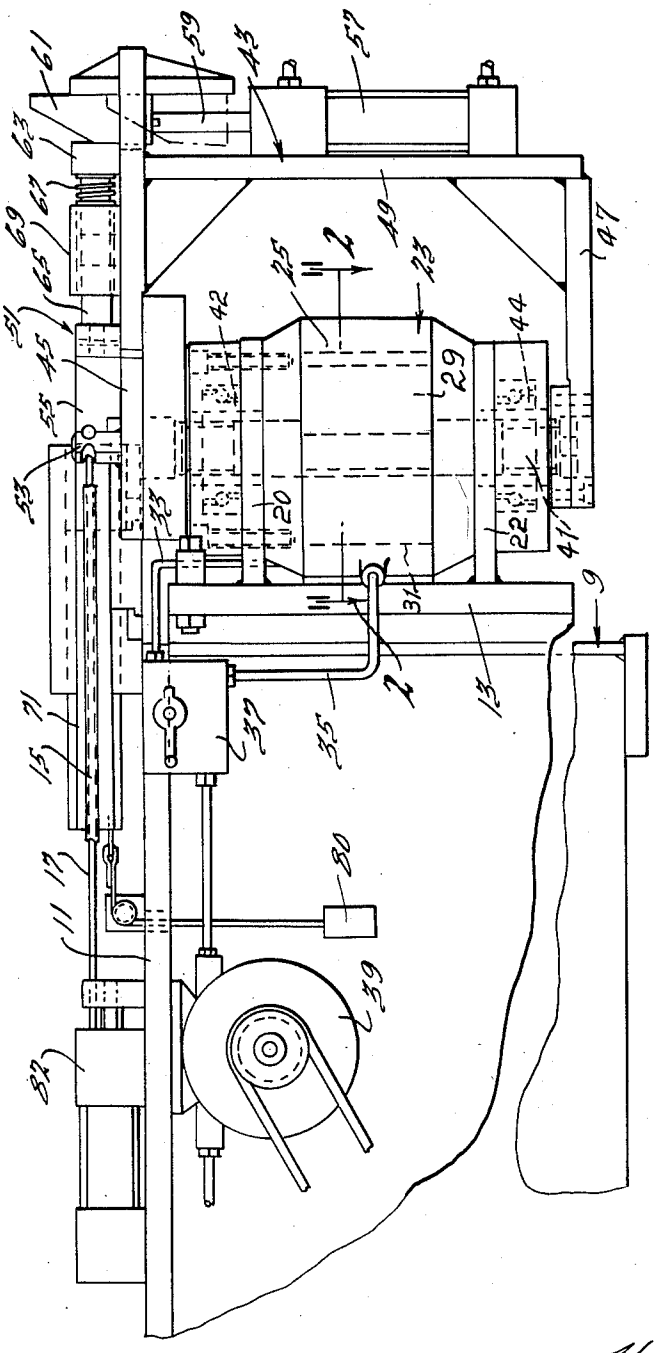
Feb. 5, 1957 W. P. HILL 2,780,269

BENDING DEVICE

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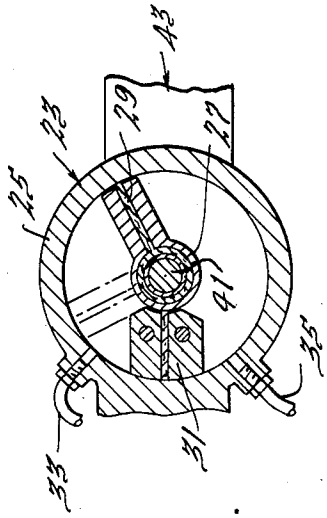


Fig. 2.

