Oct. 4, 1966 J. H. STANLEY 3,276,235

HYDRAULIC TUBE BENDING MACHINE

Filed July 2, 1963 3 Sheets-Sheet 1

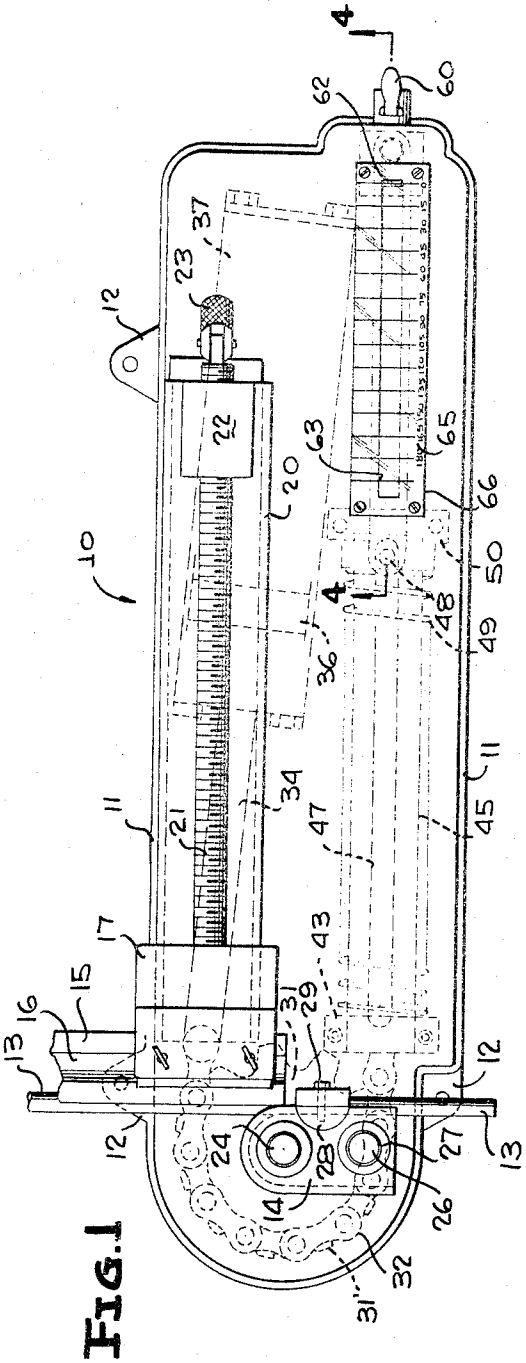

FIG. 1

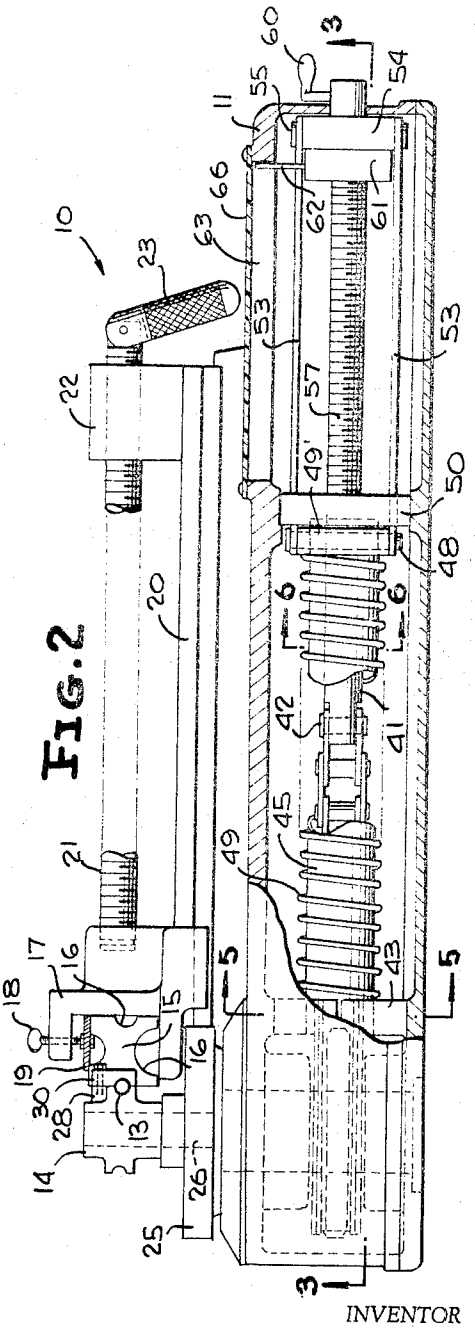

FIG. 2

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Oct. 4, 1966 J. H. STANLEY 3,276,235

