United States Patent [19]

Linquist et al.

[11] **3,924,438**

[45] **Dec. 9, 1975**

[54] **HYDRAULIC CABLE BENDER**

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[22] Filed: **Sept. 23, 1974**

[21] Appl. No.: **508,496**

[52] **U.S. Cl.** **72/388**

[51] **Int. Cl.²** **B21D 7/04**

[58] **Field of Search** 72/149, 155, 215, 216, 72/217, 218, 318, 321, 387, 388

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[57] **ABSTRACT**

A hydraulic bending apparatus for bending elongated members, such as electrical cables or the like. The bending apparatus includes a hydraulic cylinder having an extendable and a retractable ram. A drive shoe is fixed on the cylinder ram and it is provided with a hook-shaped member for engaging an elongated member. A rotating shoe is pivotally mounted on the drive shoe and it is also provided with a hook-shaped member for engaging an elongated member. Linkage means movably connects the rotating shoe to the actuating means, whereby when an elongated member is mounted between the drive shoe and rotating shoe and the actuating means ram is extended, the drive shoe is driven away from said actuating means and said rotating shoe is pivoted relative to the drive shoe to bend the elongated member.

3 Claims, 6 Drawing Figures

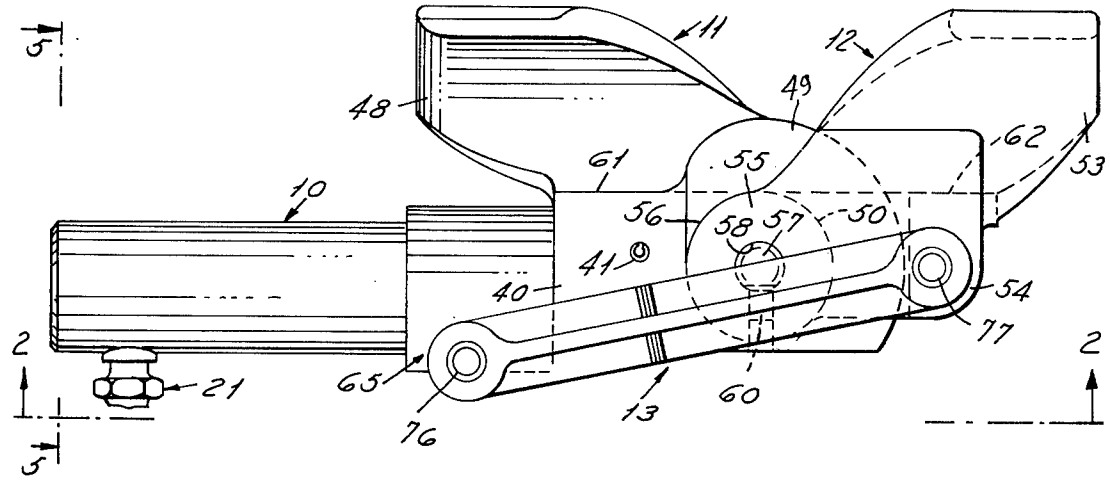


FIG. 1

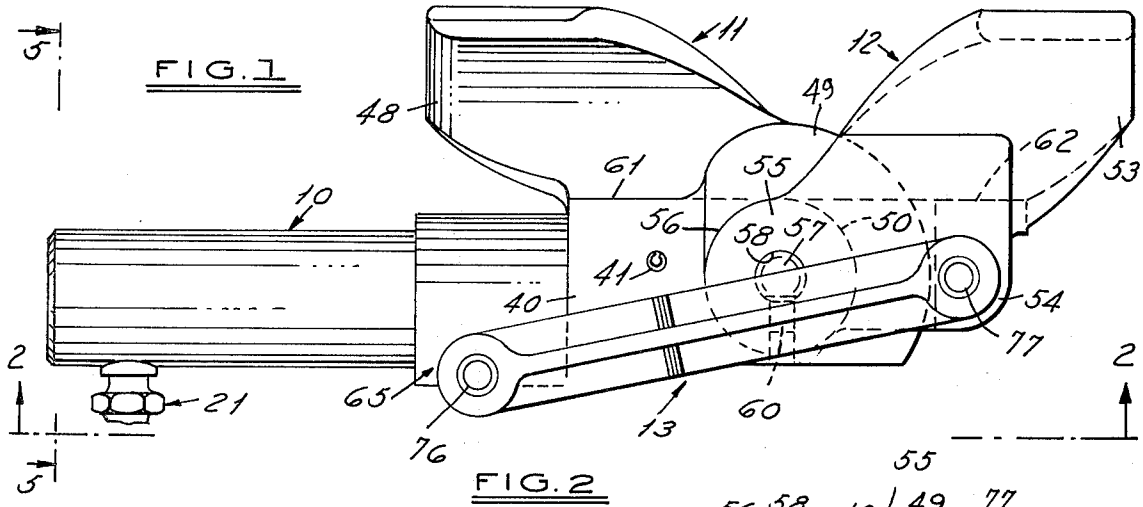


FIG. 2

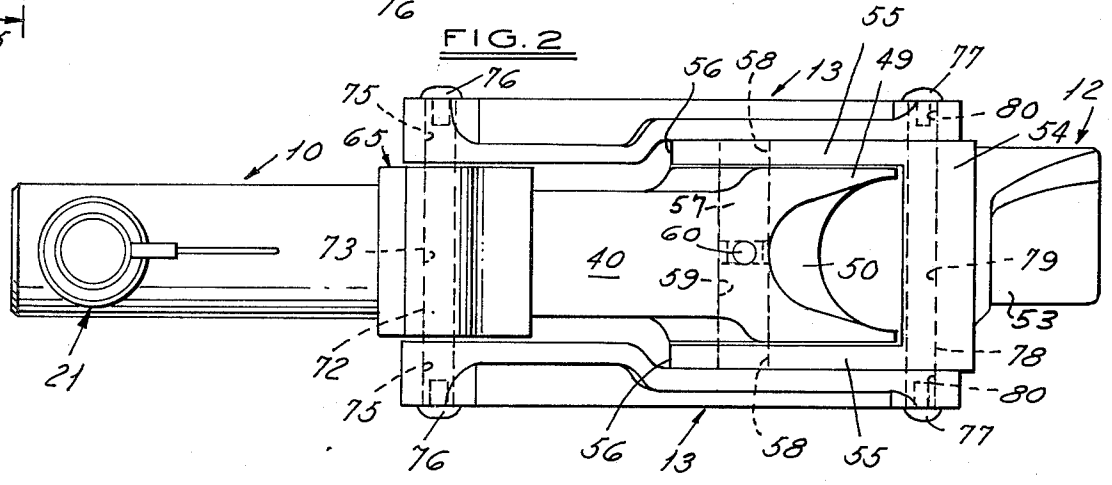


FIG. 3

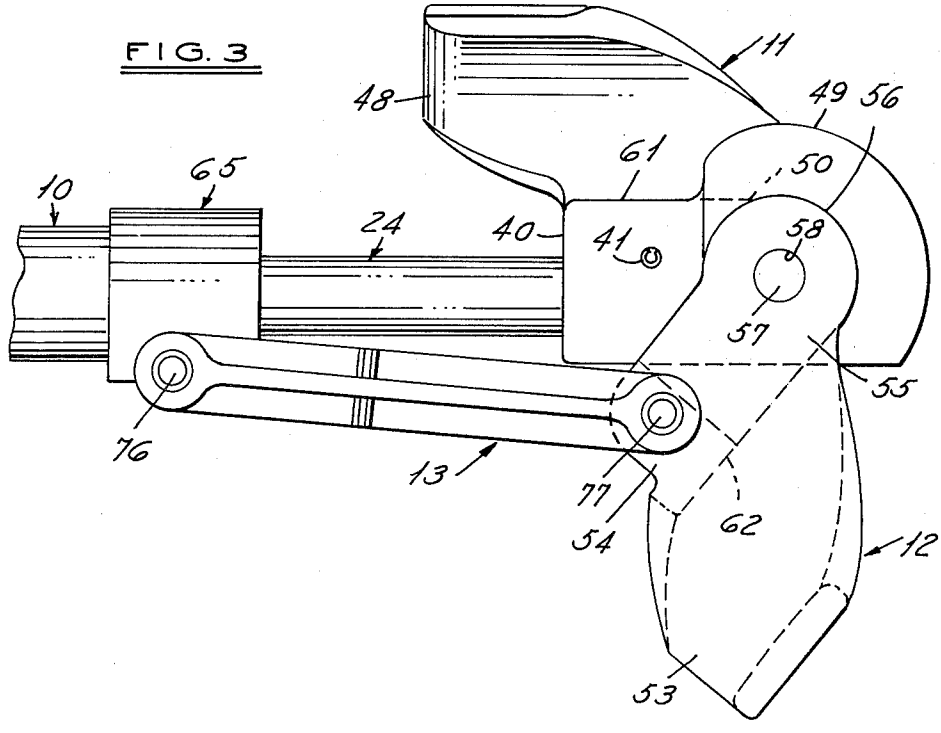


FIG. 4

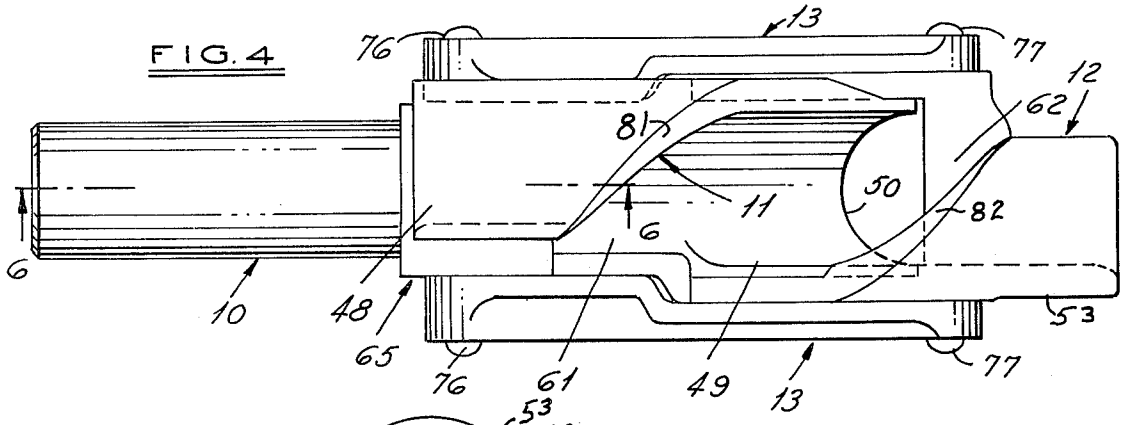


FIG. 5

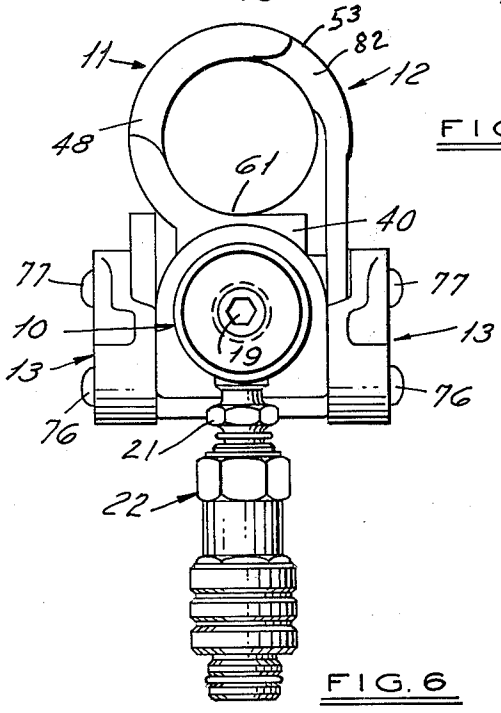
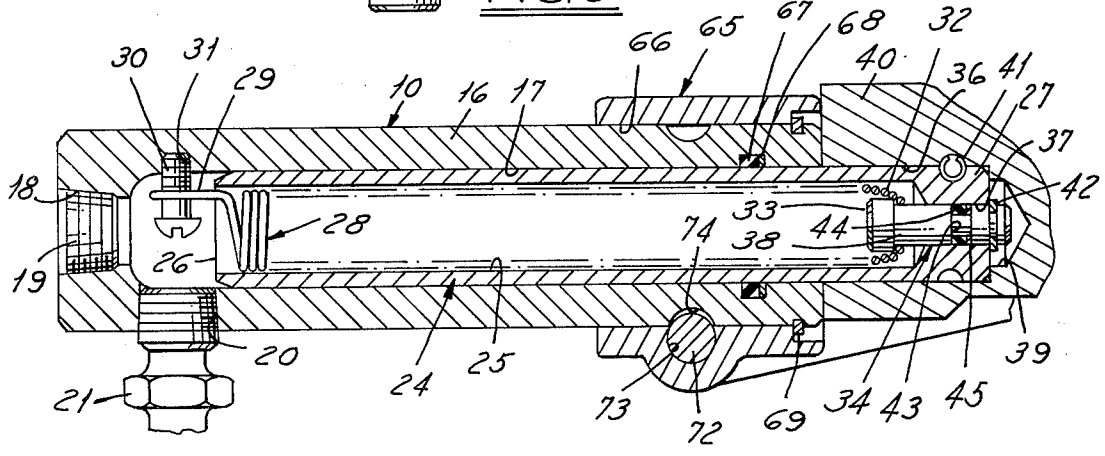