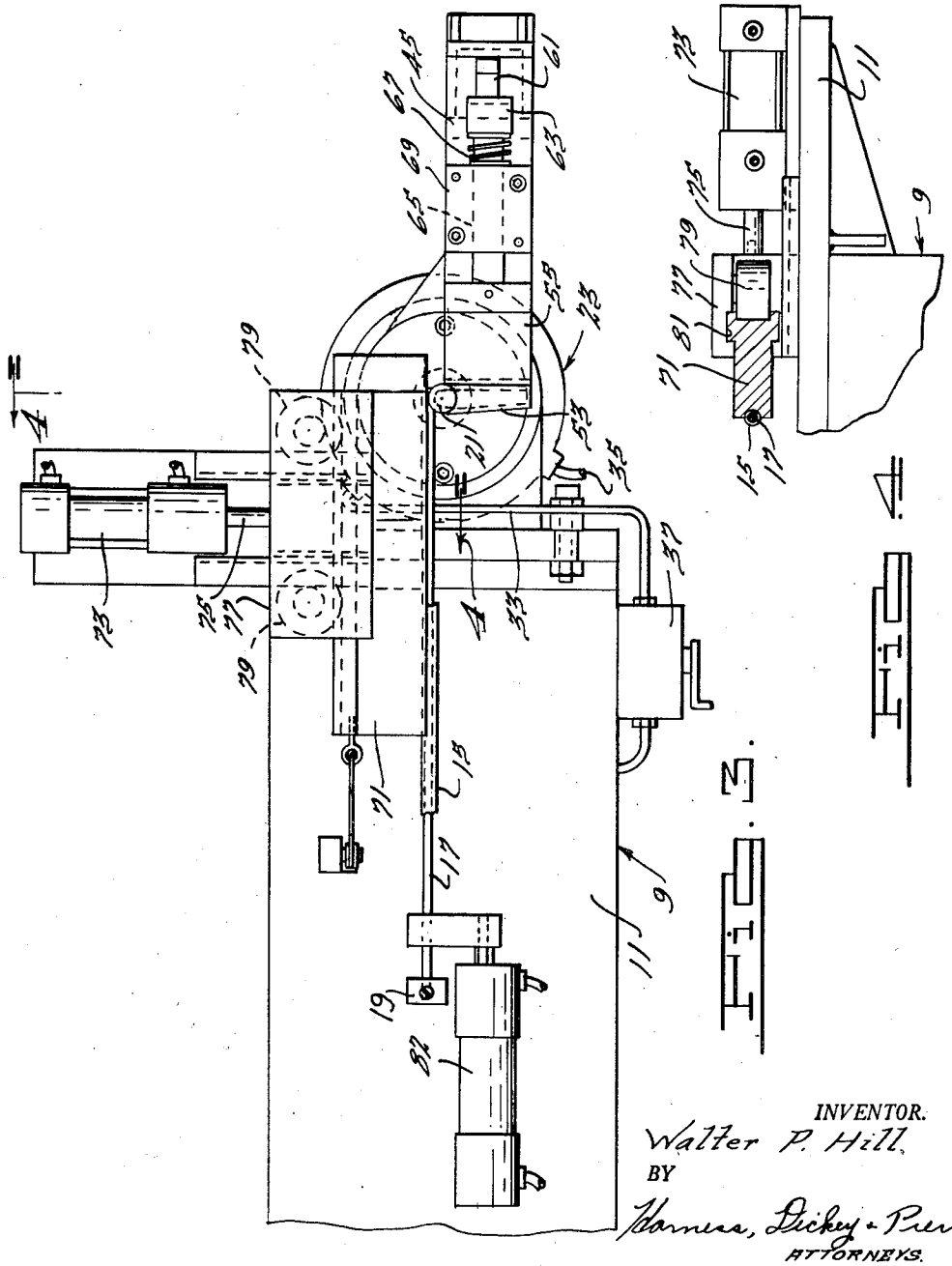
Fig. 1.