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Filed July 2, 1963 3 Sheets-Sheet 2

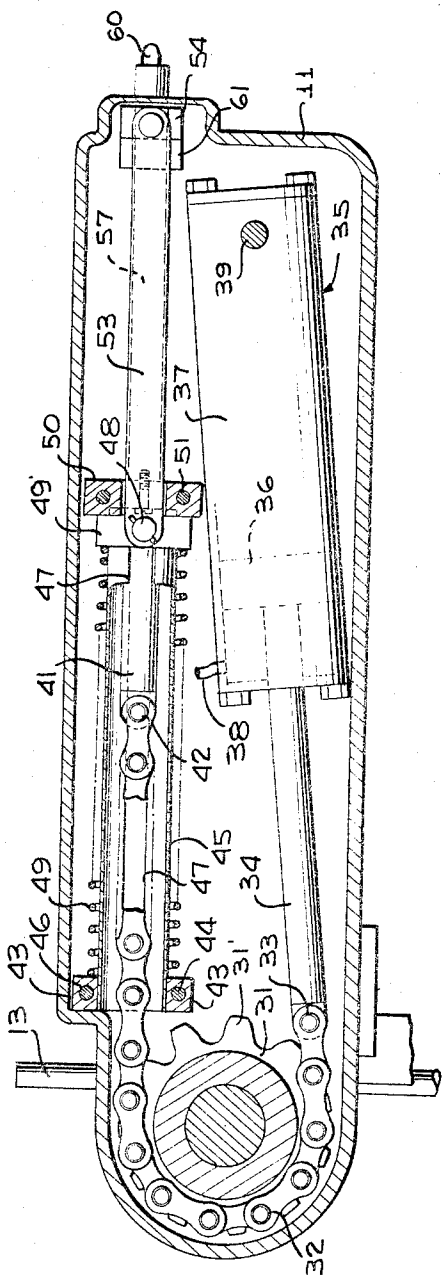

FIG. 3

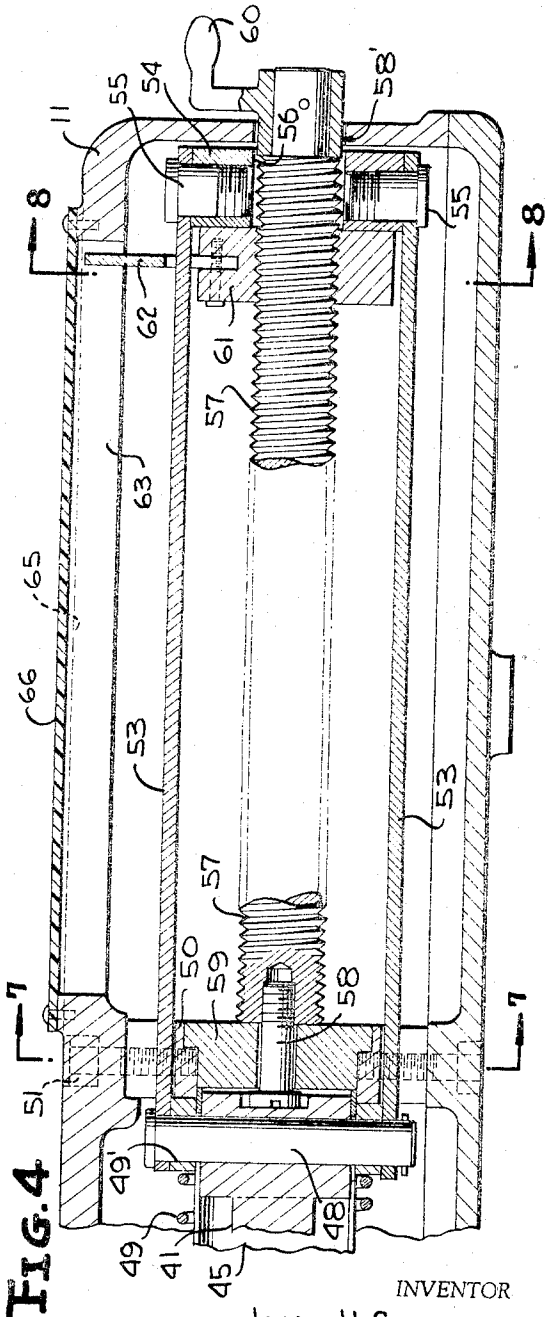

FIG. 4

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Oct. 4, 1966 J. H. STANLEY 3,276,235

