March 19, 1968 V. N. SHUBIN ET AL 3,373,587

AUTOMATIC TUBE BENDING MACHINES

Filed Dec. 8, 1966 2 Sheets-Sheet 1

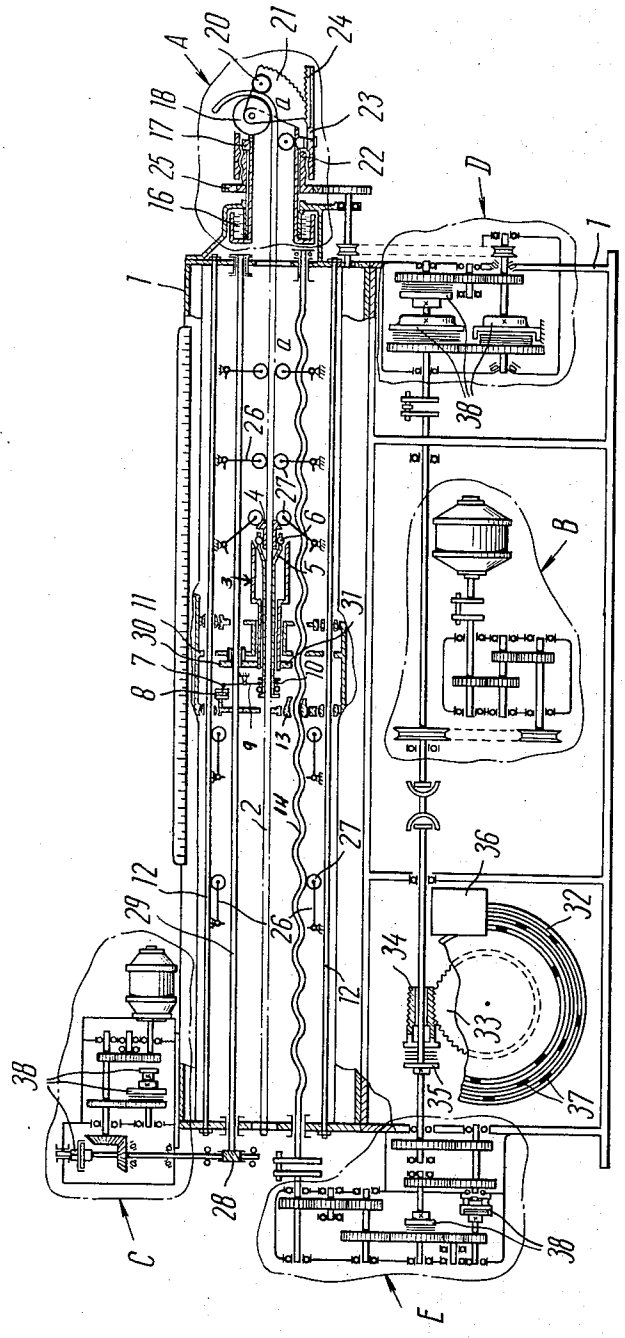


FIG. 1

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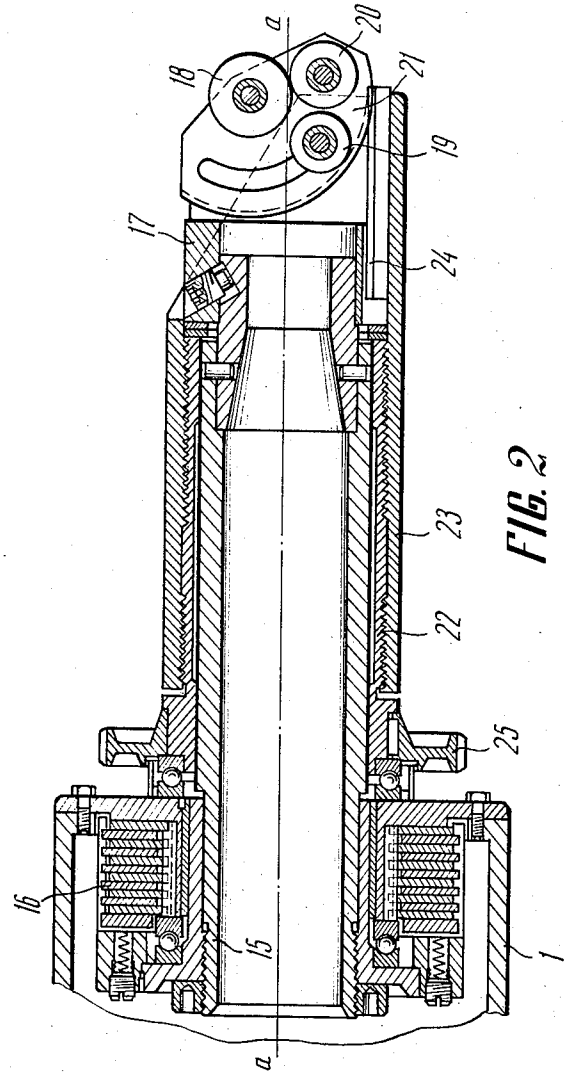


FIG. 2

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# AUTOMATIC TUBE BENDING MACHINES

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Continuation-in-part of application Ser. No. 288,210, June 17, 1963. This application Dec. 8, 1966, Ser. No. 600,178

2 Claims. (Cl. 72—158)

## ABSTRACT OF THE DISCLOSURE

An automatic tube bending machine in which a bending head is mounted on the frame so as to be capable of turning movement about an axis aligned with the geometric axis of a billet holder. A common drive is provided for the adjustable displacement of the bending means associated with the bending head, the pushing of a billet into the bending means and the turning of the bending head, respectively.

This application is a continuation-in-part of our copending application Ser. No. 288,210 filed June 17, 1963, now abandoned, and entitled, Automatic Tube Bending Machines.

More particularly, the invention relates to automatic tube bending machines which can be used efficaciously for the spatial bending of billets via pushing such billets through bending means.

It is known in the prior art to provide automatic tube bending machines wherein a tube is bent by pushing the same through bending means fixed in the bending head. In such machines, the bending head provided with the bending means is connected rigidly to the frame of the machine and the bending means generally comprise one or two stationary rolls and one movable roll or a bushing and a movable roll. In this type of machine, the value of the radii of curvature is dependent upon the position of the movable roll which can be adjustably displaced relative to the