Sept. 5, 1967 M. T. BUCKWALTER ET AL 3,339,392

BENDING STRUCTURAL SHAPES

Filed April 6, 1965 5 Sheets-Sheet 1

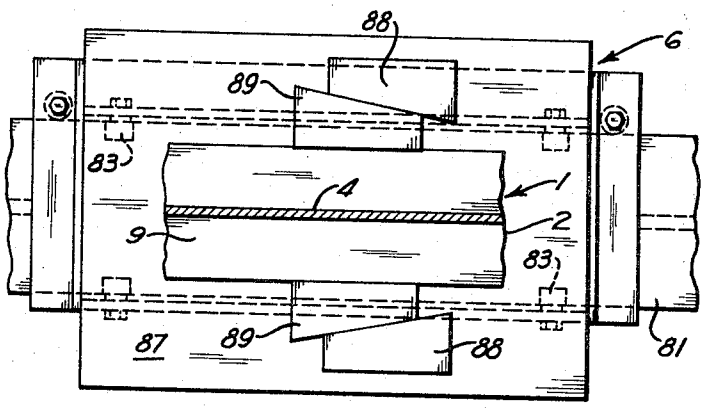


Fig. 6

Fig. 1

INVENTORS.
LLOYD E. ANDERSON, SR.
MILTON T. BUCKWALTER
BY
Brown, Critchlow, Flick & Peckham.
ATTORNEYS.

Sept. 5, 1967 M. T. BUCKWALTER ET AL 3,339,392

BENDING STRUCTURAL SHAPES

Filed April 6, 1965 5 Sheets-Sheet 2

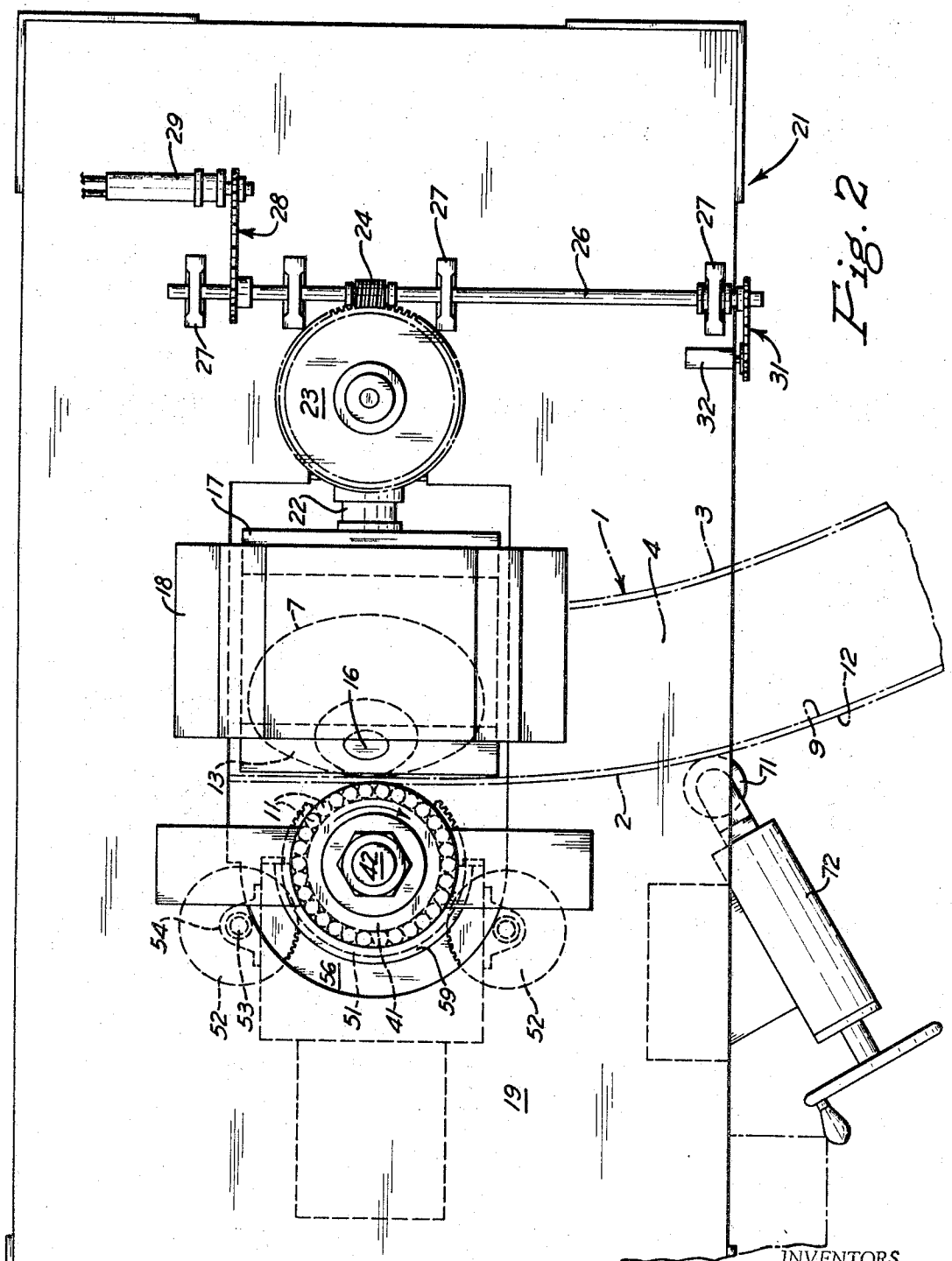


Fig. 2

INVENTORS.
LLOYD E. ANDERSON, SR.
MILTON T. BUCKWALTER
BY
Brown, Critchlow,
Flick & Peckham.
ATTORNEYS.

