

June 16, 1942.

E. E. BROOKS

2,286,255

TUBE BENDING APPARATUS

Filed April 16, 1940

3 Sheets-Sheet 1

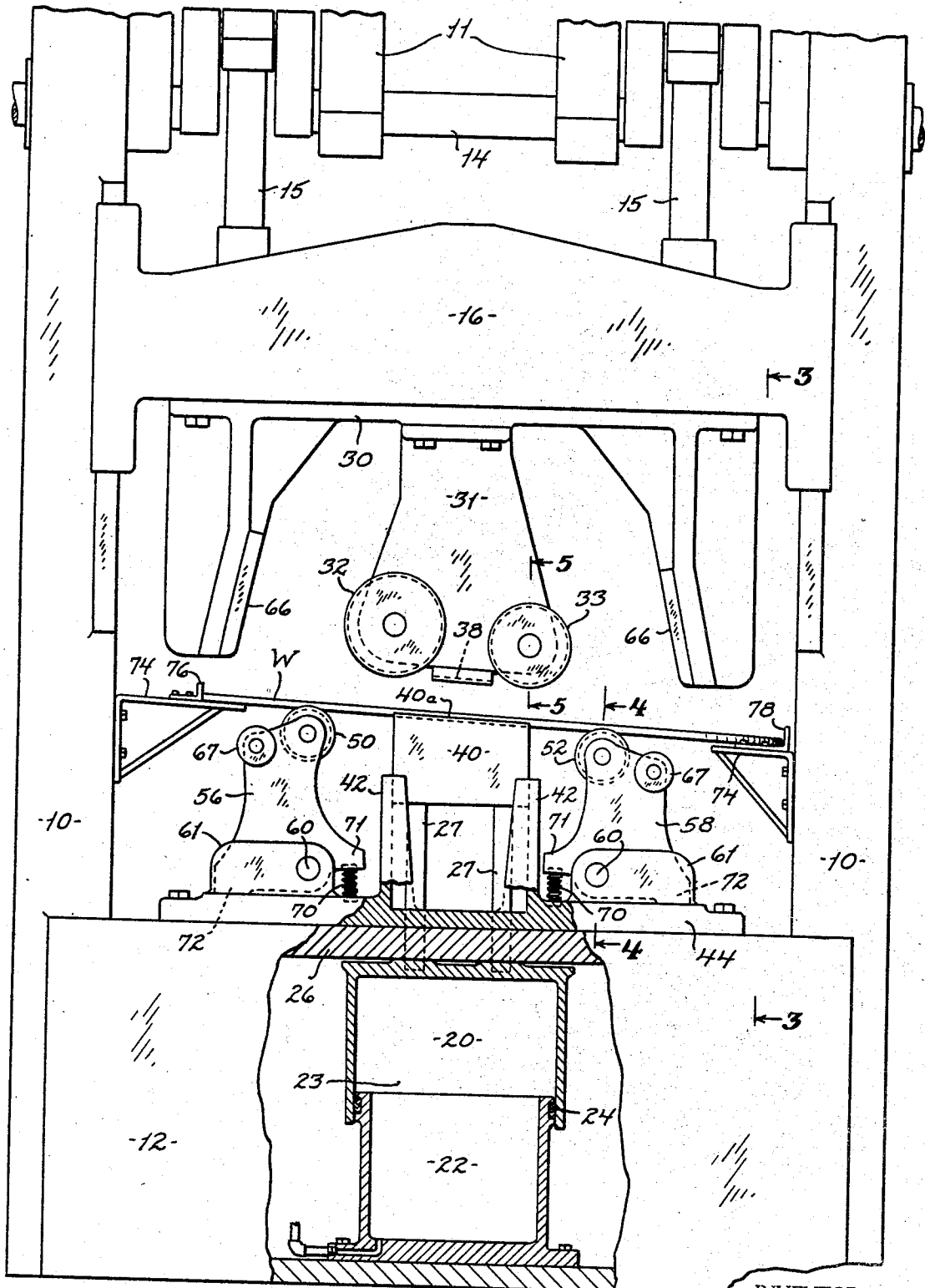


Fig. 1

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3 Sheets-Sheet 2

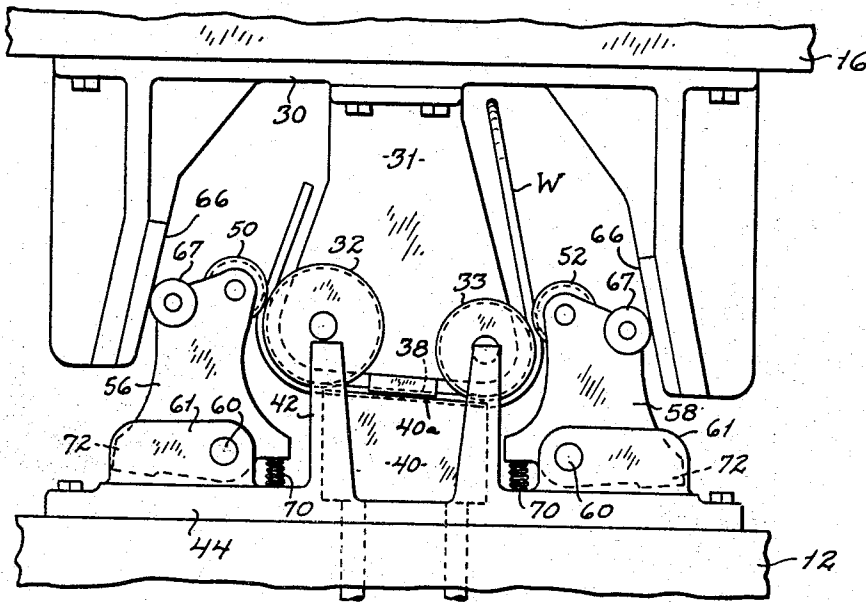


Fig. 2

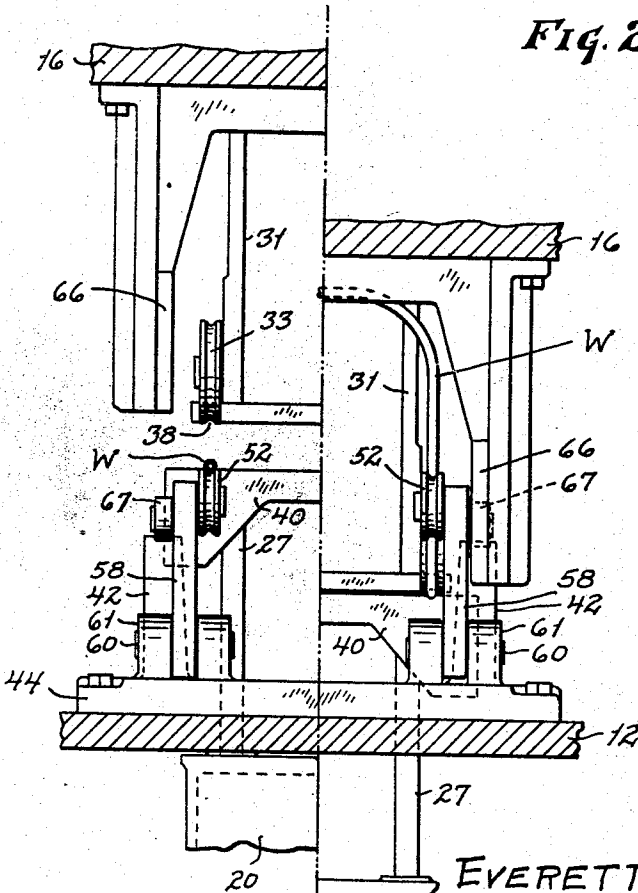


Fig. 3

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3 Sheets-Sheet 3

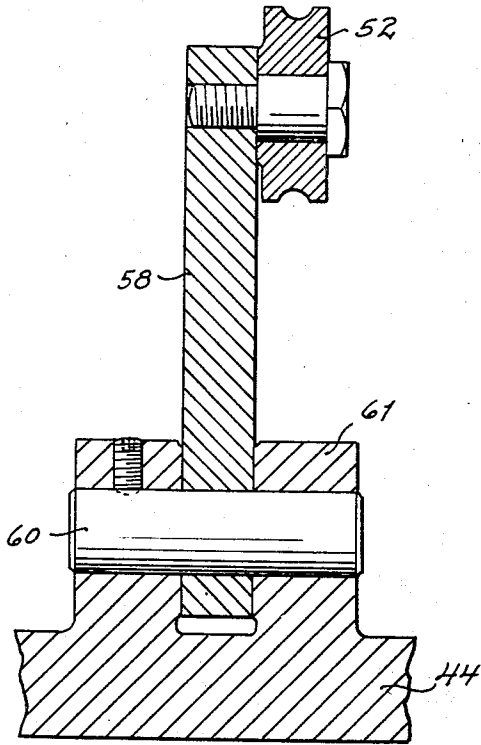


Fig. 4

