whether for operation, actuation, lubrication or the like.

### Background

**[0002]** Machines, particularly those in construction, mining, earth moving, goods handling, forestry, agriculture or other such industries, typically engage with a tool controlled by an operator to perform work. A variety of tools may be attached to a multi-purpose machine via a coupling arrangement for performing different types of work. Exemplary multi-purpose machines include excavators, backhoes, loaders, dozers, shovels, fellers, harvesters, material handlers and the like. One well-known coupling arrangement is a quick coupler, which allows coupling and decoupling of a tool and machine in a particularly efficient and quick operation.

**[0003]** Certain tools are operated utilising pressurised hydraulic fluid. Therefore, machines typically comprise a hydraulic circuit which is connected to a hydraulic circuit in the tool via a hydraulic connection arrangement. In operation the machine hydraulic circuit receives an input from an operator or control unit and directs pressurised hydraulic fluid, via the hydraulic connection arrangement, to the tool hydraulic circuit to actuate the tool. Exemplary hydraulically operated tools include buckets, tilt rotators, hammers, handling arms, multi-processors, pulverisers, saws, shears, blowers, grinders, tillers, trenchers, winches, augers, brooms, cutters, planers, delimbers, felling heads, grapples, mulchers, rakes and the like.

**[0004]** US-A-2010/170974 discloses a suitable hydraulic connection arrangement, particularly for coupling a hydraulic crusher to a working machine. A series of hydraulic hoses are mounted on the arm of the machine and lead to the cylinders on the crusher. Such an arrangement is not suitable for a quick coupling arrangement as a plurality of hoses must be disconnected and connected when installing the crusher, thereby increasing the time required and difficulty involved in swapping tools.

### Summary

**[0005]** The present disclosure provides an apparatus for coupling a tool to a machine, the machine comprising a machine fluid circuit and the tool comprising a tool fluid circuit and tool engagement means, wherein the apparatus comprises: a coupler; and a fluid connection arrangement configured to direct fluid through the coupler, wherein the coupler is configured to engage with the tool engagement means such that the tool is mounted to the machine and the fluid connection arrangement fluidly connects the tool fluid circuit to the machine fluid circuit through the coupler.

**[0006]** The present disclosure further provides a machine comprising at least one aforementioned apparatus. The present disclosure yet further provides a tool comprising a tool fluid circuit and tool engagement means, the tool engagement means being configured to connect the tool fluid circuit to the fluid connection arrangement of the aforementioned apparatus.

**[0007]** The present disclosure also provides a method of coupling a tool to a machine, wherein the machine comprises a coupling apparatus and the coupling apparatus comprises a fluid connection arrangement, the method comprising: engaging the coupling apparatus with tool engagement means such that, simultaneously, the tool is mounted to the machine and the fluid connection arrangement fluidly connects a tool fluid arrangement to a machine fluid circuit.

**[0008]** By way of example only, embodiments of a coupling apparatus, a machine comprising the apparatus and a method of coupling a machine to a tool are now described with reference to, and as shown in, the accompanying drawings.

### Brief Description of the Drawings

**[0009]**

Figure 1 is a side elevation of an embodiment of a machine comprising the coupling apparatus of the present disclosure;

Figure 2 is a side elevation of a tool separated from the machine of Figure 1;

Figure 3 is a cross-sectional side elevation of a coupling apparatus of the machine of Figure 1;

Figure 4 is an end view of a coupler of the coupling apparatus of Figure 3;

Figure 5 is a cross-sectional side elevation of the coupling apparatus of Figure 3 when engaged with the tool of Figure 2;

Figure 6 is an end view of a coupler of a further embodiment of the coupling apparatus; and

Figure 7 is a cross-sectional side elevation of a further embodiment of the coupling apparatus of the present disclosure.

### Detailed Description

**[0010]** The present disclosure is generally directed towards an apparatus for coupling a tool to a machine. The coupling apparatus is arranged to provide fluid communication between a tool fluid circuit and a machine fluid circuit. Furthermore the coupling apparatus mounts the tool to the machine. The tool may be mounted to the machine such that it can pivot, but still maintain the fluid communication. Generally, the coupling apparatus may comprise a coupler which may be actuatable between an extended and retracted position. In the extended po-

sition the coupler may engage with a tool and in the retracted position the coupler may be disengaged from the tool.

**[0011]** Figure 1 illustrates an exemplary embodiment of a machine 10, in this case an excavator, comprising at least one coupling apparatus 11 of the present disclosure. The machine 10 may be any suitable type of machine, including work machines, such as backhoes, loaders, dozers, shovels, fellers, harvesters or material handlers. The machine 10 may comprise a main body 12 having a power unit therein, such as an internal combustion engine, for providing power to ground engaging means 13, such as tracks or wheels. The machine 10 may comprise an arm arrangement 14 to which a tool 15 may be connected via the at least one coupling apparatus 11. The arm arrangement 14 may comprise a first arm 16, which may be a boom, pivotally attached to the main body 12 and may comprise a second arm 17, which may be a stick, pivotally attached to the first arm 16. A first hydraulic actuator 18 may be connected between the first arm 16 and the main body 12 to pivot the first arm 16 relative to the main body 12. A second hydraulic actuator 19 may be connected between the first and second arms 16, 17 to pivot the second arm 17 relative to the first arm.

**[0012]** The tool 15 may be pivotally attached to the arm arrangement 14, which may be to the second arm 17, via a linkage arrangement 20. A third hydraulic actuator 21 may be connected between the second arm 17 and linkage arrangement 20 to pivot the linkage arrangement 20 and tool 15 relative to the second arm 17. The linkage arrangement 20, shown in further detail in Figure 2, may comprise at least one actuator link 22 pivotally attached to the third hydraulic actuator 21 and the second arm 17. The linkage arrangement 20 may comprise at least one tool link 23 pivotally attached between at least one separating link 24 and the pivotal attachment between the third hydraulic actuator 21 and at least one actuator link 22. The at least one separating link 24 may be pivotally attached to the second arm 17 and may hold the at least one tool link 23 and the second arm 17 at a predetermined distance from one another. In the illustrated embodiment the machine 10 comprises two actuator links 22, two tool links 23 and two separating links 24

**[0013]** The tool 15 may comprise at least one tool engagement means 25. As in the illustrated embodiment, the tool 15 may comprise four tool engagement means 25 (both sides of the machine 10 and tool 15 may be substantially as shown in Figures 1 and 2). The tool engagement means 25 may comprise a recess 26 for receiving the coupling apparatus 11. The tool 15 may comprise at least one side plate 27 and each tool engagement means 25 may comprise at least one engagement plate 28 attached to the inside of the side plate 27. The recess 26 may be formed by apertures through the at least one side plate 27 and the at least one engagement plate 28. At least one outer plate 29 may be located on the outside of the at least one side plate 27 to cover the apertures through the at least one side plate 27 and the at least one engagement plate 28 to form the recess 26. The outer perimeter of the recess 26 may be circular.

