CLAIMS

1. A crossover joint for connecting a first wellbore tool to a second wellbore tool, the first wellbore tool having a primary flow path and at least one secondary flow path, and the second wellbore tool having a primary flow path and at least one secondary flow path, wherein a radial center of the primary flow path in the first wellbore tool is offset from a radial center of the primary flow path in the second wellbore tool, the crossover joint comprising:

a primary flow path configured to fluidly connect the primary flow path of the first wellbore tool to the primary flow path of the second wellbore tool; and

at least one secondary flow path configured to fluidly connect the at least one secondary flow path of the first wellbore tool to the at least one secondary flow path of the second wellbore tool.

2. The crossover joint of claim 1, wherein:

the primary flow path in the crossover joint is eccentric to the crossover joint at a first end; and

the primary flow path in the crossover joint is concentric to the crossover joint at a second end.

3. The crossover joint of claim 2, wherein the primary flow path in the crossover joint has a profile of a sigmoid function.

4. The crossover joint of claim 2, wherein the primary flow path in the crossover joint changes direction along a longitudinal axis of the crossover joint at least once.

5. The crossover joint of claim 4, wherein the primary flow path in the crossover joint comprises at least two linear segments.

6. The crossover joint of claim 4, wherein the at least one secondary flow path of the crossover joint changes direction along a longitudinal axis of the crossover joint at least once.

7. A wellbore apparatus comprising:

a first wellbore tool having a primary flow path and at least one secondary flow path;

a second wellbore tool also having a primary flow path and at least one secondary flow path, wherein a radial center of the primary flow path in the first wellbore tool is offset from a radial center of the primary flow path in the second wellbore tool; and

a crossover joint for connecting the first wellbore tool to the second wellbore tool, the crossover joint comprising:

a primary flow path fluidly connecting the primary flow path of the first wellbore tool to the primary flow path of the second wellbore tool; and

at least one secondary flow path fluidly connecting the at least one secondary flow path of the first wellbore tool to the at least one secondary flow path of the second wellbore tool.

8. The wellbore apparatus of claim 7, wherein:

the primary flow path in the crossover joint is eccentric to the crossover joint at a first end; and

the primary flow path in the crossover joint is concentric to the crossover joint at a second end.

9. The wellbore apparatus of claim 8, wherein the primary flow path of the first wellbore tool is eccentric to the first wellbore tool.

10. The wellbore apparatus of claim 8, wherein the primary flow path of the second wellbore tool is concentric to the second wellbore tool.

11. The wellbore apparatus of claim 8, wherein the at least one secondary flow path of the first wellbore tool is eccentric to the first wellbore tool.

12. The wellbore apparatus of claim 7, wherein:

the wellbore apparatus is a sand control device;

the first wellbore tool is a sand screen that comprises an elongated base pipe, a filtering medium circumferentially around the base pipe, and at least one shunt tube along the base pipe serving as an alternate flow channel, the at least one shunt tube being configured to allow gravel slurry to at least partially bypass the first wellbore tool during a gravel-packing operation in a wellbore;

the base pipe serves as the primary flow path of the sand screen; and

the at least one shunt tube serves as the at least one secondary flow path of the sand screen.

13. The wellbore apparatus of claim 12, wherein:

the at least one shunt tube is internal to the filtering medium.

14. The wellbore apparatus of claim 12, wherein:

the at least one shunt tube is external to the filtering medium.

15. The wellbore apparatus of claim 14, wherein:

each of the at least one shunt tube has a round profile, a square profile, or a rectangular profile; and

the elongated base pipe is eccentric to the sand screen.

16. The wellbore apparatus of claim 15, wherein the first wellbore tool further comprises a perforated outer protective shroud around the at least one shunt tube.

17. The wellbore apparatus of claim 7, wherein:

the second wellbore tool is a packer, the packer comprising an elongated inner mandrel, a sealing element external to the inner mandrel, and an annular region serving as an alternate flow channel, the annular region being configured to allow gravel slurry to at least partially bypass the second wellbore tool during a gravel-packing operation in a wellbore after the packer has been set in the wellbore;

the inner mandrel serves as the primary flow path of the packer; and

the annular region serves as the at least one secondary flow path of the packer.

