

CLAIMS

We claim:

- Claim 1. A system to actuate a hydraulic downhole tool, the system comprising:
a hydraulic conduit; and
a hydraulic downhole tool comprising:
a first chamber fluidly coupled to the hydraulic conduit, a second chamber separated from the first chamber by a frangible member, wherein the second chamber has a drive surface for actuating the hydraulic downhole tool using hydrostatic pressure; and
a rotational and spiralling fluid-flow path from the first chamber to the second chamber, the fluid-flow path containing a fluid-flow restrictor having a fluid inlet arranged relative to a fluid outlet to cause fluid to spiral towards the fluid outlet.
- Claim 2. The system of claim 1, wherein the frangible member prevents fluid flow from the first chamber to the second chamber when the frangible member is in an unactuated state and permits fluid flow from the first chamber to the second chamber when the frangible member is in an actuated state, and wherein the frangible member is operable to automatically actuate when a pressure differential between the first chamber and the second chamber exceeds a predetermined threshold.
- Claim 3. The system of claim 1 or 2, wherein the fluid-flow restrictor comprises a vortex-inducing fluid-flow restrictor.
- Claim 4. The system of claim 3, wherein the vortex-inducing fluid-flow restrictor comprises at least one arcuate vane.
- Claim 5. The system of claim 3, wherein the vortex-inducing fluid-flow restrictor comprises a plurality of concentric arcuate vanes.
- Claim 6. The system of claim 3, wherein the vortex-inducing fluid-flow restrictor comprises a plurality of arcuate vanes that are equidistant from an outlet of the fluid-flow restrictor.
- Claim 7. The system of claim 1, wherein the fluid-flow restrictor comprises a shaped surface.

- Claim 8. An apparatus to transmit fluid within a hydraulic downhole tool, the apparatus comprising:
- a first chamber, the first chamber being at a first pressure at a first time; a second chamber, the second chamber being at a second pressure at the first time and at a third pressure at a second time, the first pressure being greater than the second pressure and approximately equal to the third pressure;
 - a fluid-flow path from the first chamber to the second chamber, the fluid-flow path comprising:
 - a fluid inlet to receive fluid into the fluid-flow path from the first chamber,
 - a fluid outlet to deliver fluid to the second chamber from the fluid flow path, and
 - at least one fluid-flow restrictor disposed between the fluid inlet and the fluid outlet to direct fluid received from the fluid inlet into a rotational and spiralling flow path around a longitudinal axis of the fluid outlet;
 - wherein the second chamber has a drive surface for actuating the hydraulic downhole tool using hydrostatic pressure when the second chamber is at the third pressure.
- Claim 9. The apparatus of claim 8, wherein the fluid inlet is configured to introduce fluid received from a hydrostatic chamber along a direction tangential to the rotational flow path.
- Claim 10. The apparatus of claim 8, wherein the fluid-flow restrictor comprises a plurality of guide vanes forming a vortex-inducing flow path.
- Claim 11. The apparatus of claim 8, wherein the fluid-flow restrictor comprises at least one arcuate vane.
- Claim 12. The apparatus of claim 8, wherein the fluid-flow restrictor comprises a plurality of arcuate vanes that are equidistant from an outlet of the fluid-flow restrictor.
- Claim 13. The apparatus of claim 8, wherein the fluid-flow restrictor comprises a shaped surface.
- Claim 14. The apparatus of claim 13, wherein the shaped surface comprises concentric square grooves.

- Claim 15. The apparatus of claim 13, wherein the shaped surface comprises concentric oscillatory grooves.
- Claim 16. The apparatus of claim 8, wherein the fluid-flow restrictor comprises a vane and a deflector.
- Claim 17. A method of actuating a hydraulic downhole tool, the method comprising:
generating a hydrostatic pressure in a first chamber;
transmitting a fluid through a fluid-flow path from the first chamber to a second chamber, wherein the second chamber has a drive surface for actuating the hydraulic downhole tool using hydrostatic pressure, and wherein the fluid-flow path comprises at least one vortex-inducing fluid-flow restrictor having a fluid inlet arranged relative to a fluid out to cause fluid to spiral towards the fluid outlet; and
actuating the hydraulic downhole tool by transmitting the hydrostatic pressure to the second chamber to generate a hydrostatic force against at least one movable member of the hydraulic downhole tool.
- Claim 18. The method of claim 17, further comprising introducing fluid to a fluid inlet of the fluid-flow restrictor along a direction tangential to the fluid flow path, the fluid flow path being a generally rotational and spiralling fluid-flow path.
- Claim 19. The method of claim 18, wherein the fluid-flow restrictor comprises a plurality of guide vanes forming a vortex-inducing flow path.
- Claim 20. The method of claim 18, wherein the fluid-flow restrictor is operable to restrict the flow of fluid by a variable amount depending on the flow rate of the fluid.