Sept. 5, 1967 M. T. BUCKWALTER ET AL 3,339,392

BENDING STRUCTURAL SHAPES

Filed April 6, 1965 5 Sheets-Sheet 3

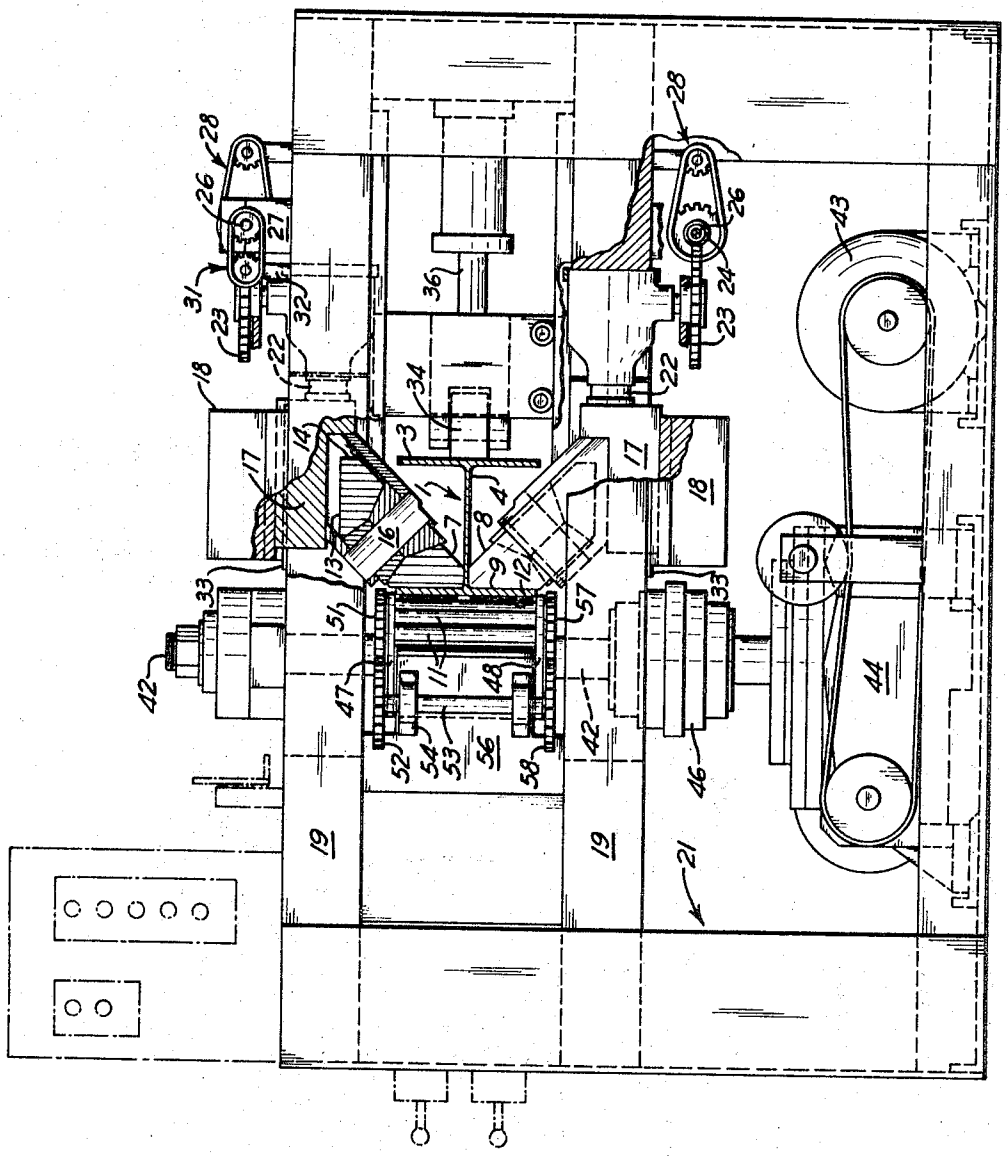


Fig. 3

INVENTORS.
LLOYD E. ANDERSON, SR.
MILTON T. BUCKWALTER
BY
Brown, Critchlow, Flick & Peckham.
ATTORNEYS.

