An electric driven portable conduit bender provided with a bending shoe assembly which is rotatably mounted on a vertical axis on the upper end of the bender housing. The bending shoe assembly is provided with a pair of grooved bending shoes which are diametrically disposed, and which are each provided with a different size hook for grasping a conduit and holding it against the bending shoe during a bending operation. A pair of polyurethane support rollers are adjustably mounted on the upper end of the bender housing on a single axis. A conduit to be bent is disposed on a support means on the upper end of the bender housing against the two support rollers and it is grasped by one of the bending hooks. A dynamically braked permanent magnet motor is employed to rotate the bending shoe assembly through a bending cycle and then through a reversed unload cycle during which the hook, which is provided with a cammed surface, rides up over and on top of the bent conduit to permit the bent conduit to be quickly and easily removed from the bending apparatus. An external dial indicator is provided for adjusting an internal adjustable cam means for controlling the degree of bend to be imparted on a conduit.

16 Claims, 14 Drawing Figures
PORTABLE ELECTRIC DRIVEN CONDUIT BENDER

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates generally to the art of bending pipe, conduits, and the like, and more particularly, to a portable electrically driven bending machine for bending pipe, conduit and the like to a preselected angle.

Heretofore, portable conduit bending machines have been provided but they have the disadvantage of being cumbersome and slow in operation, and being adapted for bending conduits that do not require large bending forces. A further disadvantage of the prior art conduit bending machines is that they are not capable of providing identical bends in a plurality of conduits. Another disadvantage of such prior art conduit bending machines is that they do not have any means for automatically preselecting the angle of bend which is to be imparted to a conduit, nor are they provided with conduit support means for supporting a conduit in such a manner that kinking of the conduit is prevented and automatic alignment of offsets may be carried out to eliminate guess work. In view of the foregoing, it is an important object of the present invention to provide a novel and improved portable electrically driven conduit bender which overcomes the aforementioned disadvantages of the prior art conduit bending machines.

The conduit bender of the present invention is portable, and it is compact and light in weight, yet it is capable of bending both rigid conduits and thin wall conduits in a fast, efficient and consistent manner. The portable conduit bender is electrically driven by a permanent magnet motor which is controlled by circuit means that permits the motor to be instantly stopped at the end of a bend cycle, and at the end of an unload cycle. The conduit bender of the present invention further includes a means for dialing the desired bend, from an exteriorly positioned dial indicator, and wherein a plurality of conduits can be bent consistently to the preset degree of bend. The operator after setting the desired bend, merely has to mount a conduit in operative position on the bender, press a bend button switch and the bend is automatically made. The pressing of a second or unload button switch then activates the bender so as to automatically eject the conduit. An outrigger structure is provided for adjusting the table unit on one side of the bender housing, and an adjustable table unit on the other side of the housing, so as to permit automatic alignment of offsets, and to eliminate guess-work in bending such offsets.

The conduit bender of the present invention includes a housing, on the upper end of which is rotatably mounted a bending shoe assembly having a pair of bending shoes, with each shoe being provided with a conduit bending hook. A pair of polyurethane conduit support rollers are pivotally mounted on a single pivot axis adjacent the bending shoe assembly for supporting a conduit in a tangential position relative to the bending shoe assembly to prevent kinking of the conduit during a bending operation. The conduit support rollers are adjustable as a unit to different positions on the housing to provide for roller support for different sizes of conduits. Each of the hooks is provided on the lower side thereof with a cam surface for automatically ejecting a bent conduit after the bending cycle.

It is another object of the present invention to provide a conduit bender which is operated by dialing the degree of bend required and pushing a bend button switch, whereby the bend maker makes the required bend, ejects the conduit automatically and then it is ready for the next bend.

OTHER OBJECTS, FEATURES AND ADVANTAGES OF THE INVENTION

Other objects, features and advantages of this invention will be apparent from the following detailed description, appended claims, and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational perspective view of a portable electric-driven conduit bender made in accordance with the principles of the present invention.

FIG. 2 is a front elevational view of the conduit bender shown in FIG. 1.

FIG. 3 is a top plan view of the conduit bender illustrated in FIG. 2, taken along the line 3—3 thereof, and looking in the direction of the arrows.

FIG. 4 is a slightly enlarged, left side elevational view of the conduit bender illustrated in FIG. 3, taken along the line 4—4 thereof, and looking in the direction of the arrows.

FIG. 5 is an enlarged, fragmentary, elevational view, partly in section, of the structure illustrated in FIG. 4, taken along the line 5—5 thereof, and looking in the direction of the arrows.

FIG. 6 is a fragmentary, enlarged, elevational view of the structure illustrated in FIG. 3, taken along the line 6—6 thereof, and looking in the direction of the arrows.

FIG. 7 is a fragmentary, elevational section view of the structure illustrated in FIG. 6, taken along the line 7—7 thereof, and looking in the direction of the arrows.

FIG. 8 is an enlarged, top plan view of the bending shoe assembly employed in the conduit bender of FIG. 3.

FIG. 9 is a fragmentary, enlarged, side elevational view of the bending shoe assembly of FIG. 3 and showing a first hook for use when bending a first size conduit.

FIG. 10 is an elevational section view of the first hook structure illustrated in FIG. 9, taken along the line 10—10 thereof, and looking in the direction of the arrows.

FIG. 11 is a fragmentary, left side elevational view of the hook structure illustrated in FIG. 10, taken along the line 11—11 thereof, and looking in the direction of the arrows.

FIG. 12 is a fragmentary, enlarged, side elevational view of a second hook employed with the bending shoe assembly of FIG. 8, and for use in bending a larger size conduit.

FIG. 13 is a schematic diagram of a suitable electric control circuit employed in the invention.