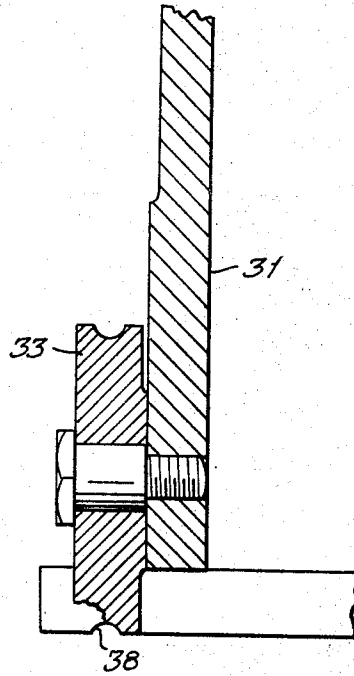


Fig. 5

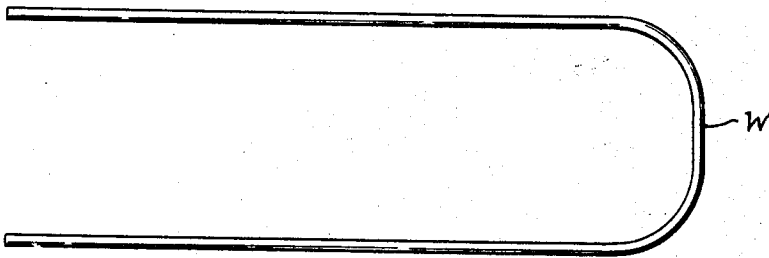


Fig. 6

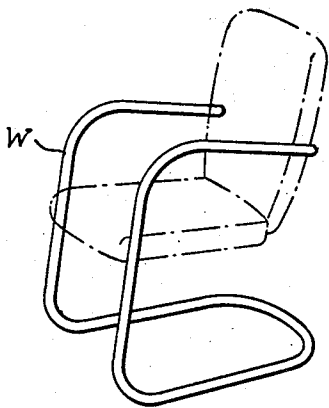


Fig. 7

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TUBE BENDING APPARATUS

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17 Claims. (Cl. 153—33)

This invention is concerned with improvements in metal bending apparatus and the general object thereof is the provision of an efficient bending apparatus adaptable to the forming of metal rods, pipes, tubing and the like.

More specifically my invention is directed to the provision of a novel tube or pipe forming apparatus adaptable to the formation of a plurality of bends in the work simultaneously in such manner that the straight portions or reaches of the tube or pipe extending from bend to bend will be uniform in length during protracted production periods of operation of the apparatus.

