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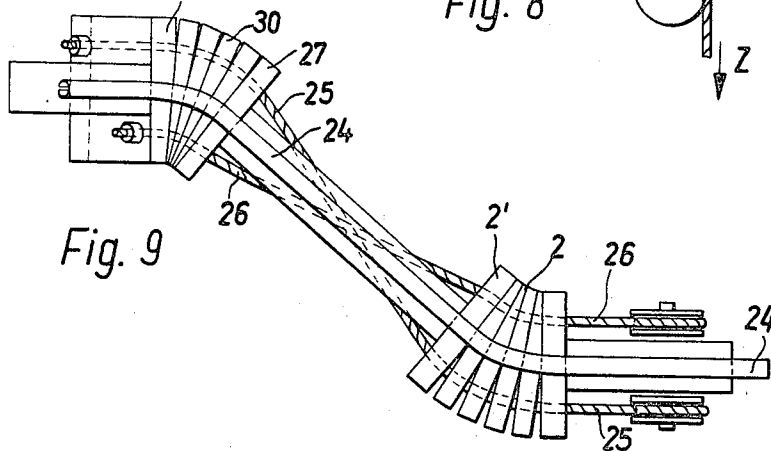
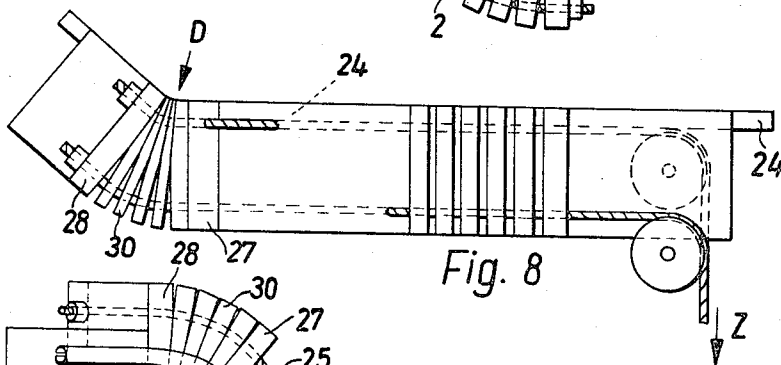
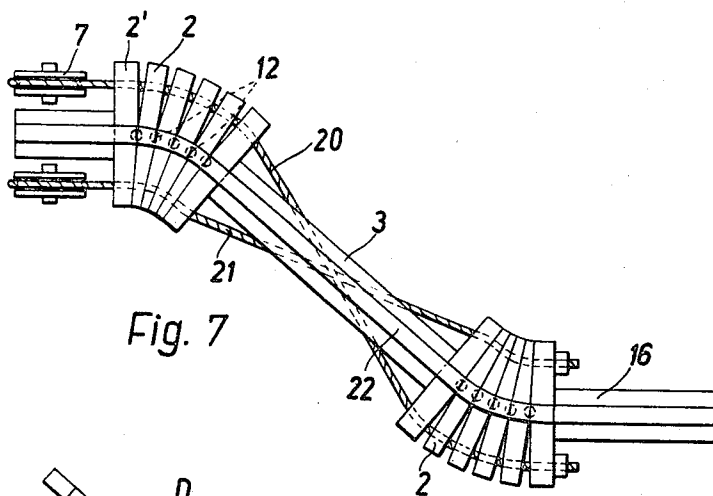
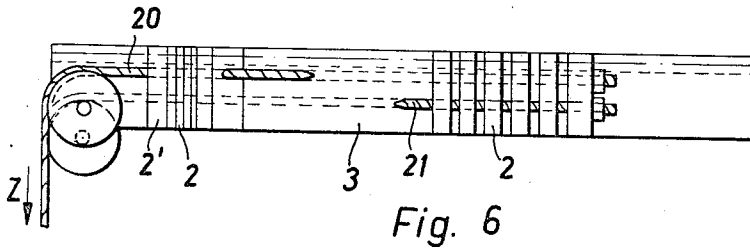
J. WERNER

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APPARATUS FOR THE BENDING OF SECTIONS, TUBES OR THE LIKE

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APPARATUS FOR THE BENDING OF SECTIONS, TUBES OR THE LIKE

Johannes Werner, Offenbach am Main, Germany, assignor to H. T. Golde G.m.b.H., Frankfurt am Main, Germany

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ABSTRACT OF THE DISCLOSURE

Bending apparatus in which a workpiece is accommodated in a housing duct formed by openings in a plurality of adjacent pivotable plates which can be pivoted by traction cables from an initial position in which plane parallel faces of the plates are in abutment to form a straight duct, to a fan-like positional arrangement in which tapered faces of the plates are caused to abut and the duct takes a curved course to effect bending of the workpiece in the duct.