FIG. 14 is a schematic view of the switches employed in the control circuit of FIG. 13, and located in the vicinity of the switch mounting plate carried on the front side of the conduit bender.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and in particular to FIGS. 1, 2 and 4, the numeral 10 generally designates a housing or base frame unit. The housing 10 includes a vertical front wall 11, a vertical rear wall 12, a vertical
left sidewall 13, and a vertical right sidewall 14. The housing walls 11 through 14 are preferably made from a suitable gauge sheet metal, and they are fixedly secured together by any suitable means, as by welding. As best seen in FIG. 1, a rectangular opening 17 is formed through the housing front wall 11 for access into a storage box or compartment formed by the right sidewall 14, the rear wall 12, a partial bottom wall 18, and an intermediate vertical wall 19. The bottom wall 18 and intermediate wall 19 are connected in any suitable manner to each other and to the housing walls, as by welding. As shown in FIG. 2, the storage compartment is enclosed along the top side thereof by a top wall 20 which is fixedly secured to the housing front and rear walls 11 and 12, and rear side wall 14 by any suitable means, as by welding. The storage compartment walls 18, 19 and 20 are made from the same material as the housing walls 11 through 14.

As shown in FIGS. 1 and 4, the housing 10 is provided on the lower right front corner and on the lower left rear corner with a ground-engaging leg pad 21 which is fixedly secured to the housing 10 by any suitable means, as by welding. As illustrated in FIGS. 1, 3 and 4, the left side of the housing 10 is rollably supported by a pair of suitable wheels 22. As illustrated in FIGS. 1 and 4, a tubular support axle 23 is mounted transversely at the lower left side of the housing 10 and it extends through the front and rear walls 11 and 12 and is fixedly secured to said walls, as by welding. A wheel axle 24 is rotatably mounted in the tubular support axle 23, as shown in FIG. 4. The axle 24 extends outwardly beyond the front and rear housing walls 11 and 12 and has mounted thereon the wheels 22. Each of the wheels 22 is releasably retained on the axle 24 by a suitable washer 25 and a cotter key 26.

As shown in FIG. 3, the housing 10 is provided with an upper support frame that includes a pair of laterally, spaced apart, longitudinally extended front and rear angle bars 29 and 30, respectively, and three transverse angle bars 31, 32 and 33. As shown in FIGS. 1 and 2, the support frame front angle bar 29 is secured to the housing front wall 11 by a pair of suitable machine screws 34. As shown in FIG. 3, the support frame rear angle bar 30 is secured to the housing rear wall 12 by a pair of suitable machine screws 35. As shown in FIGS. 1, 2 and 3, a transverse support bracket 41 is integrally formed at each end of the top cover plate 38. Each of the support brackets 41 includes an attachment arm 42 in the form of a transverse plate member which is integrally connected to the outer adjacent end of the top cover plate 38 and which extends longitudinally outward and upward from the top cover plate 38. Integrrally attached to the outer end of each of the transverse brackets 42 is a transverse, horizontal support arm 43 which has its upper surface disposed parallel to the upper surface of the top support plate 38, in a position elevated thereabove. The upper surfaces of the support arms 43 are engaged by the conduit that is processed on the conduit bender of the present invention, as more fully explained hereinafter. An integral, downwardly extended flange 44 is formed along the outer edge of each of the support arms 43.

As shown in FIGS. 2, 3 and 4, a pair of tubular mounting members, in the form of pipes 47 and 48, are fixedly secured in the upper end of the housing 10 by any suitable means, as by welding. The tubular mounting members 47 and 48 are laterally spaced apart along the front and rear walls 11 and 12, and in positions spaced downwardly equally from the top plate 38. A pair of longitudinally disposed support pipes 49 and 50 are slidably mounted in the tubular mounting members 47 and 48, respectively. The support pipe 49 is releasably secured in place in the tubular mounting member 47 by a suitable wing-head screw 51. A similar wing-head screw 52 releasably secures the support pipe 50 in the tubular mounting member 48. It will be understood that the support pipes 49 and 50 may also be used as handles for moving the conduit bender from one position to another.

As best seen in FIGS. 1, 2 and 3, a pipe support unit generally indicated by the numeral 53, is adjustably mounted on the right ends of the support pipes 49 and 50, in a position spaced from the right side of the housing 10. As shown in FIG. 1, the pipe support unit 53 includes an inverted base bracket that includes a transverse, horizontal arm 54 and a pair of integral, downwardly extended vertical legs 55. Integraliy attached to the lower end of each of the legs 55 is a horizontal, outwardly extended flange 56 which is secured by a C-shaped retainer bolt 57 and a suitable wing-nut 58 to one of the support pipes 49 and 50. The pipe support unit 53 further includes a transverse support bracket 59 which is provided at each end with an integral, upwardly extended vertical shoulder 60. The support bar 59 is fixedly secured to the transverse bracket arm 54 by any suitable means, as by welding. The upper surface of the support bar 59 is disposed on the same horizontal level, and is parallel to, the upper surfaces of the support arm 43 and the upper surface of the support table 72.

As shown in FIGS. 1 through 4, a support table unit, generally indicated by the numeral 61, is adjustably mounted on the left side of the housing 10, on the pair of support pipes 49 and 50. The support table unit 61 includes a transverse clamp 62 which has its outer ends slidably supported on the upper sides of the support pipes 49 and 50. As best seen in FIG. 4, a pair of C-shaped retainer bolts 63 are provided for securing one of the ends of the clamp bar 62 to the support pipe 49 and the other end to the support pipe 50. Each of the C-shaped retainer bolts 63 has a lower curved end mounted around the bottom of the respective support pipe 49 or 50, and a threaded, vertically disposed upper end.