A further object of the present invention is the provision of a pipe bending or rod extending apparatus wherein more than two operations may be simultaneously effected upon the tubing or pipe without undue distortion of the normal cross section of the tubing.

Other objects of my invention will become apparent from the following description hereinafter set forth and which refers to a preferred form of the invention as disclosed in the drawings. The essential features of the invention are summarized in the claims.

In the drawings Fig. 1 is a front elevation of a machine embodying my invention;

Fig. 2 is a front elevation of the pipe bending and clamping elements shown in Fig. 1 but in a different position;

Fig. 3 is a transverse cross sectional view taken along the lines 3—3 of Fig. 1;

Fig. 4 is a cross sectional view taken substantially along the lines 4—4 of Fig. 1;

Fig. 5 is a cross sectional view taken substantially along the line 5—5 of Fig. 1;

Fig. 6 is a plane view of a semi-formed work-piece pre-bent to a U-shape, and

Fig. 7 is a perspective view of the work piece after all bending operations are completed, the work piece being in the form of a tubular frame for a metal chair.

The present invention may be embodied in a variety of forms, but for convenience I have illustrated the same as being incorporated in a metal forming press of the so-called single action type. The press is equipped with a cushioned base embodied within the bed of the press and this base is illustrated as being resiliently supported by an air-cushion although springs or any other form of cushion may be utilized.

The particular type of bend formations to which the apparatus has been adapted to produce, is that of a metal chair frame comprising a continuous tube bent to form the base, legs, and arms of the chair. My apparatus, as here illustrated, is adapted to perform the operation of shaping four bends in the tubing simultaneously with each of the bends being greater than

90 degrees. The work piece W or tubing is preformed into a U-shape before being placed into the device now to be described.

As shown in Fig. 1 of the drawings, the apparatus comprises upright frame members 10 supporting a top frame member 11 the uprights 10 being mounted upon a bed structure 12. A crank shaft 14 is suitably mounted adjacent the tops of the uprights 10 to be driven by a motor and gearing not shown. The crank shaft 10 operates connecting rods 15 connected at the lower ends thereof to a ram 16 which is suitably slidably mounted on the uprights 10 to reciprocate in guideways formed therein.

The cushioning apparatus is disposed within the bed-structure 12 of the machine and may comprise a depressable pad forming the head of a piston member 20 which is vertically slidable within the bed 12 and is hollow to form with its operating cylinder structure 22, a compressed air space 23. A suitable packing gland 24 is provided to retain air under pressure within the space 23 and this space is in communication with a source of air pressure not shown. This air pressure maintains the piston 20 in a normally upward position against a plate member 26 forming part of the frame of the machine. The plate member 26 is provided with vertically extending openings in which pins 27 are disposed for a purpose to be described hereinafter.

In the particular illustration of my apparatus the immediate elements which act upon the work piece comprise pairs of grooved rollers, one roller of each pair being carried by a fixture mounted upon the ram 16 and the other one of each pair being mounted upon fixtures supported by the plate member 26 whereby one roller of each pair of rollers is reciprocated with the ram 16 while the other one of each pair of rollers is substantially vertically stationary relative to the frame of the machine. The fixtures supporting the latter rollers are slightly rockable toward and away from the path of movement of the rollers carried by the ram and the tubing comprising the work is formed or bent by the respective pairs of rollers when the ram reciprocates as will be explained.

The specific constructions of the fixtures carrying rollers for effecting the formed bends in the work and the means for clamping the work during the work bending operations will now be described.