This invention relates to devices for the bending of sections, tubes or other elongated workpieces.

An object of the present invention is to provide an apparatus which is simple relative to known apparatus used for this purpose, and which makes it possible for workpieces of the above type to be shaped by bending at various points along their length simultaneously and, if appropriate, even in different planes.

The known types of apparatus have the disadvantage that the amount of working time expended on bending is relatively long. In addition, in the case of the known apparatus, a plurality of bends can only be carried out on a workpiece in succession to one another. As a result, the precision of the spacing of the individual bends depends on the precision with which the workpiece is re-set in the apparatus for each new bend. In practice, this method of working results in tolerances of an order of magnitude which is not tolerable or at least disadvantageous for many purposes.

Therefore, the invention has an object more particularly to provide a bending apparatus which provides the optimum as regards the precision of the desired form, more particularly the spacings of the bends, and which also permits of substantially quicker operation. In addition, the invention makes it possible even for tubes having a coextensive longitudinal slot, such as are required in many cases as guide tubes for cables, to be deformed in the aforesaid manner without the predetermined slot width being undesirably altered by compressive forces in the course of the bending operation.

For this purpose, an apparatus according to the invention for the bending of elongated workpieces such as, for example, sections or tubes, is characterized by a housing duct in which the workpiece is to be bent, this duct being formed by recesses in alignment with one another in plates which are arranged one behind the other and which are arranged to be pivotable relative to one another in fan-like fashion, the housing duct being adapted to be given curvatures predetermined by the size and direction of simultaneously effected pivoting movements, the workpiece situated in the said duct being bent correspondingly thereby. The amount and direction of the pivoting movements of the individual plates relative to one another can be predetermined by suitable abutments so that the plates situated one behind the other form, like the ribs of an accordion, a body whose shape in space can

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assume optional curvatures owing to the pivoting of the plates, the housing duct being subjected at the same time to corresponding curving. The plate recesses which when the plates are situated parallel to one another in the initial position form a straight duct for the workpiece which is to be shaped, are conveniently provided at the periphery of the said plates but may also be constructed as bores extending through the plates if necessary, if suitable precautions are taken for removing the shaped workpiece from the then arcuately shaped housing duct. For example, this object could be achieved by dividing the duct-forming plates through the region of the bores, or by using open bores for a removal slot in the duct.

According to a preferred embodiment of the invention, the predetermined pivoting movement of the plates relative to one another is achieved in that part-regions of the plates corresponding to one another are constructed in plane parallel manner, while other part-regions of the plates again corresponding to one another are outwardly tapered in wedge-like manner, and that actuating means is provided whereby the plane parallel regions or the wedge-like regions of neighboring plates can be made to abut on one another selectively, the recesses provided in the plates aligning with one another to form a straight duct for housing the section or tube to be bent when the plane parallel regions abut one another, the said duct being subjected to the predetermined bending operations when the wedge-like regions abut on one another.

The actuating means used are preferably traction cables extending through the row of plates so that each region has its own traction cable associated with it. The initial position with the housing duct extending in a straight line can be obtained by pulling on the cable which brings the plane parallel regions of the plates to abut one another, whereupon the straight workpiece to be bent is inserted in the housing duct and then by pulling on the other cable the row of plates and therefore the inserted workpiece is given its predetermined bends over its entire length by pulling on the other cable.

A desired spacing between individual bends is adapted to be fixed precisely in advance in a simple manner by spacer elements between plate groups associated with the individual bends. Therefore, in a single working operation and by a single pull on one cable, an elongated workpiece can be shaped to have a plurality of bends, possibly in different planes and observing precisely the spacing of the individual bends.

According to a further feature of the invention, the apparatus can be so constructed, for example, for the bending of tubes having a coextensive longitudinal slot, that the housing duct is given a projecting rib for engaging in the longitudinal slot of the tube, by suitable configuration of the individual recesses. The rib can be formed directly or by a flexible insert element, and guarantees that the width of the slot remains unaltered while the tube is being bent.

Preferably, it is also proposed according to the present invention that neighboring plates are secured against translational movement, for example, by balls inserted in countersunk bores or the like.