A table support frame bracket, generally indicated by the numeral 66, is retained on the threaded ends of the retainer bolts 63. As shown in FIG. 4, the table support frame bracket 66 includes a transverse portion 67 to each of the ends of which is integrally attached a vertical and downwardly extended arm 68. An integral and outwardly extended horizontal flange 69 is formed on the lower end of each of the table support frame bracket arms 68, and it is provided with a threaded hole for the reception of the integral threaded upper end 71 of a knurled retainer nut 64. Each of the knurled retainer nuts 64 is provided with a cylindrical, lower, integral end 65 which is seated on the upper face of one
of the ends of the clamp bar 62. The threaded upper end of each of the C-shaped retainer bolts 63 is extended upwardly through a suitable bore formed through the adjacent knurled retainer nut 64 and it terminates at a point above the upper threaded end 71 of the retainer nut 64. A wing nut 70 is threadably mounted on the threaded upper end of each of the retainer bolts 63. As shown in FIGS. 1 through 4, a rectangular flat support table 72 is fixedly secured to the upper side of the support bracket 60 by any suitable means, as by welding. It will be seen that the rectangular flat table 72 may be adjusted upwardly or downwardly by rotating the knurled nuts 64 in the desired direction. The rotation of the knurled nuts 64 moves the support bracket ends 69 upwardly and downwardly on the upper threaded ends 71 of the knurled retainer nuts 64. The wing nuts 70 function as a locking means for locking the flat support table 72 in an adjusted position.

As shown in FIG. 1, the conduit bender of the present invention is provided with a rotatably mounted bending shoe assembly, generally indicated by the numeral 75, and a pivotally mounted roller support unit, generally indicated by the numeral 76. As best seen in FIG. 5, the roller support unit 76 comprises a pair of spaced apart rollers 77 which are rotatably mounted on a pair of spaced apart vertical shafts 78. Each of the rollers 77 is operatively mounted on a suitable bearing means 79 by a pair of retainer rings 83 and 84 for rotatably mounting each roller 77 on the upper end of its respective shaft 78. The lower end of each shaft 78 is slidably mounted in a vertical bore 80 formed on one end of a horizontally disposed roller pivot block 81. Each shaft 78 is releasably secured in its respective bore 80 by any suitable means, as by a roll pin 82. Each roller 77 is retained on its respective shaft 78 by a suitable roll pin 85.

As best seen in FIG. 5, the roller pivot block 81 is provided with a vertically disposed bore 88 which is centrally disposed between the two vertical bores 80 and which is open on the lower end for the reception of the upper end of a pivot shaft 89. The pivot shaft 89 is releasably secured in the bore 88 by a suitable roll pin 90. The lower end of the pivot shaft 89 is shown as being rotatably mounted in a vertical bore 91 formed in a horizontally disposed roller support block 92. It will be seen that the pivot block 81 is seated on the upper face of a suitable fiber washer 86 that is preferably adhered to the pivot block 81 by a suitable adhesive, as an epoxy adhesive. The pivot block 81 is free to pivot about the vertical axis of the shaft 89 in accordance with any unbalanced lateral pressure impressed on the rollers 77 by a conduit 98 that is being bent.

As shown in FIG. 5, the roller support block 92 is supported on the two transverse angle bars 32 and 33, and it is fixedly secured to these bars by any suitable means, as by welding. As shown in FIG. 3, the roller support block 92 is rectangular in plan view, and it is provided with a plurality of roller pivot shaft support bores 91, 93, 94, 95, 96 and 97 to permit the adjustment or positioning of the roller support unit 76 to various positions on the top plate 36, in accordance with the type and size conduit which is to be bent. The portable conduit bender of the present invention is particularly adapted for bending rigid electrical conduits and pipes, such as bell (E.M.T.) conduits and E.M.T. conduits. The roller support unit pivot shaft 89 would be mounted in the following named bores for the following named type conduits: bore 91—1 inch rigid and E.M.T. conduits; bore 93—⅛ inch rigid and E.M.T. conduits; bore 94—⅜ inch rigid conduit; bore 95—¼ inch E.M.T. conduit; bore 96—⅛ inch rigid and E.M.T. conduits; and bore 97—⅛ inch E.M.T. conduit.

Each of the support rollers 77 is made from polyurethane, and the outer surfaces or faces are of a flat circular diameter. In one embodiment which handled conduits of ½ inch through 1¼ inch E.M.T. conduit and ¼ inch through 1 inch rigid conduit, the diameter of the rollers 77 was ⅞ inch and the center lines of their shafts 78 were disposed 3 inches apart. It is thus seen that the rollers 77 may be of one size that may be used for bending many sizes of E.M.T. and rigid conduits. Heretofore, the prior art bending apparatus employed a follower bar to maintain the conduit rigid and to prevent kinks. Furthermore, the support rollers were formed with an outer diametrical size to fit the diameter of the E.M.T. conduit or rigid conduit being bent. Such special type rollers are not required in the conduit bender of the present invention. The structural arrangement of the roller support unit 76 is such that the unit is adapted to freely rotate about a single axis to allow a cushioning effect on the conduit being bent. The single pivot structure for the roller support unit 76 and the polyurethane structure of the rollers 77 provide a two-point cushioning contact with the conduit being bent.

As best seen in FIGS. 1 and 3, the bending shoe assembly 75 is releasably and operatively mounted on a rotatable drive plate 101 which rests on top of the top plate 36. As shown in FIGS. 2 and 3, the drive plate 101 is provided with a pair of upwardly extended, perpendicular, diametrically disposed drive pins 102 which have their lower ends fixedly mounted in the drive plate 101 by any suitable means, as by a press fit. The drive plate 101 has fixed thereto a concentrically mounted tubular drive shaft 103 which extends upwardly from the drive plate 101 and downwardly through a suitable opening in the top plate 36. The drive shaft 103 is releasably secured to the output shaft 104 of a suitable secondary gear reducer 105. As best seen in FIGS. 2 and 3, the gear reducer 105 has fixedly mounted on the upper side thereof a horizontal mounting plate 106 which is secured to the lower face of the two transverse angle bars 31 and 32 by any suitable means, as by a plurality of suitable machine screw and nut assemblies 107. The drive pins 102 are disposed parallel to the drive shaft 103.

