

9609157-7
IPDS copy

Our Ref.: 1075.P001

APPLICATION FOR REPUBLIC OF SINGAPORE LETTERS PATENT

FOR

APPARATUS FOR BENDING BARS EFFICIENTLY

**Applicant: NatSteel Technology Investments Pte
Ltd**

**Inventors: ENG Poh Tzan
NG Ghee Hua
YUEN Kok Chin**

Prepared by:

Lawrence Y.D. Ho
30 Bideford Road #07-02/03
Thongsia Building
Singapore 229922
Tel:734-8523
Fax:734-8521

7-1212000

APPARATUS FOR BENDING BARS EFFICIENTLY

FIELD OF THE INVENTION

The present invention relates to apparatus for shaping bars. In particular,
5 the present invention pertains to an apparatus for bending reinforcing bars
efficiently.

BACKGROUND OF THE INVENTION

Systems for bending bars are well known in the construction and metal
10 industries. By bars, the present invention envisages metallic wire and bars
which are suitable for providing reinforcement to reinforced concrete
structure. For example, U.S. Patent No. 4,161,110 exemplified a fully
automatic bending machine which took as its input continuous coils of wire
material. Reinforcing wires are bent and cut into appropriate shape and
15 length at a very high throughput. The advantages of such fully automated
bending system are that minimum human intervention is required.
However, capital investment of such a system is high and the product
variety limited.

20 Recently, U.S. Patent No. 5,312,522 described a table bender controller
using a computerized display screen for improving the productivity of
operator of a manually cycled table bender. The '522 controller displayed
the shape, sequence, and angle of the specified bent bar in minimizing
operator's error and compensating for possible inexperience. While '522
25 controller enabled inexperienced operator of manually cycled table bender
to climb the efficiency curve, the throughput of such computerized table
bender is limited. Furthermore, the tolerance of the bent bars is prone to
human errors.

While prior art bar bending system and controller propose to improve the production of reinforcing bars by either limiting product variety or minimizing human operator input, end users of reinforcing bars call for greater product

5 quality.

OBJECT OF THE INVENTION

It is an object of the present invention to minimize human error by automating the bending sequence, bent angle and dimension marking of a
5 bar bending apparatus.

It is another object of the present invention to improve the tolerance of bent bar angle by enhancing the resolution of the backup ram.

10 It is still another object of the present invention to improve the dimensional tolerance of the bent bar by automating the gauge marker.

It is yet another object of the present invention to enhance the overall productivity of an automated bar bending system by minimising manual
15 equipment adjustment and setup.

SUMMARY OF THE INVENTION

A turn table incorporating a centre roll and a drive pin is provided with at
20 least one mechanised backup ram, a mechanized gauge marker, and a controller coupled to the turn table, the backup ram and the gauge marker. A structure adjacent to the turn table receives bars as input and allows the operator to align the bars between the backup ram and the centre roll. The backup ram has a backup assembly coupled to a ball screw joint and a
25 prime mover for improving the resolution between the backup assembly and the bar. The backup ram, the gauge marker and the drive pin in cooperation with the controller guide the operator through the bending sequence once a shape is selected. The controller requires as input

parameters from a predetermined data structure from a remote site or an operator before the bars is to be bent efficiently and accurately. As such, minimum number of setup operations is required to bend a large variety of bars without supervision. Thus, productivity of bar bending is enhanced.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A is a top, plan, elevational view of a prior art turn table for bending reinforcing bar.

5

Fig. 1B is top, plan, elevational view of a turn table featuring backup ram and gauge marker of the present invention.

Fig. 2 is a perspective, elevational layout of a bar bending system
10 incorporating the backup and the gauge marker of the present invention.

Fig. 3 is a top, plan, elevational view of a backup ram according to Fig. 2 of the present invention.

15 Fig. 4 is a flowchart illustrating the process of the controller in bending a large variety of bars efficiently and accurately.

