CLAIMS

1. A multi-tiered socket joint comprising:

a cylindrical inner joint pipe; and

a cylindrical outer joint pipe, the inner joint and the outer joint being attached to ends of steel pipes to be joined, respectively, wherein

one of the inner joint pipe and the outer joint pipe includes

a split cylindrical portion including a plurality of split pieces that are split in a circumferential direction, and

a plurality of tiers of projections arranged in an axial direction on the plurality of split pieces, the projections being configured to project in a radial direction and each of the projections having a rectangular cross section,

another one of the inner joint pipe and the outer joint pipe includes

a cylindrical portion that is not split, and

a plurality of tiers of recesses arranged in the axial direction on the cylindrical portion, the recesses being configured to engage with the projections and each of the recesses having a rectangular cross section,

the steel pipes are joined by inserting the inner joint pipe into the outer joint pipe and by engaging the projections with the recesses, while bending the split cylindrical portion in the radial direction,

the plurality of tiers of projections have axial widths gradually becoming smaller from a tip-end side toward a base-end side,

the plurality of tiers of recesses have axial widths gradually becoming smaller from a base-end side toward a tip-end side, and

the axial width of each of the projections is set so as to have a size equal to or larger than an axial width of a recess that is on the tip-end side with respect to a recess with which the projection is to be engaged when the joints are fitted.

2. A multi-tiered socket joint comprising:

a cylindrical inner joint pipe; and

a cylindrical outer joint pipe, the inner joint pipe and the outer joint pipe being attached to ends of steel pipes to be joined, respectively, wherein

one of the inner joint pipe and the outer joint pipe includes

a split cylindrical portion including a plurality of split pieces that are split in a circumferential direction, and

a plurality of tiers of recesses arranged in an axial direction on the plurality of split pieces, each of the recesses having a rectangular cross section,

another one of the inner joint pipe and the outer joint pipe includes

a cylindrical portion that is not split, and

a plurality of tiers of projections arranged in the axial direction on the cylindrical portion, the projections being configured to project in a radial direction, and engage with the recesses and each of the projections having a rectangular cross section,

the steel pipes are joined by inserting the inner joint pipe into the outer joint pipe and by engaging the projections with the recesses, while bending the split cylindrical portion in the radial direction,

the plurality of tiers of projections have axial widths gradually becoming smaller from a projection on a

tip-end side toward a projection on a base-end side,

the plurality of tiers of recesses have axial widths gradually becoming smaller from a recess on a base-end side toward a recess on a tip-end side, and

the axial width of each of the projections is set so as to have a size equal to or larger than an axial width of a recess that is on the tip-end side with respect to a recess with which the projection is to be engaged when the joints are fitted.

3. The multi-tiered socket joint according to claim 1 or 2, wherein axial clearances formed between the projections and the respective recesses that are engaged with each other are same across all engaged portions in a state in which the joints are fitted.

4. The multi-tiered socket joint according to any one of claims 1 to 3, wherein a projection height of the plurality of tiers of projections is set equal to or smaller than a projection height of the projection that is nearest to the tip-end side, and a projection height of at least one of the plurality of tiers of projections is set smaller than of that of the projection that is nearest to the tip-end side.

5. The multi-tiered socket joint according to claim 4, wherein the plurality of tiers of projections have projection heights gradually becoming smaller from a projection on the tip-end side toward a projection on the base-end side.

6. A steel pipe with a joint comprising any one or both ends provided with any one or both of the inner joint pipe

and the outer joint pipe included in the multi-tiered socket joint according to any one of claims 1 to 5.

7. A structure comprising a plurality of steel pipes connected by a multi-tiered socket joint according to any one of claims 1 to 5.

8. A method of installing the structure according to claim 7, comprising:

restraining an axial position of one of a steel pipe with the outer joint pipe being attached to an end and a steel pipe with the inner joint pipe being attached to an end;

aligning an axial position of another one of the steel pipe with the one of the steel pipes;

inserting the other one of the steel pipes into the one of the steel pipes to fit the other one of the steel pipes with the one of the steel pipes.

9. A method of designing a multi-tiered socket joint including a cylindrical inner joint pipe; and a cylindrical outer joint pipe, the inner joint and the outer joint being attached to ends of steel pipes to be joined, respectively, wherein one of the inner joint pipe and the outer joint pipe includes a split cylindrical portion including a plurality of split pieces that are split in a circumferential direction, and a plurality of tiers of projections arranged in an axial direction on the plurality of split pieces, the projections being configured to project in a radial direction and each of the projections having a rectangular cross section, another one of the inner joint pipe and the outer joint pipe includes a cylindrical portion that is not split, and a plurality of

tiers of recesses arranged in the axial direction on the cylindrical portion, the recesses being configured to engage with the projections and each of the recesses having a rectangular cross section, and the steel pipes are joined by inserting the inner joint pipe into the outer joint pipe and by engaging the projections with the recesses, while bending the split cylindrical portion in the radial direction, the method comprising:

setting the plurality of tiers of projections to have axial widths gradually becoming smaller from a projection on a tip-end side toward a projection on a base-end side;

setting the plurality of tiers of recesses to have axial widths gradually becoming smaller from a recess on a base-end side toward a recess on a tip-end side; and

setting the axial width of each of the projections to have a size equal to or larger than an axial width of a recess that is on the tip-end side with respect to a recess with which the projection is to be engaged when the joints are fitted.