HYDRAULIC TUBE BENDING MACHINE

Filed July 2, 1963 3 Sheets-Sheet 3

FIG. 5

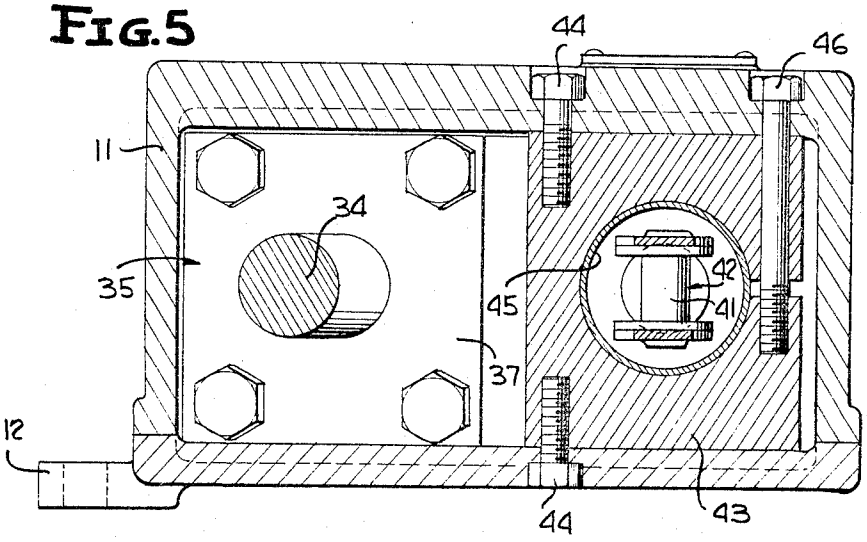

FIG. 6

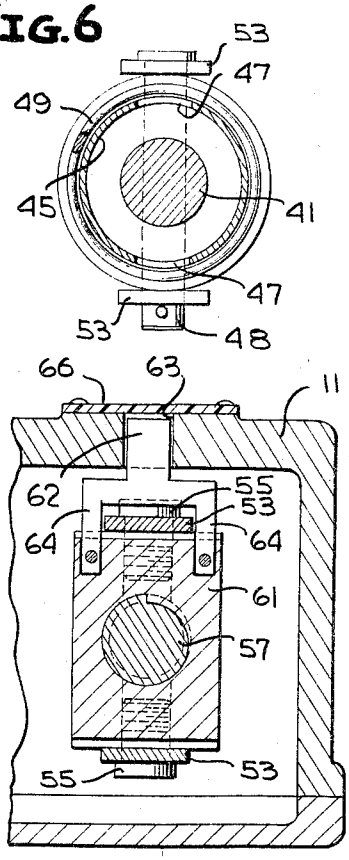

FIG. 7

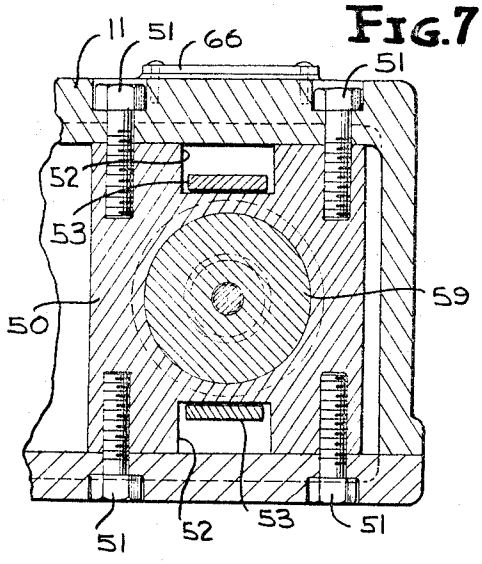

FIG. 8

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United States Patent Office 3,276,235 Patented Oct. 4, 1966

3,276,235

HYDRAULIC TUBE BENDING MACHINE

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Filed July 2, 1963, Ser. No. 292,284
15 Claims. (Cl. 72—149)

This invention relates to a hydraulic tube bending machine and more particularly to a novel arrangement of parts for applying motion to the tube bending devices and novel adjustable stop mechanism for determining the angle to which the tube is to be bent.