18. The wellbore apparatus of claim 17, wherein the inner mandrel is concentric to the packer.

19. The wellbore apparatus of claim 18, wherein the second end of the crossover joint is connected to the packer by means of:

a load sleeve external to the primary flow path at or near a first end, with at least one bored channel through and fluidly connected to the at least one secondary flow path; or

a torque sleeve external to the primary flow path at near a second opposite end with at least one bored channel through and fluidly connected to the at least one secondary flow path.

20. The wellbore apparatus of claim 17, wherein the annular region is eccentric to the packer.

21. The wellbore apparatus of claim 8, wherein an inner diameter of the primary flow path of the crossover joint is greater than an inner diameter of (i) the primary flow path of the first wellbore tool, (ii) the primary flow path of the second wellbore tool, or (iii) both.

22. The wellbore apparatus of claim 7, wherein:

the first wellbore tool is a blank pipe that comprises an elongated base pipe and at least one shunt tube along the base pipe serving as an alternate flow channel, the at least one shunt tube being configured to allow gravel slurry to at least partially bypass the first wellbore tool during a gravel-packing operation in a wellbore;

the base pipe serves as the primary flow path of the blank pipe; and

the at least one shunt tube serves as the at least one secondary flow path of the blank pipe.

23. The wellbore apparatus of claim 17, wherein the packer further comprises:

a release sleeve along an inner surface of the inner mandrel, the packer being configured so that shifting the release sleeve shears at least one shear pin along the inner mandrel;

a movable piston housing retained around the inner mandrel, with the annular region being formed between the inner mandrel and the surrounding piston housing; and

one or more flow ports providing fluid communication between the annular region and a pressure-bearing surface of the piston housing after the release sleeve has been shifted.

24. The wellbore apparatus of claim 17, wherein the sealing element of the packer is an elastomeric cup-type element.

25. The wellbore apparatus of claim 12, wherein:

the second wellbore tool is a packer, the packer comprising an elongated inner mandrel, a sealing element external to the inner mandrel, and an annular region serving as an alternate flow channel, the annular region being configured to allow gravel slurry to at least partially bypass the second wellbore tool during a gravel-packing operation in a wellbore after the packer has been set in the wellbore;

the inner mandrel serves as the primary flow path of the packer; and

the annular region serves as the at least one secondary flow path of the packer.

26. The wellbore apparatus of claim 12, wherein:

the second wellbore tool is also a sand screen that comprises an elongated base pipe, a filtering medium circumferentially around the base pipe, and at least one shunt tube along the base pipe serving as an alternate flow channel, the at least one shunt tube being configured to allow gravel slurry to at least partially bypass the second wellbore tool during a gravel-packing operation in a wellbore;

the elongated base pipe of the sand screen representing the first wellbore tool is concentric to the sand screen; and

the elongated base pipe of the sand screen representing the second wellbore tool is eccentric to the sand screen.

27. A method for completing a wellbore in a subsurface formation, the method comprising:

providing a first wellbore tool, the first wellbore tool having a primary flow path and at least one secondary flow path;

providing a second wellbore tool also comprising a primary flow path and at least one secondary flow path, wherein a radial center of the primary flow path in the first wellbore tool is offset from a radial center of the primary flow path in the second wellbore tool; and

providing a crossover joint, the crossover joint also comprising a primary flow path and at least one secondary flow path;

fluidly connecting the crossover joint to the first wellbore tool at a first end, and fluidly connecting the crossover joint to the second wellbore tool at a second end, such that the primary flow path of the first wellbore tool is in fluid communication with the primary flow path of the second wellbore tool, and the at least one secondary flow path of the first wellbore tool is in fluid communication with the at least one secondary flow path of the second wellbore tool;

running the crossover joint and connected first and second wellbore tools into a wellbore to a selected subsurface location, and thereby forming an annulus in the wellbore between the crossover joint and the surrounding wellbore;

injecting a fluid into the wellbore; and

further injecting the fluid from the wellbore and into the secondary flow paths of the first wellbore tool, the crossover joint, and the secondary flow paths of the second wellbore tool.