Sept. 5, 1967 M. T. BUCKWALTER ET AL 3,339,392

BENDING STRUCTURAL SHAPES

Filed April 6, 1965 5 Sheets-Sheet 4

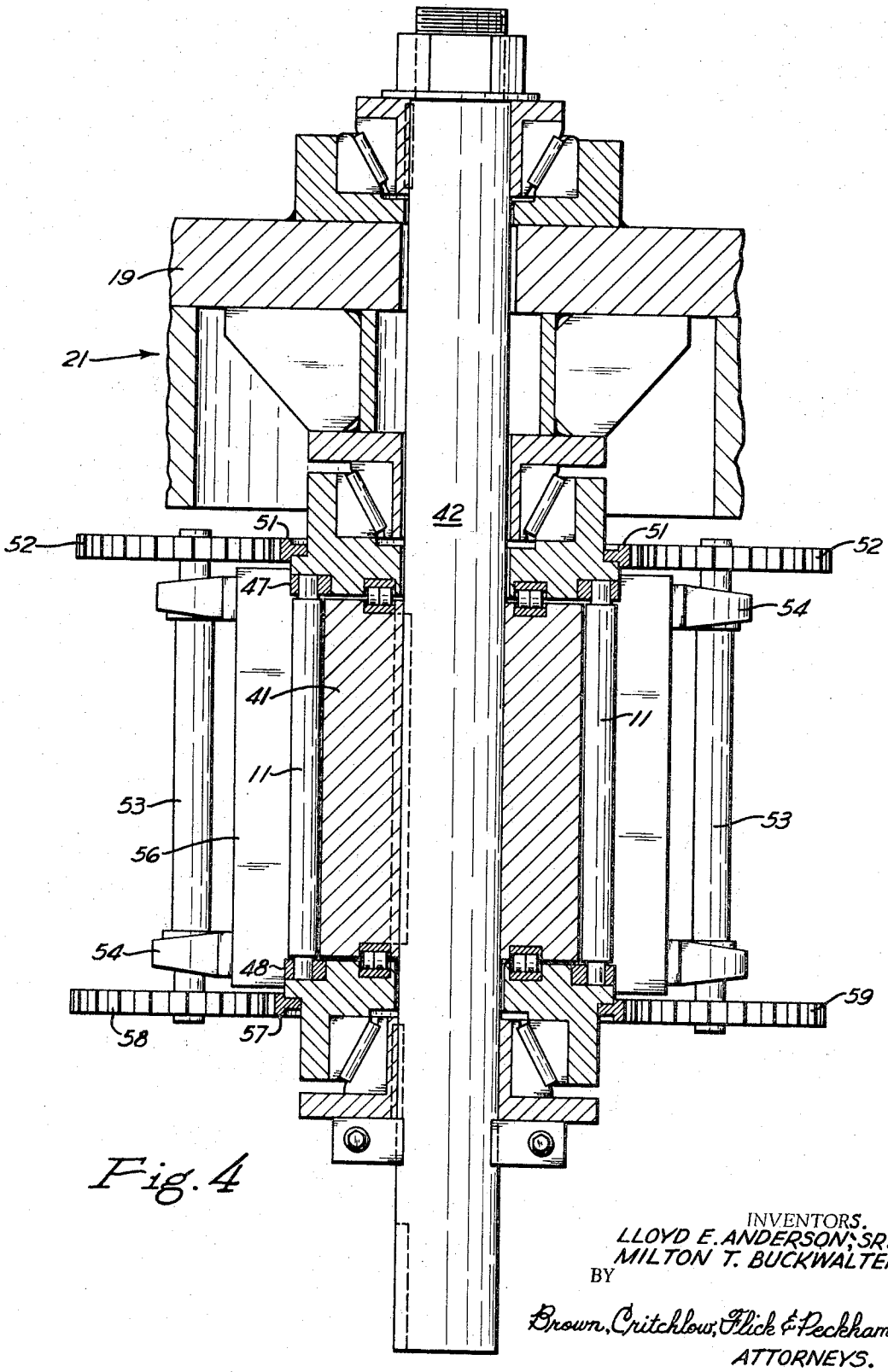


Fig. 4

INVENTORS.
LLOYD E. ANDERSON, SR.
MILTON T. BUCKWALTER
BY
Brown, Critchlow, Flick & Peckham.
ATTORNEYS.