Fixed to the lower operating face of the ram 16, is a fixture member 30 preferably in the form of a casting bolted to the underside of the ram. Depending from the fixture member 30 is a bracket member 31 which serves the purpose of both a work clamp and a carrier or roll support for two grooved forming rollers 32 laterally spaced and overhanging the bottom and one side

of the member 31. A similarly mounted pair of forming rollers 33 smaller in diameter than the rollers 32 are disposed at the opposite side of the member 31. Inasmuch as the desired bends in the workpiece W are not of the same radius, the pairs of rollers carried by the member 31 are of different diameters. The member 31 has the lower face thereof grooved, as indicated by the reference numeral 38, to engage reaches of the legs of the U-shaped work piece before any bending operations are performed thereon. Co-operating with the grooved face of the member 31 is a clamping anvil mounted upon the pins 27. This clamping anvil is in the form of a box shaped member 40 which is vertically slidable within vertically extending walls 42 formed on a fixture plate 44. The upper face 40a of the clamping member 40 may be suitably grooved to be complementary to the grooved form of the under face of the member 31 to extend a substantial distance around the circumference of the tubing comprising the workpiece and firmly clamp and support the same against distortion during the bending operations. The pair of forming rollers 32 are aligned with a pair of grooved rollers 50 and the pair of rollers 33 are aligned with a pair of grooved rollers 52, the respective pairs of rollers cooperating to bend the pipe or tubing during a downward movement or thrust of the ram member 16 of the machine.

The diameters of the rollers 32 and 33 determine the radii of the bends being formed. The pairs of rollers 50 and 52 are shiftable toward and away from the reciprocating path of the rollers 32 and 33 and are supported, preferably, by rockable frames or arms 56 and 58 respectively. These arms are supported by pivot pins 60 mounted in bracket members 61, forming part of the fixture plate 44. The rocking arrangement of the arms 56 and 58 is such that the rollers 50 and 52 are rocked inwardly toward the path of movement of the roller pairs 32 and 33 after the pivotal centers of the rollers 32 and 33 have passed downwardly below the centers of the pairs of rollers 50 and 52, this inwardly rocking motion of the rollers 50 and 52 is affected in a positive manner by cam members 66 depending from and comprising a part of the fixture member 30. These cam members act against friction rollers 67 suitably mounted upon the rocker arms 56 and 58 but out of alignment with the pairs of bending rollers as shown in Fig. 3. The arms 56 and 58 are rocked in a retracting or opposite direction by spring members 70 suitably mounted to react between the fixture plate 44 and lugs 71 formed upon the rocker arms 56 and 58 adjacent the pivot pins 60 and extensions 72 formed on the rocker arms to be disposed adjacent the fixture plate 44 serve to limit the outward swing of the arms and rollers 50 and 52.

For convenience in positioning the workpiece in the fixture before the bending operation a light frame work comprising straps 74, 76 and 78 are provided which serve as a workpiece rest and gage to position the U-shaped tubing W relative to the bending rollers and the clamping members.

The operation of the apparatus is as follows: the U-shaped piece of tubing is placed upon the above described gage frame and the machine is placed in motion. The crank shaft 14 moves the ram 16 downwardly whereupon the lower face of the roller carrier 31 will engage the two legs of the work piece and clamp the same in the grooves formed in the upper face of the depressable clamping member 40. Continued down-

ward movement of the ram will cause the legs of the work piece to be bent about the pairs of rollers 32 and 33 reacting against the pairs of rollers 50 and 52 during all of which downward movement the work piece is firmly clamped by reason of the cushion member 20 reacting upwardly against the pins 27 upon which the clamping member 40 is supported. Continuation of the downward movement of the ram causes the cam legs 66 to engage the rollers 67 thus causing the forming rollers 50 and 52 to swing inwardly and thus cause the work piece to be bent to an arc of less than 90 degrees about the forming rollers 32 and 33. After the crank of the shaft 14 has passed the downward dead center, an upward movement of the ram will relieve the pressure between the cam members 66 and the friction rollers 67. The forming rollers 32 and 33 will be retracted upwardly and the clamping member 40 will follow the upward movement of the rollers 32 and 33 until the base or cushion member 20, contacts the underside of the frame plate 26 of the machine. The spring members 70 during this part of the upward movement of the ram and the cam members 66 carried thereby, will thus cause the forming rolls 50 and 52 to be swung outwardly away from the reciprocating path of movement of the forming rollers 32 and 33. When the machine has been operated to the position of maximum upward movement of the ram, operation of the crank shaft can be arrested whereupon the formed tubing can be stripped from the forming rolls 32 and 33 to which it has clung, by a slight springing of the bends formed in the work.