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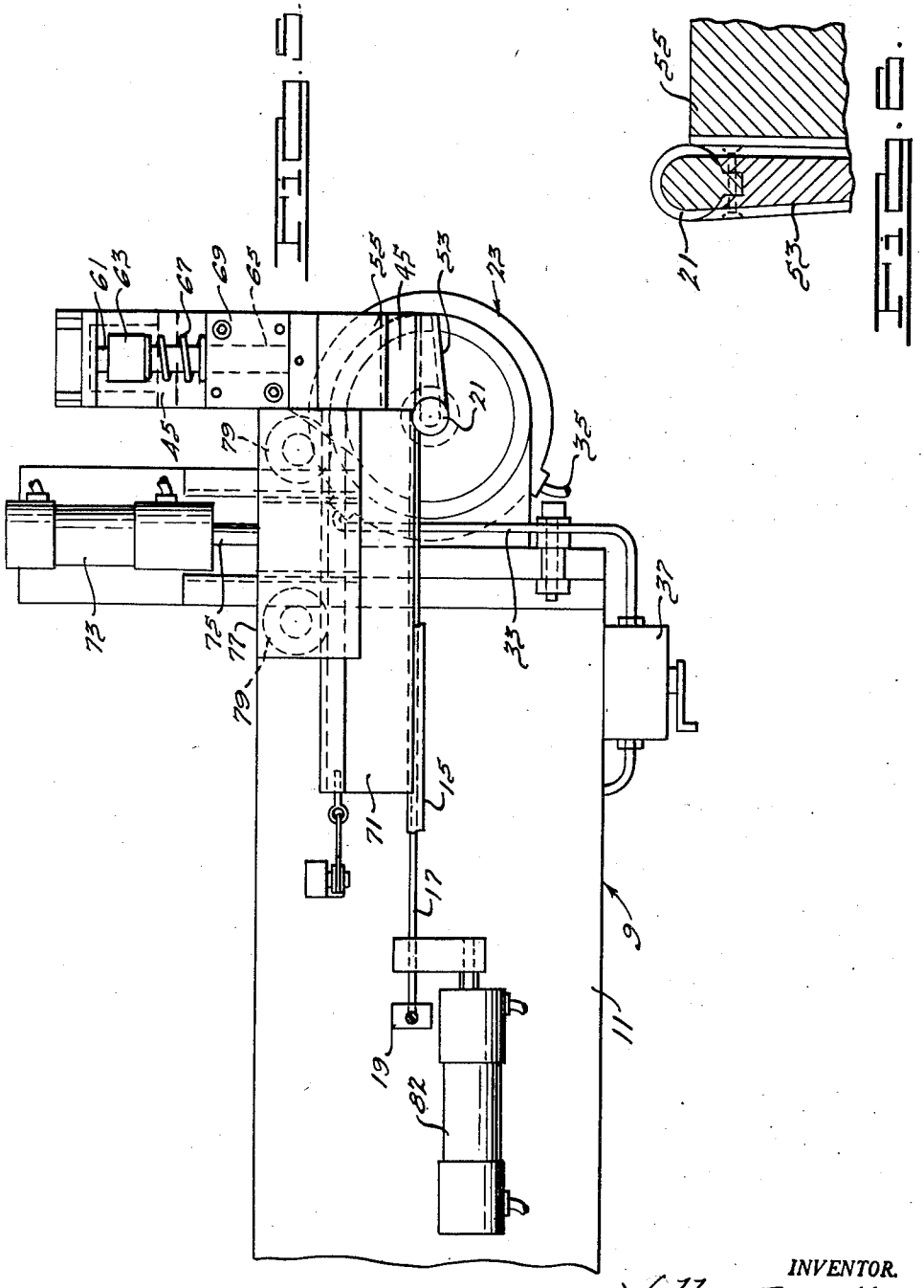


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BENDING DEVICE

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2 Claims. (Cl. 153—40)

This invention relates generally to bending devices and more particularly to an improved machine for bending workpieces in a more efficient and simple manner than has been heretofore possible.

While various types of bending machines have been designed in which a workpiece clamp or head is rotated about a bending form to bend the workpiece therearound, in all such previous devices a chain or worm and gear type drive for the clamp or head has been employed. As a result thereof, certain jerkiness or uneven motion has been imparted to the bending operation. Furthermore in tube bending a toggle or ball type mandrel has been positioned within tubing throughout the portion being bent, to prevent collapsing or deformation of the tube and such mandrel when extracted acts to smooth out any deformations or undulations in the tubing caused by the uneven drive motion. Furthermore, with such bending machines it has been necessary to clamp the workpiece, such as tubing, so tightly against the bending form that the aforementioned type of mandrel must be provided. Also, with machines of the type employing chain or worm and gear drive mechanisms, it has not been possible for the machine operator or setup man to rotate the clamp or head freely about the bending form to aid in the setup operations of the machine, without the provision of a disengageable clutch in the drive mechanism. Thus, such machines have been relatively expensive to manufacture and maintain.