Sept. 5, 1967 M. T. BUCKWALTER ET AL 3,339,392

BENDING STRUCTURAL SHAPES

Filed April 6, 1965 5 Sheets-Sheet 5

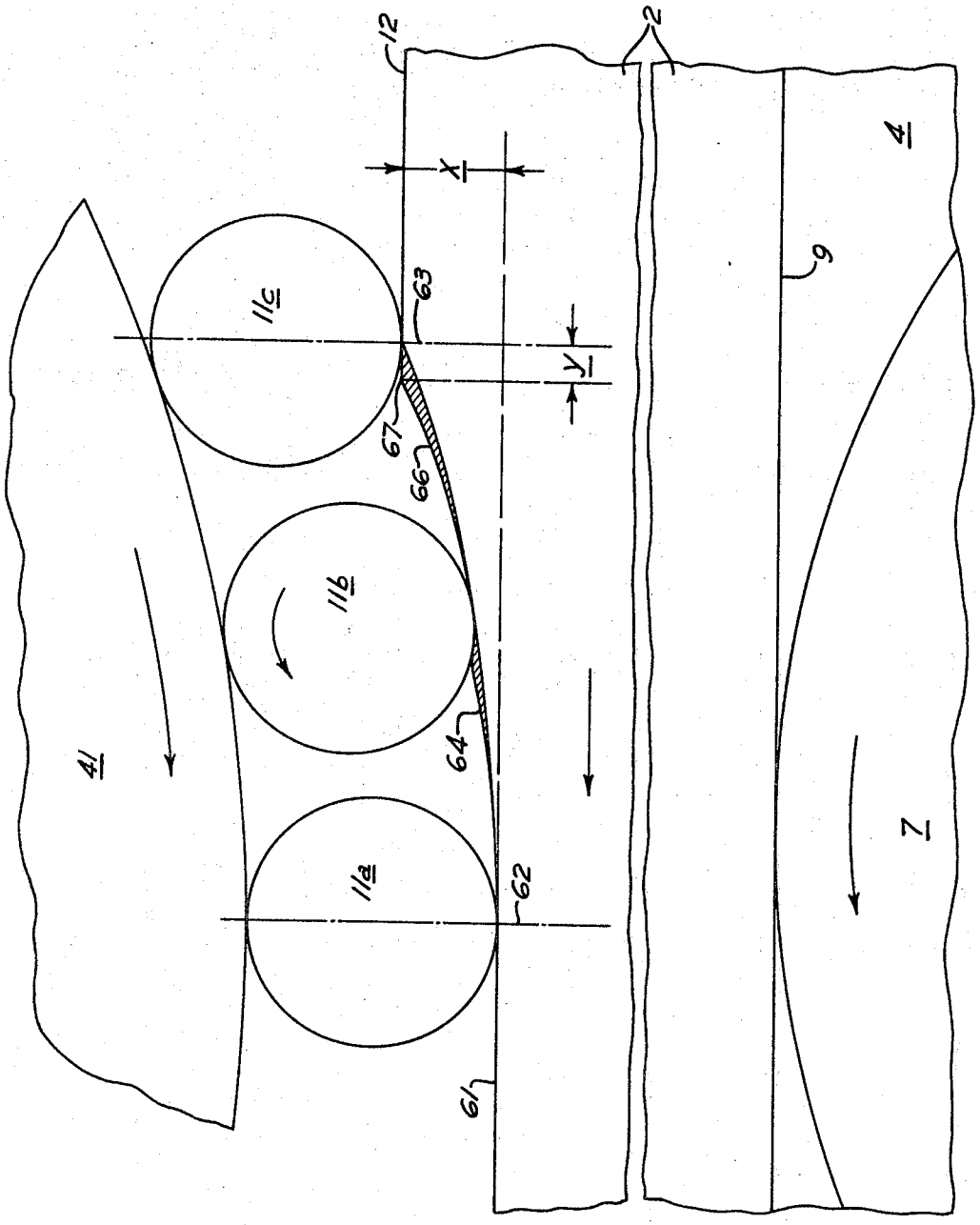


Fig. 5

INVENTORS.
LLOYD E. ANDERSON, SR.
MILTON T. BUCKWALTER.
BY
Brown, Critchlow, Flick & Peckham.
ATTORNEYS.

United States Patent Office 3,339,392 Patented Sept. 5, 1967

3,339,392

BENDING STRUCTURAL SHAPES

Milton Thomas Buckwalter, Allison Park, Pa., and Lloyd E. Anderson, Sr., Des Moines, Iowa, assignors to Pittsburgh Des Moines Steel Company, Pittsburgh, Pa., a corporation of Pennsylvania

Filed Apr. 6, 1965, Ser. No. 446,066
18 Claims. (Cl. 72—166)

ABSTRACT OF THE DISCLOSURE

An apparatus for bending preformed flanged structural beams having a plurality of planetary work rolls supported about and in rolling contact with a central backing roll for subjecting the outer face of a flange of the beam to combined rolling and swaying action which produces longitudinal plastic flow in the flange to elongate the outer face relative to the inner face and hence results in the beam bending in a direction in which the elongated flange forms the convex surface of the bent beam. The inner face of the worked flange is supported by shaped anvil rolls whose axes relative to the axes of the planetary rolls are in slightly offset planes normal to the beam flange in the zone where the rolling and swaying occur. The beam is fed to the roll system at a speed which is substantially less than the translational speed of the work rolls.

This invention relates to bending preformed shapes about a major axis of stiffness to various contours. Although not limited thereto, the invention is particularly applicable to the bending of I-beams and T-beams into circular arcs in a plane normal to the flanges of the beams.

Heretofore, such structural shapes have been bent either by pressing them between dies of the desired contour or by stretch forming them about a convex die. In die pressing, a very large initial investment is required to provide a supply of dies for various desired contours, and additional expense is incurred in storing and changing those dies. In stretch forming, the shapes that can be handled are limited to those having a relatively small cross-sectional area and, even then, stretching may produce concentrated strains in the material that weaken the beam and may even cause it to fail.

It is among the objects of this invention to provide a method and apparatus for bending preformed structural shapes in which the bending operation can be readily controlled to conform such shapes to a large number of different contours, in which beams of large cross-sectional area can be bent about a major axis of stiffness without producing internal strains that will weaken the beams, and in which bending is effected quickly and economically.

Other objects will be apparent from the following description of a preferred embodiment of the invention, in connection with the attached drawings, in which

FIG. 1 is a general plan view of the apparatus embodying the present invention;

FIG. 2 is an enlarged fragmentary plan view of a portion of the apparatus shown in FIG. 1;

FIG. 3 is a vertical elevation, partly in section, of a portion of the apparatus shown in FIG. 2;

FIG. 4 is a further enlarged fragmentary section along the line IV—IV of FIG. 2;

FIG. 5 is a diagrammatic representation of the rolling and swaging action of the planetary work rolls on a portion of the material that is being elongated; and

FIG. 6 is an enlarged fragmentary elevation of a portion of the beam feeding means shown in FIG. 1.