It will be apparent to those skilled in the art that a multiplicity of bends may be formed in tubing simultaneously by the use of the disclosed apparatus. This multiple bending is accomplished in accurate manner without any handicaps or difficulties due to any crawling or stretching action of the tubing as it is being bent. It will also be apparent that the apparatus will be adaptable to the forming of bends in tubing and barstock to obtain shapes other than the shape of the work herein illustrated.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I, therefore, particularly point out and distinctly claim as my invention:

1. In a metal bending machine the combination of a frame structure, a reciprocating ram, a work clamping anvil, a depressable air-cushioned base supporting the clamping anvil, a work clamping member carried by the ram for clamping work to the work clamping anvil, a work bending roller carried by the ram for acting upon the work after the ram has clamped the work, a bending roller supported on a pivoted arm disposed to cooperate with the bending roller on the ram and means for swinging said arm toward the ram after the center of the roller on the ram has passed below the center of the roller on said arm and while said air-cushioned base is reacting against the downward movement of the ram to thereby hold the work while being bent.
2. In a metal bending machine the combination of a frame structure, a reciprocating ram, work clamping means, a depressable, resiliently-cushioned base supporting the clamping means, a work clamping means carried by the ram for

clamping work to the work clamping means on said cushioned base, a work bending roller carried by the ram adapted to act upon the work after the ram has clamped the work to the base, a bending roller shiftably supported and disposed to co-operate with the bending roller on the ram and means for operating the last-named roller toward the ram after the center of the roller on the ram has passed below the center of the shiftable roller and while said resiliently-cushioned base is reacting against the work and the downward movement of the ram.

3. In a metal bending machine the combination of a frame structure, a reciprocating ram, a work clamping means on the ram, a depressable, cushioned base supporting a work clamping member carried by the base for clamping work to the work clamping means on the ram, work bending rollers carried by the ram for acting upon the work after the ram has clamped the work, bending rollers shiftably mounted on the frame and disposed to co-operate with the bending rollers on the ram and means for shifting the last-named rollers toward the ram as the ram descends in clamped engagement with the work while said cushioned base is reacting against the downward movement of the ram.

4. In a metal bending machine the combination of a frame structure, a reciprocating ram, a work clamping means carried by the ram, a cushioned base, means on the base co-operating with the ram to clamp the work during a work bending operation while the ram is moving downwardly, work bending shoes carried by the ram for acting upon the work after the ram has clamped the work against said cushioned base, work bending shoes shiftably mounted on the frame of the machine and disposed to co-operate with the bending shoes on the ram and reciprocating means operated with the ram for shifting said shiftable shoes toward the ram during the bending operation of the shoes carried by the ram.

5. In a metal bending machine the combination of a frame structure, a reciprocating ram, a work clamping means carried by the ram an air-cushioned base, means on the base co-operating with the ram to clamp the work during a bending operation and while the ram is moving downwardly, work bending rollers carried by the ram for acting upon the work after the ram has clamped the work against said air-cushioned base, bending rollers mounted on pivoted arms supported by the frame of the machine with the rollers disposed to co-operate with the bending rollers on the ram and means reciprocated with the ram for rocking said arms toward the ram during the bending operation of the rollers carried by the ram.