It is old and well known in the tube bending art to bend a tube to a desired angle by providing a radius block which is drivingly connected to a sprocket having a link type chain trained thereabout and each end of the chain connected to separate fluid operated motors. In such a device, it is necessary to provide a plurality of control devices for shutting off the fluid and stopping the fluid motors when the tube has been bent to a desired angle. Such control mechanisms have heretofore included a plurality of relatively expensive valve mechanisms for directing operating fluid selectively to the fluid motors wherein one fluid motor provides the necessary force for bending the tube and the other fluid motor retracts the mechanism to a starting position. The use of a pair of fluid motors necessarily complicates the valve mechanism and requires means for shifting the valve mechanism so as to shut off the operating fluid when the radius block has turned through a predetermined desired angle and for shutting off the fluid when the radius block has been returned to its initial set position.

It is an object of this invention to provide a hydraulic tube bending machine which includes only one single-acting fluid motor for actuating a chain drive and thereby avoiding the use of complicated and expensive valving arrangements.

Another object of this invention is to provide a tube bending machine having a radius block, a sprocket connected to the radius block in driving connection therewith, fluid motor means for rotating the radius block, a chain engaged with the sprocket, one end of the chain being connected to the fluid motor means and the other end of the chain being connected to an adjustable stop mechanism for limiting the movement of the chain, wherein the stop mechanism includes a rod and a block, means for adjustably positioning the block along the rod, and a stop collar connected to the chain and being movable thereby into engagement with the block to prevent further movement of the chain.

Another object of this invention is to provide the above described bending machine with a bend-angle indicator scale which is disposed adjacent to the block and has indicia thereon, the block being provided with means for cooperating with the indicia to indicate the position of the block.

Another object of this invention is to provide a tube bending machine of the character stated with a clamp block which is carried by the radius block for clamping thereto a tube which is to be bent, a vise block, a slider block mounted in the vise block for sliding movement with the tube, and means for adjustably positioning the vise block.

Another object of this invention is to provide a tube bending machine of the character stated with a guide tube, a fixed block attached to one end of the guide tube, a portion of the chain being disposed within the guide tube and being connected to a guide pin, slot means in the guide tube, the guide pin being slidably mounted in the slot means to maintain the chain in cooperative alignment with the sprocket, a journal block supporting the other end of the guide tube, and spring means disposed between the fixed block and the guide pin to bias the guide pin toward the journal block.

Another object of this invention is to provide an adjustable stop mechanism for a drive means wherein the stop mechanism comprises a rod and a traveling block, means for adjustably positioning the traveling block along the rod, a stop collar connected to the drive means and being movable thereby into engagement with the traveling block to prevent further movement of the drive means, and an indicator scale which is disposed adjacent to the traveling block and has indicia thereon to cooperate with means on the traveling block to indicate the position of the traveling block.

Another object of this invention is to provide an adjustable stop mechanism of the character stated with a transparent cover to retain lubricant, to exclude dirt and to protect the indicator scale.

Another object of this invention is to provide an adjustable stop means of the character stated wherein the previously mentioned rod is a threaded screw which is mounted for rotation and held against translation by the journal block, a stop collar connected to the chain and movable with respect to the screw threaded rod, and a threaded traveling block which is mounted for translation along the rotatable screw threaded rod between the journal block and the stop collar.

A further object of this invention is to enclose the stop mechanism within a housing which has a slot formed therein above the screw threaded rod, and to provide the screw threaded traveling block with a pointer which is disposed within the slot to prevent rotation of the traveling block and also cooperates with the indicia on the indicator scale for determining the position of the traveling block.

A still further object of this invention is to provide a stop mechanism of the character stated wherein the stop collar is connected to one end of the chain by a pair of flat links and a guide pin, and includes a guide tube which encloses a portion of the chain and has slot means therein for slidably receiving the guide pin and thereby preventing twisting of the chain.

With the above and other objects in view that will hereinafter appear, the nature of the invention will be more clearly understood by reference to the folowing detailed description, the appended claimed subject matter and the several views illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is a plan view of a portable hydraulic tube bender, which encompasses the present invention, and shows a radius block being disposed in engagement with a tube prior to a bending operation, a clamp for clamping the tube to the radius block, a slider block and vise means for engaging the tube, a chain drive for rotating the radius block and an adjustable stop mechanism for limiting the travel of the drive means.

FIGURE 2 is a longitudinal elevational view, with parts broken away for clarity, and shows one end of a link chain being connected to a vertically disposed guide pin which travels in a slotted guide tube and is spring biased toward a prebending position by a helical spring which is concentric with the guide tube, and also shows the guide pin as being connected by a pair of flat links to a stop collar, which collar is in engagement with a traveling block that is threadably mounted on a stationary screw rod and thereby prevents movement of the link chain.

