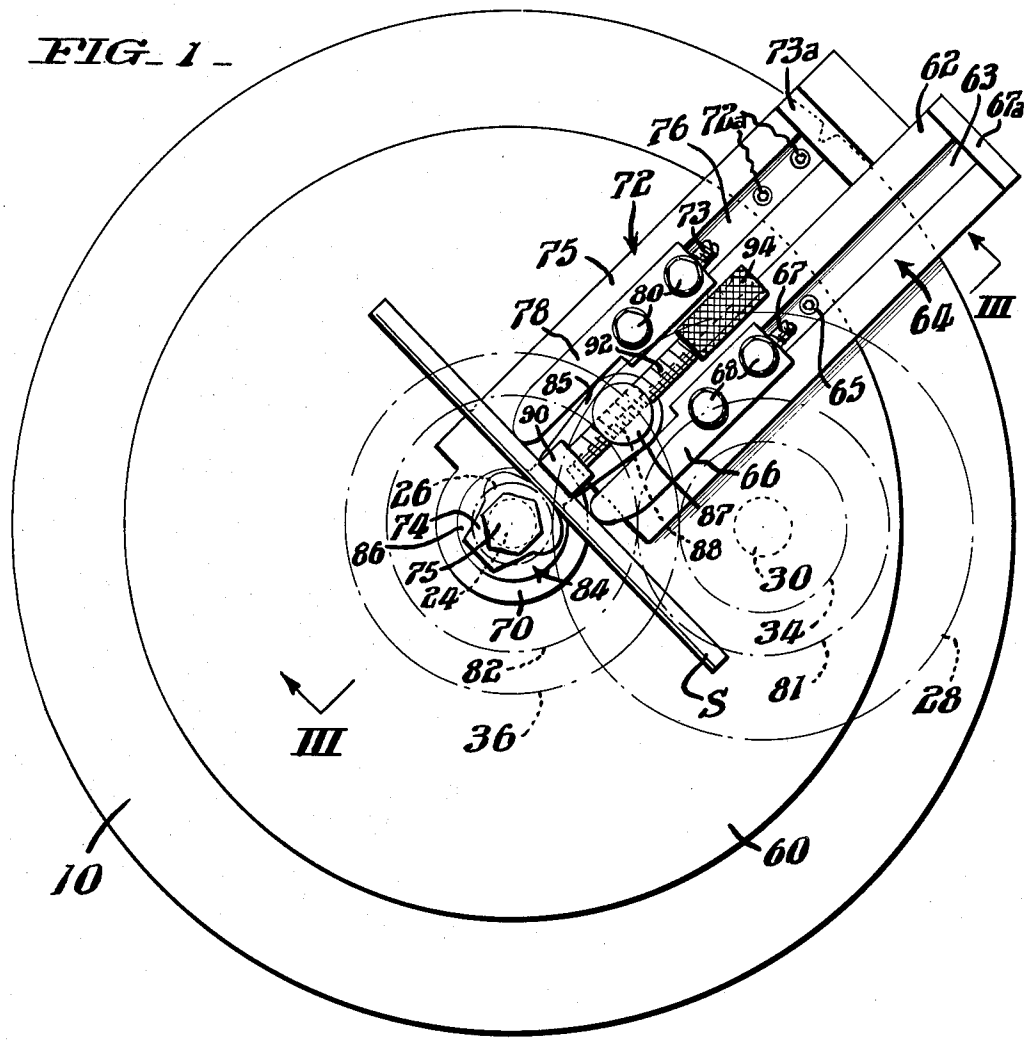
July 12, 1966 R. M. SHAW, JR 3,260,091

BENDING MACHINE

Filed May 24, 1963 6 Sheets-Sheet 1

FIG. 1



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BENDING MACHINE