**[0014]** Each tool engagement means 25 may further comprise alignment means 30 attached to the inside of the at least one side plate 27 and extending from the side plate 27 by a distance which is greater than the distance the at least one engagement plate 28 extends from the side plate 27. The alignment means 30 may be arranged such that the separating link 24 and/or second arm 17 and/or tool link 23 abuts against it to assist in aligning the coupling apparatus 11 to the recess 26.

**[0015]** The tool 15 may be of any suitable type, although the present disclosure is particularly directed towards a coupling apparatus 11 for connecting a tool 15 requiring fluid, whether for operation, actuation, lubrication, spraying or the like. The tool 15 may, for example, be a bucket with a hydraulically actuated cover as illustrated or may be any one of tiltable buckets, tilt rotators, hammers, handling arms, multi-processors, pulverisers, saws, shears, blowers, grinders, tillers, trenchers, winches, augers, brooms, cutters, planers, delimbers, felling heads, grapples, mulchers, rakes. The tool 15 may comprise a spray head or the like for providing a water spray during operation of the machine 10, for example for dust suppression. The fluid may be pressurised hydraulic fluid, water or the like.

**[0016]** The tool 15 may therefore comprise a tool fluid circuit comprising at least one valve and/or conduit around which fluid can flow. The tool fluid circuit may not be operable without an external means for pumping fluid around it, such as a pump in the machine 10. The tool 15 may comprise at least one tool port 31, 32, 33 in this case first, second and third tool ports 31, 32, 33, through which fluid can flow. The first, second and third tool ports 31, 32, 33 may be located such that the tool fluid circuit can communicate fluid through the coupling apparatus 11 and, in particular, may be located in or adjacent to the tool engagement means 25. The first, second and third tool ports 31, 32, 33 may be located in the recess 26 and may each comprise a passageway through the at least one outer plate 29. The tool fluid circuit may comprise hoses or other such conduits attached to the first, second and third tool ports 31, 32, 33 to enable fluid to flow to one or more tool actuators, lubrication points, spray heads or other means requiring fluid.

**[0017]** The machine 10 may comprise at least one machine fluid circuit around which fluid may be circulated. Each machine fluid circuit may comprise at least one pump and at least one valve for controlling the flow of fluid around at least one fluid conduit. The machine 10 may comprise a control unit for controlling the at least one pump and at least one valve based upon inputs received from an input device controllable by an operator in the main body 12, such as a joystick or at least one button. The at least one pump may receive power from the power unit. The at least one machine fluid circuit may be connected to the first, second and third hydraulic actuators 18, 19, 21 for controlling the pivoting of the arm

arrangement 14 and the tool 15. The at least one machine fluid circuit may also comprise at least one conduit leading to or away from the at least one coupling apparatus 11 for communicating fluid to or from the at least one coupling apparatus 11 and tool 15.

**[0018]** Figures 3 to 6 illustrate the at least one coupling apparatus 11 in further detail. As in the illustrated embodiment, the machine 10 may comprise four coupling apparatuses 11, each arranged for engagement with one of the four tool engagement means 25 of the tool 15. Each coupling apparatus 11 comprises a coupler 34 and a fluid connection arrangement 35 operable to direct fluid through the coupler 34. The coupler 34 is configured to engage with one of the tool engagement means 25 such that the tool 15 is mounted to the machine 10 and the fluid connection arrangement 35 fluidly connects the tool fluid circuit to the machine fluid circuit through the coupler 34. The coupler 34 and tool engagement means 25 may be configured to, when coupled, provide a pivotal connection between the machine 10, preferably the arm arrangement 14, and the tool 15.

**[0019]** Each coupling apparatus 11 may further comprise a housing 36 and the coupler 34 may be mounted within the housing 36. The coupler 34 may be rotatably mounted within the housing 36, although it may not be able to rotate by an entire 360 degrees, such that the tool 15 can pivot relative to the machine 10. The housing 36 may comprise a housing passageway 37 in which the coupler 34 is mounted and the housing passageway 37 may have a substantially circular cross-section to enable rotation of the coupler 34 within it. The housing 36 may comprise a housing passageway opening 38 at an end of the housing passageway 37 and the coupler 34 may be mounted adjacent to and/or extending from the housing passageway opening 38.

**[0020]** As illustrated in Figure 3, the housing 36 and housing passageway 37 may extend between two coupling apparatuses 11 located at opposing housing passageway openings 38. The two coupling apparatuses 11 may be aligned with one another along a single axis of rotation 39. The two coupling apparatuses 11 may be configured to couple with opposing tool engagement means 25 on opposing side plates 27 of the tool 15. As illustrated in Figure 2, there may be two sets of coupling apparatuses 11 for coupling the machine 10 to the tool 15. One set may be located between two tool links 23 and the housing 36 may comprise a body, such as a cylinder, extending between the two tool links 23. Another set may be located in the second arm 17 and the housing 36 may be formed of the second arm 17. The housing 36 may have any other suitable arrangement and, in some embodiments of the present disclosure, only a single coupling apparatus 11 may be provided for connecting the machine 10 to a tool 15 with a single tool engagement means 25.

**[0021]** The coupler 34 may comprise a pin 40 connected to a mount 41 and the pin 40 may be moveable relative to the mount 41. The coupling apparatus 11 may comprise a coupler actuator 51, which may be configured to selectively orientate the coupler 34 between an engaged orientation, in which the pin 40 is extended relative to the mount 41, and a disengaged orientation, in which the pin 40 is retracted relative to the mount 41. In the disengaged orientation, as in Figure 3, the pin 40 is in a retracted position for being disengaged from the tool engagement means 25 such that the tool 15 is separable from the machine 10 and the tool fluid circuit is fluidly disconnected from the machine fluid circuit. In the engaged orientation, as in Figure 5, the pin 40 is in an extended position for engaging with the tool engagement means 25 such that the tool 15 is mounted to the machine 10 and the fluid connection arrangement 35 fluidly connects the tool fluid circuit to the machine fluid circuit.