It is therefore an object of this invention to provide a bending machine which is capable of bending tubing of various sizes as well as workpieces of other structural shapes, in a relatively simple and efficient manner.

It is a further object of this invention to provide a bending machine of the aforementioned type, in which a uniform bending motion is obtained which eliminates undulations or deformation in the bent tubing and which eliminates the use of an expensive mandrel extending around and inside of the bent portion of the tube during the bending operation.

It is a still further object of this invention to provide an improved means for clamping the workpiece to the bending form and an improved structure for supporting the clamping means so that a lesser clamping pressure need to applied to the workpiece to maintain it in proper engagement with the bending form.

It is a still further object of this invention to provide, in a bending machine of the aforementioned type, a hydraulic motor for directly driving the bending head, and which includes a rotating piston having shaft portions extending beyond the opposite ends of the piston cylinder to which the bending head or clamp carrier is directly, rigidly connected.

It is a still further object of this invention to provide a bending machine of the aforementioned type, in which hydraulic pressure to the hydraulic motor can be cut off, so as to permit the bending head to be manually moved to aid in the setting up of the machine, and which eliminates the use of disengaging clutches or the like, in the drive mechanism.

It is a still further object of this invention to provide a relatively simple and inexpensive machine which will uniformly and efficiently bend various structural shapes, including relatively thin-walled tubing, in a simple, speedy and effective manner not heretofore possible.

These and other objects of this invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, in which:

Figure 1 is a fragmentary side elevational view of the device of this invention;

Fig. 2 is a sectional view of the structure illustrated in Fig. 1, taken along the line 2—2 thereof;

Fig. 3 is a plan view of the structure illustrated in Fig. 1 showing the position of the device after bending a workpiece;

Fig. 4 is a view partially in section and partially in elevation of the structure illustrated in Fig. 3, taken along the line 4—4 thereof;

Fig. 5 is a plan view similar to Fig. 3, illustrating the position of parts of the device prior to the bending of the workpiece; and

Fig. 6 is an enlarged sectional view of the bending form and clamping members.

Referring now to the drawings, it will be seen that the machine includes a base or supporting structure **9**, including a top bed or plate **11** and an end wall structure **13**. The particular machine illustrated herein is arranged for bending relatively thin-walled tubing **15** and suitable automatic means may be provided for automatically feeding the tubing onto the plate **11** and for automatically feeding the tubing into the bending mechanism. However, for purposes of simplicity, the automatic feed mechanism is not shown in detail herein but a rodlike mandrel **17** is shown as being supported on the plate **11** and connected therewith adjacent its rear end by suitable bracket structure **19**. The forward end of the mandrel terminates adjacent a bending form **21**, which is supported, as will be hereinafter described. The bending form **21** is illustrated as being of a cylindrical shape and having a groove in the periphery thereof, of a size adapted to receive and support the tubing **15**. The forward end of the mandrel **17** terminates just forwardly of the center of the bending form **21**, so as to extend into the inside of the bend on the tubing when the tubing is inserted over the mandrel and bent, as will be hereinafter described.