FIGURE 3 is a horizontal longitudinal sectional view, taken on line 3—3 of FIGURE 2, and shows the link chain as being connected at one end to an adjustable stop mechanism, a central portion of the link chain be-

ing trained around a drive sprocket and the other end of the link chain being connected to a piston rod of a pivotally mounted fluid motor.

FIGURE 4 is an enlarged vertical longitudinal sectional view, taken on line 4—4 of FIGURE 1, and illustrates the details of the adjustable stop mechanism.

FIGURE 5 is an enlarged vertical transverse cross-sectional view, taken on line 5—5 of FIGURE 2, and shows the guide tube as being firmly held within a split block.

FIGURE 6 is an enlarged sectional view, taken on line 6—6 of FIGURE 2, and shows the guide pin as being received within a pair of vertically aligned slots in the guide tube.

FIGURE 7 is a fragmentary vertical cross-sectional view, taken on line 7—7 of FIGURE 4, and shows a pair of vertically aligned flat links disposed within recesses in a fixed journal block.

FIGURE 8 is a fragmentary vertical cross-sectional view, taken on line 8—8 of FIGURE 4, and shows a threaded traveling block mounted on the screw threaded rod and having a pointer which is disposed for travel within a slot in the housing to prevent rotation of the threaded traveling block.

Referring to the drawings in detail, there is shown a portable tube bending machine, generally indicated by the numeral **10**, which includes a housing **11** and a plurality of lugs **12** for fixing the tube bending machine **10** to a work surface, not shown. A rod or tube **13**, which is to be bent, is disposed transversely of the tube bending machine **10** and is engaged on opposite sides by a radius block **14** and a slider block **15**.

The slider block **15** is provided with a plurality of arcuate cut-outs **16** for receiving therein various sizes of tubes **13** and is mounted for sliding movement with the tube **13**, as the tube moves during bending, by a vise block **17**. The vise block **17** is provided with an adjustment screw **18** and a plate **19** for properly positioning the slider block **15**. The vise block **17** is mounted for sliding movement on a bed **20** and is movable therealong by a vise screw **21** which is rotatable within a nut block **22** that is welded to the bed **20**. A pivotally mounted handle **23** is connected to the vise screw **21** for turning the screw and moving the vise block **17** for pressing the slider block **15** into engagement with the tube **13**.

The radius block **14** is provided with the usual U-shaped groove for receiving the rod or tube **13** therein, and as is shown, the radius block **14** is capable of producing a 180° bend in the tube **13**. The radius block **14** is mounted for rotation about the axis of a vertically disposed center pin or shaft **24**. A rotary plate **25** is keyed to the shaft **24** to turn therewith and carries a drive pin **26** to cause rotation of the radius block **14**. The drive pin **26** is received within an opening **27**, of the radius block **14**, which is offset from the center pin or shaft **24** to provide for a mechanical advantage for turning of the radius block **14**. The radius block **14** is provided with a lug **28** which has a threaded bore for receiving a clamp bolt **29** such that the lug **28** cooperates with the clamp block **30** for fixedly clamping the tube **13** to the radius block **14**.

The center pin or shaft **24** is rotatably journaled in the housing **11** and is keyed to a sprocket **31**. The sprocket **31** has a plurality of teeth **31'** for engagement with a link chain **32**. One end of the link chain **32** is connected by a pin **33** to a piston rod **34** of a fluid motor, generally indicated by the numeral **35**. The fluid motor **35** is preferably hydraulically actuated and includes the piston rod **34**, a piston **36** and a cylinder **37** and is provided with hydraulic fluid by a conduit **38** which connects the fluid motor **35** to a pump or other source of pressure (not shown). The cylinder **37** may be welded or rigidly fastened to the housing **11** but as is shown in FIGURE 3, it is preferable to provide a trunnion **39** for

pivotally mounting the cylinder **37** to the housing **11** to thereby minimize wear on the piston **36** and the fluid seals (not shown).

The link chain **32** extends from the piston rod **34**, is trained about the sprocket **31**, and is pivotally secured to a connector rod **41** by a pin **42**. As is shown in FIGURE 5, a split block **43** is securely fastened to the housing **11** by a pair of bolts **44** and is clamped to one end of a guide tube **45** by a locking bolt **46**. The guide tube **45** is provided with a pair of longitudinally extending vertically aligned slots **47**, as is shown in FIGURES 3 and 6, for slidably receiving therein a guide pin **48** which is carried by the end of the rod **41**. A helical return spring **49** surrounds the guide tube **45** and is compressed between the split block **43** and a ring-like abutment member **49** impaled by the guide pin **48** during movement of the piston **36** into the cylinder **37**. After completion of a bending operation, the return spring **49** causes the abutment member **49'** to slide back along the tube **45** to its position of FIGURES 2 and 4, thus retracting the radius block **14**, and returning the piston **36** and the guide pin **48** to the positions shown in FIGURES 1 and 2 in preparation for the next bending operation.