DESCRIPTION OF THE EMBODIMENT OF THE INVENTION

An apparatus for bending bars is described. In the following description, numerous specific details are set forth such as backup ram and gauge marker, etc. in order to provide a thorough understanding of the present invention. It will be obvious to one skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known parts such as those involved with the front end of reinforcing bar manufacturing operation are not shown in order not to obscure the present invention.

10

Fig. 1A is top, plan, elevational view of a prior art turn table for bending bars. An automatic bar bender 1 is shown having a turn table 4 flushed on a surface with at least two stoppers 12. The turn table 4 has a plurality of pin openings 6 which are disposed concentrically with the centre of the turn table 4. The pin openings 6 receives at least one drive pin 8 and at least one centre roll 10 for bending at least one bar 14 which is typically introduced manually. One end of the bar 14 is guided manually to a chalk mark 13 and cantilevered among the drive pin 8, the centre roll 10 and the stopper 12 before it is bent. More recently, backup rams 11 are disposed adjacent to improve the bent angle of the bar. Backup rams 11 features a rack and pinion mechanism (not shown in detail) which allows the operator to adjust the ram in a step wise manner. Prior art bar benders such as U.S. Patent No. 5,312,522 automated the basic bending sequence of reinforcing bars by using the drive pin 8 and the centre roll 10 as variable while fixing the position of the stopper 12 and backup ram 15 with respect to the centre roll 10. Such approaches resulted in improvement in productivity but the quality of bent bars remains unsatisfactory.

25

Fig. 1B describes a new bar bender 2 which automates dimension marking and improves the resolution of the backup ram. Instead of manually marking the position of the bar 14 for bending, the present invention introduces a gauge marker 30 for aligning the bar 14 in the correct position for bending and also for guiding the bar through the entire bending sequence. The details of the gauge marker 30 shall be elaborated in connection with the description of Fig. 2 below. Some of advantage of having the gauge marker are the further reduction in human error and improved tolerance of the finished product and control of bending sequence.

Another novel feature of the present invention is the automation of the backup ram 15. As mentioned briefly above, prior art backup ram are either fixed or adjustable stepwise. A major disadvantage of prior art stoppers or more recent backup ram is minimal role they play in automating the bending sequence. In contrast, the backup ram 15 of the present invention minimises human error in selecting the wrong size centre roll 10. In other words, for a particular shape and diameter of bar 14, the controller 40 actuates the backup ram 15 to reach the correct position automatically to receive the bar. If a wrong size center roll 10 is used, then the operator would not be able to align the bar 14 with the gauge marker 30. Alternatively, there will be a gap between the backup ram 15 and the bar 14 if smaller centre roll 10 were used. As such, the operator will be alerted to the incorrect choice of centre roll. Furthermore, should an incorrect bar be used, the bar bender 2 of the present invention also flags the operator. In Fig. 1B, the bar 14 is cantilevered among the tip of the backup assembly 23', the drive pin 8 and the centre roll 10. If an over sized bar is selected, then the bar 14 cannot be lodged therebetween. For an under sized bar,

the gap of the bar among the backup assembly 23', the drive pin 8 and the centre roll 10 will be evident. It follows that the backup ram 15 of the present invention serves as a self correcting mechanism in minimizing human errors.

5

Another disadvantage of prior art backup ram is the unpredictability of resolution which contributes to poor quality of bent bars. By resolution, the present invention refers to the graduated movement of the backup ram 15 along the longitudinal axis of the shaft 22 (see Fig. 3). As mentioned above
10 in the description of Fig. 1A, prior art bar bender 1 relies on either stoppers 12 and/or manual backup ram 11 to guide the bar. In contrast, the backup ram 15 of the present invention is mechanised and coupled to a controller 40 (shown in Fig. 2). The backup ram 15 of the present invention fine tunes the resolution such that when the backup assembly 23 is extended or
15 retracted to a position 23', the backup ram assembly 23' is biased against the bar 14 without leaving a gap or bending it. As a result, the bar 14 is always positioned optimally for bending. The tolerance of bent bar angle improves accordingly.