Rigidly welded to the front plate structure **13** of the supporting structure **9** are a pair of vertically spaced bracket plates **20** and **22** between which is fixed a hydraulic motor **23**, which includes a housing or cylinder portion **25** having a rotating piston **27** therein. The piston **27** includes a vane **29** which engages the inner wall of the cylinder **25** and the cylinder is provided with a shoe or stator **31** which coacts with piston **27** and vane **29** to divide the cylinder into two chambers, as shown in Fig. 2. A conduit **33** communicates with the interior of the cylinder **25** on one side of the stator and a conduit **35** communicates with the interior of the cylinder on the opposite side of the stator **31**. The conduits are connected through a valve **37**, of any suitable structure, with a suitable fluid pump **39** so that fluid under pressure may be applied to the interior of the cylinder to cause rotation of the piston in one direction or the other. The valve **37** is of the type which may relieve the pressure of the fluid in the cylinder so that the piston can be easily turned. Shaft means **41** extend from the piston **27** through the opposite ends of the cylinder **25** so that upper and lower shaft portions project from the top and bottom of the cylinder, the shaft being supported by conventional ball bearings **42** and **44** carried by the cylinder **25**.

A carrier **43** is provided, which includes an upper plate section **45**, a lower plate section **47**, and a vertical plate section **49**, which interconnects the upper and lower plate sections adjacent one end thereof. The upper and lower

plate sections 45 and 47 are rigidly connected with the projecting shaft means 41 above and below the cylinder 25 in the manner illustrated, so that the carrier 43 is rigidly connected with the shaft and will rotate upon rotation of the piston 27 and the shaft means 41. The generally channel or U-shaped carrier 43 is thus extremely rigid and is rigidly connected with the hydraulic motor shaft means by any suitable means such as a spline connection. The bending form 21 is rigidly connected with the upper plate 45 of the carrier, with its center axis disposed in alignment with the axis of the shaft 41. Clamping means 51 are carried on the upper plate 45 of the carrier 43 for clamping the tubing 15 against the forming block 21. The clamping means includes a portion 53 connected with the bending form 21 and a complemental clamping head 55 slidably supported on the carrier. The clamping head 55 is actuated by any suitable means such as a piston and cylinder unit 57, which is supported on the vertical leg 49 of the carrier 43 and has a piston rod 59 projecting upwardly therefrom and carrying a wedge-shaped actuator 61 on the upper end thereof. The wedge-shaped actuator 61 coacts with a member 63 supported on the upper leg of the carrier and a pin 65 is connected to the member 63 so that when the piston rod 59 moves upwardly the clamping head 55 will move toward the bending form 21 and clamping portion 53 to tightly clamp the tube against the bending form. A spring 67 is provided between the member 63 and a housing member 69 which slidably supports the pin 65 so that when the piston rod 59 is retracted the clamping member will move away from the tube and bending form. In view of the fact that the carrier 43 is of a rigid construction and the clamping portion 53 rigidly connected therewith, by welding or the like, the tube can be firmly clamped in contact with the bending form without the application of extremely high pressure between the clamping portion 53 and the head 55, which would cause unnecessary tubing deformation .

Supported on the upper plate 11 of the supporting structure 9 is a wiper block or follower 71 which has its inner face extending substantially parallel to the mandrel 17 and is suitably grooved to receive and support the tubing being bent so as to retain the tubing against lateral movement and so as to prevent any lateral deflection of the mandrel 17 during the bending operation. The wiper block or follower 71 is actuated by means of a piston and cylinder unit 73, the piston rod 75 of which is connected with a housing member 77 in which are rotatably supported bearing members 79. The bearing members 79 engage the back face of the block 71 and the housing 77 is provided with suitable guideways 81 to permit the block 71 to slide fore and aft relative to the housing 77 on the bearing member 79. However, extension of the piston rod 75 will move the block 71 toward the tube and mandrel to properly engage the latter, as previously described, but frictional movement of the tube will permit the block 71 to slide and maintain proper contact therewith during the bending operation. Weight means 80 is connected with the block 71 to return the same to its initial position after it has been moved forwardly. An hydraulically actuated tube ejector 82 is provided for pushing the tube off of the mandrel after the bending operation has been completed.