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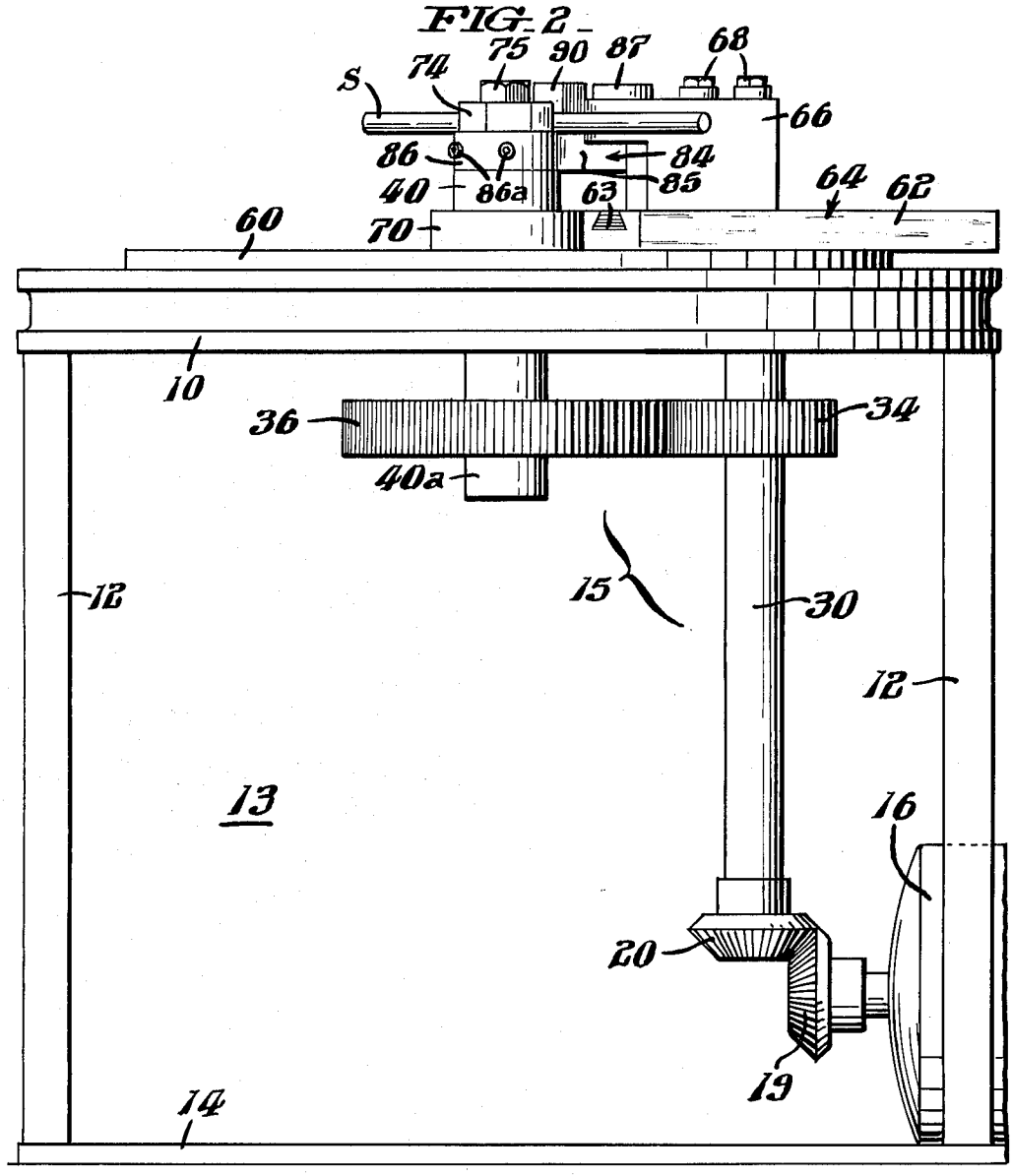
FIG. 2



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BENDING MACHINE

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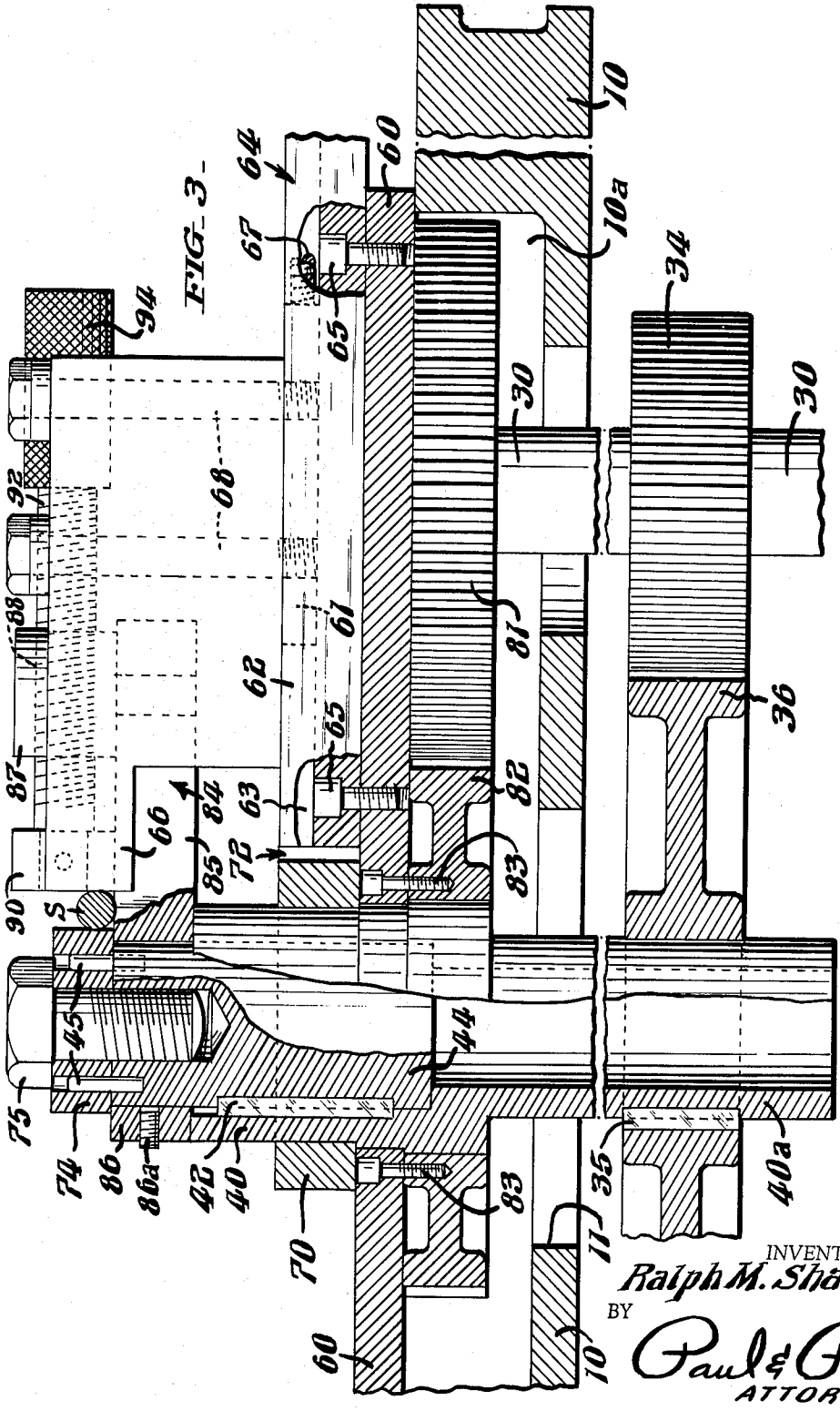
FIG. 3