28. The method of claim 27, wherein:

the fluid is a gravel slurry for forming a gravel pack;

the first wellbore tool is a sand screen that comprises an elongated base pipe, a filtering medium circumferentially around the base pipe, and at least one shunt tube along the base pipe serving as an alternate flow channel, the at least one shunt tube being configured to allow gravel slurry to at least partially bypass the first wellbore tool during a gravel-packing operation in a wellbore;

the base pipe serves as the primary flow path of the sand screen; and

the at least one shunt tube serves as the at least one secondary flow path of the sand screen.

29. The method of claim 28, further comprising:

running a setting tool into the inner mandrel of the packer;

pulling the setting tool to mechanically shift a release sleeve from a retained position along the inner mandrel of the packer, thereby releasing the piston housing for axial movement; and

communicating hydrostatic pressure to the piston housing through the one or more flow ports, thereby axially moving the released piston housing and actuating the sealing element against the surrounding wellbore.

30. The method of claim 29, wherein:

running the setting tool comprises running a washpipe into a bore within the inner mandrel of the packer, the washpipe having the setting tool thereon; and

releasing a movable piston housing from its retained position by pulling the washpipe with the setting tool along the inner mandrel, thereby shifting a release sleeve and shearing the at least one shear pin, and thereby releasing the piston housing for axial movement along the inner mandrel.

31. The method of claim 28, wherein during the injecting step, the at least one secondary flow path in the crossover joint has a fluid pressure that is higher than a fluid pressure in the primary flow path of the crossover joint.

32. The method of claim 27, wherein during the injecting step, the at least one secondary flow path in the crossover joint has a fluid pressure that is higher than a fluid pressure in the wellbore annulus.

33. The method of claim 27, wherein the at least one secondary flow path in the first wellbore tool is connected to the at least one secondary flow path in the crossover joint by means of a manifold.

CLAIMS

1. A crossover joint for connecting a first wellbore tool to a second wellbore tool, the first wellbore tool having a primary flow path and at least one secondary flow path, and the second wellbore tool having a primary flow path and at least one secondary flow path, wherein a radial center of the primary flow path in the first wellbore tool is offset from a radial center of the primary flow path in the second wellbore tool, the crossover joint comprising:

a primary flow path configured to fluidly connect the primary flow path of the first wellbore tool to the primary flow path of the second wellbore tool; and

at least one secondary flow path configured to fluidly connect the at least one secondary flow path of the first wellbore tool to the at least one secondary flow path of the second wellbore tool,

wherein the at least one secondary flow path in the first wellbore is connected to the at least one secondary flow path in the crossover joint by means of a manifold.

2. The crossover joint of claim 1, wherein:

the primary flow path in the crossover joint is eccentric to the crossover joint at a first end; and

the primary flow path in the crossover joint is concentric to the crossover joint at a second end.

3. The crossover joint of claim 2, wherein the primary flow path in the crossover joint has a profile of a sigmoid function.

4. The crossover joint of claim 2, wherein the primary flow path in the crossover joint changes direction along a longitudinal axis of the crossover joint at least once.

5. The crossover joint of claim 4, wherein the primary flow path in the crossover joint comprises at least two linear segments.

6. The crossover joint of claim 4, wherein the at least one secondary flow path of the crossover joint changes direction along a longitudinal axis of the crossover joint at least once.

7. A wellbore apparatus comprising:

a first wellbore tool having a primary flow path and at least one secondary flow path;

a second wellbore tool also having a primary flow path and at least one secondary flow path, wherein a radial center of the primary flow path in the first wellbore tool is offset from a radial center of the primary flow path in the second wellbore tool; and

a crossover joint for connecting the first wellbore tool to the second wellbore tool, the crossover joint comprising:

a primary flow path fluidly connecting the primary flow path of the first wellbore tool to the primary flow path of the second wellbore tool; and

at least one secondary flow path fluidly connecting the at least one secondary flow path of the first wellbore tool to the at least one secondary flow path of the second wellbore tool,

wherein the at least one secondary flow path in the first wellbore is connected to the at least one secondary flow path in the crossover joint by means of a manifold.

