

A method of bending metal roofing sheets and a bending apparatus.

Technical area

This invention relates to a bending apparatus for metal sheets with upstanding edges and to a method of bending metal sheets that have upstanding flat edges ending with beads.

Background technique

A method of cladding a roof with metal sheet is the standing seam method in which the steel sheets have upstanding longitudinal edges that end with snap-on beads. The beads may then be rolled tight. The seams are so high that there could never be so much water on the roof that the water could reach the upper ends of the seams. The seams could for example be 8 cm high and, usually, full length sheets are used so that there are no transverse joints. This method is not used for cupola roofs whether or not they have constant or varied bending radius since the roofing sheets must then be bent before they are mounted.

The sheets may be of steel, aluminium, zinc, or copper.

Object of invention

It is an object of the invention to provide a bending apparatus for metal sheets with upstanding edges and in particular such an apparatus that permits for a variable bending radius, and to provide a method for bending a metal sheet that has upstanding flat edges ending with beads and in particular a method of bending a sheet with a radius that varies along the length of the sheet. This is accomplished principally in that, without rolling the beads, one rolls the flat edges gradually thinner towards the beads, and in particular in that one varies the thinning.

The invention is defined by the claims.

Brief description of the drawings

- Figure 1 shows, in a cross-sectional view, the rolling unit of a bending apparatus.

- Figure 2 shows, on a larger scale and in cross section, a metal sheet that is also shown in figure 1 and it is an end view seen as indicated by the arrows 2-2 in figure 4.
- Figures 3-5 are examples of metal sheets that can be bent by the device shown in figure 1.

Description of an illustrated and preferred embodiment

In **figure 1**, the rolling unit in a bending apparatus is shown during the rolling of a metal roofing sheet 10 with upstanding edges 11,13 that end in beads 12,14 as can best be seen in **figure 2**. One of the beads is larger than the other so that the beads of two adjacent sheets can be snapped together and if necessary also then be rolled sealed. The flat parts of the edges 11,13 are clamped between two rolls 15,16 and 17,18 respectively in two rolling devices 19,20.

The rolling unit comprises a frame 30 with guides in the form of guide rails 31,32 and 33,34 respectively for the two rolling devices 19,20. Since the two rolling devices, each one for rolling an upstanding edge 11,13, are similar, only the rolling device 20 is described in detail. It has a frame 35 that is slidably carried and guided by the guide rails 33,34. The frame 35 can be moved along the guide rails by means of a ball screw 36. The frame 35 carries slidably on a guide 37 a bearing housing 38 in which an inner bearing part 39 is turnable. An axle 40 for the roll 17 is journaled in this bearing part 39. The bearing part 39 is turnable in the bearing housing 38 by means of a ball screw 41 and the bearing housing 38 is movable along the guide 37 by means of a ball screw 42. The roll 18, the counter roll, is journaled in a housing 43, the position of which is adjustable by means of a ball screw 45.

Besides the illustrated rolling unit, the bending apparatus comprises an input unit with powered feeding-in rollers and an output unit also having powered rollers. These two units are conventional and are therefore not illustrated.

By angular adjustment of the rolls 15,16 by means of the ball screw 41, one may roll the edges 11 and 13 gradually thinner towards their beads 12 and 14, which makes the outer parts of the edges longer and bends the sheet. Surprisingly, the sheet will bend although

the beads are not rolled thinner. By adjusting the obliqueness of the rolls 15,17, one can vary the radius of bending. Since such adjustment will also displace the rolls 15,17, one must also adjust the position of the housing 38 by means the ball screw 42 and also adjust the position of the corresponding housing of the rolling device 19. When one wants a sheet with a varying radius of bending along its length, one can carry out these adjustments during the rolling. The ball screws can be controlled by motors controlled by a computer. The programming can be carried out based on experience and fine adjustment can be carried out in a test rolling. In this way one may make long roofing sheets for roofs with a varying slope. By means of the ball screw, one can adjust the device to various sheet thicknesses.

By adjusting the inclination of the rollers 15,17 so that they roll the edges 11 and 13 thinner towards the edge base, one can also make the sheet bend somewhat upwards, but in order to get a bigger bending upwards, one must roll also the flat middle portion of the sheet. Such a rolling unit can be added to the machine for that purpose.

The rolling devices 19,20 can be moved along the guides 31-34 during the rolling so that one may roll roofing sheets of the kind shown in **figures 3-5** having varying width. Such sheets are adapted for example for cupola roofs. Sheets having bow-formed sides with a constant radius are adapted for cupola roofs having constant radius of their bows whereas sheets having bow-formed sides with a varying radius are adapted for cupola roofs having varying radius of their bows. It is possible to bend sheets with a bending radius that varies along their length. Sometimes it will also be necessary to bend sheets of the kind shown in figure 3 which have their one side convex and their other side concave.

During the bending of a sheet, one controls the ball screws 36 so that the bending apparatus is continuously adapted to the change of the width of the sheet. The ball screws 41 and 42 are simultaneously controlled so that the bending is adapted to the change of width in accordance with algorithms defined for the form of sheet, that is, in accordance with a predefined schedule.

Instead of compulsory controlling the rolling devices 19,20 along the guides 31-34, one can have the rolling devices freely movable along the guides so that they are guided by the upstanding edges of the sheet. A balanced pneumatic device may be provided to initially set the positions of the rolling devices on the guides and then have the sheet edges guiding their positions on the guides.

Claims

1. A method of bending metal sheets (10) that have upstanding sides (11,13), **characterised in** that one rolls the sides (11,13) gradually thinner towards one end of them to make the sheet bend away from the thinned ends.
2. A method according to claim 1 or 2, **characterised in** that one rolls each upstanding side (11,13) between two rollers (15,16 and 17,18 resp.), and during the rolling varies the angle between the two axes of the rollers and/or the rolling pressure so as to vary the bending radius of the sheet.
3. A method according to claim 2, **characterised in** that, during the rolling, one varies the angle between the axes of the rollers and/or the rolling pressure following a predetermined schedule.
4. A method according to any one of the preceding claims for bending a sheet (10), in particular a roofing sheet, that has the ends of its upstanding sides (11,13) formed into beads (12,13), **characterised in** that, without thinning the beads (12,13), one rolls the sides gradually thinner towards the beads.
5. A bending apparatus for bending metal sheets with upstanding sides (11,13), **characterised by**, for each side, a rolling device (19,20) with a pair of rolls (15,16 and 17,18 respectively) for rolling the side between them, a device (42) for adjusting the rolling force, and a device (40,41) for adjusting the angle between the axes of the rolls.
6. A bending apparatus according to claim 5, **characterised in** that the rolling devices (19,20) are movably carried by a frame (30) so as to be movable towards and away from each other along guides (31-34) for adjustment to the width of the sheet.

7. A bending apparatus according to claim 6, **characterised in** that the rolling devices (19,20) are freely movable sideways and are guided sideways by the upstanding sides of the sheet for adaptation to the width of the sheet.
8. A bending apparatus according to any one of the claims 5-7, **characterised in** that the devices for adjustment of angle and rolling pressure comprise ball screws (41,42) controlled by motors.
9. A bending apparatus according to any one of the claims 5-9, **characterised by** ball screws (36) for displacement of the rolling devices (19,20) along their guides.