The present invention is predicated on elongating a

portion of a structural shape by longitudinal plastic flow involving a reduction in cross section to cause the shape to bend about a neutral axis. The invention is applicable to various structural shapes, including, without limitation, those having a flange and a web extending longitudinally on one side of the flange, as for example, H-beams, I-beams, channels, and angles. For purposes of illustration, the invention is described herein with reference to bending an H-beam into an arcuate curve in a plane normal to the flange. In this case, one of the flanges is elongated substantially uniformly across its width (without, however, appreciably increasing its width), and a portion of the web immediately adjacent to this flange is also elongated, by feeding those portions of the beam longitudinally at a controlled speed through a rolling and swaging zone. The resulting asymmetrical elongation of the beam causes it to bend. In some other cases, elongation of the flange alone is all that is needed to provide the desired curvature. In still other cases, as in bending a channel in a plane normal to the web with the flanges on the concave side of the final curved beam, the elongation would extend substantially uniformly over the web, and might also extend to adjacent portions of the flanges. If the elongation is distributed substantially uniformly across the width of the flange or web, as the case may be, the resulting curvature will tend to be in a plane that is substantially normal to that member. On the other hand, if there is a substantial and progressive differential in reduction and elongation between the top and bottom of the flange, or between one side and the other of the web, the resulting curvature will tend to be in the plane of the member subjected to such differential elongation.

Returning to the illustrative case of an H-beam that is to be bent in a plane normal to its flanges, the beam, in passing through the rolling and swaging zone, has the inner face of one flange supported for substantially its full width by supporting anvil rolls, and the opposite or outer face of the same flange is subjected to a rapid succession of rolling and swaging blows that cause plastic flow of the flange material in the longitudinal direction in which the beam is moving. These rolling and swaging blows result from successively striking the face of the flange with a plurality of work rolls that are translated longitudinally in the same direction as the beam but at a speed greatly in excess of the speed at which the beam is fed into the rolling and swaging zone. The action of the work rolls causes longitudinal plastic flow, elongation, and reduction in thickness of that portion of the beam contacted by the work rolls. In addition, the portion of the web that is immediately adjacent to this flange is preferably also elongated, in part, by the rolling action of the supporting anvil rolls.

Referring to the drawings, an H-beam **1** of conventional design has flange portions **2** and **3** connected by a central web portion **4**. The bending apparatus includes beam feeding means **6** for forcing a flange and an adjacent portion of the web of the beam longitudinally between pyramidal supporting anvil rolls **7** and **8**, which contact the inner face **9** of flange **2** and a portion of the adjacent web, and planetary work rolls **11**, which contact the outer face **12** of the same flange. These various rolls, in making contact with the beam, define a rolling and swaging zone, wherein the flange and a portion of the adjacent web are elongated.

The two pyramidal anvil support rolls **7** and **8** are mounted one on each side of web **4**; and each roll has a flange contacting surface **13** and a web contacting surface **14**. The rolls are rotatably mounted on shafts **16**, which are supported at an angle of 45° to the horizontal in roll housings **17**. The latter are slidably mounted for horizontal reciprocation in stationary blocks **18**,

which are bolted to slabs **19**, forming part of the frame **21** of the machine. Horizontal adjustment of anvil rolls **7** and **8** is provided by screw jacks **22**, which slide housings **17** in blocks **18**. Each jack is operated through a worm gear **23**, a worm **24**, and a shaft **26** mounted on pillow blocks **27** secured to slab **19**. Each shaft **26** is turned through a sprocket chain drive **28** by an air motor **29**, or by some other suitable means. Shaft **26** is also connected by a sprocket chain drive **31** to a counter **32** for indexing the horizontal position of anvil rolls **7** and **8**. Vertical adjustment of those rolls is most conveniently effected by inserting or removing shims **33** between the stationary blocks **18** and slabs **19**, but any other suitable means may be used.

A roller **34**, which is mounted at the end of a hydraulic or screw-actuated ram **36**, can be adjustably pressed against the outer face of flange **3** (see FIG. 3) to provide additional lateral support for the beam against the rolling and swaging pressure of the planetary work rolls. Roller **34** also prevents the web **4** from elongating in a direction normal to the flange rather than parallel to the flange as is desired. In addition, the roller serves as a fulcrum for additional bending pressure that is applied to the beam by an external bending roll to be described later herein.

Planetary work rolls **11** revolve about a backing roll **41**, which is keyed to a vertical shaft **42** and driven by motor **43** through reduction gear **44** and flexible coupling **46**. The upper and lower ends of the work rolls **11** are supported in top and bottom roll retainers or rings **47** and **48**, respectively. Top ring **47** is secured to an annular gear **51**, concentric with shaft **42** and meshing with two idler gears **52**, which are rigidly connected to separate shafts **53**, rotatably supported in suitable bearings **54** mounted on a backing block **56**. The bottom ring **48** is secured to a similar annular gear **57**, which meshes with two additional idler gears **58** also rigidly mounted on shafts **53**. This gearing prevents relative rotation between the top and bottom retainer rings **47** and **48** and assures that the axes of the planetary work rolls **11** will remain parallel to the axis of shaft **42**.