The end of the guide tube **45**, opposite from the end thereof which is supported by the split block **43**, is supported by a journal block **50**. The journal block **50** is rigidly secured to the housing **11** by a plurality of bolts **51**, as is shown in FIGURE 7, and has a pair of vertically aligned recesses **52** for slidably receiving a pair of vertically aligned flat links **53** which are connected to the guide pin **48**, as shown in FIGURES 3 and 4. The flat links **53** are fixedly connected to a stop collar **54** by a pair of locking bolts **55**. The stop collar **54** has a central aperture **56** for receiving therethrough a rotatable, threaded rod or captive screw **57**. The rod or screw **57** is rotatably connected to a thrust bearing **59** by a screw **58**, said bearing **59** being mounted in the journal block **50**. The rod or screw **57** is also journaled for rotation in the housing **11** as at **58'** and is provided with a handle **60**. An internally threaded nut or traveling stop block **61** is movable along the rod or screw **57** by rotation of the handle **60**.

A pointer **62** travels within a slot **63**, in the housing **11**, and is connected to the nut or traveling block **61** by a pair of bifurcated legs **64**, as is shown in FIGURE 8. A bend angle indicator scale **65** is provided on the housing **11**, as is shown in FIGURE 1, and underlies a transparent plastic cover **66** which excludes dirt and protects the indicator scale **65**. The bend angle indicator scale **65** is provided with indicia which ranges between zero degrees and 180°, and in cooperation with the pointed **62**, gives a visual indication of the position of the nut or traveling block **61** and of the angle to which the tube **13** is to be bent.

In the operation of the tube bending machine **10**, the tube **13** is placed transversely of the housing **11** and is clamped to the radius block **14** by the clamp block **30**. The slider block **15** is moved into engagement with the tube **13** by advancing the vise block **17** and the vise screw **21** by rotating the handle **23**. The nut or traveling block **61** is moved along the rod or screw **57**, and away from the stop collar **54**, by rotating the handle **60** and the rod or screw **57** until the pointer **62** is positioned along the bend angle indicator scale **65** in alignment with the indicia which indicates the desired bend angle. Fluid under pressure is then provided through the conduit **38** to force the piston **36** and the piston rod **34** into the cylinder **37**. Movement of the piston rod **34** into the cylinder **37** causes the link chain **32** to rotate the sprocket **31** and the center pin or shaft **24**. The rotary plate **25** is keyed to the center pin or shaft **24**, and rotates therewith and moves the drive pin **26** to cause rotation of the radius block **14** and thereby bend the rod or tube **13**.

As the chain **32** rotates the sprocket **31**, the connecting rod **41** pulls the guide pin **48** along the slots **47** in the guide tube **45** to compress the return spring **49** between

the split block **43** and the abutment member **49'**. In addition, the guide pin **48** pulls upon the flat links **53** and the block or stop collar **54** until the block or stop collar **54** engages the adjusted nut or traveling block **61** and further movement is prevented thereby. The travel of the guide pin **48** within the slots **47**, of the guide tube **45** prevents the chain **32** from becoming twisted and from becoming disengaged from the sprocket **31**. Also, as the nut or traveling block **61** is adjusted along the rod or screw **57**, the pointer **62** travels within the slot **63** in the housing **11** and prevents the nut or traveling block **61** from rotating about the screw **57**.

After the rod or tube **13** has been bent, it may be found that spring-back in the tube has not been accurately compensated for. Thus, it may be necessary to increase the bend by a few more degrees. It is an important feature of the present invention that the rod or screw **57** and the handle **60** do not move axially during the bending operation and, therefore, the handle **60** is always accessible for changing the bend setting without making it necessary for all of the parts to be first returned to their starting positions.

While preferred forms and arrangement of parts have been shown in illustrating the invention, it is to be clearly understood that various changes in details and arrangement of parts may be made without departing from the spirit and scope of the invention as defined in the appended claimed subject matter.

