CLAIMS

1. An ironing mold for performing ironing on a convex formed portion formed using a surface treated metal plate as a raw material, comprising:

a punch that is inserted into the formed portion; and

a die having a pushing hole into which the formed portion is pushed together with the punch,

characterized in that the pushing hole includes a shoulder portion disposed on an outer edge of an inlet of the pushing hole and constituted by a curved surface having a predetermined curvature radius, and an inner peripheral surface which extends from a radius end of the shoulder portion in a pushing direction of the formed portion, and along which an outer surface of the formed portion slides in response to relative displacement between the punch and the die, and

the inner peripheral surface extends non-parallel to an outer peripheral surface of the punch, and the inner peripheral surface is provided with a clearance that corresponds to an uneven plate thickness distribution, in the pushing direction, of the formed portion prior to the ironing relative to the outer peripheral surface to ensure that an amount of ironing applied to the formed portion remains constant in the pushing direction.

2. The ironing mold according to claim 1, characterized in that a skewness Rsk of the surface treated metal plate is less than -0.6 and no less than -1.3, and that the curvature radius of the shoulder portion and the clearance between the radius end and the punch are determined such that

when the curvature radius of the shoulder portion is set as r, the clearance between the radius end and the punch is noted as c_{re}, and a plate thickness of the formed portion prior to the ironing in a position that is sandwiched between the radius

end and the punch upon completion of the ironing is noted as t_{re},

a relationship of $0 < Y \leq 14.6X - 4.7$ between Y, which is expressed by $\{(t_{re} - c_{re}) / t_{re}\} \times 100$, and X, which is expressed by r/t_{re}, is satisfied.

~~3. The ironing mold according to claim 2, characterized in that a skewness Rsk of the surface treated metal plate is less than -0.6.~~

3~~4~~. The ironing mold according to claim 1, characterized in that a skewness Rsk of the surface treated metal plate is no less than -0.6 and no more than 0, and that the curvature radius of the shoulder portion and the clearance between the radius end and the punch are determined such that

when the curvature radius of the shoulder portion is set as r, the clearance between the radius end and the punch is noted as c_{re}, and a plate thickness of the formed portion prior to the ironing in a position that is sandwiched between the radius end and the punch upon completion of the ironing is noted as t_{re},

a relationship of $0 < Y \leq 12.3X - 7.0$ between Y, which is expressed by $\{(t_{re} - c_{re}) / t_{re}\} \times 100$, and X, which is expressed by r/t_{re}, is satisfied.

~~5. The ironing mold according to claim 4, characterized in that a skewness Rsk of the surface treated metal plate is no less than -0.6.~~

4~~6~~. The ironing mold according to any one of claims 1 to 3~~5~~, characterized in that the surface treated metal plate is a Zn coated steel plate formed by applying a Zn coating to a surface of a steel plate.

5~~7~~. A formed material manufacturing method comprising the steps of:

forming a convex formed portion by performing at least one forming process on a surface treated metal plate; and

performing ironing on the formed portion using an ironing mold after forming the formed portion,

characterized in that the ironing mold includes:

a punch that is inserted into the formed portion; and

a die having a pushing hole into which the formed portion is pushed together with the punch,

the pushing hole includes a shoulder portion disposed on an outer edge of an inlet of the pushing hole and constituted by a curved surface having a predetermined curvature radius, and an inner peripheral surface which extends from a radius end of the shoulder portion in a pushing direction of the formed portion, and along which an outer surface of the formed portion slides in response to relative displacement between the punch and the die, and

the inner peripheral surface extends non-parallel to an outer peripheral surface of the punch, and the inner peripheral surface is provided with a clearance that corresponds to an uneven plate thickness distribution, in the pushing direction, of the formed portion prior to the ironing relative to the outer peripheral surface to ensure that an amount of ironing applied to the formed portion remains constant in the pushing direction.

6~~8~~. The formed material manufacturing method according to claim 5~~7~~, characterized in that a skewness Rsk of the surface treated metal plate is less than -0.6 and no less than -1.3, and that the curvature radius of the shoulder portion and the clearance between the radius end and the punch are determined such that

when the curvature radius of the shoulder portion is set as r, the clearance

between the radius end and the punch is noted as c_{re}, and a plate thickness of the formed portion prior to the ironing in a position that is sandwiched between the radius end and the punch upon completion of the ironing is noted as t_{re},

a relationship of $0 < Y \leq 14.6X - 4.7$ between Y, which is expressed by $\{(t_{re} - c_{re}) / t_{re}\} \times 100$, and X, which is expressed by r/t_{re}, is satisfied.

~~9. The formed material manufacturing method according to claim 8, characterized in that a skewness Rsk of the surface treated metal plate is less than -0.6.~~

7~~10~~. The formed material manufacturing method according to claim 5~~7~~, characterized in that a skewness Rsk of the surface treated metal plate is no less than -0.6 and no more than 0, and that the curvature radius of the shoulder portion and the clearance between the radius end and the punch are determined such that

when the curvature radius of the shoulder portion is set as r, the clearance between the radius end and the punch is noted as c_{re}, and a plate thickness of the formed portion prior to the ironing in a position that is sandwiched between the radius end and the punch upon completion of the ironing is noted as t_{re},

a relationship of $0 < Y \leq 12.3X - 7.0$ between Y, which is expressed by $\{(t_{re} - c_{re}) / t_{re}\} \times 100$, and X, which is expressed by r/t_{re}, is satisfied.

~~11. The formed material manufacturing method according to claim 10, characterized in that a skewness Rsk of the surface treated metal plate is no less than -0.6.~~

8~~12~~. The formed material manufacturing method according to any one of claims 5

to 7~~7 to 11~~, characterized in that the surface treated metal plate is a Zn coated steel plate formed by applying a Zn coating to a surface of a steel plate.