**[0022]** The mount 41 may comprise a mount body 42, a piston 43 extending from the mount body 42 and a piston head 44 at the opposing end of the piston 43 to the mount body 42. The mount body 42 may have a substantially circular outer periphery such that it can rotate within the housing passageway 37. The outer periphery of the mount body 42 may be of substantially the same dimension as the housing passageway 37 such that the mount body 42 is closely fitted within the housing passageway 37. The mount body 42, piston 43 and piston head 43 may be formed of separate components (not shown) which are joined together during assembly of the coupling apparatus 11.

**[0023]** The mount 41 may be fixed axially such that it cannot move along the axis of rotation 39 but can rotate at least partially within the housing 36. For example, although not shown in the Figures, the mount body 42 may comprise a rib extending around its outer periphery which engages within a groove around the housing passageway 37. Alternatively, a rib may be provided around the housing passageway 37 at either end of the mount body 42 to prevent it from moving axially. The mount 41 is separated from the housing passageway opening 38 by the pin 40.

**[0024]** The pin 40 may comprise a pin outer end 45 which is adjacent to the housing passageway opening 38 when in the retracted position and separated from the housing passageway opening 38 outside of the housing 36 when in the extended position. The pin outer end 45 may be for engagement with the tool engagement means 25, preferably the recess 26, and may comprise a chamfer 46 around its edge to improve the ease of alignment with the recess 26. The pin 40 may extend from the pin outer end 45 to a pin inner end 47, which may be adjacent to the mount 41 when in the retracted position and separated from the mount 41 when in the extended position. The pin 40 may have a substantially circular outer periphery such that it can rotate within the housing passageway 37. The outer periphery of the pin 40 may be of substantially the same dimension as the housing passageway 37 such that the pin 40 is closely fitted within the housing passageway 37.

**[0025]** The pin 40 may comprise an internal chamber

48 extending from the pin inner end 47 and sealed by the piston 43 of the mount 41. An O-ring or the like (not shown) may be located between the piston 43 and the pin 40 to provide a suitable seal. The piston head 44 may be located within the internal chamber 48 and sealably mounted therein such that the internal chamber 48 may be separated into a first chamber 49 and a second chamber 50. The first and second chambers 49, 50 may define spaces of variable volume for receiving variable volumes of hydraulic fluid.

**[0026]** The pin 40 and mount 41 may be connected to one another such that they cannot rotate relative to one another about the axis of rotation 39. For example, the piston 43 and/or piston head 44 may comprise ridges which are mounted in grooves in the pin 40 which extend parallel to the axis of rotation 39 (or vice-versa).

**[0027]** The coupler actuator 51 may comprise the piston 43, piston head 44, first and second chambers 49, 50 and an actuator hydraulic circuit 52 for transferring hydraulic fluid to and from each of the first and second chambers 49, 50 for extending and retracting the pin 40. The actuator hydraulic circuit 52 may comprise first and second actuator conduits 53, 54 for communicating hydraulic fluid between the first and second chambers 49, 50 respectively and to at least one machine fluid circuit via first and second actuator ports 55, 56 in the housing 36.

**[0028]** The first and second actuator conduits 53, 54 may extend from the first and second chambers 49, 50, through the piston head 44, through the piston 43, through the mount body 42 and to first and second actuator grooves 57, 58 extending at least partially around the mount body 42. In particular, the first and second actuator grooves 57, 58 may extend around the outer surface of the mount body 42 in a plane perpendicular to the axis of rotation 39. The first and second actuator grooves 57, 58 may be aligned with the first and second actuator ports 55, 56 through the housing 36 and, as a result, hydraulic fluid may be communicated from the first and second actuator grooves 57, 58 to the first and second actuator ports 55, 56 whilst the mount 41 rotates. Hydraulic fluid may be directed to the first chamber 49 via the first actuator conduit 53 for moving the pin 40 into the retracted position or may be directed to the second chamber 50 via the second actuator conduit for moving the pin 40 into the extended position.

**[0029]** The coupling apparatus 11 may further comprise a coupler axial lock 59 for selectively preventing movement of the coupler 34 along the axis of rotation 39. The coupler axial lock 59 may be for providing an additional safety feature in the case of loss of hydraulic fluid pressure or the like. The coupler axial lock 59 may comprise an axial locking pin 60 mounted in the housing 36 and moveable between an extended position, in which it extends into the housing passageway 37 (see Figure 5) and a retracted position, in which it does not extend into the housing passageway 37 (see Figure 3). The coupler axial lock 59 may comprise an actuator 61, such as a solenoid, for selectively moving the axial locking pin 60 between its extended and retracted positions upon a command from the control unit in the machine 10. Alternatively, the actuator 61 may be manually operated.

**[0030]** The coupler axial lock 59 may comprise at least one locking groove 62, 63 extending around the coupler 34. In the illustrated embodiment the coupler axial lock 59 comprises first and second locking grooves 62, 63 extending around the outer surface of the pin 40. The first locking groove 62 may be positioned such that the pin 40 can extend into it when the pin 40 is extended such that the pin 40 can be locked in the extended position. The second locking groove 63 may be positioned such that the pin 40 can extend into it when the pin 40 is retracted such that the pin 40 can be locked in the retracted position. As the at least one locking groove 62, 63 extends at least partially around the coupler 34, the coupler 34 can rotate whilst the coupler axial lock 59 is locked but cannot move along the axis of rotation 39.

**[0031]** The fluid connection arrangement 35 may comprise at least one connection passageway 64, 65, 66 extending from at least one connection passageway opening 67, 68, 69 in the outer end 45 of the coupler 34 to at least one connection port 70, 71, 72 in the housing 36. In the illustrated embodiment the fluid connection arrangement 35 comprises first, second and third connection passageways 64, 65, 66 extend from first, second and third connection passageway openings 67, 68, 69 to first, second and third connection ports 70, 71, 72. Each of the first, second and third connection passageways 64, 65, 66 may be for transferring fluid at different pressures or volumes between the machine fluid circuit and the tool fluid circuit.

**[0032]** The at least one connection port 70, 71, 72 may be connected to at least one machine fluid circuit via hoses or other such conduits. The at least one connection passageway opening 67, 68, 69 may be configured to form fluid seals with the at least one tool port 31, 32, 33 for connection to the tool fluid circuit when the pin 40 is in the extended position. Therefore, each at least one connection passageway 64, 65, 66 may be arranged to communicate fluid between the machine and tool fluid circuits when the pin 40 is in the extended position.