6. In a metal bending machine the combination of a frame structure, a reciprocating ram, a work clamping means carried by the ram, an air-cushioned base having means thereon co-operating with the ram to clamp the work during a work bending operation and while the ram is moving downwardly, work bending means carried by the ram for acting upon the work after the ram has clamped the work against said air-cushioned base, shiftable work bending means mounted on the frame adjacent the cushioned base and supported by the frame of the machine with the shiftable work bending means disposed to co-operate with the work bending means on the ram and reciprocating means on the ram for shifting the shiftable bending means toward the

ram during the work bending operation of the ram.

7. In a metal bending machine of the character described, the combination of a frame structure supporting a reciprocating ram, a depressable air-cushioned base serving to act against the movement of the ram in one direction, work clamping members carried by the ram and the base for clamping the work during part of the stroke of the ram, a pair of work bending rollers one carried by the ram and the other supported by the frame of the machine, shiftable means mounted on the frame of the machine for supporting the last-named roller and means operated in timed relation to the working stroke of the ram for shifting said last-named roller toward the path of roller carried by the ram.

8. In a metal bending machine of the character described, the combination of a frame structure supporting a reciprocating ram, a depressable, air-cushioned base supported by the frame structure and serving to act against the work bending movement of the ram in one direction, a pair of work clamping members sloped to complementarily engage the work and respectively carried by the ram and base for clamping the work during that part of the stroke of the ram when the work is being bent, pairs of work bending rollers one pair being carried by the ram and the other pair being supported by the frame of the machine for simultaneously effecting multiple bends in the work, shiftable means mounted on the frame of the machine for supporting the last-named pair of rollers and means operated in timed relation to the working stroke of the ram for shifting said last-named rollers toward the path of the ram on opposite sides thereof.

9. In a metal bending machine of the character described a frame structure, a reciprocating ram supported by the frame structure, a shiftable air-cushioned member supported by the machine frame and positioned to yieldingly oppose working movement of the ram, the base of the ram being adapted to clamp the work against the cushion member during a certain portion of the working movement of the ram while shifting the work relative to the machine frame, a pair of rollers mounted upon the ram and rollers mounted upon the machine frame, said rollers being adapted to form bends in the work during said work-shifting movement of the ram and base and means for effecting movement of the rollers carried by the machine frame relative to the path of movement of the ram during the work operating movement of the ram.

10. In a metal bending machine of the character described a frame structure, a reciprocating ram supported by the frame structure, a shiftable air-cushioned member supported by the machine frame and positioned to yieldingly oppose working movement of the ram, the base of the ram being adapted to clamp the work against the cushion member during a certain portion of the working movement of the ram while shifting the work relative to the machine frame, a pair of rollers mounted upon the ram each roller being adapted to form a separate bend in the work and rollers mounted upon the machine frame to co-operate with the rollers on the ram to form said bends, said rollers on the machine frame being adapted to form bends in the work during said work-shifting movement of the ram and base and means for effecting movement of the rollers carried by the machine frame relative to the path of movement of the ram during the work

operating movement of the ram, whereby a continuation of the bending operations upon the work is effected after the centers of the rollers on the ram have been shifted past the centers of the rollers on the machine frame.

11. In a metal bending machine of the character described a frame structure, a reciprocating ram supported by the frame structure, a shiftable air-cushioned member supported by the machine frame and positioned to yieldingly oppose working movement of the ram, the base of the ram being adapted to clamp the work to the cushion member during a certain portion of the working movement of the ram while shifting the work relative to the machine frame, pairs of rollers mounted upon the ram for effecting separate bends on the work and rollers mounted upon the machine frame in operative alignment with the rollers on the ram, said rollers being adapted to form continuations of the bends in the work during said work-shifting movement of the ram and base and means for effecting movement of the last-named rollers.