20 Fig. 2 is a perspective, elevational layout of a bar bending system incorporating the backup rams as well as the gauge marker of the present invention. The automated bar bender 2 of the present invention comprises the turn table 4, the backup rams 15, the gauge marker 30, a structure 20 for receiving and aligning bars and a controller 40. As described above in
25 connection with Fig. 1B, the turn table further comprises a plurality of pin openings 6 for receiving at least one drive pin 8 and at least one centre roll 10. In Fig. 2, two backup rams 15 are disposed on the same surface as the turn table 4 and perpendicularly with respect to the axis of the bar (not

shown in Fig. 2) placed between the centre roll 10 and the drive pin 8. The backup rams 15 are coupled to the controller for improving the resolution of the backup ram . The structure 20 or bay features a plurality of rollers 20 for receiving and transporting bars thereon. At the end of the structure 20 and
5 opposite the turn table 4 is disposed the gauge marker 30 for aligning the bar 14 in the correct position for bending and also for guiding the bar along the structure through the entire bending sequence. The gauge marker 30 comprises a guide plate 32 and guide arms 34. The guide plate 32 has a surface against which one end of a bar or bars can be indexed. The gauge
10 marker is further coupled (not shown in Fig. 2) to the controller for automating the dimensional marking of the bending locations of the bar. As described below in Fig. 4, the gauge marker 30 also steps the operator through the entire bending sequence by traversing along the longitudinal axis of bar (not shown in Fig. 2). It should be understood by one skilled in
15 the art that the guide plate 32 and guide arms 34 are just one mode of dimensionally marking the bending locations of the bar. Other alternatives such as optical marking are also contemplated.

Fig. 3 is a top, plan, elevational view of a backup ram according to Figs. 1B
20 and 2 of the present invention. The backup ram 15 comprises a prime mover 16, a chain coupling, a ball screw jack 18, a limit switch 19, a shaft assembly 22 and a backup assembly 23. The backup ram is securely fixed to the same surface as the turn table 4 with a mounting base assembly 21. The shaft assembly 22 together with the ball screw jack 18 delivers superior
25 resolution for the backup ram assembly 23 by maintaining sufficient gap between the assembly 23 and the bar 14 without misaligning the bar. The backup assembly 23 further comprises at least one roller 26 and optionally another roller 24 for contacting the surface of the bar (not shown in Fig. 3)

without introducing undue friction thereto. As mentioned briefly above, prior art backup ram are either fixed or manually manipulated with rack and pinion mechanism which invariably leaves an undesirable gap between the backup ram and the bar. The backup ram 15 of the present invention is also coupled to the controller 40 which may reset the backup ram for the next bending assignment as soon as a previous bending operation is terminated. Consequently, the productivity of bar bending operation is improved.

Fig. 4 is a flowchart illustrating the process of the controller 40 in bending a large variety of bars efficiently and accurately. The controller 40 initializes itself in step 60 and reboots the system in step 62. Then in step 64, the controller determines if it is in any of the four operation modes - automatic downloading of parameters from remote source, modification of downloaded parameters, reloading of parameters, or calibration. If automatic downloading option is chosen or selected, then the controller 40 accesses a communication network in step 66. The controller receives bending data in step 68. Next, in step 70 it specifies the movement or position for the backup ram 15 and the position of drive pin 8 and size of centre roll 10. This is followed in step 72 by programming the gauge marker 30 for the bending sequence. In step 74, all the parameters is transferred to automatic bar bender 2. At the same time, the display of the controller 40 displays the monitoring options and sequence in steps 76 and 78.