**[0033]** Each connection passageway 64, 65, 66 may comprise a first internal passageway 73 extending from the piston head 44, through the piston 43, through the mount body 42 and to a connection groove 74 extending at least partially around the outer surface of the mount body 42. In particular, the connection groove 74 may extend around the outer surface of the mount body 42 in a plane perpendicular to the axis of rotation 39. The connection groove 74 of each connection passageway 64, 65, 66 may be aligned with a connection port 70, 71, 72 through the housing 36 and, as a result, fluid may be communicated from the connection groove 74 to the connection port 70, 71, 72 whilst the mount 41 rotates. Each connection passageway 64, 65, 66 may also comprise a second internal passageway 75 in the form of a sealing

conduit 76 extending from a connection passageway opening 67, 68, 69 into the corresponding first internal passageway 73. Each sealing conduit 76 may be mounted within a bore 77 through the pin 40 and may be sufficiently long that, when the pin 40 is extended, the sealing conduit 76 is still sealed with the first internal passageway 73 in the mount 41. A seal, such as in the form of an 0-ring 78, may ensure that fluid does not leak from the moving joint between the sealing conduit 76 and the first internal passageway 73.

**[0034]** The first and second actuator grooves 57, 58, first and second locking grooves 62, 63 and at least one actuator groove 74 may each comprise an annular volume extending around and inwards from the outer surface of the coupler 34. However, in some embodiments they may not extend all of the way around the coupler 34.

**[0035]** The coupling apparatus 11 may comprise further seals and/or bearings between its parts to maintain fluid seals and ensure that relative rotation can occur. In particular, O-rings 79 may be located around the coupler 34 in between adjacent first and second actuator grooves 57, 58, first and second locking grooves 62, 63 and actuator grooves 74.

**[0036]** The tool 15 may comprise a tool lock (not shown in the Figures) for selectively engaging with the pin 40 and preventing rotation of the pin 40 relative to the tool 15 when in the recess 26. For example, an actuator may be mounted to side plate 27 and/or engagement plate 28 and may be operable to move a locking pin into a correspondingly located aperture in the pin 40. This may ensure that correct alignment is maintained between the at least one connection passageway opening 67, 68, 69 and at least one tool port 31, 32, 33 when in use.

**[0037]** During connection the pin 40 may be moved into its retracted position by the coupler actuator 51. The arm arrangement 14 may be moved into position adjacent the tool 15 by the first, second and/or third hydraulic actuators 18, 19, 21. The linkage arrangement 20 and/or second arm 17 may be aligned in the correct position relative to the tool 15 by the alignment means. The coupler actuator 51 may subsequently be operated to move the pin 40 into its extend position such that the pin 40 engages the recess 26 of the tool engagement means 25 and the tool 15 cannot be separated from the machine 10. Furthermore, in the extend position the at least one connection passageway opening 67, 68, 69 may form a fluid seal with the at least one tool port 31, 32, 33 such that fluid can pass between the at least one machine fluid circuit and the at least one tool fluid circuit. In the illustrated embodiment all four coupling apparatuses 11 may be operated to move four pins 40 into corresponding recesses in the tool 15.

**[0038]** The machine 10 can therefore operate the tool 15 based upon an input from an operator, whether it is to move the tool 15 via the arm arrangement 14 or operate the tool 15 via the at least one tool fluid circuit. During operation the tool 15 may be rotated or pivoted about the axis of rotation 39. As the pin 40 can also rotate around the axis of rotation 39, the fluid connection is maintained and the tool fluid circuit can be operated. Rotation between the pin 40 and tool 15 may be prevented during operation by engaging the tool lock.

**[0039]** During disconnection the pin 40 may be moved to its retracted position such that it exits the recess 26. Thus the tool and machine fluid circuits are separated and the tool 15 can be separated from the machine 10.

**[0040]** In the embodiment shown in Figures 2 to 5 the first, second and third connection passageway openings 67, 68, 69 are aligned with one another along a single axis when viewed in the plane of the pin outer end 45 (see Figure 4 in particular). However, in a further embodiment shown in Figure 6 the first, second and third connection passageway openings 67, 68, 69 may be arranged in a triangular arrangement. As a result, the first, second and third connection passageway openings 67, 68, 69 are closer to the axis of rotation 39, where stresses in the pin 40 may be lower.

**[0041]** In a further embodiment, the coupler 34 need not be extendable and may instead comprise a single pin without the coupler actuator 51. The fluid connection arrangement 35 may be substantially similar to that described above and extend through a single rotatable pin body. The tool engagement means 25 may instead be moveable between a locked and unlocked position. For example, the tool engagement means 25 may each comprise a hook for receiving the coupler 34 and a lock for locking the coupler 34 in the hook.

**[0042]** Furthermore, in embodiments the machine 10 may comprise at least one pair of supply and return coupling apparatuses 11. The supply coupling apparatus 11 may be configured to provide the supply line for fluid travelling from the machine fluid circuit to the tool fluid circuit. The return coupling apparatus 11 may be configured to provide the return line for fluid travelling from the tool fluid circuit to the machine fluid circuit.

**[0043]** Figure 7 illustrates a further embodiment in which two coupling apparatuses 11 are connected to one another by a separating body 80 located between them in the housing passageway 37. The separating body 80 may be connected, for example by welding, to the inner ends of the mounts 41. As a result, the mounts 41 may be fixed relative to one another. The separating body 80 may be a tube as illustrated. The separating body 80 may comprise a body axial lock 81 for preventing axial movement of the separating body 80 and mounts 41 along the axis of rotation 39 whilst allowing them to rotate at least partially within the housing 36. The body axial lock 81 may comprise a groove 82 extending around the separating body 80 and a body locking pin 83 which may be mounted through the housing 36 such that it can extend into the housing passageway 37. The body locking pin 83 and groove 82 may be correspondingly positioned such that the body locking pin 83 extends into the groove 82, thereby preventing axial movement of the separating body 80. In addition, the separating body 80 may provide a convenient means by which to easily install, in a single

step, the entire arrangement of two coupling apparatuses 11 into the housing passageway 37.

Industrial Applicability

**[0044]** The coupling apparatus 11 of the present disclosure may enable a fluid connection and a physical connection between the tool 15 and the machine 10 to be formed with a single connector. The number of parts may be minimised in this manner, thereby reducing weight at the end of the arm arrangement 14. In addition, known quick couplers may increase the "height" of the tool 15 as they increase they comprise bodies located between the tool 15 and second arm 17. In the present disclosure no such separating bodies are required, thereby minimising the height of the tool 15. Furthermore, the number of steps required to couple the tool 15 to the machine 10 may be minimised since the fluid connection and physical connection may occur simultaneously.