FIG. 6



HYDRAULIC CABLE BENDER

SUMMARY OF THE INVENTION

This invention relates generally to an apparatus for bending elongated members, and more particularly, to a hydraulically actuated bender for bending electrical conductors.

Wire bending apparatuses have been provided heretofore. However, they have had inherent disadvantages, such as the disadvantage of having the strands of a cable spread sidewardly outward during bending of the cable. A further disadvantage of the prior art cable bending apparatuses is that they are complex and costly. Still another disadvantage of the prior art cable bending apparatuses is that they have removable or loose parts or shoes which are subject to being lost or mislaid, and which in use result in increased labor time and costs in operating such apparatuses. An example of such prior art cable bending apparatuses is disclosed in U.S. Pat. No. 3,813,914. Accordingly, it is an important object of the present invention to provide a novel and improved cable bending apparatus which overcomes the aforedescribed disadvantages of the prior art cable bending apparatuses.

It is another object of the present invention to provide a novel and improved cable bending apparatus which is hydraulically operated, and which is simple and compact in construction and economical to manufacture.

It is a further object of the present invention to provide a novel and improved cable bending apparatus which eliminates all removable or loose parts so as to provide a unitary apparatus.

It is still another object of the present invention to provide a novel and improved cable bending apparatus, which includes a hydraulic cylinder having an extendable and retractable ram on which is mounted a drive shoe having a hook-shaped portion for engaging the cable. A rotating shoe having a hook-shaped portion for engaging the cable is pivotally mounted on the drive shoe. A linkage means movably connects the rotating shoe to the hydraulic cylinder, whereby when a cable is mounted between the drive shoe and the rotating shoe and the hydraulic cylinder ram is extended, the drive shoe is driven away from the hydraulic cylinder, and said rotating shoe is pivoted relative to the drive shoe to bend the elongated member. The drive shoe includes an arcuate bending guide around which the cable is bent during a bending operation, and the bending guide serves to prevent spreading of the strands of the cable during the bending operation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a hydraulic cable bender made in accordance with the principles of the present invention, and showing the hydraulic cable bender in a position prior to bending an electrical conductor.

FIG. 2 is a bottom plan view of the hydraulic cable bender structure illustrated in FIG. 1, taken along the line 2—2 of FIG. 1, and looking in the direction of the arrows.

FIG. 3 is a side elevational view of the hydraulic cable bender of the present invention, and showing the hydraulic cable bender in a position after bending an electrical conductor.

FIG. 4 is a top plan view of the hydraulic cable bender structure illustrated in FIG. 1.

FIG. 5 is a left side elevational view of the hydraulic cable bender structure illustrated in FIG. 1, taken along the line 5—5 thereof, and looking in the direction of the arrows.

FIG. 6 is a fragmentary, elevational section view of the hydraulic cable bender structure illustrated in FIG. 4, taken along the line 6—6 thereof, and looking in the direction of the arrows.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and in particular to FIG. 1, the numeral 10 generally designates an actuating means in the form of a hydraulic cylinder. The numeral 11 generally designates a drive shoe, and the numeral 12 generally designates a rotating shoe 12 which is adapted to be rotated relative to the drive shoe 11 by a pair of parallel links 13 and the hydraulic cylinder 10, as described more fully hereinafter.

As shown in FIG. 6, the hydraulic cylinder 10 includes an elongated cylindrical body 16 in which is formed a longitudinally extended cylinder ram or piston chamber 17. The front or right end of the cylinder body 16, as viewed in FIG. 6, is open, and the left end is enclosed by an end wall that has a threaded hole 18 formed therethrough in which is seated a threaded plug 19. As shown in FIG. 6, the cylindrical body 16 is provided with a threaded inlet port 20 that is disposed adjacent the rear or left end of the cylindrical body 16. A nipple fitting 21 is threadably mounted in the inlet port 20. As shown in FIG. 5, a suitable quick disconnect coupler 22 is operatively attached to the nipple 21, and it is adapted to connect the cylinder 10 to a suitable source of hydraulic fluid under pressure, as for example, a hydraulic hand pump or a hydraulic power pump.