As shown in FIG. 4, the secondary gear reducer 105 is operatively connected to and driven by a suitable primary gear reducer generally indicated by the numeral 110. The primary gear reducer 110 is operatively connected to and driven by a suitable permanent magnet electric drive motor, generally indicated by the numeral 111. In FIG. 4, the numeral 112 generally indicates a control box for the electrical control circuit for the motor 111. The numeral 113 designates a two-conductor electrical cable that contains the lead wires connecting the control means in the control box 112 to the permanent magnet motor 111. The numeral 114 designates a three-conductor electrical cable for connecting the control circuit in the control box 112 to a suitable 120 volts, 60 Hertz source of power through the grounded power plug 115. As shown in FIG. 4, the lower end of the conduit is operatively connected to the conduit indicated by the numeral 116 so as to provide access to the control box 112. As shown in FIGS. 2 and 4, the
control box 112 is provided with an attachment flange 117 on the lower end thereof and on the upper end thereof for securing the control box to the intermediate housing wall 19 by a plurality of machine screw and nut assemblies 118.

As best seen in FIG. 8, the bending shoe assembly 75 comprises a wheel or rotor member which has two arcuate bending shoes 119 and 120 that are integrally attached to a central hub 123. The bending shoes 119 and 120 are diametrical opposite disposed and they are each provided with a circumferential arcuate recess as 121 and 122, respectively, which extends for an arcuate distance of about 120°. The recesses 121 and 122 are formed concave inwardly around the periphery of each shoe, as shown in FIG. 9. Each of the bending shoes 119 and 120 is provided with a bore 124 and 125, respectively, for the reception of the drive pins 102.

The drive pin bores 124 and 125 are oppositely disposed, on a common diameter line, and they are offset about 17° from a diameter line which is parallel to the longitudinal axis of the conduit engaging hooks 133 and 133a. The central hub 123 is provided with a suitable bore 126 in which is slidably received the drive shaft 103.

As shown in FIG. 8, each of the bending shoes 119 and 120 is provided with a pivoting mounted hook 133 and 133a for operative engagement with the conduit 98 to be bent during the bending operation. As shown in FIGS. 8 and 9, the bending shoe 119 is provided with a hook bearing face 128 which is disposed so as to be perpendicular to a conduit 98 before the initiation of the bending operation, as illustrated in FIG. 3. As shown in FIG. 8, the conduit hook 133 is pivotally mounted against the bearing face 128 by a pivot pin 129 which is disposed perpendicular to the bearing face 128. The pivot pin 129 has the inner end mounted in a bore 127 in the bending shoe 119, and the outer end is operatively mounted in a bore 131 that is formed through the mounting journal 132 of the bending shoe 133. The pivot pin 129 is secured in place against axial movement by a pair of suitable retainer rings 130.

As best seen in FIG. 9, the conduit hook 133 is provided with an arm 134 which is integrally attached at its inner end to the hub 132. An arcuate conduit engaging front end 135 is integrally attached to the outer end of the hook arm 134. It will be understood that the hook 133 is pivotally mounted on the outer end of the pivot pin 129, and that the hook 133 is provided with a stop shoulder 136 on the upper side thereof to limit counterclockwise rotation of the hook 133, as viewed in FIG. 9.

It will be seen that the stop shoulder 136, as viewed in FIG. 9, acts as a stop in clockwise rotation and that it would engage the upper inner portion of the shoe 119 and prevent complete rotation of the hook. It will be seen from FIG. 9 that the arcuate conduit engaging front end 135 is provided on its inner face with a concave surface 139 that combines with the concave surface 121 on the shoe 119 to form a substantially circular conduit enclosure.

As illustrated in FIG. 10, the lower end of the hook arcuate front end 135 is formed with a relieved arcuate end face portion 137 so that the left front corner, as viewed in FIG. 8, is removed. As viewed in FIG. 8, the bending shoe assembly 75 would rotate in a clockwise direction during the bending operation and then be reversed and rotated in a counterclockwise direction to release the hook 133 to grip a conduit 98. The trailing corner 137 of the arcuate front end portion 135 relieved or removed, the hook 133 during the reversal operation of the shoe assembly 75 will ride up on the conduit portion engaged by the hook 133 and be cammed upwardly into a released position so that the bent conduit 98 may be quickly and easily removed. In effect, the bent conduit 98 is ejected from the hook 133 to permit removal of the bent conduit and the insertion of the next conduit that is to be bent. The arcuate end face 137 on the hook front end 135 thus acts as a first cam portion or cam face for causing the hook 133 to ride up and over the conduit and thus be moved upwardly to a released position. The cam face 137 is angled upwardly from the plane of rotation of the shoe assembly 75 at an angle of about 50°.

It will be seen from an inspection of FIGS. 10 and 11 that the surface of the cam face 137 also is slightly curved downwardly and outwardly in a convex manner. As shown in FIG. 10, the curved cam surface 137 terminates at its lower end in a second tapered cam surface 138 on the extreme lower end of the hook end portion 135. The cam face portion 138 is also tapered upwardly from the plane of rotation, approximately at a 5° angle.

The conduit hook 133a is shown in side elevational view in FIG. 12, and parts of the hook 133a which are the same as the parts of the hook 133 are marked with the same reference numerals followed by the small letter a. The hook 133a is identical to the hook 133 in structure and function and the only difference is in size. As shown in FIG. 8, the bending shoe assembly 75 is mounted on the drive pins 102 to permit use of the bending hook 133a for bending a large diameter conduit. If it is desired to bend a smaller size conduit and it falls within the limits of conduits that can be handled by the hook 133 then the bending shoe assembly 75 is removed by being lifted upwardly and turned 180° again slidably mounted downwardly onto the drive pin 102.