## Claims

**1.** An apparatus for coupling a tool to a machine, the machine comprising a machine fluid circuit and the tool comprising a tool fluid circuit and tool engagement means, wherein the apparatus comprises:

a coupler; and
a fluid connection arrangement configured to direct fluid through the coupler,

wherein the coupler is configured to engage with the tool engagement means such that the tool is mounted to the machine and the fluid connection arrangement fluidly connects the tool fluid circuit to the machine fluid circuit through the coupler.

**2.** An apparatus as claimed in claim 1 wherein the coupler is configured to engage with the tool engagement means such that the tool is pivotally mounted to the machine.

**3.** An apparatus as claimed in claim 2 further comprising a housing, the coupler being at least partially rotatably mounted within the housing.

**4.** An apparatus as claimed in claim 3 wherein the fluid connection arrangement comprises at least one passageway, the at least one passageway extending from an outer end of the coupler to a port in the housing.

**5.** An apparatus as claimed in claim 4 wherein the at least one passageway comprises an internal passageway extending from the outer end of the coupler to a groove extending around the coupler, the groove being located adjacent to the port such that fluid can pass between the port and the outer end of the coupler via the groove and internal passageway.

**6.** An apparatus as claimed in any one of claims 3 to 5 further comprising a coupler axial lock arranged to prevent axial movement of the coupler and allow rotational movement of the coupler.

**7.** An apparatus as claimed in any one of the preceding claims further comprising a coupler actuator, the coupler actuator being configured to selectively orientate the coupler between:

an engaged orientation for engaging with the tool engagement means such that the tool is mounted to the machine and the fluid connection arrangement fluidly connects the tool fluid circuit to the machine fluid circuit; and
a disengaged orientation for being disengaged from the tool engagement means such that the tool is separable from the machine and the tool fluid circuit is fluidly disconnected from the machine fluid circuit.

**8.** An apparatus as claimed in any one of the preceding claims wherein the coupler comprises a pin connected to a mount, the pin being moveable relative to the mount.

**9.** An apparatus as claimed in claim 7 and claim 8, wherein the coupler actuator is configured to move the pin relative to the mount such that in the engaged orientation the pin is extended relative to the mount and in the disengaged orientation the pin is retracted relative to the mount.

**10.** An apparatus as claimed in claim 9 wherein:

the pin comprises an internal chamber and the mount comprises a piston head sealably mounted within the internal chamber such that the internal chamber is separated into first and second chambers; and
the coupler actuator comprises an actuator hydraulic circuit for transferring fluid to and from each of the first and second chambers for extending and retracting the pin.

**11.** A machine comprising at least one apparatus as claimed in any one of the preceding claims.

**12.** A tool comprising a tool fluid circuit and tool engagement means, the tool engagement means being configured to connect the tool fluid circuit to the fluid connection arrangement of the apparatus claimed in any one of claims 1 to 11.

**13.** A tool as claimed in claim 12 further comprising a

tool lock configured to engage with the coupler prevent rotation of the coupler relative to the tool.

**14.** A method of coupling a tool to a machine, wherein the machine comprises a coupling apparatus and the coupling apparatus comprises a fluid connection arrangement, the method comprising:

engaging the coupling apparatus with tool engagement means such that, simultaneously, the tool is mounted to the machine and the fluid connection arrangement fluidly connects a tool fluid arrangement to a machine fluid circuit.

**15.** A method as claimed in claim 14 wherein engaging the coupling apparatus with tool engagement means comprises:

extending a pin relative to a mount such that the pin is located in the tool engagement means and at least one passageway extending to an outer end of the pin is fluidly connected to the tool fluid circuit, which extends to the tool engagement means.