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BENDING MACHINE

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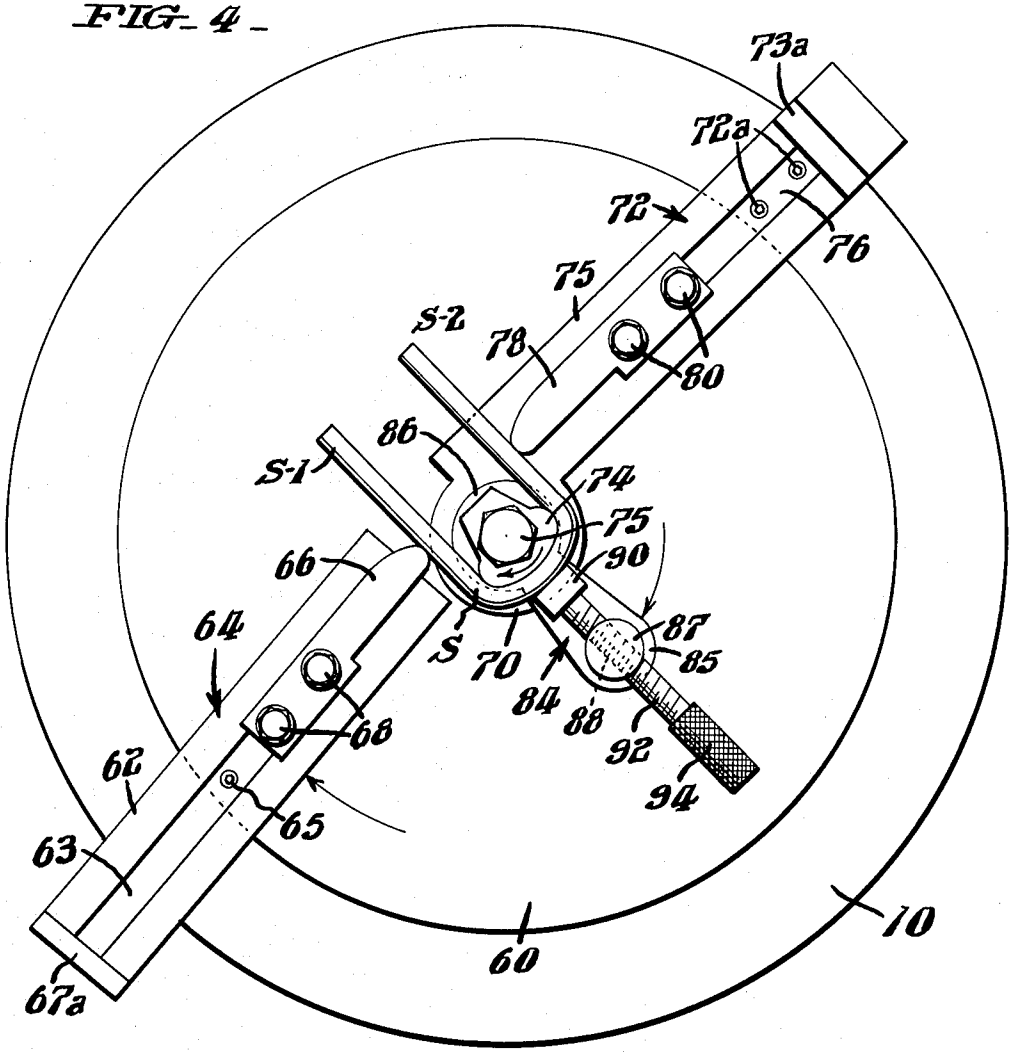
FIG. 4