FIG. 3 shows the bending shoe assembly 75 in an initial or starting position for bending the end of the conduit 98. The bending hook 133a is shown as being in engagement with the end of the conduit 98 which is to be bent. If the conduit bender is programmed for a bend 90°, then upon initiation of the drive motor 111 the bending shoe assembly 75 will be moved to move the hook 133a to the broken line position designated by the numeral 142. Upon actuating the conduit bender for an unloading operation, the bending shoe assembly 75 is rotated in a reverse or counterclockwise direction so as to return the bending hook 133a to its initial solid line position shown in FIG. 3. During the reverse movement of the bending shoe assembly 75, the bending hook 133a would be cammed upwardly by action of the cam faces 137 and 138 riding on the bent portion of the conduit 98 so as to cam the hook 133a to a raised position to permit ejection or removal of the bent conduit 98. After the bent conduit 98 has been removed, the hook 133a falls downwardly by gravity to the starting position and is ready for insertion of the next conduit 98 to be bent in a succeeding operation.

It will be seen from FIG. 3 that when the bending shoe assembly 75 is rotated in a clockwise direction, the bending operation of the conduit is gripped against the respective bending shoe 119 or 120 and it is pulled around one of the bending shoe assemblies during the bending operation and the conduit 95 is rolled on the roller 77 and is provided with the aforesaid cushioning effect provided by the support unit 76. The
shoulders 60 on the pipe support unit 53 prevent the conduit 98 from being kicked out of the conduit support unit during bending and unloading operations.

FIGS. 6 and 7 illustrate the adjustable degree of bend indicator for setting the conduit bender for a particular desired angle of bend. The adjustable bend angle indicator is mechanically operated off the primary gear reducer 110 and it in turn operates suitable control limit switches for initiating and terminating a bend operation. As shown in FIG. 7, the primary gear reducer 110 is provided with an output shaft 143 on which is fixed a spur type gear 114 by a suitable set screw 145. Coupler member 144 is releasably secured by a set screw 147 to the input shaft 146 of a gear reducer, generally indicated by the numeral 148. The gear reducer 148 is constructed so as to provide a one-to-one ratio of rotation between the bending shoe assembly 75 and the output shaft 153 (FIG. 6) of the gear reducer 148. The gear reducer 148 is supported by the input shaft 146 and the output shaft 153.

As shown in FIG. 6, the gear reducer output shaft 153 is slidably mounted within the enlarged rear sleeve end 154 of a cam shaft, generally indicated by the numeral 155. The cam shaft sleeve end 154 is releasably secured to the gear reducer output shaft 153 by a suitable set screw 156. The front portion of the cam shaft 155 is made to a reduced diameter, as indicated by the numeral 157 and the front end thereof is threaded, as indicated by the numeral 158. The cam shaft reduced diameter portion 157 extends outwardly through the housing front wall 11, a gasket 159, a switch mounting plate 160 and a dial indicator 164. As shown in FIGS. 2 and 6, the switch mounting plate 160 is secured to the housing front wall 11 by a plurality of suitable machine screws 161. A hand operated knob 165 is-threadably mounted on the shaft threaded outer end 158, for reasons described in detail hereinafter.

As best seen in FIG. 6, the lower U-shaped end 166 of a switch mounting bracket is swingably mounted on the shaft 155 against the enlarged portion 154, and it is retained in axial position by a suitable retainer ring 167. The upper end 168 of the switch mounting bracket carries a pair of limit switches 169 and 171 in side-by-side disposition. The limit switches 169 and 171 are releasably secured to the upper end 168 of the switch mounting bracket by a pair of suitable machine screws 173, as shown in FIG. 7. The limit switches 169 and 171 are provided with roller type switch operators 170 and 172, respectively. The limit switch 169 functions as a shut-off switch for terminating the unloading cycle. The limit switch 171 functions to limit or control the bending cycle.

The lower end 166 of the switch mounting bracket is swingably mounted on the shaft 155 and may be adjustable thereabout for adjusting the positions of the limit switches 169 and 171. As shown in FIGS. 6 and 7, an adjusting pivot block 177 is provided with a pivot shaft 178 which is operatively mounted through a suitable aperture in the upper end 168 of the switch mounting bracket. Threadably mounted through the pivot block 177 is an elongated adjusting screw 179. As shown in FIG. 7, the outer end of the adjusting screw 179 extends through the housing right side wall 14, and it is provided with a threaded end 180 that is slotted for the reception of a screwdriver for rotating the adjustable shaft 179. It will be understood that when the shaft 179 is rotated in the appropriate direction, the block 177 will be moved to the right or to the left, as viewed in FIG. 7, for adjusting the positions of the limit switches 169 and 171. It will be understood that the adjusting screw 179 is rotatably mounted through the housing side wall 14 so as to retain it in axial position and against axial movement when it is rotated for adjusting the block 177. A suitable lock nut 181 is provided for locking the adjusting screw 179 in a desired adjusted position. The last described adjustment is used only when the bender is initially assembled, or when the bender is repaired, for the purpose of timing the start of a bend cycle.

As shown in FIGS. 6 and 7, an elongated cam arm 185 is fixedly mounted by any suitable means, as by a roll pin, on the front end of the enlarged portion of the cam shaft 155. As viewed in FIGS. 6 and 7, a suitable shaft 186 is operatively mounted on the upper end of the cam arm 185 and it fixedly supports a non-rotatable round type cam 187 that is adapted to engage the roller switch operator 170 on the shut-off limit switch 169 when the cam arm 185 is in the position shown in FIGS. 6 and 7. A suitable shaft 188 is operatively mounted on the lower end of the cam arm 185 and it fixedly supports a non-rotatable round type cam 189 which is adapted to function as an emergency shut-off cam for operating the roller switch operator 172 on the bending cycle cut-off limit switch 171.

As shown in FIG. 6, an elongated sleeve cam shaft 192 is rotatably mounted about the reduced outer end shaft portion 157 of the shaft 155. The outer end of the sleeve shaft 192 extends outwardly through the housing wall 11 and through the dial indicator 164 and into an annular projection 190 on the front face of the dial indicator 164 where it is fixed to the dial indicator by a suitable retainer screw 193.

As shown in FIGS. 6 and 7, an adjustable cam arm 194 has its upper end fixedly secured, as by welding, to the inner end of the sleeve shaft 192. A suitable shaft 196 is operatively mounted on the lower end of the cam arm 194 and it fixedly supports a non-rotatable round type cam 195 which is adapted to function as a shut-off cam for operating the limit switch 171 at the end of a bending cycle of a predetermined degree.