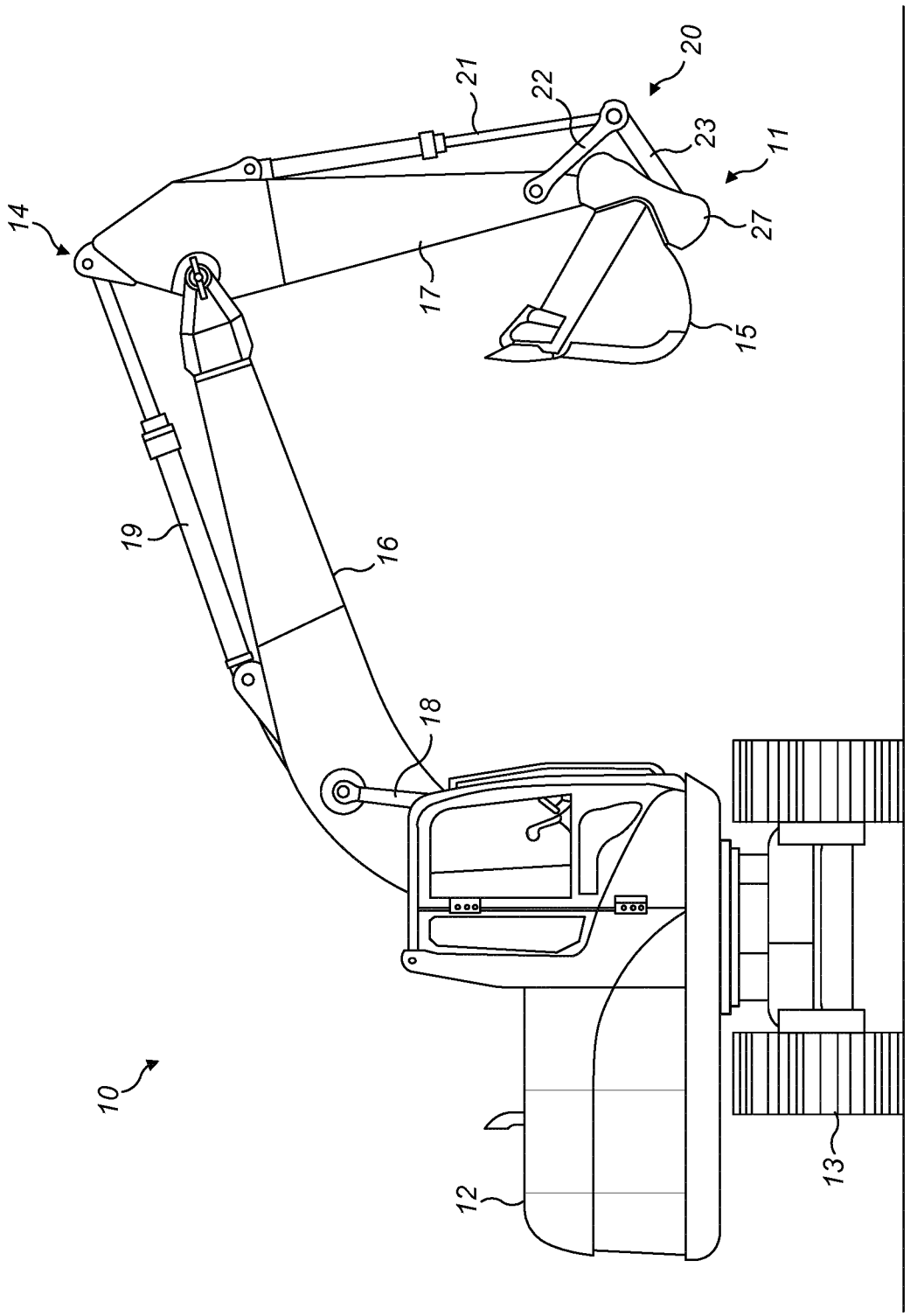


FIG. 1

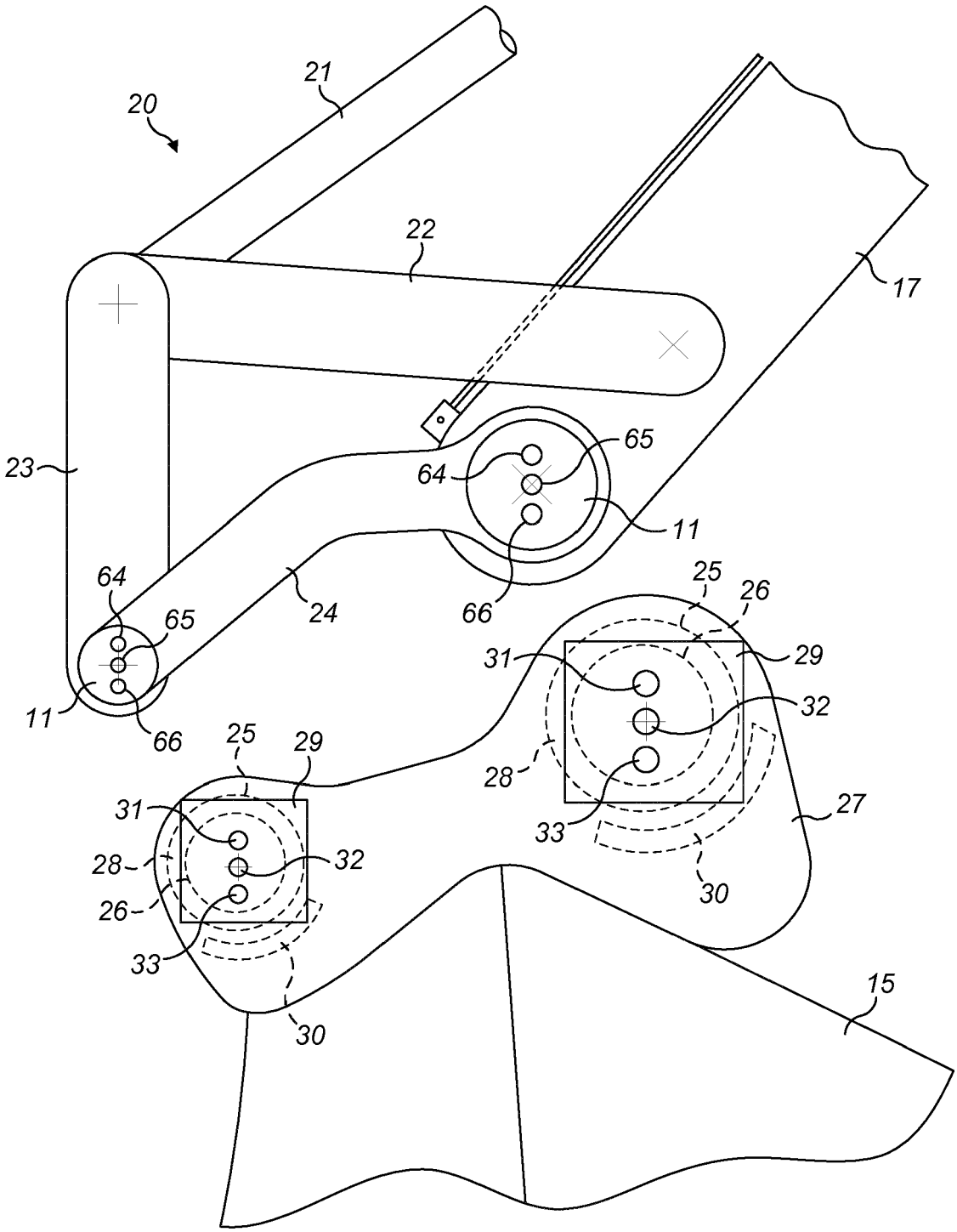


FIG. 2

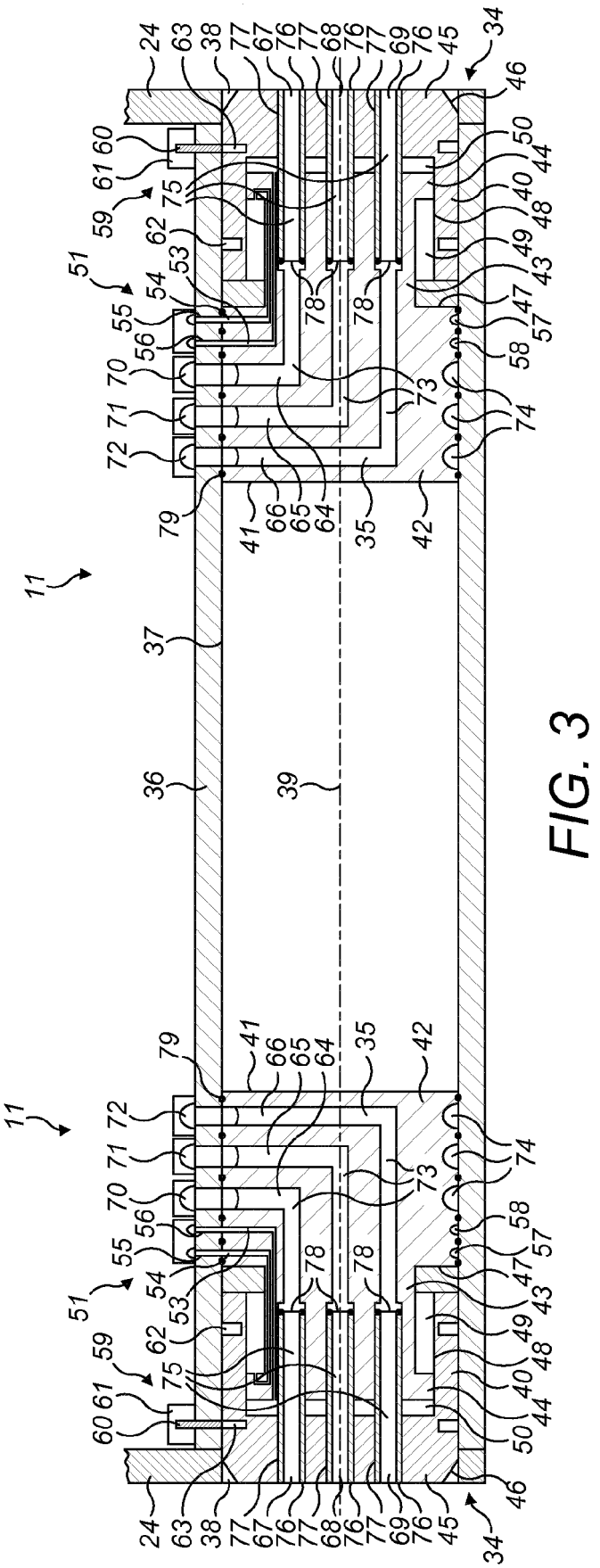
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FIG. 3