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BENDING MACHINE

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FIG. 9

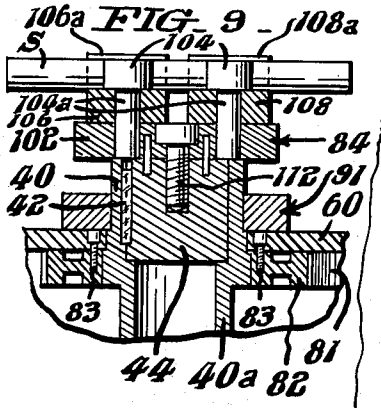


FIG. 5

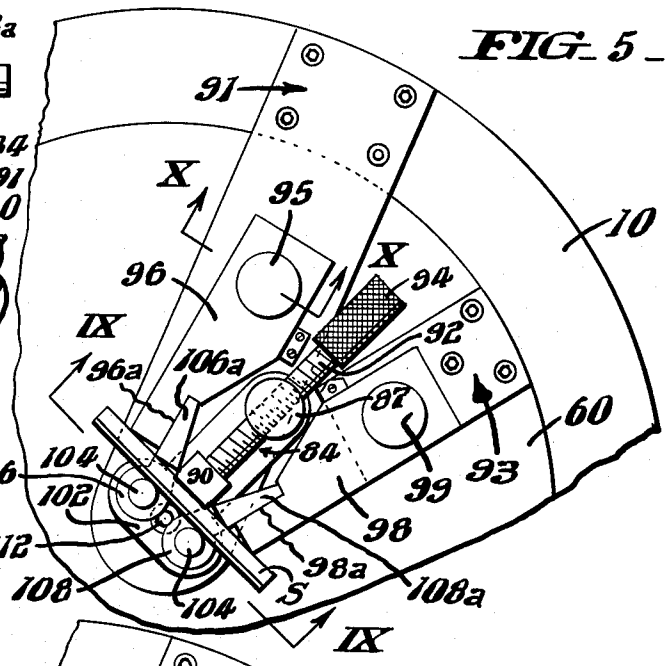


FIG. 10

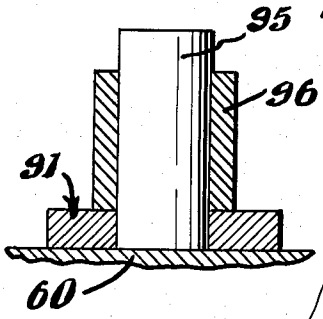
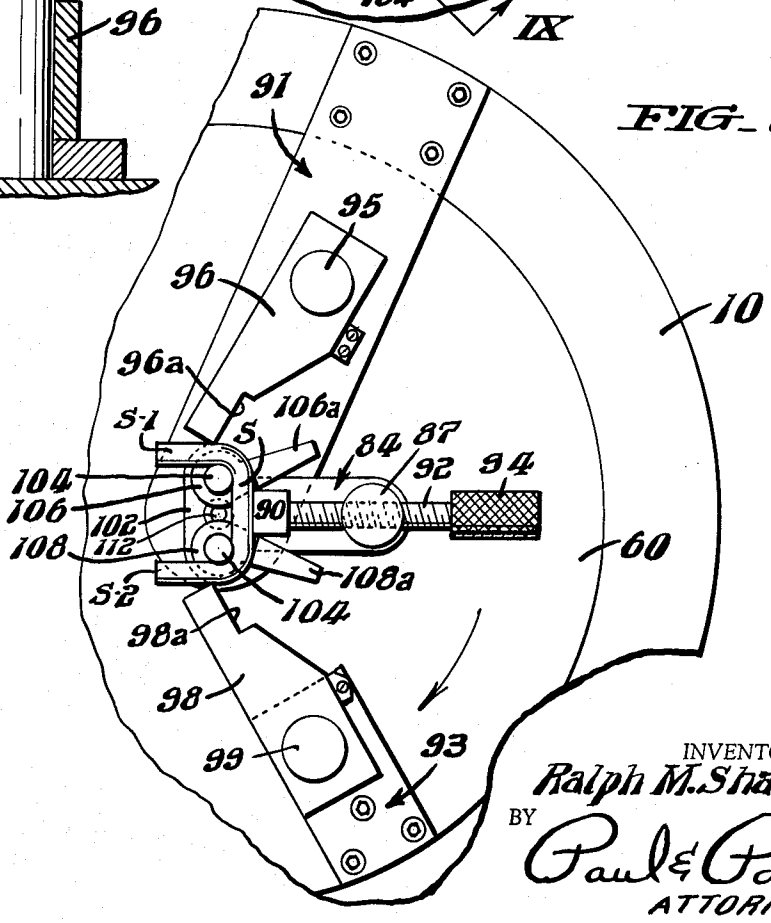