FIG. 13 is a schematic diagram of an illustrative electric control circuit for controlling the operation of the conduit bender of the present invention. However, it will be understood that other suitable control circuits may be employed. The numeral 115 designates a grounded power plug. The plug 115 is operatively connected to the three-conductor cable 114, as shown in FIG. 4, and which includes two conductors 202 and 203 and the ground lead wire 204 (FIG. 13). The conductor 202 includes a conventional fuse 205. The AC power is converted by a suitable rectifier 209 into a DC current for energizing the permanent magnet motor 111, as more fully described hereinafter.

As shown in FIG. 1, there are three control button switches mounted on the switch mounting plate 160 and they include the bend button switch 199, the unload button switch 200, and the emergency stop button switch 201.

In use, the conduit bender of the present invention would be moved adjacent to the area where the bent conduits are to be employed so that the conduits may be bent at the job site. The conduit 98 being bent is disposed on the pipe or conduit support unit 53, and across the two support bracket arms 43 and the support table 72 if the conduit 98 is of a length that it would extend over the last named structural units and is have
a bend made in the conduit at an intermediate point between the ends thereof. Assuming that the conduit 98 to be bent is of a size which would require the use of the hook 133a, then the bending shoe assembly 75 would be positioned on the drive shaft 103 in the position shown in FIG. 3, with the hook 133a overlapping and engaging the conduit 98. The operator would then release the hand knob 165 by rotating it clockwise, as viewed in FIG. 2 to permit setting of the bending dial indicator 164. The dial indicator 164 is shown in FIG. 2 in an initial position before setting the degree of bend.

In order to provide a 90° bend in the conduit 98, the dial indicator 164 would be manually turned counterclockwise to the appropriate degree indicated on the face of the dial, namely, a 90° position. With the knob 165 in the aforesaid released position, the dial indicator sleeve shaft 192 is free to rotate about the cam shaft 157 so that the adjustable cam arm 194 may be moved relative to the cam arm 185 to bring the round cam 195 into the desired position to operate the limit switch 169 to shut the machine off at the end of the desired bending cycle. After the dial indicator 164 has been set to the desired degree position, the hand knob 165 is rotated in the clockwise direction, as viewed in FIG. 2, to bring the inner reduced diameter portion 162 against the projection 190 on the dial indicator 164, and this action provides a friction lock between the adjustable sleeve shaft 192 and the cam shaft 157. It will be understood that the position degree indicia marked on the face of the dial indicator 164 are disposed in calibrated positions so as to correspond to an adjustment position of the adjustable round cam 195 and the arcuate degrees of travel which it traverses when it moves from an adjusted position counterclockwise (as viewed in FIG. 7) up to the point where it contacts the limit switch operator 172 for opening the normally closed limit switch 171.

The aforesaid method of mounting the conduit 98 on the conduit bender support structure and against the roller support unit 76, the setting of the degree indicator 164, and the locking of the indicator 164 to the adjustable cam means puts the conduit bender into condition for the initiation of the bending cycle. The operator then presses the bend push switch 199 for initiating the desired 90° bending cycle. As shown in FIG. 13, the bending switch 199 is operatively connected in a circuit between the conductors 202 and 203, which includes the emergency stop button switch 201, the normally closed limit switch 171, the normally closed contact 231 of the unload contactor 237, and the bend contactor 232.

The pressing of the bend button switch 199 energizes the bend contactor 232 through the last mentioned circuit, thereby operating the bend contactor contacts. The normally open bend contact 235 is closed and forms a parallel circuit with the lead wires 233 and 234 across the bend switch 199. The normally closed bend contact 236 in the unload contactor circuit opens, and the normally open bend contact 242 closes to energize the CR relay 243. The two normally open bend contacts 214 and 244 are also closed. The energizing of the CR relay closes the CR contact 207 which completes a circuit between the conductors 202 and 203 through the lead wires 206, 208 and 210, to energize the full wave bridge rectifier 209. The normally closed CR relay contact 227 is opened before the normally open CR relay contact 219 closes. It will be seen that the energizing of the CR relay 243 completes a circuit to energize the permanent magnet motor 111 to turn the bending shoe assembly 75 through the bending cycle in a clockwise direction, as viewed in FIG. 3. The permanent magnet motor 111 is supplied with DC current from the rectifier 209 through the lead wires 211 and 213, the bend contact 214, lead wire 218, CR relay contact 219, lead wires 220, 221, 222 and 223, bend contact 224 and lead wires 225 and 212.

The permanent magnet motor 111 continues to rotate the bending shoe assembly 75 until the adjustable cam 195 is rotated upwardly to engage the cam operator 172 and open the bending limit switch 171. The opening of the bending limit switch 171 de-energizes the aforesaid rectifier and permanent magnet motor energizing circuits, and the conduit bender is now ready for the unloading or ejection cycle. It will be seen from FIG. 7 that if the adjustable cam 195 fails to operate the limit switch 171, that the cam 189 following immediately thereafter will then operate as a second or follow-up means for opening the limit switch 171 to terminate the bending cycle. The opening of the limit switch 171 drops the bending contactor 232 and the CR relay 243, thus closing the CR contact 227 to short the armature of the permanent magnet motor 111 and produce a dynamic braking effect on the bending shoe assembly 75. The broken line path of the dynamic braking is indicated by the numeral 247 in FIG. 13.

The unload cycle is initiated by pressing the unload button switch 200 which energizes the unload contactor 237. The bend contactor 232 and the unload contactor 237 are mechanically interlocked by a suitable means 238 to prevent simultaneous operation of the two contactors. As shown in FIG. 13, the unload button switch 200 is operatively connected in a circuit between the conductors 202 and 203 which includes the emergency stop button switch 201, the normally closed unload limit switch 169, the normally closed contact 236 of the bend contactor 232, and the unload contactor 237. The pressing of the unload button switch 200 energizes the unload contactor 237 through the last mentioned circuit, thereby operating the unload contactor contacts. The normally open unload contact 241 is closed and forms a parallel circuit with the lead wires 239 and 240 across the unload switch 200. The normally closed unload contact 231 in the bend contactor circuit opens, and the normally open unload contact 246 closes to complete a circuit through the lead wires 244 and 245 through the CR relay 243. The two normally open unload contacts 216 and 229 are also closed.