Referring again to Fig. 4, if the controller 40 receives the modification of downloaded parameters as in step 80, the controller queries the operator through the graphic display for the type of centre roll, drive pin, line and

hole number in step 82. Next, in steps 84 and 86, the controller requests for parameteric data on the bend angle and length of bar. In step 88, the controller 40 transfers these modification information to the automatic bar bender 2.

5

If however, a reloading of parameters option is received by the controller 40, the controller 40 dispenses with all the remote access steps and proceeds directly to step 74 where the system reloads all parameters stored previously in temporary memory (not shown in Figures) before the
10 interruption of power supply to the bar bender 2. This option occurs when the bender's power supply is cut off unexpectedly or temporarily in the midst of a bending assignment. Under this reloading of parameters option, the remaining piece count and parameters of the bending job are saved in the temporary memory and downloaded to the bender 2. The bending
15 sequence restarts at step 74.

Finally, if calibration option is received by the controller 40 as in step 90, the system initiates and steps through the standard calibration procedures.

20 While the present invention has been described particularly with reference to FIGS. 1 to 4 with emphasis on an apparatus for bending bars efficiently, it should be understood that the figures and chart are for illustration only and should not be taken limitation on the invention. In addition, it is clear that the method and apparatus of the present invention has utility in many
25 applications where automatic shaping of reinforcing bars is required. It is contemplated that many changes and modifications may be made by one of ordinary skill in the art without departing from the spirit and the scope of the invention as described.



CLAIMS

1 1. In a system for bending bars into a plurality of shapes
2 efficiently, said system including a turn table incorporating a centre roll, a
3 drive pin and a controller having at least one input means adapted to
4 receive parameter information on the bending sequence of a desired bar
5 shape, an apparatus for bending bars efficiently comprising:

6 at least one backup ram disposed on said turn table and adjacent
7 said centre roll for improving tolerance of bent bar angle, said bar being
8 cantilevered among said centre roll, said drive pin and said ram, said
9 backup ram further having a backup assembly adopted to bias the bar
10 without gripping and bending it; and

11 at least one gauge marker disposed a predetermined distance from
12 said turn table for guiding said bars automatically through said bending
13 sequences; said gauge marker further having an indicia against which one
14 end of said bars is offset and moving with said bar through said bending
15 sequence for minimizing human error and improving dimensional tolerance
16 of bent bars,

17 whereby said controller coupled to said backup ram and said gauge
18 marker allows minimum number of set up operations to bend bars into a
19 plurality of shapes efficiently and effectively.

1 2. An apparatus for bending bars as in claim 1 wherein said turn
2 table has a structure adjacent to it for receiving and aligning bars, said
3 structure has rollers disposed perpendicularly to the longitudinal axis of
4 said structure.

1 3. An apparatus for bending bars as in claim 1 wherein said
2 controller has a display for displaying a plurality shapes of bar and
3 parameter information therefor.



1 4. An apparatus for bending bars as in claim 1 wherein said
2 controller is coupled remotely for receiving therefrom parameter information
3 of the predetermined shapes of bar.

1 5. An apparatus for bending bars as in claim 1 wherein said
2 controller has a plurality of modules for calibrating said apparatus, for
3 modifying bending sequences, for downloading of remote information
4 automatically, and for reloading of previously stored parameters.

1 6. An apparatus for bending bars as in claim 1 wherein said
2 backup ram comprising at least one prime mover, a ball screw jack, a shaft
3 assembly and said backup assembly.

1 7. An apparatus for bending bars as in claim 1 wherein said
2 centre roll further comprising a roll and a pin.

1 8. An apparatus for bending bars as in claim 1 wherein said
2 indicia comprising a surface substantially perpendicular to the longitudinal
3 axis of said bar.

1 9. An apparatus for bending bars as in claim 1 wherein said
2 indicia comprising an optical marker.

1 10. An apparatus for bending bars as in claim 1 wherein said
2 gauge marker operates in coordination with said controller and said backup
3 ram for guiding said bar through said bending sequence.