10. A method of designing a multi-tiered socket joint including: a cylindrical inner joint pipe; and a cylindrical outer joint pipe, the inner joint pipe and the outer joint pipe being attached to ends of steel pipes to be joined, respectively, wherein one of the inner joint pipe and the outer joint pipe includes a split cylindrical portion including a plurality of split pieces that are split in a circumferential direction, and a plurality of tiers of recesses arranged in an axial direction on the plurality of split pieces, each of the recesses having a rectangular cross section, another one of the inner joint pipe and the outer joint pipe includes a cylindrical portion that is not split, and a plurality of tiers of

projections arranged in the axial direction on the cylindrical portion, the projections being configured to project in a radial direction, and engage with the recesses and each of the projections having a rectangular cross section, and the steel pipes are joined by inserting the inner joint pipe into the outer joint pipe and by engaging the projections with the recesses, while bending the split cylindrical portion in the radial direction, the method comprising:

setting the plurality of tiers of projections such that that axial widths gradually become smaller from a projection on a tip-end side toward a projection on a base-end side;

setting the plurality of tiers of recesses such that axial widths gradually become smaller from a recess on a base-end side toward a recess on a tip-end side; and

setting the axial width of each of the projections to have a size equal to or larger than an axial width of a recess that is on the tip-end side with respect to a recess with which the projection is to be engaged when the joints are fitted.

11. The method for designing a multi-tiered socket joint according to claim 9 or 10, wherein the axial widths of the plurality of projections and the plurality of respective recesses are set in such a manner that axial clearances formed between the projections and the respective recesses that are engaged with each other are same across all engaged portions in a state in which the joints are fitted.

12. A method of manufacturing a multi-tiered socket joint including a cylindrical inner joint pipe; and a cylindrical outer joint pipe, the inner joint and the outer joint being

attached to ends of steel pipes to be joined, respectively, wherein one of the inner joint pipe and the outer joint pipe includes a split cylindrical portion including a plurality of split pieces that are split in a circumferential direction, and a plurality of tiers of projections arranged in an axial direction on the plurality of split pieces, the projections being configured to project in a radial direction and each of the projections having a rectangular cross section, another one of the inner joint pipe and the outer joint pipe includes a cylindrical portion that is not split, and a plurality of tiers of recesses arranged in the axial direction on the cylindrical portion, the recesses being configured to engage with the projections and each of the recesses having a rectangular cross section, and the steel pipes are joined by inserting the inner joint pipe into the outer joint pipe and by engaging the projections with the recesses, while bending the split cylindrical portion in the radial direction, the method comprising:

forming the plurality of tiers of projections such that axial widths gradually become smaller from a projection on a tip-end side toward a projection on a base-end side;

forming the plurality of tiers of recesses such that axial widths gradually become smaller from a recess on a base-end side toward a recess on a tip-end side; and

forming the axial width of each of the projections so as to have a size equal to or larger than an axial width of a recess that is on the tip-end side with respect to a recess with which the projection is to be engaged when the joints are fitted.

13. A method of manufacturing a multi-tiered socket joint

including a cylindrical inner joint pipe; and a cylindrical outer joint pipe, the inner joint pipe and the outer joint pipe being attached to ends of steel pipes to be joined, respectively, wherein one of the inner joint pipe and the outer joint pipe includes a split cylindrical portion including a plurality of split pieces that are split in a circumferential direction, and a plurality of tiers of recesses arranged in an axial direction on the plurality of split pieces, each of the recesses having a rectangular cross section, another one of the inner joint pipe and the outer joint pipe includes a cylindrical portion that is not split, and a plurality of tiers of projections arranged in the axial direction on the cylindrical portion, the projections being configured to project in a radial direction, and engage with the recesses and each of the projections having a rectangular cross section, and the steel pipes are joined by inserting the inner joint pipe into the outer joint pipe and by engaging the projections with the recesses, while bending the split cylindrical portion in the radial direction, the method comprising:

forming the plurality of tiers of projections such that axial widths gradually become smaller from a projection on a tip-end side toward a projection on a base-end side;

forming the plurality of tiers of recesses such that axial widths gradually become smaller from a recess on a base-end side toward a recess on a tip-end side; and

forming the axial width of each of the projections so as to have a size equal to or larger than an axial width of a recess that is on the tip-end side with respect to a recess with which the projection is to be engaged when the joints are fitted.

14. The method of manufacturing a multi-tiered socket joint according to claim 12 or 13, wherein the plurality of projections and the plurality of respective recesses are formed in such a manner that axial clearances formed between the projections and the respective recesses that are engaged with each other are same across all of engaged portions in a state in which the joints are fitted.