The energizing of the CR relay effects a reversing of the rotation of the permanent magnet motor 111. The normally open CR contact 207 is closed to again complete the aforesaid circuit between the conductors 202 and 203 to energize the full wave bridge rectifier 209. The normally closed CR relay contact 227 is opened before the normally open CR relay contact 219 closes. The energizing of the CR relay 243 thus completes a circuit to energize the permanent magnet motor 111 to turn the bending shoe assembly 75 through the unload cycle in a counterclockwise direction, as viewed in FIG. 3, to return the bending hook 133a to its initial position.

The permanent magnet motor 111 is supplied with DC current from the rectifier 209 through the lead wires 211 and 230, the unload contact 229, the lead wires 222, 221 and 220, the CR relay contact 219, the
lead wires 218 and 215, the unload contact 216, and the lead wires 217 and 212. The reverse operation of the permanent magnet motor 111 rotates the cam shaft 157 in a clockwise direction until the round cam 187 engages the switch operator 170 to open the unload limit switch 169. The normally open contacts of the unload contactor 237 open, the normally open contacts of the CR relay open, and the CR relay contact 227 closes to effect a shorting of the armature of the permanent magnet motor 111 to stop the motor in milliseconds and provide a dynamic braking effect on the bending shoe assembly 75. The bent conduit is then removed from the conduit bender and the apparatus is ready for another bending cycle.

A suitable relay to carry out the function of the CR relay contactor 243 is a relay contactor available from Struthers-Dunn Inc., Pitman, New Jersey, under Model No. 425 XB XW. A suitable reversing contactor for carrying out the functions of the bend contactor 232 and the unload contactor 237 is available from Struthers-Dunn Inc., Pitman, New Jersey, under Model No. 575 XX74, X74.

The use of the two polyurethane rollers 77 mounted on a single pivot permits the rollers to swing or move with the conduit being bent and resting against the rollers, and prevents kinking or wrinkles in the conduit. The use of the two rollers 77 also allows a closer adjustment to the shoe assembly 75. The rollers 77 are adjustable to various positions on top of the conduit bender so that the same rollers can be used when bending different sizes of conduits.

The hooks 133 and 133a with their cammed surfaces allow the conduit to unload automatically when the bending shoe assembly 75 is reversed after a bending operation. The hooks, due to the cammed surface, ride up on top of the conduit during a reversal motion of the bending shoe assembly 75, so that the operator can grasp the bent conduit and pull it out of the bender.

The adjustability of the cam 195, together with the dial indicator structure, provides a means for quickly and easily adjusting the degree of bend from the outside of the bending apparatus. The quick and easy means for adjusting the angle of bend for the conduit permits the operator to quickly and accurately process a plurality of conduits and provide the same consistent bend to the same. The employment of the permanent magnet motor and the control circuit therefore provides a quick and accurate braking of the bend shoe assembly 75 at the end of the bending cycle and at the end of the unload cycle.

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.

What is claimed is:

1. An electric driven conduit bender having a housing and a rotatable bending shoe means operatively mounted on said housing, an electric motor for driving said shoe means, and a control circuit means including switch means for energizing and controlling the operation of said electric motor, the combination comprising:
   a. said cam means including an adjustable cam for controlling the operation of said switch means; and,
   b. a cam adjustment means mounted externally on said housing for adjusting said adjustable cam.

2. The conduit bender structure as defined in claim 1, wherein:
   a. said cam adjustment means includes a releasable locking means for movement to a position to release said adjustable cam for adjusting movement relative to said cam means, and for movement to another position to lock said adjustable cam to said cam means.

3. The conduit bender structure as defined in claim 2, wherein:
   a. said cam adjustment means includes a dial indicator having bend indicia thereon and being connected to said adjustable cam for adjusting said cam to a desired bend angle when said releasable locking means releases said adjustable cam relative to said cam means.

4. The conduit bender structure as defined in claim 3, including:
   a. means for pivotally mounting said switch means in said housing; and,
   b. means for adjusting said switch means about its pivotal mounting to provide a fine adjustment means for adjusting the angle of conduit bend.

5. In an electric driven conduit bender having a housing and a rotatable bending shoe means operatively mounted on said housing, an electric motor for driving said shoe means, and a control circuit means including switch means for energizing and controlling the operation of said electric motor, the combination comprising:
   a. a speed reducer operatively connected to said electric motor and having an output shaft that rotates in a one-to-one ratio relative to the rate of rotation of said bending shoe means;
   b. a shaft having one end fixedly connected to said speed reducer output shaft and the other end extending outwardly from said bending housing;
   c. a cam arm mounted on said shaft and extending perpendicularly out from said shaft;
   d. said switch means including a first switch for terminating the rotative bending cycle of said bending shoe means, and a second switch for terminating the rotative reversing unload cycle of said bending shoe means;
   e. a first cam member mounted on one end of said cam arm for controlling the operation of said second switch;
   f. a sleeve shaft telescopically mounted on said first named shaft for rotation thereabout and having one end of an adjustable cam arm fixed thereto;
   g. a second cam member mounted on the other end of said adjustable cam arm for controlling the operation of said first switch;
   h. a third cam member mounted on the other end of said first named cam arm for controlling the operation of said first switch in the event that said second cam member fails to control said first switch;
   i. a dial indicator fixed on said sleeve shaft and disposed exteriorly of said housing and provided with bend indicia thereon for rotatably adjusting said sleeve shaft about said first named shaft to adjust the position of said second cam member for controlling the operation of said first switch after said bending shoe means has been rotated through a desired bend angle to which said dial indicator has been set; and,
15. means for releasably locking said sleeve shaft to said first named shaft after an adjustment setting of said sleeve shaft by said dial indicator.