The invention is explained in more detail hereinafter relative to a few embodiments for the bending of a tube in accordance with the invention, with reference being made to the accompanying drawing wherein:

FIGURE 1 is a plan view of one embodiment of the invention for the bending of a tube with three bends spaced apart from one another, the apparatus being shown in the initial position with the housing duct straight;

FIGURE 2 is a side view of the apparatus shown in FIG. 1;

FIGURE 3 shows the same view as FIG. 1, but after the tube has been inserted and bent;

FIGURE 4 is a view on a larger scale of a single plate, approximately on line IV—IV of FIG. 3;

FIGURE 5 is a cross-section taken on the line V—V of FIG. 4;

FIGURE 6 is a side view of another embodiment which also permits two bends to be formed in a tube, but in different directions of curvature;

FIGURE 7 is a plan view of the apparatus shown in FIG. 6 with the inserted tube after the bending thereof;

FIGURE 8 shows a side view of a further development of the apparatus shown in FIGS. 6 and 7, a plate group permitting, in addition to a bend in the opposite direction to the other plate group, a bend out of the plane of the two groups also; and

FIGURE 9 is a plan view of the apparatus according to FIG. 8 with a tube inserted and bent.

The apparatus shown in FIGS. 1 to 3 has three groups of plates 2 which are separated from one another by spacer elements 3. The plates 2 are arranged in rows on cables 4, 4' and 5, 5', one end in each case being secured by a lead seal 6 and the other end extending over a pulley 7. The drawings show how the plates are plane parallel in form in the region of the cables 4, 4', whereas in the region of the cables 5, 5', they taper outwardly in wedge-like manner. The bodies formed by the plate groups, therefore, can assume selectively the shape shown in FIG. 1 or the shape shown in FIG. 3, depending on whether the cables 4, 4' are pulled to bring the plane parallel regions to abut against one another or the cables 5, 5' are pulled to draw the outwardly tapered regions against one another.

The individual plates are provided, as FIGS. 4 and 5 show, with orifices 8 and 9 through which the cables are passed, and also with countersunk bores 10, 11 for accommodating balls 12 which secure the plates against translational movement without hindering the pivoting movement of the plates. In the initial position of the apparatus shown in FIG. 1, recesses 13 at the edge of the plates form a straight housing duct for the tube to be bent. Since this tube in the example concerned is constructed as a tube 14 provided with a continuous longitudinal slot, the plates are additionally constructed to receive a plate assembly 15 which serves as a rib to engage in the slot of the tube 14 and thus guarantee that the width of the slot is not modified during the bending of the tube.

End plates 2' connected rigidly to the spacer elements 3 and also to the end pieces 16, are constructed in the same way as the plates 2 at the side facing towards the plate groups, i.e. they are provided at one side only with an outward tapering. However, it is important to note that the angle of taper of the individual plates may differ, depending on the desired bending of the tube. The angle of taper may also vary within one group of plates. Therefore, with an apparatus according to the invention, it is possible by a suitable choice of the taper of the individual plates to predetermine the desired tube bend very precisely and such a bend can be reproduced exactly as often as desired and therefore this feature is of great value for the precise manufacture of a large series of tubes with precisely coinciding bends in mass production. While FIG. 1 shows the initial position of the apparatus with a straight open housing duct 13 for the tube which is to be bent, FIG. 3 shows that the apparatus, after the insertion of the tube 14, forces the said tube when the cables 5, 5' are pulled, into the desired curved form, maintaining precisely the straight portions defined by the spacer elements 3.

Pulling the cables can be effected, for example, in the direction Z (FIG. 2), by any desired source of power, for example, mechanical, hydraulic or pneumatic. Naturally, it is readily possible to take the cables further to a suitable force-storing device.

Instead of recesses 13 which form an open duct into

which the tube to be bent can be laid, a housing duct can also be formed by through bores in the plates forming a closed duct through which the tube to be bent is passed, similar to the manner in which the cables are passed through the orifices 8 and 9. Closed housing ducts are advantageous when bending tubes in several planes, whereas on the other hand an open duct simplifies the introduction of the tube without limiting bending possibilities to a single plane.

Furthermore, depending on the kind of drive used for the traction cables, it is possible to dispense entirely with guide pulleys 7, and instead of the two cables 4, 4' or 5, 5' meeting in the middle of the apparatus, it is possible to use only a single cable which is lead-sealed at one end of the apparatus and at the other end is coupled to a device for subjecting the cable to tractive force.