FIG. 6



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BENDING MACHINE

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FIG. 7

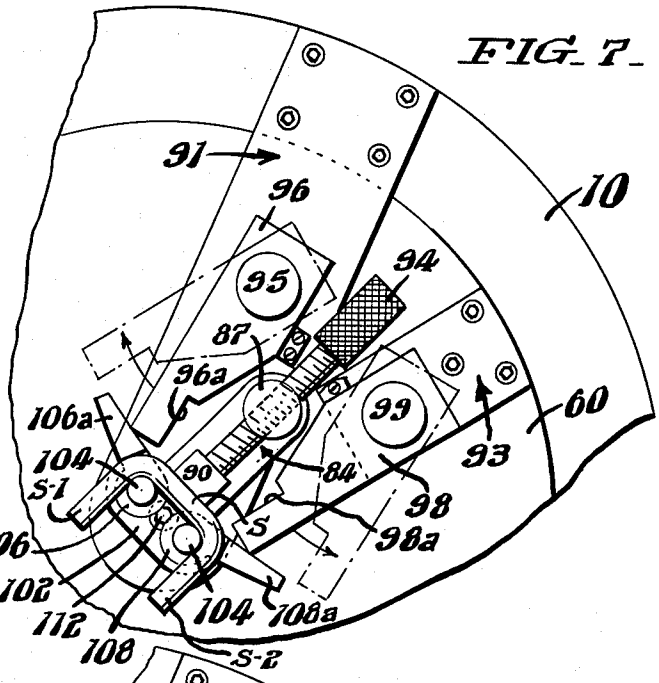

FIG. 11

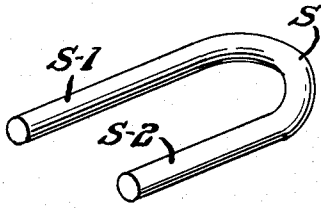

FIG. 12

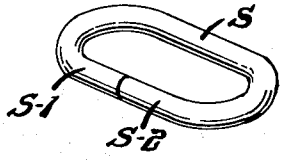

FIG. 8

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United States Patent Office

3,260,091

Patented July 12, 1966

3,260,091

BENDING MACHINE

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Filed May 24, 1963, Ser. No. 283,021
13 Claims. (Cl. 72—152)

This invention relates to bending machines and, in particular, it is concerned with machines and improvements thereto for angularly bending rods, bars, tubes and the like of metal or other flexible materials.

It is the primary object of this invention to provide a simple, inexpensive and reliable bending machine for making profile bends of variable radii or multiple radii in stock with the bending occurring in either a clockwise or counter-clockwise direction in a single operation or pass of the machine. Although an existing machine known as a "Stretch Bender" can do this type of bending, all of the bends produced by that machine can only be made in the same direction and the machine itself, as distinguished from the machine of this invention, is extremely expensive.

It is a further object of this invention to provide a bending machine having the capacity to implant bends in structural members which have been traditionally shaped by drop forging through use of a punch press while the members are hot, thus providing substantial savings in time and costs.

It is a further object of this invention to provide a bending machine having, in addition to the above outlined advantages, the feature wherein relatively large floor space heretofore necessary to accommodate movement of the bending stock and bending apparatus is no longer required. It is also my object to provide a superior bending apparatus which can be assembled and used with the standard bending machines now in existence, such as the mechanism described in U.S. Patent No. 2,884,987, issued to R. M. Shaw, Jr., on May 5, 1959.

Other objects and attendant advantages of this invention will more readily appear from the following detailed description and the attached drawings wherein:

FIG. 1 is a view in top plan of the bending machine conveniently embodying one form of my invention;

FIG. 2 is a view in side elevation of the mechanism shown in FIG. 1;

FIG. 3 is a view in partial side elevation and in vertical section taken as indicated by the lines and arrows III—III in FIG. 1;

FIG. 4 is a view in top plan illustrating the movement of certain parts of the apparatus from the positions shown in FIG. 1;

FIG. 5 is a fragmentary detail plan view of one modification of the bending apparatus of this invention;

FIG. 6 is a fragmentary detail plan view similar to FIG. 5 wherein a succeeding operative step is shown;

FIG. 7 is a fragmentary detail plan view showing the third step of the bending operation wherein a chain link is formed;

FIG. 8 is a fragmentary detail plan view showing the fourth step of the bending operation otherwise disclosed in the preceding three figures;

FIG. 9 is a vertical sectional view taken along the lines and arrows IX—IX of FIG. 5;

FIG. 10 is a vertical sectional view taken along the lines and arrows X—X of FIG. 5;

FIG. 11 is an enlarged perspective view of the bent stock having a U-shape; and,

FIG. 12 is an enlarged perspective view of the finished bent stock forming a closed chain link.

Although this description makes use of the technical words of the art, it will be understood that the invention is not limited to the apparatus described thereby and that equivalent structure and substitutions may be made where such are practical and advantageous.

It should be understood that the mechanism of this invention and the method of operation thereof constitutes an appreciable improvement to the basic bending machines well known in the art whereby said inexpensive machines gain capacity to create shapes heretofore unattainable. For example, the machine disclosed in my United States Patent No. 2,884,987, dated May 5, 1959, is representative of a suitable bending machine to which the improvements of this invention can be effectively applied and incorporated. The description of the bending machine set forth in that patent is included herein by reference and certain mechanical apparatus fully disclosed in that patent are only generally described in this application.