stationary portion of the machine. The value of the bending angle depends upon the length of the tube which is being pushed or moved and the angle between the bending planes is changed or altered by turning a billet about its geometrical axes at the moment when the billet is not clamped by the bending means.

An objectionable characteristic or disadvantage of the known machines resides in the fact that at the turning of the billet the portion thereof which is already bent touches or contacts the frame or the floor. In addition, the portion of the tube which has already been bent frequently rests or sets against the frame during the course of further bending of the tube and this limits the practicality of the use of such machines for the spatial bending of complex billets.

Attempts have recently been made to eliminate the above referred to objectionable characteristic by positioning the bending means at a location farther from the frame or from the floor, but such measures do not eliminate entirely such disadvantages and in fact, result in new problems. More specifically, such measures require a machine of larger size and more complex construction.

An important object of the present invention is to provide an automatic tube bending machine which is capable, as compared to known machines of the same type, of bending billets possessing a more complex configuration.



Yet another object of the invention is to provide a machine which is small as regards size, simple in operation and inexpensive to manufacture and maintain.

Further objects and advantages of the invention will become more readily apparent from the following detailed description and annexed drawings and in which drawings:

FIGURE 1 is a diagrammatic view of a tube bending machine incorporating the essentials of the present invention, and

FIGURE 2 is a detailed view partly in elevation and partly in section of the bending head.