8. The wellbore apparatus of claim 7, wherein:

the primary flow path in the crossover joint is eccentric to the crossover joint at a first end; and

the primary flow path in the crossover joint is concentric to the crossover joint at a second end.

9. The wellbore apparatus of claim 8, wherein the primary flow path of the first wellbore tool is eccentric to the first wellbore tool.

10. The wellbore apparatus of claim 8, wherein the primary flow path of the second wellbore tool is concentric to the second wellbore tool.

11. The wellbore apparatus of claim 8, wherein the at least one secondary flow path of the first wellbore tool is eccentric to the first wellbore tool.

12. The wellbore apparatus of claim 7, wherein:

the wellbore apparatus is a sand control device;

the first wellbore tool is a sand screen that comprises an elongated base pipe, a filtering medium circumferentially around the base pipe, and at least one shunt tube along the base pipe serving as an alternate flow channel, the at least one shunt

tube being configured to allow gravel slurry to at least partially bypass the first wellbore tool during a gravel-packing operation in a wellbore;

the base pipe serves as the primary flow path of the sand screen; and

the at least one shunt tube serves as the at least one secondary flow path of the sand screen.

13. The wellbore apparatus of claim 12, wherein:

the at least one shunt tube is internal to the filtering medium.

14. The wellbore apparatus of claim 12, wherein:

the at least one shunt tube is external to the filtering medium.

15. The wellbore apparatus of claim 14, wherein:

each of the at least one shunt tube has a round profile, a square profile, or a rectangular profile; and

the elongated base pipe is eccentric to the sand screen.

16. The wellbore apparatus of claim 15, wherein the first wellbore tool further comprises a perforated outer protective shroud around the at least one shunt tube.

17. The wellbore apparatus of claim 7, wherein:

the second wellbore tool is a packer, the packer comprising an elongated inner mandrel, a sealing element external to the inner inaridrel, and an annular region serving as an alternate flow channel, the annular region being configured to allow gravel slurry to at least partially bypass the second wellbore tool during a gravel-packing operation in a wellbore after the packer has been set in the wellbore;

the inner mandrel serves as the primary flow path of the packer; and

the annular region serves as the at least one secondary flow path of the packer.

18. The wellbore apparatus of claim 17, wherein the inner mandrel is concentric to the packer.

19. The wellbore apparatus of claim 18, wherein a second end of the crossover joint is connected to the packer by means of:

a load sleeve external to the primary flow path at or near a first end, with at least one bored channel through and fluidly connected to the at least one secondary flow path; or

a torque sleeve external to the primary flow path at near a second opposite end with at least one bored channel through and fluidly connected to the at least one secondary flow path.

20. The wellbore apparatus of claim 17, wherein the annular region is eccentric to the packer.

21. The wellbore apparatus of claim 8, wherein an inner diameter of the primary flow path of the crossover joint is greater than an inner diameter of (i) the primary flow path of the first wellbore tool, (ii) the primary flow path of the second wellbore tool, or (iii) both.

22. The wellbore apparatus of claim 7, wherein:

the first wellbore tool is a blank pipe that comprises an elongated base pipe and at least one shunt tube along the base pipe serving as an alternate flow channel, the at least one shunt tube being configured to allow gravel slurry to at least partially bypass the first wellbore tool during a gravel-packing operation in a wellbore;

the base pipe serves as the primary flow path of the blank pipe; and

the at least one shunt tube serves as the at least one secondary flow path of the blank pipe.

23. The wellbore apparatus of claim 17, wherein the packer further comprises:

a release sleeve along an inner surface of the inner mandrel, the packer being configured so that shifting the release sleeve shears at least one shear pin along the inner mandrel;

a movable piston housing retained around the inner mandrel, with the annular region being formed between the inner mandrel and the surrounding piston housing; and

one or more flow ports providing fluid communication between the annular region and a pressure-bearing surface of the piston housing after the release sleeve has been shifted.