The hydraulic cylinder 10 includes a tubular cylinder ram or rod, generally indicated by the numeral 24, and which is mounted in the cylinder ram chamber 17. The cylinder ram 24 is provided with an elongated tubular spring chamber 25 which is open at the rear end 26 of the cylinder rod. The front end of the tubular spring chamber 25 is enclosed by the cylinder ram head end wall 27. An extension spring, generally indicated by the numeral 28, is operatively mounted in the spring chamber 25. The spring 28 functions as a return spring to return the cylinder ram 24 to the initial starting position shown in FIG. 6, as more fully described hereinafter.

One end 29 of the spring 28 is looped around a round head screw 30 that is threadably mounted in a threaded bore 31 that is formed in the cylinder body 16. The other end 32 of the spring 28 is operatively mounted around the head 33 of a spring retaining pin generally indicated by the numeral 34.

The spring retaining pin 34 includes an elongated cylindrical body 38 which is slidably mounted through a bore 37 formed through the cylinder ram head end wall 27. As shown in FIG. 6, the right or closed end of the cylinder ram 24 is operatively mounted in a bore 36 formed in the drive shoe body 40. The spring retainer pin body 38 extends beyond the cylinder ram closed end 27 and into a bore 39 in the drive shoe body 40. The bore 39 is a reduced diameter extension of the bore 36. The cylinder ram 24 is releasably secured in the bore 36 by a suitable roll pin 41. The spring retainer pin 34 is retained in the bore 37 by a suitable retainer ring 42. As shown in FIG. 6, an annular groove 43 is

formed around the periphery of the spring retaining pin body 38 at a position within the bore 37. A suitable O-ring 44 and back-up ring 45 are operatively mounted in the annular groove 43.

As shown in FIGS. 1 and 4, the drive shoe 11 includes a cable engaging hook 48 which is integrally formed on the drive shoe body 40. As shown in FIG. 5, the cable engaging hook 48 extends upwardly from the drive shoe body 40 and is arcuately formed for a radial distance slightly greater than 180°, so as to provide an open side for the removal of a bent cable after a bending operation. The drive shoe 11 further includes an integral cable bending guide 49 which has an arcuate or sheave-like member or seat 50 formed at the front end thereof for cradling and gripping a cable during a bending operation and to form a mandrel that the cable is bent around. The sheave-like member 50 also provides side support during a bending operation and prevents the wire strands in a cable from spreading outward sidewardly. It also contains or seats the cable at the center point of the bend. The numeral 61 in FIGS. 4 and 5 designates an arcuate cable seat on the drive shoe body 40 which joins and is a continuation of the arcuate cable guide seat 50.

As shown in FIGS. 1, 2 and 4, the rotating shoe 12 includes a cable engaging hook 53 which is integrally formed on a yoke member that includes a transverse yoke portion 54 and a pair of longitudinally extended arms 55 which are integral with the transverse yoke portion 54. As seen from FIGS. 1, 2, 4 and 5, the cable engaging hook 53 on the rotating shoe 12 extends upwardly from the transverse yoke portion 54 and is arcuately formed for a radial distance slightly greater than 180° so as to provide an open side for the removal of a bent cable after a bending operation. It will be seen from FIG. 5 that the cable engaging hook 48 on the drive shoe 11 extends upwardly from one side of the bending apparatus and the cable engaging hook 53 on the rotating shoe extends upwardly from the other side of the bending apparatus. As shown in FIG. 2, the longitudinal yoke arms 55 are disposed on the outer sides of the arcuate cable bending guide 49 and they are disposed on opposite end of the drive shoe body 40. The rear ends of each of the longitudinal yoke arms 55 are rounded, as indicated by the numerals 56. The longitudinal yoke arms 55 are pivotally attached to the drive shoe body 40 by a transverse pivot pin 57. As best seen in FIG. 2, the pivot pin 57 is operatively mounted through a transverse bore 59 formed through the drive shoe body 40 and through a bore 58 in each of the longitudinal yoke arms 55. The pivot pin 57 is secured in place by a suitable set screw 60. As shown in FIGS. 1 and 4, an arcuate cable seat 62 is formed on the upper side of the yoke transverse member 54, and it is aligned with the cable seat 61 when the drive shoe 11 and the rotating shoe 12 are in the initial position shown in FIG. 1.