As lateral support for the planetary roll assembly, there is provided on the opposite side of that assembly from the rolling and swaging zone a hardened steel liner **59**, which is in the shape of a half cylinder conforming to the outer diameter of the planetary assembly and is mounted in a cylindrical recess in backing block **56** (see FIG. 2). The heavy rolling and swaging pressure of the planetary assembly against the beam flange causes the work rolls **11** on the opposite side of that assembly to be squeezed between backing roll **41** and liner **59**, so that the liner, in addition to its supporting function, increases the pressure of the work rolls against their backing roll and assures rolling contact between the two, as the backing roll rotates about shaft **42**. This rolling contact causes the work rolls to rotate around their own axes and also around the axis of their backing roll, the speed of the latter rotation being one-half the surface speed of the backing roll.

Backing roll **41** is preferably driven so that work rolls **11** will be fed against the outer face of flange **2** in the same direction in which the beam is being moved longitudinally by feeding means **6**. The work rolls will then be successively wedged between their backing roll and the outer face of the flange, being driven by friction with the backing roll and being in rolling contact with that roll and the flange surface. The action of the work rolls on a portion of the flange that is being moved through the rolling and swaging zone is shown diagrammatically in FIG. 5. In this figure, it is assumed that the flange is moving to the left, that the work rolls are rotating counterclockwise about their own axes while being translated in a clockwise direction about the axis of the backing roll, and that the backing roll is rotating in a clockwise direction. The anvil support rolls on the other side of the flange are therefore rotating in a counterclockwise direction. The diameter of the planetary assembly and the diameter and spacing of the work rolls are so related to the actual reduction in cross-section of the flange that there will be at least one work roll, and preferably two as shown in FIG. 5, in contact with the flange at all times. In addition, the translation speed of the work rolls is sufficiently high relative to the feed speed of the beam to avoid any idle periods and to minimize the vibration from the hammering blows of the work rolls, as well as to impart a flatter or less rippled finish to the outer surface of the flange being worked on. In FIG. 5, of the three planetary work rolls **11***a*, **11***b*, and **11***c*, the first and last are shown, just before breaking and making, respectively, contact with the reduced portion **61** and the unreduced portion **12** of flange **2**, while roll **11***b* is in rolling and swaging engagement with that flange. It will be apparent that the rolling and swaging zone lies between the lines **62** and **63**, where the flange material is caused to flow in the direction from **63** to **62** by the swaging and rolling action of the work rolls. This flow of material and resulting elongation results in a reduction in thickness x of the flange, which is exaggerated in the figure to make clearer the action of the work rolls. In this connection, it will be noted that anvil support roll **7**, which presses against the inner face **9** of flange **2** is tangent to that face at a point somewhat behind, that is, to the right of line **62**, where the work roll is tangent to the opposite face of the flange just before moving out of contact with that face. In other words, the axes of the anvil support rolls and of the planetary roll system are in slightly offset planes normal to the beam flanges to provide more uniform support for the inner face of the flange in the active zone where rolling and swaging occur. This offset also causes the planetary work roll in its tangent position to exert on the flange of the beam in the zone of plastic flow a bending force that further induces the flange to assume the desired curvature. The amount of such offset will depend on the type of material being bent, as well as on the size, spacing, and speed of translation of the work rolls.

In FIG. 5, the arcuate lines **64** and **66** indicate the intermediate surfaces of the outer face of the flange during the rolling and swaging operation. Surface **64** resulted from the plastic flow effected by the traverse of roll **11***a* (and preceding work rolls). Ideally, that surface approaches the arc of a circle having its center on the axis of the backing roll **41**, but departs somewhat therefrom because of the continuous movement of the beam as it is fed longitudinally into the rolling and swaging zone. Surface **66** represents a similar intermediate surface resulting from the flow of material caused by the partial traverse of work roll **11***b* (and preceding work rolls) through said zone. The horizontal distance y between points **63** and **67** represents the longitudinal movement of the beam during the interval when roll **11***b* moved to its present position from the present position of roll **11***c*. Although the peripheries of the work rolls traverse the same circular arc about the axis of the planetary roll system, nevertheless, because of the longitudinal movement of the beam, there is always an increment of flange material subjected to plastic flow by the traverse of the work roll through the rolling and swaging zone. These increments are shown in exaggerated form by the shaded portions under arcs **64** and **66** in FIG. 5.

It is an inherent characteristic of a planetary roll system that the rate of plastic flow of a given material will vary with the speed at which the material is fed into the active reduction zone, that the amount of work or plastic flow effected by each individual work roll during its traverse through that zone will vary inversely with the ratio of the translation speed of the roll to the longitudinal feeding speed of the material being elongated, and that the actual amount of plastic flow will be determined by the spacing between the planetary roll system

and anvil support rolls 7 and 8. As previously indicated, this spacing can be controlled by adjusting the horizontal position of the anvil support rolls by means of screw jacks 22. Another feature of the planetary roll system is that quite large amounts of plastic flow, which under the conditions here involved produces substantial elongation and reduction in thickness, can be effected in a single pass through the rolling and swaging zone.