I claim:

1. In a tube bending machine, a radius block, fluid motor means for rotating said radius block, a sprocket connected to said radius block in driving connection therewith, a chain engaged with said sprocket, one end of said chain being connected to said fluid motor means and the other end of said chain being connected to an adjustable stop mechanism for limiting the movement of said chain, said stop mechanism including a rod and a block, means for adjustably positioning said block along said rod, a stop collar connected to said chain and being movable thereby into engagement with said block to prevent further movement of said chain.

2. In a tube bending machine, a radius block, fluid motor means for rotating said radius block, a sprocket connected to said radius block in driving connection therewith, a chain engaged with said sprocket, one end of said chain being connected to said fluid motor means and the other end of said chain being connected to an adjustable stop mechanism for limiting the movement of said chain, said stop mechanism including a rod and a block, means for adjustably positioning said block along said rod, a stop collar connected to said chain and being movable thereby into engagement with said block to prevent further movement of said chain, a bend-angle indicator scale disposed adjacent to said block and having indicia thereon, said block having means thereon cooperating with said indicia to indicate the position of said block.

3. In a tube bending machine, a housing, a shaft rotatably mounted in said housing and having a sprocket affixed thereto; a fluid motor including a piston disposed therein and a piston rod extending therefrom, a link-chain connected at one end to said piston rod and trained around said sprocket, a radius block disposed above said housing and being mounted on said shaft, a rotary plate keyed to said shaft and carrying a drive pin which cooperates with said radius block to cause rotation thereof, a clamp block carried by said radius block for clamping thereto a tube which is to be bent; a vise block, a slider block mounted in said vise block for sliding movement with said tube, and means for adjustably positioning said vise block.

4. In a tube bending machine, a radius block, fluid motor means for rotating said radius block, a sprocket connected to said radius block in driving connection therewith, a chain engaged with said sprocket, one end of said chain being connected to said fluid motor means and the other end of said chain being connected to an adjustable stop mechanism for limiting the movement of said chain, said stop mechanism including a rod and a block, means for adjustably positioning said block along said rod, a stop collar connected to said chain and being movable thereby into engagement with said block to prevent further movement of said chain; a guide tube, a fixed block attached to one end of said guide tube, a portion of said chain being disposed within said guide tube and being connected to a guide pin, slot means in said guide tube, said guide pin being slidably mounted in said slot means to maintain said chain in cooperative alignment with said sprocket, a journal block supporting the other end of said guide tube, and spring means disposed between said fixed block and said guide pin to bias said guide pin toward said journal block.

5. A tube bending machine comprising, a housing, a shaft rotatably mounted in said housing and having a sprocket affixed thereto; a fluid motor including a cylinder having a piston disposed therein and a piston rod extending therefrom, a link chain connected at one end to said piston rod and trained around said sprocket, the other end of said link chain being connected to an adjustable stop mechanism for limiting the movement of said link chain; a radius block disposed above said housing and being mounted on said shaft, a rotary plate keyed to said shaft and carrying a drive pin which cooperates with said radius block to cause rotation thereof, a clamp block carried by said radius block for clamping thereto a tube which is to be bent; a vise block, a slider block mounted in said vise block for sliding movement with said tube, and means for adjustably positioning said vise block; said stop mechanism including a rod and a block, means for adjustably positioning said block along said rod, a stop collar connected to said chain and being movable thereby into engagement with said block to prevent further movement of said chain.

6. A tube bending machine comprising, a housing, a shaft rotatably mounted in said housing and having a sprocket affixed thereto; a fluid motor including a cylinder having a piston disposed therein and a piston rod extending therefrom, a link chain connected at one end to said piston rod and trained around said sprocket, the other end of said link chain being connected to an adjustable stop mechanism for limiting the movement of said link chain; a radius block disposed above said housing and being mounted on said shaft, a rotary plate keyed to said shaft and carrying a drive pin which cooperates with said radius block to cause rotation thereof, a clamp block carried by said radius block for clamping thereto a tube which is to be bent; a vise block, a slider block mounted in said vise block for sliding movement with said tube, and means for adjustably positioning said vise block; a split block fixedly attached to said housing and encompassing one end of a guide tube, said other end of said link chain being disposed within said guide tube and being connected to a guide pin, slot means in said guide tube, said guide pin being slidably mounted in said slot means to maintain said link-chain in cooperative alignment with said sprocket, and a journal block fixed to said housing and supporting the other end of said guide tube; said stop mechanism including a thrust bearing carried by said journal block, a rotatable screw mounted for rotation and held against translation by said thrust bearing, said screw being journaled in said housing and having handle means exterior of said housing to rotate said screw; link means connected to said guide pin for movement therewith, a stop collar fixedly connected to said link means, a threaded traveling block mounted for translation along said rotatable screw between said thrust bearing and said stop collar; a bend-angle indicator scale fixed adjacent to said traveling block and having indicia thereon, means on said traveling block cooperating with said indicia to indicate the position

of said traveling block, and a transparent cover to exclude dirt and protect said indicator scale.