FIGS. 6 and 7 show how an apparatus according to the invention can be constructed for executing two spaced-apart bends in opposite directions and in a single plane in a tube. Here two groups of plates 2 are arranged with their tapered ends directed in opposite directions, and the cables 20 for the initial position and 21 for the bending position are made to cross over in the region of the spacer element 3, so that the S-shaped tube 22 shown in FIG. 7 is obtained. In order to obviate friction at the cables, these are conveniently guided in different planes from one another, as FIG. 6 shows, with appropriate offsetting of the bores provided in the plates 2 for accommodating the cables.

Finally, FIGS. 8 and 9 show diagrammatically, by way of a further development of the apparatus shown in FIGS. 6 and 7, an apparatus with which it is possible to impart to a tube 24 additionally to the S-bends obtained by crossing the cables 25 and 26 (plan view in FIG. 9) a bend out of this plane in the direction opposite to the direction of the arrow Z (side view in FIG. 8). Here in the region between the end plates 27 and 28, the plates 30 are given wedge-like tapering of such an amount and direction that this group of plates bends upwards out of the plane of the S-shaped deformation when the deformation-effecting rope 26 is pulled. Since this is the direction of the plate edges forming the housing duct, it is convenient to provide an abutment which exerts pressure in the direction D towards the tube in order to prevent the tube from springing out of the housing duct which is open here during the bending operation. The abutment can conveniently be constructed as a resiliently mounted shaped member for providing a certain amount of yielding during the bending operation, or can also be formed, for example, of a steel strip which covers the appropriate recesses in the plates 30 and sides in the longitudinal direction of the housing duct formed by the said recesses.

The invention is naturally not limited to details of the illustrated embodiments. Instead of the inclined tapered surfaces, it would also be possible to provide abutments for limiting the pivoting movement of the individual plates relative to one another, and instead of the cables described here as traction means, it would also be possible to use other traction means or devices which bring about the desired pivoting movements by subjecting the plate groups to pressure. The plates also are not limited to the illustrated rectangular outline shown, nor to a specific position or extent of the plane parallel regions or the outwardly tapering regions, especially since appropriate means could also be used for limiting the pivoting movements of a plate group instead of these regions.

What is claimed is:

1. Apparatus for the bending of a workpiece, said apparatus comprising a plurality of adjacent plates co-operatively providing a housing duct for accommodating a workpiece to be bent, said plates being arranged to be pivotable relative to one another in fan-like fashion, and actuating means to pivot said plates so that the housing duct takes a shape controlled by the movements of said plates, whereby there is effected a corresponding bending

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of the workpiece situated in the said duct, said plates having plane parallel faces adapted for abutting each other and faces tapered outwardly in wedge-like manner and adapted for abutting each other, said actuating means selectively causing the plane parallel faces and the tapered faces of adjacent plates to abut on one another, the plates having openings aligned with one another to form a straight duct for receiving the workpiece to be bent when the plane parallel faces abut one another, the said duct having a curved course when the tapered faces abut one another, said actuating means comprising at least one traction cable extending through the plates to control the same.

2. Apparatus according to claim 1 comprising balls engaging in neighboring plates to secure the same against translational movement.

3. Apparatus according to claim 1 wherein said actuating means comprises a second traction cable which crosses the first said cable, selected of the plates having face parts tapered outwardly in wedge-like manner in a further direction, whereby said workpiece can be bent to S-shape.

4. Apparatus according to claim 1, wherein the plates are arranged in at least two groups, said apparatus further comprising spacer elements between said groups.

5. Apparatus according to claim 4, wherein the ta-

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pered faces of the plates of the two groups taper in different directions when the plane parallel faces of the plates abut.

6. Apparatus according to claim 1, wherein the openings forming the workpiece housing duct are situated at the periphery of the plates.

7. Apparatus according to claim 1, comprising inwardly projecting ribs on said plates for engagement in a longitudinal slot of the workpiece to be bent.

8. Apparatus according to claim 1, a traction force generating device and means whereby the traction cable extending through the plates is lead-sealed at the terminal plate, the other end of the cable being connected to said traction force generating device.

References Cited

UNITED STATES PATENTS

2,714,916	8/1955	Green	72—465
2,729,265	1/1956	Jones	72—478

CHARLES W. LANHAM, *Primary Examiner*.

RONALD D. CREFE, *Assistant Examiner*.

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