The amount of plastic flow in the flange material will determine the amount of its elongation and, together with any accompanying elongation of the adjacent web portion of the beam, will determine the resulting curvature imparted to the beam. In H-beams, where the width of the web is relatively small compared to the width of the flanges, curving the beam in the plane of the web may be accomplished with little or no rolling pressure on that portion of the web adjacent the flange being deformed. However, when the web is relatively wide compared to the width of the flanges, it is preferably in almost all cases to elongate also that portion of the web immediately adjacent to the flange that is being deformed. Such elongation is effected by rolling pressure exerted by faces 13 of pyramidal anvil support rolls 7 and 8, this pressure being controlled by the insertion or removal of shims 33 to adjust the vertical position of those rolls. Other portions of the web not subjected to rolling pressure are also elongated by the stretching of adjacent portions, but such elongation is slight and decreases towards flange 3, which lies in or close to the neutral plane of bending.

As the beam emerges from the rolling and swaging zone, it may be desirable to subject it to the pressure of a bending roll 71 that bears against the outer surface of flange 2. The bending roll subjects the flange to tension stresses that are effective in the adjacent region of the flange where the material is in a plastic state, making it easier for the planetary work rolls to elongate the flange in that region and also helping to control the amount of curvature finally imparted to the beam. The amount of pressure asserted by the bending roll can be varied by adjusting jack 72 on which that roll is rotatably mounted.

When bending long beams to a substantially uniform curvature, it may be desirable to control that curvature within narrow limits by the use of an adjustable radius arm 73. The outer end of this arm is provided with a gripping head 74 clamped or otherwise secured to the end of the beam when it first emerges from the rolling and swaging zone. The inner end of the arm is slidably received in a radius member 76 and is clamped therein by bolts 77. The radius member 76 is rotatable about a fixed pivot 78. As the beam is moved through the rolling and swaging zone, the radius arm maintains the end of the beam and the desired curvature thereby serves a useful gauging and control function.

The beam feeding means 6 may take a variety of forms. That shown in the drawings (FIGS. 1–6) includes a frame 81, which supports a reciprocating carriage 82. The carriage is moved back and forth on rollers 83 by a chain drive 84 connected to a motor 86. A vertically extending plate 87 is mounted on the carriage and adapted to contact the outside surface 12 of flange 2 of the beam. The plate is provided with fixed wedges 88 spaced above and below the edges of the beam flange and the flange is secured between those wedges by means of movable wedges 89. Motor 86 is preferably provided with speed control means (not shown) for adjusting the feeding speed of the beam into the rolling and swaging zone.

It is among the advantages of this invention that it provides an economical and effective means for bending many sizes and configurations of structural shapes about a longitudinal neutral axis, without the disadvantages previously adverted to in die forming and stretch forming such shapes. These desirable results are largely obtained by subjecting selective portions of the beam material to longitudinal plastic flow in the rolling and swaging zone,

thereby to elongate that portion of the beam and cause it to bend in the desired plane. It will be apparent that with obvious modifications, other structural shapes than those described herein can be bent in accordance with the methods and means herein described. For example, in bending a channel beam in a plane normal to the web portion, a single anvil support roll would be used to support the inner face of the web, while the opposite face was subjected to the rolling and swaging action of the planetary work rolls.

According to the provisions of the patent statutes, we have explained the principle of our invention and have illustrated and described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. A beam bender for bending a structural beam having integral first and second members, such as flange and web members, extending longitudinally at right angles to each other with the first member having a flat outer face and an opposed inner face and with the second member extending out from the inner face of the first member but not from the outer face of that member, said apparatus comprising: anvil roll means for supporting the inner face of the first member; rolling and swaging means for rapidly and successively contacting the outer face of the first member with a plurality of work rolls that are translated longitudinally of said face to produce, by a combination of rolling and swaging, longitudinal plastic flow in the first member without substantial lateral plastic flow therein, for elongating that member relative to that portion of the beam remote from the first member; and feeding means for moving the first member longitudinally between the anvil roll means and the rolling and swaging means at a controlled speed that is considerably less than the translational speed of the work rolls contacting the outer face of the first member, whereby the differential elongation of the first member relative to that portion of the beam remote from the first member will cause the beam to bend so that the outer face of the first member will form a convex surface.

2. Apparatus according to claim 1, in which the work rolls are in the form of planetary rolls that are revolved as a system at high speed about and in rolling contact with a central backing roll.

3. Apparatus according to claim 2, in which the axis of the anvil roll means and the axis of the planetary roll system lie in different planes normal to the face of the member contacted by the anvil roll means.

4. Apparatus according to claim 1, in which the first member is a flange of the beam and in which the second member is a web of the beam.

5. Apparatus according to claim 1 that also includes auxiliary means for applying a bending pressure to the beam on the exit side of the rolling and swaging means while supporting the beam on the other side of said latter means, such pressure providing a bending moment that is effective to stretch the first member longitudinally in the region of plastic flow therein.

6. Apparatus according to claim 1 that also includes guide means for positively guiding in a curved path one end of the beam after it has passed through the rolling and swaging means while other portions of the beam are still passing through said latter means, thereby to apply a bending moment to the beam in the region of plastic flow that will assist said differential elongation.