Referring, preliminarily, to FIG. 2, of the drawings, a typical bending machine is shown comprising a table like work base **10** supported at a working height from the floor brace **14** by a plurality of legs **12**. The legs and table define an interior area **13** wherein the drive apparatus, generally designated by the numeral **15**, of the machine is located. The drive apparatus **15** comprises a reversible electric motor **16** connected to a drive shaft **30** by a pair of meshing beveled gears **19** and **20**. Shaft **30** has a spur gear **34** fixedly mounted thereon, gear **34** being engaged with a second spur gear **36** fixedly mounted on a spindle sleeve **40***a*. The meshing spur gears **34** and **36** are of such relative size that spindle sleeve **40***a* is driven at approximately one half the speed of shaft **30**. It should be understood that the drive mechanism disclosed herein is but one form of various types of drive apparatus which can be used to rotate shaft **30** and spindle sleeve **40***a* at pre-determined rates of speed, in both directions, according to the manipulation of control switches (not shown) by an operator. A speed reducer can be included in the drive mechanism if necessary.

Positioned immediately on top of base **10** and rotating freely thereabove, is a flat, circular shaped supporting member or plate **60**. Plate **60** has the same axis as does spindle sleeve **40***a* even though the members rotate separately. Fixedly mounted on member **60** is a single, wiper arm assembly, generally designated by the numeral **64**. Spindle **40**, a continuation of spindle sleeve **40***a*, extends above plate **60** and rotates separately from base member **70** of the stationary wiper arm assembly **72** shown in FIG. 1. A piece of rod stock "S" is shown in position against an interchangeable die **74** which is held in position by a threaded nut **75**.

Referring now to FIG. 1 of the drawings, it is seen that circular table **10** is larger in diameter than moveable plate **60**, and that the moveable wiper arm assembly **64** is fixedly attached to the plate **60** by bolts **65**, only one being shown in FIG. 1. In distinction, stationary wiper arm assembly **72** is fixably attached to table **10** by two bolts **72***a*.

The moveable wiper arm assembly **64** comprises a wiper arm **62** having a center slot **63** in which a slide **61** (shown in FIG. 3) moves. A tapered-end swaging block **66** is mounted on slide **61** by a pair of threaded bolts **68**. A threaded stem **67**, attached to slide **61** and threaded through block **67***a* in arm **62** allows the swaging block **66** to be adjusted closer or at a greater distance from the tube or bar stock "S."

The stationary wiper arm assembly **72** is similar in construction to assembly **64** and consists of an arm **75** having a base **70** extending around spindle **40**, a central groove **76**, a swaging block **78** mounted on a slide (not shown) by a pair of bolts **80**, the slide controlled by a stem **73** operating through a block **73***a*.

An interchangeable, work piece clamp assembly **84** is attached to the spindle **40** by a member **86** which extends around spindle **40** and holds the assembly **84** tightly thereagainst. Base member **85** of the clamp **84** has an upstanding stud **87** with a threaded bore **88** extending through the center. A bearing block **90** presses against the stock "S" and is held by a threaded shaft **92** extending through bore **88** and a knurled thumb adjusting surface **94**. The bearing block **90** can be adjusted by threading the shaft **92** so as to move the block at a greater or less distance from the die **74** held opposite at the top of the spindle **40**.

Referring now to FIG. 3 of the drawings, it is seen that most of the structure shown and described in connection with FIGS. 1 and 2 is shown in this figure in vertical sectional view. Spindle sleeve **40***a* extends upward through a hole **11** in the table **10** where it joins spindle **40**. Gear **36**, keyed at point **35**, delivers torque from the spur gear **34** and shaft **30** to spindle **40** which, in turn, is keyed at point **42** to a center plug **44**. Positioned on top of plug **44** is an interchangeable die **74** which is selected according to the shape of the stock and the desired angle or bend to be implanted. A pair of locking pins **45** maintain die **74** rigid with plug **44** and bolt **75** is threaded into plug **44** to complete the engagement. Clamp base **86**, mounted around plug **44**, is held tightly against that element by a plurality of threaded plugs **86***a* one of which is shown in FIG. 3. Within a recessed area **102** in table **10**, a spur gear **81** is mounted on shaft **30**, this gear engages a second spur gear **82** which rotates freely around the base of spindle **40**. A plurality of threaded bolts **83**, two of which are shown in FIG. 3, fixedly connect gear **82** to the moveable plate **60**. It should be understood that the torque supplied by motor **16** through shafts **24** and **30** is delivered to spindle **40** by gears **34** and **36**, and, at the same time, torque is also delivered to moveable support plate **60** by means of gears **81** and **82**.