12. In a machine of the character described, the combination of a machine frame, a ram reciprocally mounted for vertical movement in the machine frame, said frame being mounted upon a bed, a depressible air-cushioned base member mounted within the bed, a frame plate overlying the machine bed, tube bending means interposed between said ram and said plate comprising a tubular engaging and clamping member mounted upon the lower end of the ram and a tubular engaging and clamping member disposed above said plate upon the bed, pin members resting on the base member and extending through said plate and serving to support resiliently the last-named work engaging and clamping member, pairs of tube bending rollers mounted upon the work clamping member carried by the ram, pairs of tube bending rollers shiftablely mounted upon said plate in co-operative relation to the rollers on the work clamping member and means for shifting said last-named rollers toward the rollers on the ram, said means being carried by the ram.

13. In a machine of the character described, the combination of a machine frame, a ram reciprocally mounted for vertical movement in the machine frame, said frame being mounted upon a bed, a depressible air-cushioned base member mounted within the bed, a frame plate overlying the machine bed, a tube bending means interposed between said ram and said plate comprising a tubular engaging and clamping member mounted upon the lower end of the ram and a tubular engaging and clamping member disposed above said plate upon the bed, pin members resting on the base member and extending through said plate and serving to support resiliently the last-named work engaging and clamping member, a tube bending roller mounted upon the work clamping member carried by the ram, a tube bending roller swingably mounted upon said plate in cooperative relation to the roller on the ram and means for shifting said last-named roller toward the roller on the ram, said means being carried by the ram.

14. In a machine of the character described, the combination of a machine frame, a ram reciprocally mounted for vertical movement in the machine frame, said frame being mounted upon a bed, a depressible air-cushioned base member mounted within the bed, a frame plate overlying

the machine bed, a tube bending means interposed between said ram and said plate comprising a tubular engaging and clamping member mounted upon the lower end of the ram and a tubular engaging and clamping means disposed above said plate upon the bed, pin members resting on the base member and extending through said plate and serving to support resiliently the last-named work engaging and clamping member, pairs of grooved tube bending rollers mounted upon the work clamping means carried by the ram, pairs of grooved tube bending rollers swingably mounted upon said plate in co-operative relation to the path of movement of the rollers on the ram swingable arms supporting the last-named rollers and cam means for shifting said last-named rollers toward the rollers on the ram, said cam means being carried by the ram.

15. In a tube bending machine of the reciprocating type, the combination of a tube clamping means adapted to shift as the tube is being bent with a reciprocating ram of the machine and with a depressible base means incorporated in the base of the machine and comprising a grooved clamping member on the ram and a grooved clamping member operatively supported by the depressible base member and pairs of grooved tube bending rollers mounted to have the grooves thereof in alignment with the grooves in the clamping members and some of the rollers being adapted to move in unison with the clamping movement of the ram and other of the rollers being moveable relative to the ram during a predetermined portion of the work clamping movement of the ram and means movable by the ram for actuating said last named rollers toward said first-named rollers during said predetermined portion of the ram movement.

16. In a metal bending machine, the combination of a frame structure, a reciprocating ram, work clamping means, a depressible, resiliently cushioned base supporting the clamping means, a work clamping means carried by the ram for clamping work to the work clamping means on said cushioned base, work bending means carried by the ram for acting upon the work after the ram has clamped the work to the base, a bending roller supported on a pivoted arm disposed to cooperate with the work bending means on the ram, means for swinging said arm toward the ram after the work bending means on the ram has passed below the center of the roller on said arm, and means for urging said arm away from the ram after the ram has been elevated.

17. In a metal bending machine, the combination of a frame structure, a reciprocating ram, work clamping means, a depressible resiliently-supported base supporting said clamping means, work clamping means carried by the ram for clamping work to the work clamping means on said base, a work bending roller carried by the ram for acting upon the work after the ram has clamped the work to the base, an arm pivotally supported on said frame structure, a work bending roller supported on said arm and disposed to cooperate with the work bending roller on the ram, means for swinging said arm toward the ram after the center of the roller on the ram has passed below the center of the roller on the arm, and spring means interposed between said arm and frame structure and operative to shift said arm in the opposite direction upon the elevation of said ram.

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