

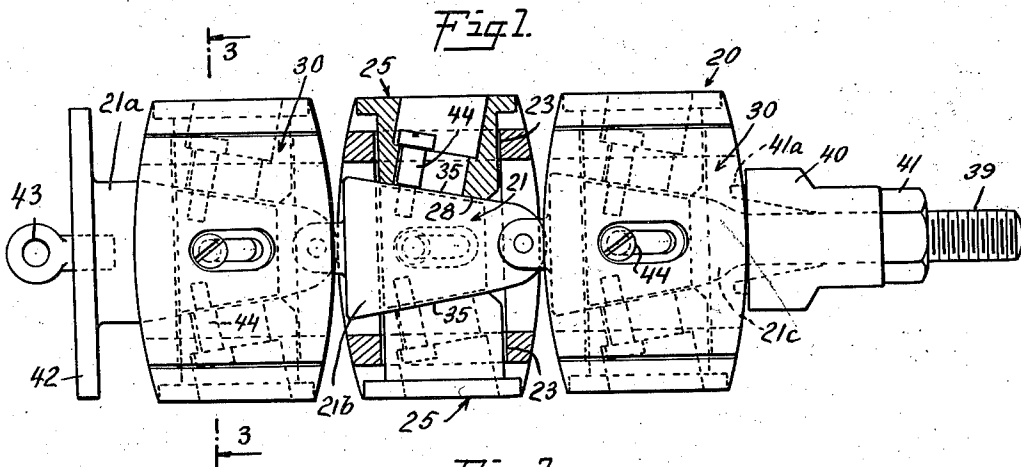
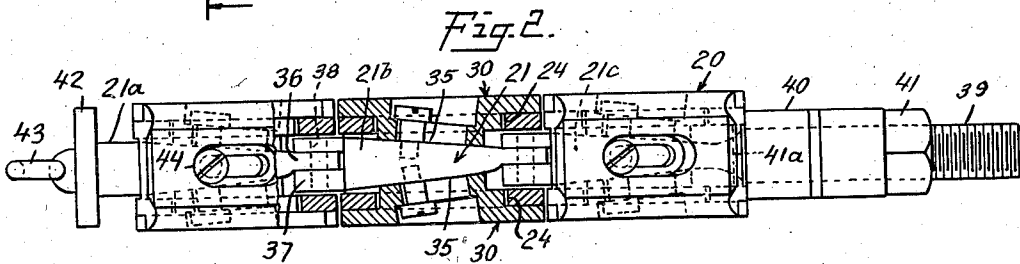
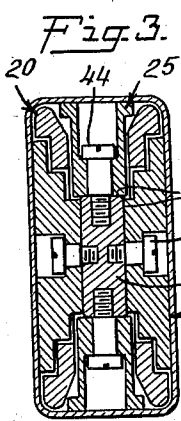
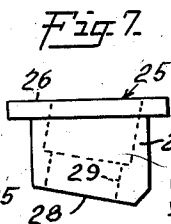
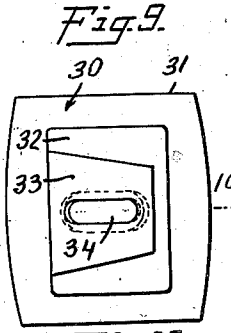
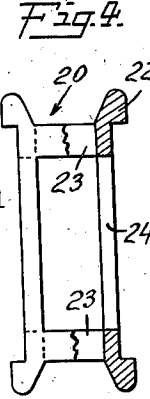
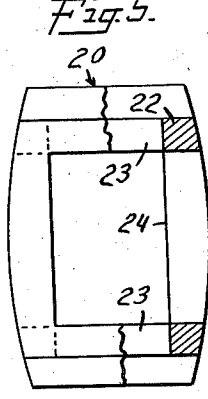
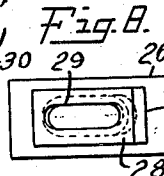
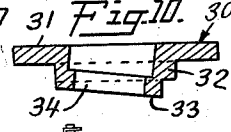
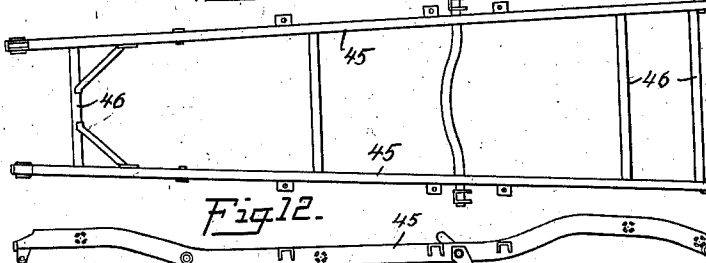
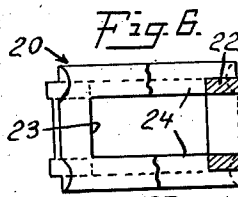
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METHOD AND APPARATUS OF BENDING TUBING