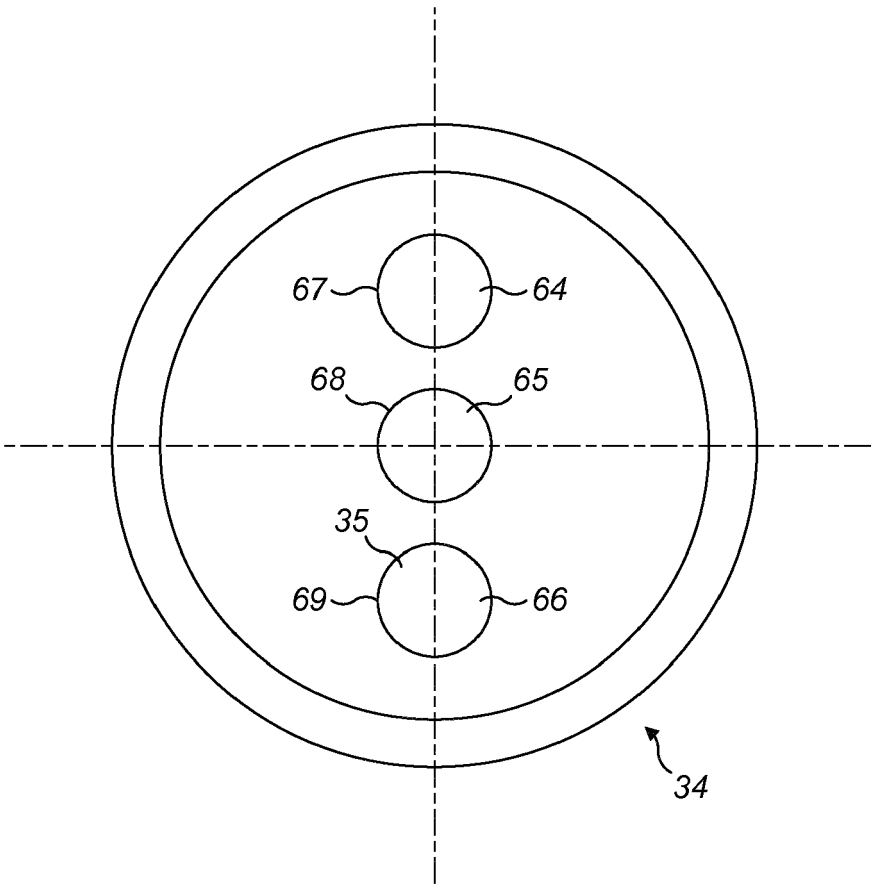


FIG. 4

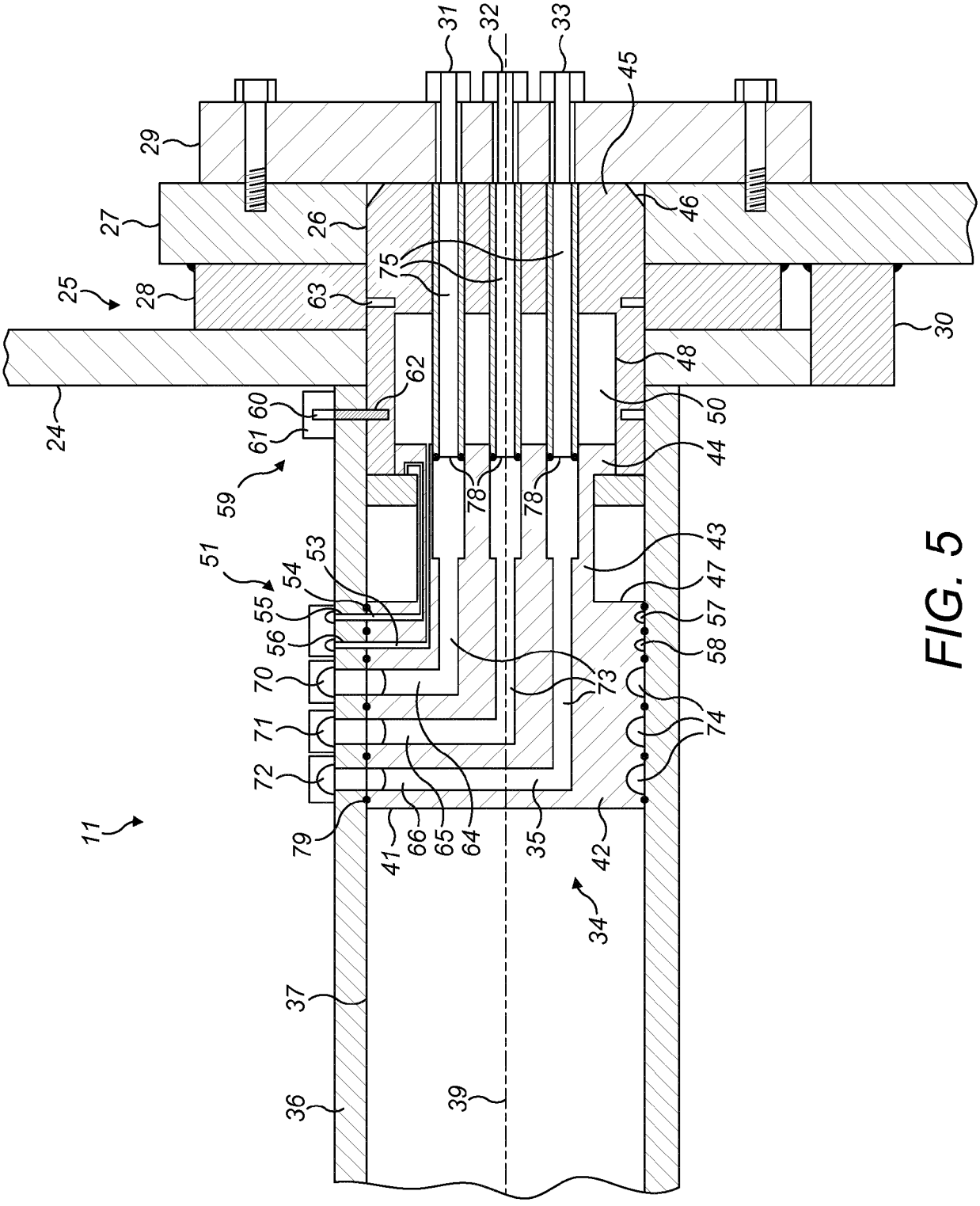
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FIG. 5