As best seen in FIG. 6, the cylinder 10 has fixedly mounted on the front or right end thereof a cylinder pivot block, generally indicated by the numeral 65. The cylinder pivot block 65 has a longitudinal bore 66 formed therethrough. The front or right end of the cylinder 10 is slidably mounted in the bore 66 and is secured therein by a suitable retainer ring 69. A suitable O-ring seal and back-up ring 67 and 68 are operatively mounted in an annular groove formed in the wall of the cylinder chamber 17 for sealing engagement with the cylinder end 24.

The pair of parallel links 13 provides a linkage means for movably connecting the rotating shoe 12 to the cylinder or actuating means 10. As shown in FIG. 2, a transverse link pin 72 is rotatably mounted through a bore that is formed by a partial bore 73 (FIG. 6) formed through the cylinder pivot block 65, and a partial bore 74 formed through the cylinder body 16 (FIG. 6). As shown in FIG. 2, the ends of the link pin 72 are received in transverse bores 75 formed in the rear ends of the links 13. The rear ends of the links 13 are each secured by a suitable button-head screw 76 to its respective end of the link pin 72. The front ends of the links 13 are each secured by a button-head screw 77 to an outer end of a transverse link pin 78 which is rotatably mounted in a transverse bore 79 formed through the yoke transverse portion 54. The ends of the link pin 78 extend through suitable bores 80 in the front ends of the links 13.

The top view in FIG. 4 of the bending apparatus of the present invention shows that the outer end of the cable engaging hook 48 is formed perpendicular or square to the longitudinal axis of the hook 48, and that the inner end 81 is formed at an acute angle so that it obliquely angles or slants from the open side of the hook 48 transversely toward the closed side of the hook 48 and longitudinally inwardly. It will also be seen from FIG. 4 that the cable engaging hook 53 is formed with an outer end perpendicular or square to the longitudinal axis of the hook 53, and that the inner end 82 thereof is formed at an acute or oblique angle which extends or slants from the open side of the hook 53 transversely toward its closed end and longitudinally inward. The shoes 11 and 12 are mounted on pivot pin 57 with the inner ends 81 and 82 on each of the shoes 11 and 12 respectively facing each other or in opposed relationship thereto. That is, the closed side of hook 11 extends from one side of the bending apparatus, and the closed side of hook 12 extends from the opposite or other side of the bending apparatus.

In use, the cable bending apparatus of the present invention is slipped onto an elongated member to be bent as, for example, a cable, by disposing the bending apparatus of the present invention in a position as viewed in FIG. 4. The elongated member is moved down between the inner ends 81 and 82 of the shoes 11 and 12 respectively and then under the hook engaging members 48 and 53 of the shoes 11 and 12 respectively. The cable is inserted parallel to the inner ends 81 and 82 through the open sides of the hook members 48 and 53, turned against the closed sides of the hooks 11 and 12 to be disposed in axial alignment with the arcuate curved inner surfaces of said hook members and the longitudinal axis of the cylinder 10.

The hydraulic cylinder 10 is then actuated, whereby the cylinder ram 24 is moved forwardly or to the right as viewed in FIGS. 3 and 6, so as to pivot the rotating shoe 12 in a clockwise direction, as viewed in FIG. 3. The elongated member or cable disposed in the bending apparatus is engaged and held by the cable engaging hooks 48 and 53, and continued operation of the hydraulic cylinder 10 moves the rotatable shoe 12 to a desired degree of bend as, for example, in FIG. 3, whereby a bend greater than 90° would have been formed on an elongated member held in the bending apparatus of the present invention.