Filed Sept. 6, 1933



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METHOD AND APPARATUS OF BENDING
TUBING

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15 Claims. (Cl. 153—63)

This invention relates to the art of bending tubing and has reference more particularly to a novel method of bending tubing and to a new device for supporting the tubing from within so that it may be bent by suitable instrumentalities without being collapsed. The method and apparatus of the invention are of special utility in the bending of tubing having flat sides, as for example tubing having the cross-section of a rectangle or trapezoid or parallelogram; and for purposes of explanation, the application of the invention to the bending of tubing of rectangular cross-section will be described and illustrated in detail, though it is to be understood that the invention is susceptible of use in the bending of tubing of a wide variety of cross-sectional shapes.

The method of the invention involves supporting the tubing from within while subjecting it to outside pressure to give it the desired curvature, the tubing being thus shaped as desired without substantial change in cross-section by reason of the internal support. The external pressure for giving the tubing the desired lengthwise curvature may be applied in any suitable manner. Preferably it is applied by means of a press equipped with co-acting dies whose operative surfaces conform to the shape desired in the finished tubing, but other means of applying the pressure to effect the desired curvature may be employed.

The apparatus employed for the internal support of the tubing during the operation of curving it lengthwise may be described as an articulated, expandable and contractible mandrel. It includes a plurality of aligned mandrel sections, each movable relatively to those adjacent to it, and each consisting of a hollow supporting frame and opposed movable side walls thereon, preferably two pairs of such movable side walls, together with means for moving the opposed side walls outwardly to expand the mandrel and to allow them to move toward each other to contract it. This latter means includes a series of actuating-members, preferably one for each of the sections, and all of them connected end-to-end for swinging movement, each of these actuating-members being provided with surfaces adapted to engage the inner portions of the opposed movable side walls to govern or effect the movement of those walls outwardly and inwardly. Means are also provided, preferably in the form of a screw, for effecting the relative lengthwise movement of the frames carrying the movable side walls and the actuating-members, this movement in one direction operating to force the movable walls outwardly, and in the other direction permitting

those walls to be moved inwardly to effect the necessary variation in the transverse dimensions of the mandrel.

The tubing to be curved lengthwise in accordance with the invention may be tubing made from sheet metal stock by bending a strip of the sheet metal along lengthwise lines to the form of a tube having a single lengthwise seam, and then welding along this seam. In preparation for the lengthwise bending of the tube, the articulated, expandible and collapsible mandrel is placed within the tube, and the sections and actuating-members of the mandrel are moved relatively so that the walls of the pairs mounted on the sections are moved outwardly into hard contact with the internal walls of the tube. The tube is then subjected to pressure to give it the desired lengthwise curvature, and this may be done in any suitable manner as, for instance, by the employment of rolls, cams, dies, or the like. For most purposes it is best to provide a set of dies whose operative surfaces have the curvature desired in the finished tubing, and the shaping of the tubing is effected by a press in which these dies are mounted. During the application of the pressure, the tube walls are supported against collapse by the mandrel mounted within it, with the result that at the completion of the bending operation the tubing has substantially its original cross-section at all points throughout its length.

The invention will be better understood by reference to the following description, taken in connection with the accompanying drawing, which illustrates the preferred embodiment of the invention.

In the drawing:

Fig. 1 is a view of one form of the apparatus useful in practicing the new method, the apparatus being shown in side elevation, partly in section;

Fig. 2 is a top plan view of the apparatus partly in longitudinal section;

Fig. 3 is a section on the line 3—3 of Fig. 1;

Figs. 4, 5, and 6 are respectively end, side and top views, partly in section, showing the frame or cage of the mandrel;

Figs. 7 and 8 are respectively side and face views illustrating the construction employed in one of the sets of expansion-members mounted on the frame;

Figs. 9 and 10 are face and sectional views respectively, illustrating the construction employed in the other pair of expansion-members mounted on the frame; and

Figs. 11 and 12 are plan and elevation views

of an automobile frame having tubular side-members curved in the direction of their length for the manufacture of which the invention of this application is of special utility.