24. The wellbore apparatus of claim 17, wherein the sealing element of the packer is an elastomeric cup-type element.

25. The wellbore apparatus of claim 12, wherein:

the second wellbore tool is a packer, the packer comprising an elongated inner mandrel, a sealing element external to the inner mandrel, and an annular region serving as an alternate flow channel, the annular region being configured to allow gravel slurry to at least partially bypass the second wellbore tool during a gravel-packing operation in a wellbore after the packer has been set in the wellbore;

the inner mandrel serves as the primary flow path of the packer; and

the annular region serves as the at least one secondary flow path of the packer.

26. The wellbore apparatus of claim 12, wherein:

the second wellbore tool is also a sand screen that comprises an elongated base pipe, a filtering medium circumferentially around the base pipe, and at least one shunt tube along the base pipe serving as an alternate flow channel, the at least one shunt tube being configured to allow gravel slurry to at least partially bypass the second wellbore tool during a gravel-packing operation in a wellbore;

the elongated base pipe of the sand screen representing the first wellbore tool is concentric to the sand screen; and

the elongated base pipe of the sand screen representing the second wellbore tool is eccentric to the sand screen.

27. A method for completing a wellbore in a subsurface formation, the method comprising:

providing a first wellbore tool, the first wellbore tool having a primary flow path and at least one secondary flow path;

providing a second wellbore tool also comprising a primary flow path and at least one secondary flow path, wherein a radial center of the primary flow path in the first wellbore tool is offset from a radial center of the primary flow path in the second wellbore tool; and

providing a crossover joint, the crossover joint also comprising a primary flow path and at least one secondary flow path;

fluidly connecting the crossover joint to the first wellbore tool at a first end, and fluidly connecting the crossover joint to the second wellbore tool at a second end, such that the primary flow path of the first wellbore tool is in fluid communication with the primary flow path of the second wellbore tool, and the at least one secondary flow path of the first wellbore tool is in fluid communication with the at least one secondary flow path of the second wellbore tool, wherein the at least one secondary flow path in the first wellbore is connected to the at least one secondary flow path in the crossover joint by means of a manifold;

running the crossover joint and connected first and second wellbore tools into a wellbore to a selected subsurface location, and thereby forming an annulus in the wellbore between the crossover joint and the surrounding wellbore;

injecting a fluid into the wellbore; and

further injecting the fluid from the wellbore and into the secondary flow paths of the first wellbore tool, the crossover joint, and the secondary flow paths of the second wellbore tool.

28. The method of claim 27, wherein:

the fluid is a gravel slurry for forming a gravel pack;

the first wellbore tool is a sand screen that comprises an elongated base pipe, a filtering medium circumferentially around the base pipe, and at least one shunt tube along the base pipe serving as an alternate flow channel, the at least one shunt tube being configured to allow gravel slurry to at least partially bypass the first wellbore tool during a gravel-packing operation in a wellbore;

the base pipe serves as the primary flow path of the sand screen; and the at least one shunt tube serves as the at least one secondary flow path of the sand screen.

29. The method of claim 28, further comprising:

running a setting tool into the inner mandrel of the packer;

pulling the setting tool to mechanically shift a release sleeve from a retained position along the inner mandrel of the packer, thereby releasing the piston housing for axial movement; and

communicating hydrostatic pressure to the piston housing through the one or more flow ports, thereby axially moving the released piston housing and actuating the sealing element against the surrounding wellbore.

30. The method of claim 29, wherein:

running the setting tool comprises running a washpipe into a bore within the inner mandrel of the packer, the washpipe having the setting tool thereon; and

releasing a movable piston housing from its retained position by pulling the washpipe with the setting tool along the inner mandrel, thereby shifting a release sleeve and shearing the at least one shear pin, and thereby releasing the piston housing for axial movement along the inner mandrel.

31. The method of claim 28, wherein during the injecting step, the at least one secondary flow path in the crossover joint has a fluid pressure that is higher than a fluid pressure in the primary flow path of the crossover joint.

32. The method of claim 27, wherein during the injecting step, the at least one secondary flow path in the crossover joint has a fluid pressure that is higher than a fluid pressure in the wellbore annulus.

33. The crossover joint of any one of claims 1 to 26 or the method of any one of claims 27 to 32, wherein the at least one secondary flow path in the second wellbore tool is connected to the at least one secondary flow path in the crossover joint by means of a manifold.