CLAIMS

What is claimed is:

1. A well screen assembly, comprising:

a tubular base pipe comprising a sidewall aperture that communicates fluid between an interior central bore of the base pipe and an exterior of the base pipe;

a filtration screen around the base pipe, the filtration screen defining a lateral fluid passage along an axial length of the well screen assembly; and

a flow control device coupled to the base pipe and the filtration screen, the flow control device comprising a ring sealing the lateral fluid passage from the central bore and a plurality of elongate restrictor passages in the ring, the restrictor passages oriented longitudinally relative to the base pipe, residing azimuthally spaced apart from each other in an array around the circumference of the base pipe, and configured to communicate fluid between the lateral fluid passage and the central bore, the restrictor passages each comprising a contiguous tubular structure traversing the complete length of the respective restrictor passage and having a plurality of internal, square edged orifices each orifice defined by a fixed, annular protrusion extending inwardly from an interior surface of the restrictor passage, with at least one of the plurality of orifices located between opposing ends of the tubular structure.

2. The well screen assembly of claim 1, where each orifice is square edged on both a first opening and an opposing opening.

3. The well screen assembly of claim 1, where the annular protrusion comprises a square shoulder that is orthogonal to the longitudinal axis of the restrictor passage.

4. The well screen assembly of claim 3, where the annular protrusion comprises a second square shoulder opposite the first mentioned shoulder, the second shoulder is orthogonal to the longitudinal axis of the restrictor passage.

5. The well screen assembly of claim 4, where the annular protrusion comprises an inner sidewall surface extending from the first mentioned shoulder to the second

shoulder, and the inner sidewall surface is parallel to the longitudinal axis of the restrictor passage.

6. The well screen assembly of claim 5, where the inner sidewall surface of the restrictor passage meets the first mentioned shoulder at a right angle, without a fillet or chamfer.

7. The well screen assembly of claim 4, where the annular protrusion comprises a cylindrical inner sidewall surface extending from the first mentioned shoulder to the second shoulder.

8. The well screen assembly of claim 1, where the flow area through the orifices is the most restrictive flow area through the flow control device.

9. The well screen assembly of claim 1, where the orifices are equally spaced along the longitudinal length of the restrictor passage.

10. The well screen assembly of claim 1, where the flow area of one orifice is different than the flow area of another orifice.

11. The well screen assembly of claim 1, where the length of annular protrusion along the longitudinal axis of the restrictor passage is less than half the largest transverse inner dimension of the restrictor passage.

12. The well screen assembly of claim 1, where the length of annular protrusion along the longitudinal axis of the restrictor passage is less than the largest transverse inner dimension of the annular protrusion.

13. The well screen assembly of claim 1, where the restrictor passage is an internal bore of a tube that is threadingly secured in the ring.

14. The well screen assembly of claim 1, where the restrictor passage extends from a location proximate the lateral fluid passage of the screen and a location proximate the sidewall aperture of the base pipe.

15. The well screen assembly of claim 1, where the restrictor passage apart from the annular protrusions has a substantially uniform transverse dimension.

16. A well device, comprising:

a tubing having a sidewall aperture through to a central bore of the tubing;

a flow control housing carried on the tubing and defining an annular chamber over the aperture;

a flow control ring sealing a first portion of the annular chamber in fluid communication with the aperture from a second portion of the annular chamber; and

a plurality of single-piece orifice tubes extending longitudinally through the flow control ring, the orifice tubes azimuthally spaced apart from each other in an array around the circumference of the tubing and communicating the first and second portions of the annular chamber, each of the orifice tubes comprising a plurality of internal, square edged orifices each defined by a fixed, annular protrusion extending inwardly from an interior surface of the orifice tube, with at least one of the plurality of orifices located between opposing ends of the respective orifice tube.

17. The well device of claim 16, where the orifice tube apart from the annular protrusions has a substantially uniform transverse dimension.

18. The well device of claim 17, where the length of annular protrusion along the longitudinal axis of the orifice tube is less than half the largest transverse inner dimension of the orifice tube.

19. A method of controlling flow in a well, the method comprising:

receiving, in a flow control device, flow between an interior central bore of a tubular base pipe and a filtration screen about the base pipe; and

restricting the flow with a plurality of elongate restrictor passages oriented longitudinally relative to the base pipe, residing azimuthally spaced apart from each other in an array around the circumference of the base pipe, and each comprising a contiguous tubular structure traversing the complete length of the respective restrictor passage and having a plurality of internal, square edged orifices defined by a fixed, annular protrusion extending inwardly from an interior surface of the restrictor passage,

with at least one of the plurality of orifices located between opposing ends of the tubular structure.

20. The method of claim 19, further comprising affixing a flow tube comprising the restrictor passage into the flow control device.

21. The well device of claim 16, where the annular protrusion comprises:

a first square shoulder that is orthogonal to the longitudinal axis of the orifice tube;

a second square shoulder opposite the first shoulder that is orthogonal to the longitudinal axis of the orifice tube; and

a cylindrical inner sidewall surface that is parallel to the longitudinal axis of the orifice tube and extends from the first shoulder to the second shoulder, and where the inner sidewall surface meets at least the first mentioned shoulder at a right angle, without a fillet or chamfer.