5 The mandrel comprises a plurality of sections generally designated 20, and a plurality of actuating-members designated 21, one actuating-member corresponding to each section and lying within its section. Each section includes a frame or cage 22 of open construction, as is illustrated in Figs. 4, 5, and 6; it is preferably of oblong shape, has openings 23 at the top and bottom, and openings 24 at its sides, and its ends are curved in the manner indicated in Figs. 1 and 5.

15 This frame or cage 22 carries two pairs of movable walls. The wall-members 25 are mounted over the top and bottom openings 23 of the cage, and each of these members has a flat face 26 and a projection 27 which enters the opening in the frame and terminates in an inclined surface 28. Extending through this member is a slot 29 elongated lengthwise of the member, and of enlarged size adjacent to the face 26. The pair of side walls 30 are mounted over the side openings 24 of the frame, and each member 30 has a flat face 31 and a projection 32 which terminates in an inclined surface 33. A slot 34, elongated lengthwise of the member, extends through the member, and this slot is enlarged at the face of the member as is illustrated.

Each actuating-member 21 is provided with inclined operating surfaces 35 at its sides and at its top and bottom, so that when the member is moved relatively to its corresponding frame in the direction of convergence of the inclined surfaces, a double wedge-action takes place. Each member 21 is connected to the next one for swinging movement by the pivot construction illustrated; thus, in the apparatus illustrated the end member 21a has a forward end portion 36 which is received between the spaced parts 37 of the next member 21b and connected thereto by a pin 38. The member 21b is similarly connected to the next member 21c. The end one of the several actuating-members is provided at its free end with a threaded portion 39 on which is mounted a block 40 and a nut 41. The block 40 fits loosely on the threaded portion 39 and is provided with a pair of lugs 41a which enter the frame of the adjacent mandrel section. The actuating-member at the opposite end of the mandrel is provided with an end plate 42 having a ring or eye 43 thereon.

In order to hold the movable wall plates in place on the mandrel sections, the actuating-member for each section is provided with headed pins 44 extending outwardly from the inclined surfaces thereof and passing through the slots in the wall plates. The head of each pin lies within the enlarged portion of its slot, the bottom wall of which is inclined to correspond with the inclination of the corresponding surface of the actuating member, as is illustrated in the drawing.

65 A flexible, expansible and contractible mandrel of the construction above illustrated and described may be employed in the manufacture of curved tubing of various constructions and cross-sectional shapes and adapted for various purposes. A typical purpose for which this invention is especially adapted is the manufacture of side-members for automobile frames of light weight, great strength, and low cost. Such a frame is indicated in Fig. 11. It consists of 75 side-members 45 and cross-members 46, each

of which is preferably formed from a strip of sheet metal by bending the strip along lengthwise lines to the form of a tube having a single lengthwise seam, and then welding along the seam. The tubular side-members of this frame 5 may have any desired cross-section, but that which is preferred is rectangular, with slightly rounded corners. These side-members may be straight in plan, but in elevation they must be curved lengthwise, as for instance to provide 10 arches through the forward and rear portions of the side-members which extend over the front and rear axles of the car.

To give to the tubes for these side-members this desired lengthwise curvature, a mandrel of the construction above described is inserted in the tube, and then expanded by moving the pairs of opposed plates outwardly into hard contact with the interior walls of the tube. This outward or expansion movement is effected by turning the nut 41 relative to the screw 39 and thereby moving the several actuating-members 21 relative to the several frames 22, whereupon the wedge surfaces upon the actuating-members move the opposed walls mounted on the frame outwardly. The tube with the mandrel therein may then be subjected to pressure by suitable instrumentalities to give it the desired curvature, and as it is so curved the elements of the mandrel move relatively as may be necessary and while still maintaining their supporting relation to the walls of the tube. When the operation of curving the tube as desired has been completed, the mandrel is collapsed more or less by turning the nut 41 relative to the screw 39 in the 35 opposite direction, whereupon the mandrel may be withdrawn from the tube for further use in connection with curving a portion of the other end of the same tube, or in curving another tube throughout its length.

Various changes may be made in the details of construction and arrangement of the parts without departing from the invention or sacrificing any of the advantages thereof.

I claim:

1. A device for supporting tubing during bending thereof, comprising a plurality of members, walls movably mounted therein, a plurality of actuating devices, one for each member, said members being connected together for swinging movement, and means for moving said members and devices relatively, the devices in said movement effecting a movement of said walls relatively to said members.
2. A device for supporting tubing during bending thereof, comprising a plurality of members having openings therethrough and lateral walls movably mounted therein, a plurality of actuating devices lying one within each member, said members being connected together for swinging movement, and means for effecting relative movement of said members and devices and thereby effecting movement of said walls relatively to said members.
3. A device for supporting tubing during bending thereof comprising a plurality of mandrel sections each comprising a hollow frame structure and walls movably mounted in said structure, and a plurality of actuating devices extending through said frame structures and operatively connected to said walls said sections being connected for swinging movement and said sections and devices being relatively movable, said devices in said movement in one direction forcing said walls apart.