It will thus be appreciated that a tube to be bent is sleeved on the mandrel 17 so that a desired portion thereof projects beyond the bending form 21. The clamping cylinder 57 is then actuated to move the clamping head 55 into engagement with the tube to properly clamp the tube in contact with the bending form 21 and against the clamping portion 53. The follower or wiper block 71 is then moved into engagement with the tube by actuation of the piston and cylinder unit 73. The tubing can then be bent around the bending form 21 by actuating the hydraulic motor 23. Such actuation is occasioned by controlling the valve 37 so that fluid flows into the cylinder 25 to cause rotation of the piston 27 and thus rotation of the shaft means 41. Rotation of the shaft causes rotation of the carrier 43 and because a single vane piston is employed in the cylinder the piston will move more than 180° before the stator 31 prevents further movement. This movement carries the carrier 51 and the clamp about the axis of the shaft 41 and bending form 21 to bend the tube therearound 180° or any desired amount. By reversing the valve the carrier can be returned to its initial position and thereafter the piston and cylinder units 57 and 73 actuated to move the clamping members and wiper block away from the tube and the tube can then be removed in its bent form.

In setting up a machine of this type for a bending operation, it is extremely desirable that the carrier be rotatable manually by the machine operator or setup man. By positioning the valve so that there is no appreciable fluid pressure in the hydraulic motor, the operator can manually grasp the carrier and rotate it as there is no substantial resistance to rotation of the piston 27 and shaft means 41. Thus, the drive mechanism of this invention permits manual operation without providing disengageable clutches such as are necessary where a chain drive or a worm and gear drive is provided. Furthermore, the hydraulic motor provides a uniform motion which is not obtained with chain or worm and gear drives and thus bends the tubing without any undulations or deformities in the bend and without the necessity of incorporating a toggle or ball-type mandrel which extends through the tubing and the bent portions thereof, and which must be pulled through the bent portion of the tubing in an attempt to remove the undulations or deformities therein. It will thus be appreciated that with the structure of this invention the tubing can be bent with a simple type mandrel and with no concern of crushing or deforming the tubing by the clamping means because of the rigid mounting of the carrier and clamping means on the carrier. Further, in view of the hydraulic motor, manual setup operations can be made with the mechanism, and uniform bending motion is provided, thus enabling the bending of the tubing in a more simple, efficient and economical manner than has been heretofore possible.

What is claimed is:

1. A device for bending workpieces, including a supporting structure, a hydraulic motor including a cylinder rigidly connected with said structure, shaft means extending through said cylinder and having a vane attached thereto and projecting therefrom into sealing engagement with the cylinder wall, a stator connected with the cylinder wall and coacting with said shaft means and vane to divide said cylinder into two chambers, conduit means connected with the interior of said cylinder on one side of said stator and conduit means connected with the interior of said cylinder on the opposite side of said stator so that the application of fluid under pressure into either of said conduits will cause said vane and shaft means to rotate in one direction or the other relative to said cylinder, said shaft means projecting beyond the opposite ends of said cylinder, a carrier rigidly connected with the projecting ends of said shaft means and spaced from said cylinder so as to be swingable about said cylinder through an angle of at least 180°, a bending form supported on said carrier and having its axis disposed in alignment with the axis of said shaft means, clamp means on said carrier for clamping a workpiece against said form, and follower means supported on said supporting structure and actuable to engage said workpiece to prevent lateral movement thereof during the bending operation effected by the rotation of said shaft and vane.

2. The combination set forth in claim 1 including a fluid pump mounted on said supporting structure, valve means mounted on said supporting structure and operatively connected between said pump and said cylinder conduits so as to control the flow of fluid from said pump to said cylinder and so that said cylinder can be relieved of fluid

pressure to permit said carrier and said shaft means to be easily rotated by hand.

References Cited in the file of this patent

UNITED STATES PATENTS

397,919	Hornig	Feb. 19, 1889
1,575,014	Snell	Mar. 2, 1926
1,826,403	O'Brien	Oct. 6, 1931
2,232,506	Acton	Feb. 18, 1941
2,350,066	Parker	May 30, 1944
2,357,873	Bower	Sept. 12, 1944
2,389,937	Schmitt	Nov. 27, 1945
2,489,326	Rockstrom	Nov. 29, 1949
2,633,105	Lasater	Mar. 31, 1953

FOREIGN PATENTS

603,740	Great Britain	June 22, 1948