The operation of this form of my invention is substantially as follows. The selected bar or tube stock "S" is placed against a selected die **74** and the bearing block **90** of the clamp assembly **84** is threaded tight pressing the stock "S" firmly against the die. Wiper arm assemblies **64** and **72** are placed in the initial position, that is, adjacent one another, as in FIG. 1 and the swaging blocks **66** and **78** are positioned in contact with the stock "S." When motor **16** is started and torque delivered through the gears, the wiper arm assembly **64**, attached to moveable plate **60**, begins to rotate in a clockwise direction as seen in FIG. 1, while wiper assembly **72** remains stationary. Accordingly, spindle **40**, die **74** and clamp assembly **84** begin to rotate in the same direction as torque is delivered to gear **36**. Referring now to FIG. 4, it will be observed that moveable wiper assembly **64** has rotated approximately 180 degrees while the spindle has rotated approximately 90 degrees, and, as a consequence, the stock "S" and, particularly, its ends S–1, S–2 have been bent around die **74** into a U-shape. Stock "S" is held tightly against the die member at all times by the clamping assembly **84** so that no movement of the stock separate from the die is permitted. During normal operations, power is continually applied until wiper arm **64** rotates beyond the 180 degree position so that the ends S–1, S–2 almost touch. At this point, the motor is reversed by a limit switch (not shown) and the wiper apparatus **64** and plate **60** rotate back to the position shown in FIG. 1. The clamp **84** and the swaging blocks **66**, **78** are then loosened so that the stock "S" can be removed. It has been found that when the stock "S" is composed of a flexible material it is often advisable to bend the stock beyond the U-shape position so that when it is removed from the bending machine, the bent stock will spring only to a U-shape. It should be understood that this apparatus can be supplemented with a series of switches and electrical circuits as disclosed in Patent No. 2,884,-987, referred to above, whereby the machine operation is partially automatic. Automatic switches can be placed on table **10** so that forward direction of the wiper apparatus **64** is stopped before the ends S1, S2 of the stock come into contact.

A modification of the bending machine of this invention is illustrated in FIGS. 5 through 8. Referring first to FIG. 5, a stationary wiper arm **91** is fixedly mounted to the table **10** and moveable armb **93** is mounted to moveable support plate **60**. In describing these figures, parts having the same construction and operation as in the preceding figures will be identified by the same numbers. Mounted for movement around upstanding studs **95** and **99** of arms **91** and **93** are swaging blocks **96** and **98**, respectively, each having an indentation **96***a* and **98***a* at the inner end. The spindle **40** and plug **44**, driven in a manner similar to that disclosed in FIG. 3, is equipped with an elliptical cross-piece member **102** which is attached to plug **44** by a bolt **112**, member **102** forming the base for the clamp assembly **84**. A pair of round dies **104** have cylindrical bases **104***a* extending through a pair of bearing members **106**, **108**. These members, at the end, have raised elongated portions **106***a* and **108***a* which bear against the stock "S" as described below.

Referring now to FIG. 9, spindle **40** is shown having a plug **44** with a key **42** connecting the two, and a bolt **112** holding the clamping base **102** to the plug **44**. It should be understood that when spindle **40** rotates the dies **104** together with bearing members **106**, **108**, rotate holding the stock "S" in the position shown.

As shown in FIG. 10, swaging stud **95** extends upward from wiper arm **91** through the swaging block **96** and allows said member to rotate therearound.

The operation of this modification of this invention, designed primarily to form chain links out of tubular stock, is described below. In FIG. 5, the stock "S" is positioned between the two dies **104** and the clamp apparatus **84**. The stock "S" is also held between the bearing members **106**, **108** and the two dies **104**, and the members **106**, **108** fitting within recesses **96***a* and **98***a* of the swaging blocks. After the clamp **84** is threaded tightly against the stock "S," the motor is started thereby moving plate **60** and wiper arm **93** in a clockwise direction until, as shown in FIG. 6, the swaging blocks **96** and **98** have bent the stock "S" into substantially a U-shape. As shown in FIG. 7, the motor is then reversed and the moveable wiper arm **93** is returned almost to the initial position. Then swaging blocks **96** and **98** are rotated around plugs **95** and **99**, as shown by the dot and dash lines so that the raised portions **106***a* and **108***a* of bearing members **106**, **108** can be positioned outside of the swaging blocks **96** and **98** as shown in FIG. 7, after which blocks **96** and **98** are returned to the full line portions shown. With the bearing members **106***a* and **108***a* now pressed against the ends S–1 and S–2, and the swaging blocks **96** and **98** pressed against the bearing members, the motor is activated in the forward direction causing the bearing members **106**, **108** to close the ends of the stock so as to form a complete link as shown in FIG. 8. In FIGS. 11 and 12, the tubular stock "S" is shown having a U-shape and then as a closed link.

It should be understood that although the apparatus of this invention has been described as bending simple

bar stock into U-bolts and closed links, the same apparatus with suitable stationary and moveable dies can be used to bend in one operation unusual shapes, such as the roof truss of a railroad car. The roof truss of a bus customarily has a long sweep in the middle and a straight bend on each end. These structural members are normally made on a punch press and are bent while hot by what is known as drop forging. The same bending can be achieved by the machine of this invention saving the very considerable costs of a heating furnace, a drop forge, the punch press and the dies together with the necessary labor. In addition, my bending machine is adaptable to forming in one operation the side frames of a glider having multiple bends of close radii while comparative machines require two or more passes to implant similar bends in such stock.

Although this invention has been described with reference to specific forms and embodiments thereof, it will be apparent to those skilled in the art that various changes other than those referred to above may be made in the form of the apparatus, that equivalent elements may be substituted for those illustrated in the drawings, that parts may be reversed, and that certain features of the invention may be used to advantage independently of the use of other features, or within the spirit and scope of the invention as defined in the appended claims.