As shown in FIGURE 1, the tube bending machine includes a frame denoted generally 1 provided with a bending head A having bending means operably related thereto capable of turning about an axis aligning with the geometric axis *a—a* of a billet 2. The billet 2 is adapted to be gripped by holding means constituted by a collet 3 which houses cams 4 embracing the billet 2 and a rod 5 which is interconnected via rolls 6. The rod 5 is adapted to receive a load from rod 7 of a power cylinder 8 through a lever 9 and ring 10 of a bearing means located on the rod 5. The rod 5 transmits the load to the roll 6 and cam 4.

The collet 3 is secured to a carriage 11 movable along guides 12 of the frame 1 by the action of a screw pair including a nut 13 fixed to the carriage 11 and a lead screw 14 kinematically connected through a common drive B of the tube bending machine. The carriage 11 together with the billet 2 is movable along the guides 12 by such screw pair for providing means for pushing the billet 2 into the bending means of the head A. The carriage 11 is adapted to be returned to its initial position by means of the same screw pair.

The bending head A includes a hollow shaft 15 (FIG. 2) which is mounted in a cantilever fashion on the frame 1, a friction clutch 16 provided with stationary discs secured in the frame and movable discs coupled to the hollow shaft 15, as well as a casing 17 mounted on the hollow shaft 15. It will further be noted that stationary rolls 18 and 19 are fixed in the casing 17 and a movable roll 20 is mounted on a toothed sector 21 operably related to the casing 17. The hollow shaft 15 is provided with a bushing 22 freely seated thereon and having an exterior thread equipped with a rack 24, with the bushing 22 and a bushing 23 constituting a screw pair. The rack 24 is located in a slot of the casing 17 and coacts with the toothed sector 21. The screw pair is kinematically connected to the common drive B by means of a gear 25 rigidly secured to the bushing 23 which is provided with an internal thread. By virtue of the foregoing, the bending head A is capable of turning about an axis in alignment with the geometric axis *a—a* of the billet 2. The turning or rotation of the bending head A permits the selection of an optimum direction of bending which results in the elimination of obstacles which may be present by protruding or extending parts of the machine or the floor. In addition, the turning of the head A also means that it is possible to decrease the dimensions of the machine since it is unnecessary to elevate the billet 2 a substantial distance above the frame 1.

Moreover, the fact that the bending head A is mounted on the frame 1 by the friction clutch 16 means it is possible to utilize such clutch for preventing any dangerous overloads which may arise in the course of the adjusting displacement of the movable roll 20.

The frame 1 also includes means for providing longitudinal stability of the billet 2 when the billet 2 is being moved or pushed through the bending means. Each of the means for providing such longitudinal stability is constituted by a pair of levers 26 located opposite each other. One end portion of each lever 26 is hinged or

pivoted to the frame 1, while the other end portion supports a roll 27. Each pair of the rolls 27 supported by the levers 26 fixes the position of the billet 2 between or intermediate the collet 3 and the bending means. The machine further incorporates means for turning the billet 2 which includes a worm pair 28, the worm of which is connected to individual drive C with the worm wheel being connected by a shaft 29 to the collet 3 via a gear 30 mounted on the carriage 11 and movably connected by a key to the shaft 29, and a gear 31 rigidly secured on the collet 3 which coacts with the gear 30.

The means for automatically controlling the machine includes a disc 32 employed as programming means which is rigidly fixed on the shaft of a worm wheel 33 meshing with a worm 34 connected to the common drive B by means of an electro-magnetic coupling 35. A commanding device 36 coacts with cams 37 provided on the disc 32 in accordance with the required bending parameters.

The commanding device 36 is connected electrically to electro-magnetic friction clutches 38 housed in reducers D and E operably coupled to the common drive B. More specifically, in the reducer D the means for the adjustable displacement of the movable roll and the turning of the bending head A while in the reducer E, the means for moving or pushing the billet 2 in the individual drive C for the means for turning the billet 2 are illustrated.