22. The well device of claim 16, where each orifice is square edged on both a first opening and an opposing opening.

CLAIMS

1. A well screen assembly, comprising:

a tubular base pipe comprising a sidewall aperture that communicates fluid between an interior central bore of the base pipe and an exterior of the base pipe;

a filtration screen around the base pipe, the filtration screen defining a lateral fluid passage along an axial length of the well screen assembly; and

a flow control device coupled to the base pipe and the filtration screen, the flow control device comprising a ring sealing the lateral fluid passage from the central bore and a plurality of elongate restrictor passages in the ring, the restrictor passages oriented longitudinally relative to the base pipe, residing azimuthally spaced apart from each other in an array around the circumference of the base pipe, and configured to communicate fluid between the lateral fluid passage and the central bore, the restrictor passages each comprising a single-piece contiguous tubular structure independent of the base pipe, filtration screen and ring, and traversing the complete length of the respective restrictor passage and having a plurality of internal, square edged orifices each orifice defined by a fixed, annular protrusion extending inwardly from an interior surface of the tubular structure, with at least one of the plurality of orifices located between opposing ends of the tubular structure.

2. The well screen assembly of claim 1, where each orifice is square edged on both a first opening and an opposing opening.

3. The well screen assembly of claim 1, where the annular protrusion comprises a square shoulder that is orthogonal to the longitudinal axis of the restrictor passage.

4. The well screen assembly of claim 3, where the annular protrusion comprises a second square shoulder opposite the first mentioned shoulder, the second shoulder is orthogonal to the longitudinal axis of the restrictor passage.

5. The well screen assembly of claim 4, where the annular protrusion comprises an inner sidewall surface extending from the first mentioned shoulder to the second shoulder, and the inner sidewall surface is parallel to the longitudinal axis of the restrictor passage.

6. The well screen assembly of claim 5, where the inner sidewall surface of the restrictor passage meets the first mentioned shoulder at a right angle, without a fillet or chamfer.

7. The well screen assembly of claim 4, where the annular protrusion comprises a cylindrical inner sidewall surface extending from the first mentioned shoulder to the second shoulder.

8. The well screen assembly of claim 1, where the flow area through the orifices is the most restrictive flow area through the flow control device.

9. The well screen assembly of claim 1, where the orifices are equally spaced along the longitudinal length of the restrictor passage.

10. The well screen assembly of claim 1, where the flow area of one orifice is different than the flow area of another orifice.

11. The well screen assembly of claim 1, where the length of annular protrusion along the longitudinal axis of the restrictor passage is less than half the largest transverse inner dimension of the restrictor passage.

12. The well screen assembly of claim 1, where the length of annular protrusion along the longitudinal axis of the restrictor passage is less than the largest transverse inner dimension of the annular protrusion.

13. The well screen assembly of claim 1, where the restrictor passage is an internal bore of a tube that is threadingly secured in the ring.

14. The well screen assembly of claim 1, where the restrictor passage extends from a location proximate the lateral fluid passage of the screen and a location proximate the sidewall aperture of the base pipe.

15. The well screen assembly of claim 1, where the restrictor passage apart from the annular protrusions has a substantially uniform transverse dimension.

16. A well device, comprising:

a tubing having a sidewall aperture through to a central bore of the tubing;

a flow control housing carried on the tubing and defining an annular chamber over the aperture;

a flow control ring sealing a first portion of the annular chamber in fluid communication with the aperture from a second portion of the annular chamber; and

a plurality of contiguous single-piece orifice tubes extending longitudinally through the flow control ring, the orifice tubes azimuthally spaced apart from each other in an array around the circumference of the tubing and communicating the first and second portions of the annular chamber, each of the orifice tubes independent of the tubing, the flow control housing, and the flow control ring, and comprising a plurality of internal, square edged orifices each defined by a fixed, annular protrusion extending inwardly from an interior surface of the orifice tube, with at least one of the plurality of orifices located between opposing ends of the respective orifice tube.

17. The well device of claim 16, where the orifice tube apart from the annular protrusions has a substantially uniform transverse dimension.

18. The well device of claim 17, where the length of annular protrusion along the longitudinal axis of the orifice tube is less than half the largest transverse inner dimension of the orifice tube.

19. A method of controlling flow in a well, the method comprising:

receiving, in a flow control device, flow between an interior central bore of a tubular base pipe and a filtration screen about the base pipe; and

restricting the flow with a plurality of elongate restrictor passages oriented longitudinally relative to the base pipe, residing azimuthally spaced apart from each other in an array around the circumference of the base pipe, and each comprising a single-piece contiguous tubular structure independent of the base pipe and the filtration screen, and traversing the complete length of the respective restrictor passage, and having a plurality of internal, square edged orifices defined by a fixed, annular protrusion extending inwardly from an interior surface of the tubular structure, with at

least one of the plurality of orifices located between opposing ends of the tubular structure.

20. The method of claim 19, further comprising affixing a flow tube comprising the restrictor passage into the flow control device.

21. The well device of claim 16, where the annular protrusion comprises:

a first square shoulder that is orthogonal to the longitudinal axis of the orifice tube;

a second square shoulder opposite the first shoulder that is orthogonal to the longitudinal axis of the orifice tube; and

a cylindrical inner sidewall surface that is parallel to the longitudinal axis of the orifice tube and extends from the first shoulder to the second shoulder, and where the inner sidewall surface meets at least the first mentioned shoulder at a right angle, without a fillet or chamfer.

22. The well device of claim 16, where each orifice is square edged on both a first opening and an opposing opening.