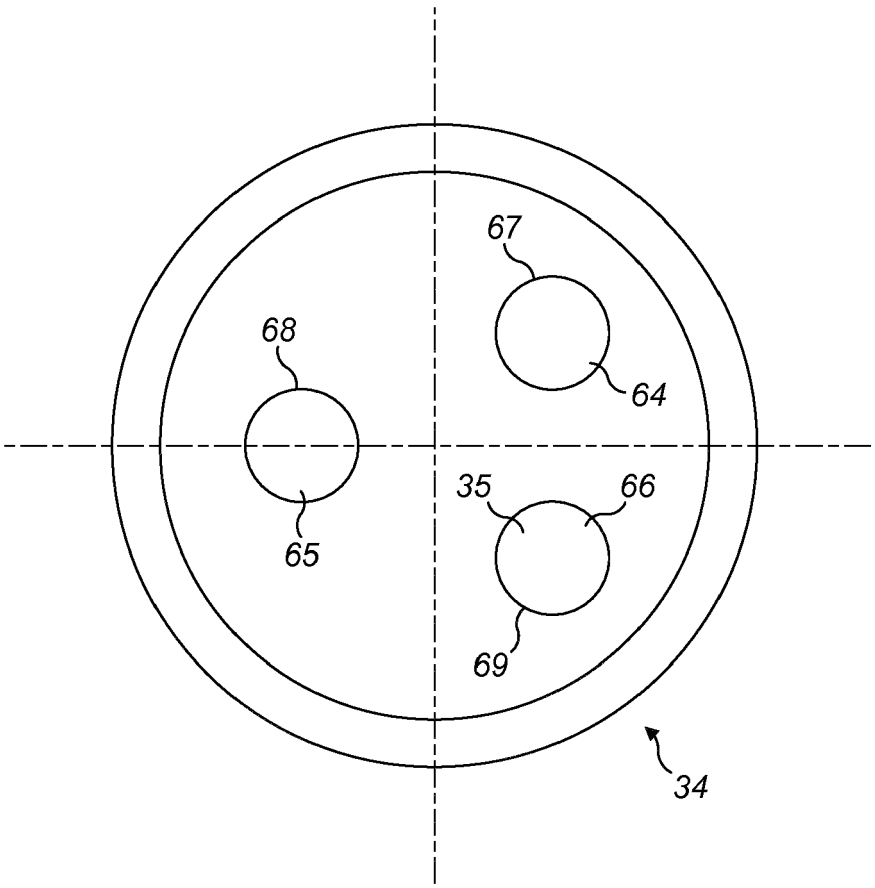


FIG. 6

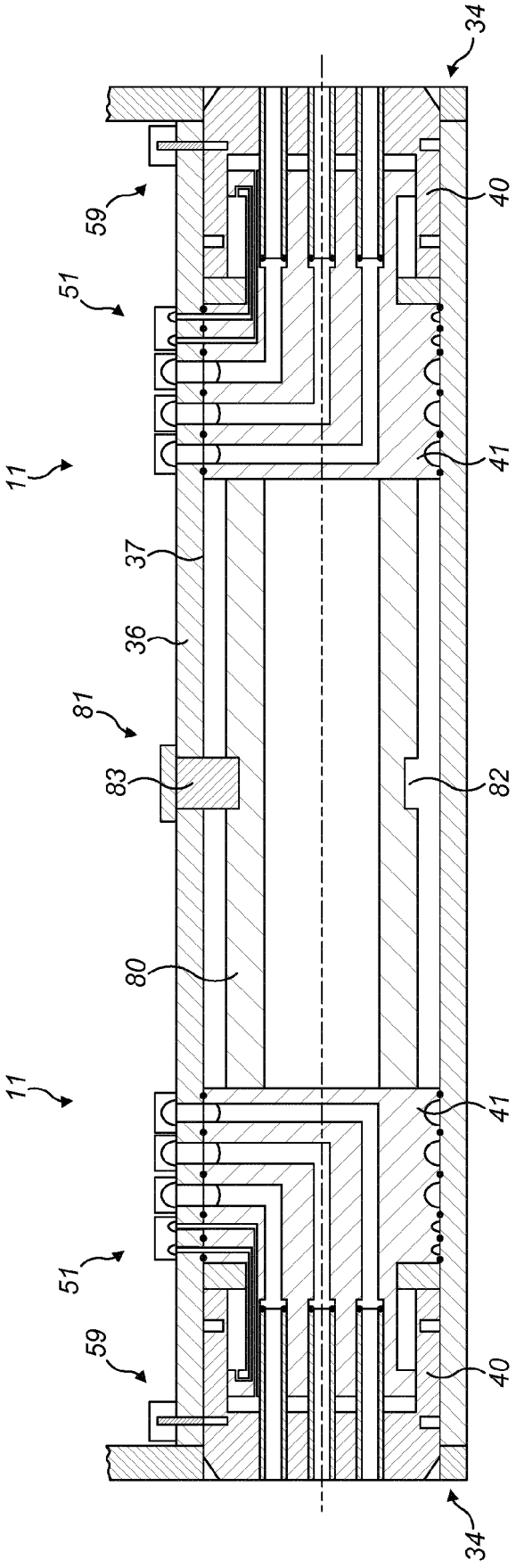


FIG. 7

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Application Number
EP 16 20 1100

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