7. An adjustable stop mechanism for a drive means comprising a rod and a traveling block, means for adjustably positioning said traveling block along said rod, a stop collar connected to said drive means and being movable thereby into engagement with said traveling block to prevent further movement of said drive means, an indicator scale disposed adjacent to said traveling block and having indicia thereon, said traveling block having means thereon cooperating with said indicia to indicate the position of said traveling block.

8. An adjustable stop mechanism for a drive means comprising, a rod and a traveling block, means for adjustably positioning said traveling block along said rod, a stop collar connected to said drive means and being movable thereby into engagement with said traveling block to prevent further movement of said drive means, an indicator scale disposed adjacent to said traveling block and having indicia thereon, said traveling block having means thereon cooperating with said indicia to indicate the position of said traveling block, and a transparent cover to exclude dirt and protect said indicator scale.

9. An adjustable stop mechanism for a chain drive including a chain and means at one end thereof for pulling said chain, said stop mechanism comprising; a journal block, a screw mounted for rotation and held against translation by said journal block, a stop collar connected to the other end of said chain and being movable with respect to said screw, a threaded traveling block mounted for translation along said rotatable screw between said journal block and said stop collar, an indicator scale fixed adjacent to said traveling block and having indicia thereon, and means on said traveling block cooperating with said indicia to indicate the position of said traveling block.

10. Apparatus as defined in claim 9 wherein said stop mechanism is enclosed within a housing, a slot formed in said housing along said screw, said means on said traveling block comprising a pointer, said pointer being disposed in said slot to prevent rotation of said traveling block.

11. An adjustable stop mechanism for a chain drive including a chain and means at one end thereof for pulling said chain, said stop mechanism comprising; a journal block, a screw mounted for rotation and held against translation by said journal block, a stop collar connected to the other end of said chain and being movable with respect to said screw, a threaded traveling block mounted for translation along said rotatable screw between said journal block and said stop collar, an indicator scale fixed adjacent to said traveling block and having indicia thereon, and means on said traveling block cooperating with said indicia to indicate the position of said traveling block; said stop collar being connected to said other end of said chain by a pair of flat links and a guide pin, a guide tube enclosing a portion of said chain, slot means in said guide tube, said guide pin being slidably mounted in said slot means to prevent twisting of said chain.

12. In a tube bending machine, tube bending means including a turnable radius block, means for turning the radius block and including a sprocket and a chain engaged with the sprocket, a single acting hydraulic cylinder and piston means operatively connected with the chain at one end to move the chain in a tube bend effecting direction, a spring means operatively connected at the other end of the chain and effective for returning the chain to its initial position after a bending operation, and adjustable stop means for limiting the movement of the chain in a tube bend effecting direction thereby to limit the tube bending to a predetermined angle, said stop means including a stop member adjustable along the path of movement of said other end of the chain, and an abutment member movable with said other end of the chain and engageable with said stop member.

13. In a tube bending machine, tube bending means including a turnable radius block, means for turning the radius block and including a sprocket and a chain engaged with the sprocket, a single acting hydraulic cylinder and piston means operatively connected with the chain at one end to move the chain in a tube bend effecting direction, a spring means operatively connected at the other end of the chain and effective for returning the chain to its initial position after a bending operation, and adjustable stop means for limiting the movement of the chain in a tube bend effecting direction thereby to limit the tube bending to a predetermined angle, said stop means including a captive screw rotatable but held against endwise movement relative to said other end of the chain, a stop member threaded on the screw and adjustable therealong in one direction or the other by rotation of the screw, and an abutment member movable with said other end of the chain and engageable with said stop member in its position of adjustment on the screw.

14. Tube bending means as defined in claim 13 wherein there also is included a tube bend indicating scale, an indicator movable with the stop member and in cooperative relation to the scale.

15. Tube bending means as defined in claim 13 wherein there also is included a tube bend indicating scale, an indicator movable with the stop member and in cooperative relation to the scale, said other chain end, said screw, said stop and said abutment being mounted in a housing and said indicator being operable in a slot at the position of the scale, and there being included a transparent window covering the slot to prevent ingress of foreign matter into the housing and contained lubricant from egress out of the housing.

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R. D. GREFE, *Assistant Examiner.*