It will be seen that a cable or other elongated member is bent around the bending guide or sheave-like member 50 which acts as a mandrel and prevents side-

ward spreading of the cable strands during a bending operation. It will be understood that the movement of the cylinder ram **24** outwardly from the cylinder body **16** can be stopped at any point within the length of travel that the ram **24** is capable of making, so as to provide any degree of bend in a cable, between 0° and the maximum bend position shown in FIG. **3** of 120°. The usual bend is about 90°. Small cable, such as aluminum cable, tends to spring back more than copper cable, and accordingly, such cable must be overbent to obtain a 90° bend or whatever other degree of bend is desired. After the desired bend has been made on a cable or other elongated member, the bending apparatus may be twisted sideways so as to move it out through the open sides of the cable engaging hooks **48** and **53**, so as to permit the bending apparatus to be detached from the cable. The bending apparatus may then be returned to the initial position shown in FIG. **1** by releasing the hydraulic pressure on the cylinder **10** to permit the spring **28** to return the shoes **11** and **12** to their initial position shown in FIG. **1**. It will be seen that the present invention provides a hydraulic cable bending apparatus which is unitary in construction so as to eliminate removable or loose parts, such as bending shoes.

While it will be apparent that the preferred embodiment of the invention herein disclosed is well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change.

We claim:

1. In a bending apparatus for bending an elongated member as a cable or the like, the combination comprising:

a. an actuating means having an extendable and retractable ram;

b. a drive shoe body fixedly mounted on said ram for engaging an elongated member, said drive shoe body including:

1. a drive shoe, said drive shoe including a first hook with open and closed sides with an outer end portion perpendicular to the longitudinal axis of said hook and an inner end portion extending transverse to said longitudinal axis slanting longitudinally inwardly from the open side of said hook toward the closed side of said hook;

2. a cable bending guide means on the opposite end of said drive shoe body adapted to provide an arcuate seat for said elongated member;

c. a rotating shoe for engaging an elongated member and being pivotally mounted on said drive shoe body;

1. said rotating shoe including a second hook with open and closed sides with an outer end portion perpendicular to the longitudinal axis of said hook and an inner end portion extending transverse to said longitudinal axis slanting longitudinally inwardly from the open side of said hook toward the closed side of said hook;

d. said rotating shoe being pivotally mounted on a pivot means on said drive shoe with the inner end portion on each of said hooks in opposed relationship to each other;

e. linkage means connecting said rotating shoe to said actuating means;

whereby an elongated member adapted to be mounted within each of said hooks is adapted to be bent around said arcuate bending guide when said actuating means in energized to extend said ram.

2. In a bending apparatus for bending an elongated member, as a cable or the like, the combination comprising:

a. an actuating means having an extendable and retractable ram;

b. a drive shoe means having a first hook with open and closed sides with an outer end portion perpendicular to the longitudinal axis of said hook and an inner end portion extending transverse to said longitudinal axis slanting longitudinally inwardly from the open side of said hook toward the closed side of said hook;

c. a rotating shoe means pivotally mounted on said drive shoe means, and having a second hook with open and closed sides with an outer end portion perpendicular to the longitudinal axis of said hook and an inner end portion extending transverse to said longitudinal axis slanting longitudinally inwardly from the open side of said hook toward the closed side of said hook;

d. said inner end portions on each of said hooks pivotally mounted in opposed relationship to each other; and

e. linkage means connecting said rotating shoe means to said actuating means.

3. In a bending apparatus for bending an elongated member as a cable or the like, the combination comprising:

a. an actuating means having an extendable and retractable ram;

b. a drive shoe body fixedly mounted on said ram for engaging an elongated member, said drive shoe body including:

1. a drive shoe, said drive shoe including a first hook with open and closed sides with an outer end portion perpendicular to the longitudinal axis of said hook and an inner end portion extending transverse to said longitudinal axis slanting longitudinally inwardly from the open side of said hook toward the closed side of said hook, and wherein the closed side of said first hook extends from one side of said bending apparatus;

2. a cable bending guide means on the opposite end of said drive shoe body adapted to provide an arcuate seat for said elongated member;

c. a rotating shoe for engaging an elongated member and being pivotally mounted on said drive shoe body;

1. said rotating shoe including a second hook with open and closed sides with an outen end portion perpendicular to the longitudinal axis of said hook and an inner end portion extending transverse to said longitudinal axis slanting longitudinally inwardly from the open side of said hook toward the closed side of said hook, and wherein the closed side of said second hook extends from the other side of said bending apparatus;

d. said rotating shoe being pivotally mounted on a pivot means on said drive shoe with the inner end portion on each of said hooks in opposed relationship to each other;

e. linkage means connecting said rotating shoe to said actuating means;

whereby an elongated member adapted to be mounted within each of said hooks is adapted to be bent around said arcuate bending guide when said actuating means in energized to extend said ram.

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