In order to simplify the essence of the invention means utilized for automatically controlling the machine are not shown or described in detail, since such means may be readily understood and incorporated by persons skilled in the art.

The operating cycle for the present machine is similar to that of known machines of the same type and consequently, only that part of the operation of the invention, mainly the turning or rotation of the bending head A provided with the bending means is described in detail.

The turning of the bending means is effective along the same kinematic arrangement as the adjusting displacement of the movable roll 20. During the working movement of the roll 20, the gear 25 rotated by the common drive B transfers such rotation to the bushing 22 having the exterior thread and thereafter in part shifting, that is to say in the direction of the displacement of the tube being bent to the bushing 23 by virtue of the threaded connection between such bushings. The rack 24 secured on the bushing 23 by moving backwardly and forwardly in the guiding slot of the casing 17 rigidly connected to the hollow shaft 15 displaces the toothed sector 21 carrying the roll 20. During the course of rotation of the gear 25 in the opposite direction, the bushing 23 moves in the backward direction more to the left as shown in FIGURES 1 and 2, until the same is coupled completely with the bushing 22 whereupon the bending roll returns to its initial position. Hence, the torque is transferred through the rigidly closed worm pair, rack 24 and guiding slot of the casing 17 to the hollow shaft 15 and the friction clutch 16 which connects the hollow shaft with the frame 1.

The hollow shaft 15, together with the bending head A turns or rotates due to the turning of the discs of the clutch 16 at the moment when the torque applied exceeds the torque developed by the friction forces between the discs.

As previously indicated, the turning of the bending head is necessary where changing or altering the direction of bending and is employed when the portion of the billet already bent in the course of further bending or turning of the billet 2 contacts the machine plane or torque. The changing of the direction of bending without changing the predetermined angle between the planes of curvatures in the billet is accomplished by turning the bending head A followed by a simultaneous turning of the billet 2 at the same angle.



Upon the completion of the bending of a billet which is performed automatically, the machine is inactivated and the article removed manually therefrom. At the end of the operating cycle, the carriage 11 is at extreme front or forward position and is moved to its initial position, together with the next billet 2 to be fixed in the collet 3.

The invention is not to be confined to any strict conformity to the showings in the drawings but changes or modifications may be made therein so long as such changes or modifications mark no material departure from the spirit and scope of the appended claims.

What is claimed is:

1. An automatic tube bending machine comprising a frame, a bending head provided with bending means, means mounting said bending head on said frame for turning movement about an axis aligned with the geometric axis of a billet, a holder for gripping the billet, means for pushing a billet into said bending means mounted on the frame and carrying said holder, and a common drive for the machine providing for adjustable displacement of said bending means, pushing of a billet into said bending means and turning said bending head, respectively.

2. An automatic tube bending machine including a frame, a bending head provided with bending means mounted on said frame and capable of turning about an axis aligned with the geometric axis of a billet, said bending head comprising a hollow shaft through which a billet is adapted to pass, cantileverly mounted on the frame, being defined by a friction clutch having stationary discs fixed in the frame and movable discs connected to the hollow shaft, stationary rolls, a casing rigidly mounted on said hollow shaft and supporting said stationary rolls of the bending means, a first bushing having an exterior thread and freely seated on said hollow shaft, a second bushing having an interior thread constituting with said first bushing a screw pair and having a rack located in a slot of said casing, a toothed sector turnably mounted on said casing coacting with said rack, a movable roll, said sector supporting said movable roll of the bending means, and means kinematically connecting said screw pair to the common drive to adjustably displace said movable roll of the bending means and turn said bending head, a holder for gripping the billet, means for pushing a billet into said bending means mounted on the frame and carrying said holder, and a common drive for the machine providing for adjustable displacement of said bending means, pushing of a billet into said bending means and turning said bending head, respectively.


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