7. A beam bender for bending a structural shape having a flange and a web extending longitudinally on the inside of the flange, the apparatus comprising: anvil roll means for supporting the inside of the flange over substantially its full width; a group of planetary work rolls rotatable at high speed about and in rolling contact with a central backing roll for subjecting the outside of the flange to a

rapid succession of rolling and swaging blows in a defined zone to induce longitudinal plastic flow in that zone, but without inducing substantial lateral plastic flow in said zone, thereby to elongate the flange relative to the web portion remote from the flange; and feeding means for moving the flange longitudinally between the anvil roll means and the planetary rolls at a controlled speed that is considerably less than the translational speed of the work rolls in the rolling and swaging zone and in the same direction as the translational movement of those rolls in that zone, whereby the differential elongation of the flange relative to that portion of the web remote from the flange will cause the beam to bend with the flange forming the convex side of the beam.

8. Apparatus according to claim **7**, in which the axes of the anvil roll means and the axis of the central backing roll lie in spaced parallel planes normal to the outer face of the flange.

9. Apparatus according to claim **7** that also includes auxiliary means for applying bending pressure to the beam on one side of the rolling and swaging zone while supporting the beam on the other side of said zone, such pressure providing a bending moment that is effective to stretch the flange longitudinally in the region of plastic flow in said zone.

10. Apparatus according to claim **7** that also includes guide means for positively guiding in a curved path one end of the beam after it has passed through the rolling and swaging zone while other portions of the beam are still passing through that zone, thereby to apply a bending moment to the beam in the region of plastic flow that will assist said differential elongation.

11. A beam bender for bending a structural beam having first and second opposed flanges with flat outer faces and with inner faces connected by an integral web extending longitudinally at right angles to the flanges, the apparatus comprising: anvil roll means for supporting the inner face of the first flange; a group of planetary work rolls rotatable at high speed about and in rolling contact with a central backing roll for progressively subjecting the outer face of the first flange to a rapid succession of rolling and swaging blows in a defined zone to induce longitudinal plastic flow in the first flange without inducing substantial lateral plastic flow therein, thereby to elongate the first flange relative to the second flange; and feeding means for moving the first flange longitudinally between the anvil roll means and the planetary rolls at a controlled speed that is considerably less than the translational speed of the work rolls in said rolling and swaging zone and in the same direction as the translational movement of those rolls in that zone, whereby the differential elongation of the first flange relative to the second flange will cause the beam to bend with the first flange forming the convex side of the beam.

12. Apparatus according to claim **11**, in which the axes of the anvil roll means and the axis of the central backing roll lie in spaced parallel planes normal to the outer face of the first flange.

13. Apparatus according to claim **12** that also includes a support roll engaging the outer face of the second flange, the axis of the support roll lying in the plane containing the axis of the anvil roll means.

14. Apparatus according to claim **11** that also includes auxiliary means for applying a bending pressure to the beam on the exit side of the rolling and swaging zone while supporting the beam on the other side of that zone, such pressure producing a bending moment that is effective to stretch the first flange longitudinally in the region of plastic flow therein.

15. Apparatus according to claim **11** that also includes guide means for positively guiding in a curved path one end of the beam after it has passed through the rolling and swaging zone while other portions of the beam are still passing through that zone, thereby to apply a bending moment to the beam in the region of plastic flow that will assist said differential elongation.

16. Apparatus according to claim **11** that also includes auxiliary roll means for applying a bending pressure to the beam on the exit side of the rolling and swaging zone while supporting the beam on the other side of that zone, such pressure providing a bending moment that is effective to stretch the first flange longitudinally in the region of plastic flow therein, and that further includes pivoted guide means for positively guiding in a curved path one end of the beam after it has passed through the rolling and swaging zone while other portions of the beam are still passing through that zone.

17. Apparatus according to claim **11**, in which the anvil roll means includes a pair of pyramidal rolls disposed on different sides of the web and rotatable about axes inclined to the plane of the flange, each pyramidal roll having a first rolling face for supporting a portion of the inner surface of the flange and a second rolling face substantially normal to the first rolling face for rolling engagement with a portion of the web adjacent the flange, and means for adjusting the spacing between the second roll faces of those rolls for applying rolling pressure to said web portion to elongate that portion.

18. A beam bender for bending a structural shape having a flange member and a web member extending longitudinally on one side of the flange member, said apparatus comprising anvil roll means for supporting a face of one of said members, rolling and swaging means for rapidly and successively contacting the opposite face of the same member with a plurality of work rolls to induce longitudinal plastic flow in that member, the work rolls being in the form of planetary rolls that are revolved at high speed about and in rolling contact with a central backing roll with the axis of the anvil roll means and the axis of the planetary roll system lying in different planes normal to the face of the member contacted by the anvil roll means, and feeding means for forceably moving the beam longitudinally between the anvil roll means and the rolling and swaging means at a controlled speed that is considerably less than the translational speed of the work rolls contacting said one member.

References Cited

UNITED STATES PATENTS

311,250	1/1885	Koehler	72—224
431,179	7/1890	Bickley	72—224
1,707,991	4/1929	Oskamp	72—210
1,929,987	10/1933	Mead	72—187
2,144,783	1/1939	Ungerer	72—197
2,710,550	6/1955	Sendzimir	72—46
3,192,756	7/1965	Cartwright	72—197

CHARLES W. LANHAM, *Primary Examiner.*

A. RUDERMAN, *Assistant Examiner.*