4. A device for supporting tubing during bending thereof comprising a plurality of mandrel sections each comprising a hollow frame structure and walls movably mounted in the structure, and a plurality of actuating devices connected together end for end for swinging movement and extending through said structures, each device having inclined surfaces engaging the walls in a section, said sections and devices being relatively movable and said devices in said movement in one direction forcing said walls outwardly.

5. A device for supporting tubing during bending thereof comprising a plurality of mandrel sections each comprising a hollow frame structure and walls movably mounted in the structure, a plurality of actuating devices connected together for swinging movement and extending through the frame structures, each device engaging the walls of one section, and a single means mounted on one of said devices and engageable with one of said sections for effecting relative movement of said sections and devices, said devices in said movement causing said walls to move outwardly from said structures.

6. A device for supporting tubing during bending thereof, comprising a plurality of mandrel sections each comprising a hollow frame and walls movably mounted thereon and each wall having a projection entering the interior of its frame, and a plurality of actuating devices, one for each frame, extending through said frames and connected together for swinging movement, each device having inclined surfaces engaging the projections on the walls of its mandrel section, said sections and devices being relatively movable and said surfaces causing outward movement of said walls upon relative movement of said sections and devices in one direction.

7. In a device for supporting tubing during bending thereof, a plurality of mandrel sections connected together for relative swinging movement, each section carrying flat surfaced walls mounted thereon and movable relatively to their section to increase the transverse overall dimensions of their section in at least two intersecting planes, and means for moving said walls to increase said dimensions.

8. In a device for supporting tubing during bending thereof, an expansible mandrel comprising a series of loosely connected hollow frames, movable side walls for each frame, each wall having a projection entering the frame and having an inclined end surface, and means for securing said walls in said frame while permitting outward movement thereof.

9. In a device for supporting tubing during bending thereof, a plurality of hollow frames, side walls mounted in said frames, a plurality of actuating devices, one for each frame, connected together for swinging movement and extending through said frames, means on each device for holding the walls of its frame in place while permitting said walls a limited freedom of movement relative to their frame and permitting said device a limited freedom of movement relative to said walls, and means on said device for engaging said

walls and moving them outwardly upon relative movement of the device and its frame.

10. A method of bending tubing having at least three sides which are flat on both inner and outer faces, which comprises mechanically applying outwardly directed supporting pressure to the inner faces of all said sides upon a plurality of separate spaced areas thereof of substantial size, said areas being distributed in a row along said faces and said pressure tending to force said areas outwardly without altering the contour thereof, and, while said pressure is maintained, applying inwardly directed pressure on outer faces of the tubing to bend the latter between said areas.

11. A method of bending tubing of rectangular cross-section and having flat inner walls, which comprises mechanically applying outwardly directed supporting pressure upon a plurality of separate areas of substantial size spaced in a row along each of the inner walls of the tubing, said pressure tending to force said areas outwardly and, while said supporting pressure is maintained, applying inwardly directed forming pressure on the outer surfaces of the tubing throughout the length of the tubing which is to be bent to bend said tubing between said areas.

12. A device for supporting tubing during bending thereof, comprising a plurality of members, connections between the members permitting the device to assume a curved shape, a plurality of lateral wall elements movably mounted on each of said members, and means for moving said elements relatively to said members to vary the transverse overall dimensions of said members with the elements in place in at least two planes intersecting at right angles.

13. A device for supporting tubing during bending thereof, comprising a plurality of members, connections between the members permitting the device to assume a curved shape, lateral walls movably mounted on said members and having flat faces lying in planes at an angle to one another, and means operable at the end of the group of members for moving the walls of the several members to vary the transverse dimensions thereof in at least two intersecting planes.

14. A device for supporting tubing during bending thereof, comprising a plurality of members connected together for swinging movement, at least three walls movably mounted on each member, said walls lying in intersecting planes, a plurality of actuating devices, one within each member, and means for operating said actuating devices to cause each device to move the walls of its associated member.

15. A device for supporting tubing during bending thereof, comprising a plurality of mandrel sections, walls mounted on the sections and movable outward relative to said sections, and a plurality of actuating devices connected for swinging movement and lying within said sections, said sections and devices being relatively movable for moving said walls to alter the transverse overall dimensions of said sections in at least two intersecting planes.

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