Having described my invention; I claim:

1. In a bending machine, the combination comprising a spindle mounted for rotation, a die mounted on the spindle for movement therewith, an adjustable clamp fixedly attached to the spindle and positioned to hold the work against the die as the spindle rotates, a moveable support plate mounted coaxially with the spindle but arranged to rotate freely therefrom, a moveable bending arm fixedly mounted on said support means proximate to the spindle so that upon rotation of the support means the bearing surface of the bending arm describes an arc around the spindle, a stationary bending arm fixedly mounted adjacent the spindle and positioned so that when the spindle rotates the bearing surface of the stationary bending arm describes an arc around the spindle identical to that of the moveable bearing arm, a power source and a gear train connecting the source to both the spindle and the support means, said gear train being arranged so that the spindle and support means rotate in the same direction with the support means rotating at twice the velocity of the spindle.

2. The bending machine as defined in claim **1** wherein the clamp comprises a clamp base mounted on the spindle, a threaded bearing arm having a bearing block at the end proximate to the die and a threaded bore stud mounted on the clamp base through which the bearing arm is adjusted so as to press the bearing block against the stock.

3. The bending machine as defined in claim **2** wherein the support plate rotates around the spindle, the plate being attached to a spur gear therebeneath which rotates around the spindle, said spur gear being driven by a second gear mounted on a driving shaft.

4. In a bending machine, the combination comprising a flat support table, a spindle positioned on the table and mounted for rotation, a die fixedly mounted on the spindle for rotation therewith, an adjustable clamp fixedly attached to the spindle and positioned to hold the work to be bent against the die as the spindle rotates, a moveable support plate mounted coaxially with the spindle and in the same plane as the table so as to rotate freely thereon, a moveable wiper assembly fixedly mounted on said support plate proximate to the spindle so that upon rotation of the support plate the bearing surface of the wiper assembly describes an arc around the spindle, a stationary wiper assembly fixedly mounted on the table adjacent the spindle and positioned relative to the spindle so that when the spindle rotates the leading edge of the stationary wiper arm describes an arc identical with that of the moveable wiper arm, both of said wiper arms being positioned adjacent one another at the initial step of the bending operation, a power source and a gear train connecting the source to the spindle and the support means, said gear train arranged to rotate the spindle and support plate in the same direction while the support plate rotates at twice the velocity of the spindle.

5. The bending machine as defined in claim **4** wherein a pair of bearing members are mounted on the spindle and rotate therewith, said members being shaped to hold the work and being positioned so that the wiper arms press against the members and cause the work to be bent completely around the spindle.

6. In a machine of the character described, for bending rods, bars, tubes and the like, the combination comprising revolvable die means, a stationary main bending member, a movable main bending member, said bending members being disposed for engaging one side of the work respectively at longitudinally spaced points along the length thereof, said die means being disposed for engaging the opposite side of the work at a point intermediate the points engaged by said bending members, means mounting said movable bending member for describing an arc about said die means, a power source, gear means operatively interposed between said power source and both said die means and movable bending member and operable for actuating said die means and simultaneously moving said movable bending member at a substantially greater angular rate than that at which said die means is turned.

7. The bending machine according to claim **6** wherein a clamp operable for securing the work to the die means is mounted for rotary movement with the die means.

8. The bending machine according to claim **6** wherein the angular rate of movement of the movable bending member is twice as great as that of the die means.

9. The bending machine according to claim **6** wherein auxiliary bending members are operable for bending the opposite end portions of the work respectively about said die means, and said main bending members are operable independently of said auxiliary bending members for bending the opposite end portions of the work approximately ninety degrees respectively about said die means, and for then actuating said auxiliary bending members whereby to bend the opposite end portions of the work approximately another ninety degrees respectively about said die members.

10. The bending machine according to claim **9** wherein the die means is provided with oppositely facing rounded surface areas about which, respectively, the opposite end portions of the work are bent, and the auxiliary bending members are mounted for pivotal movement respectively about the centers of curvature of said surface areas.

11. The bending machine according to claim **9** wherein the die means includes a pair of members round in transverse section disposed on opposite sides of, and equidistantly from, the central axis of the machine and mounted for orbital movement about said axis, and the auxiliary bending members are mounted for pivotal movement respectively about said pair of members.

12. The bending machine according to claim **9** wherein the main bending members respectively include pivotally mounted work engaging parts, and the auxiliary bending members and said work engaging parts are selectively operatively positionable with said auxiliary bending members between said work engaging parts or with said work engaging parts between said auxiliary bending members.

13. In a machine of the character described, for bending rods, bars, tubes and the like, the combination comprising a rotatable support, a spindle extending through said support and rotatable independently thereof, a die, clamping means for holding the work against the die during the bending operation, said die and clamping

means being mounted on said spindle for rotating therewith, a stationary bending member mounted adjacent the die, a movable bending member mounted upon said rotatable support adjacent the stationary bending member for describing an arc around the die, each of said bending members including an arm having a central lengthwise groove, a slide adjustably positioned within the groove, and a swaging block mounted upon said slide, a power source, and connecting means arranged between the power source and both the die and the movable bending member independently whereby in the bending operation both the die and the movable bending member

rotate in the same direction, the bending member rotating faster than the die.

References Cited by the Examiner

UNITED STATES PATENTS

670,019	3/1901	Gillies	72—400
2,501,241	3/1950	Shaw	72—155
2,884,987	5/1959	Shaw	72—383

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