6. The conduit bender structure as defined in claim 5, including:

a. means for pivotally mounting said first and second switches on said first named shaft for selective adjustment about the axis of said first named shaft to provide a fine adjustment means for adjusting the angle of conduit bend.

7. The conduit bender structure as defined in claim 6, wherein said means for pivotally mounting said first and second switches on said first named shaft includes:

a. a bracket having one end pivotally mounted on said first named shaft and having said first and second switches mounted on said bracket; and,

b. screw adjustment means operatively mounted in said housing and threadably connected to said bracket for adjusting the position of said bracket relative to said first named shaft to provide a fine adjustment means for adjusting the angle of conduit bend.

8. In a conduit bender, the combination comprising:

a. a housing;

b. a bending shoe means rotatably mounted on a first axis on said housing;

c. a conduit support means on said housing for supporting a conduit on a second axis perpendicular to said first axis and tangential to said bending shoe means; and,

d. a pair of support rollers operatively mounted on said housing for supporting engagement with a conduit disposed on said conduit support means;

1. said pair of support rollers are mounted on a common support means for rotation about separate axes parallel to said first axis;

2. said common support means is pivotally mounted on said housing on a single pivot axis parallel to said first axis;

3. each of said pair of support rollers is made from polyurethane;

4. said common support means is adjustably mounted on said housing for movement to various positions in accordance with the size conduit to be bent;

e. a permanent magnet motor carried in said housing and operatively connected to said bending shoe means for rotating said bending shoe means in one direction through a bending cycle and in the opposite direction through an unload cycle;

f. control circuit means for energizing said permanent magnet motor through said bending cycle and said unload cycle, and for dynamically braking said permanent magnet motor at the end of each of said cycles;

g. a control circuit means for energizing said permanent magnet motor, and including a first switch for terminating the rotative bending cycle of said bending shoe means, and a second switch for terminating the rotative reversing unload cycle of said bending shoe means;

h. adjustable control means for controlling the operation of said control circuit means and the degree of bend to be made on a conduit;

i. said adjustable control means includes:

1. a speed reducer operatively connected to said permanent magnet motor and having an output shaft that rotates in a one-to-one ratio relative to the rate of rotation of said bending shoe means;

2. a shaft having one end fixedly connected to said speed reducer output shaft and the other end extending outwardly of said bender housing;

3. a cam arm mounted on said shaft and extending perpendicularly out from said shaft;

4. a first cam member mounted on one end of said cam arm for controlling the operation of said second switch;

5. a sleeve shaft telescopically mounted on said first named shaft for rotation thereabout and having one end of an adjustable cam arm fixed thereto;

6. a second cam member mounted on the other end of said adjustable cam arm for controlling the operation of said first switch;

7. a third cam member mounted on the other end of said first named cam arm for controlling the operation of said first switch in the event that said second cam member fails to control said first switch;

8. a dial indicator fixed on said sleeve shaft and disposed exteriorly of said housing and provided with bend indicia thereon for rotatably adjusting said sleeve shaft about said first named shaft to adjust the position of said second cam member for controlling the operation of said first switch after said bending shoe means has been rotated through a desired bend angle to which said dial indicator has been set; and,

9. means for releasably locking said sleeve shaft to said first named shaft after an adjustment setting of said sleeve shaft by said dial indicator.

9. The conduit bender structure as defined in claim 8, including:

a. means for pivotally mounting said first and second switches on said first named shaft for selective adjustment about the axis of said first named shaft to provide a fine adjustment means for adjusting the angle of conduit bend.

10. The conduit bender structure as defined in claim 9, wherein said means for pivotally mounting said first and second switches on said first named shaft includes:

a. a bracket having one end pivotally mounted on said first named shaft and having said first and second switches mounted on said bracket; and,

b. screw adjustment means operatively mounted in said housing and threadably connected to said bracket for adjusting the position of said bracket relative to said first named shaft to provide a fine adjustment means for adjusting the angle of conduit bend.

11. The control bender structure defined in claim 8, wherein:

a. said conduit support support unit is adjusibly mounted on one side of said housing, and a table support unit is adjusibly mounted on the other side of said housing.

12. The conduit bender structure defined in claim 8, wherein:

a. said bending shoe means includes at least one bending shoe having a hook operatively mounted thereon for grasping a conduit and retaining the same on the bending shoe during a bending operation.

13. The conduit bender structure defined in claim 8, wherein:
a. said hook has one end pivotally mounted on said bending shoe; and,
b. the other end of said hook has a concave inner surface for coaction with a grooved surface on said bending shoe for grasping a conduit therebetween.

14. The conduit bender structure defined in claim 13, wherein:
a. said other end of said hook has at least one cam surface on the lower side thereof, whereby when said bending shoe is rotated through an unload cycle, said cam surface will engage the conduit and ride up on the conduit and move the hook to a position released from the conduit.

15. In a conduit bender having a housing with a plurality of pivot shaft support bores and a rotatable bending shoe means operatively mounted on said housing, the combination, comprising:
a. a pair of laterally spaced apart conduit support rollers pivotally mounted on the housing in an operative position adjacent the bending shoe means;
b. said pair of support rollers are operatively mounted on a common support means;
c. said common support means being pivotally mounted on said housing on a single pivot shaft support means; and

d. said single pivot shaft support means is adjustably mounted on said housing into one of said plurality of pivot shaft support bores in accordance with the size conduit to be bent.

16. In a conduit bender having a housing and a rotatable bending shoe means operatively mounted on said housing, the combination comprising:
a. a hook operatively mounted on said bending shoe means for grasping a conduit and retaining the same on the bending shoe means during a bending operation;
b. said hook has one end pivotally mounted on said bending shoe means;
c. the other end of said hook has a concave inner surface for coaction with a grooved surface on said bending shoe means for grasping a conduit therebetween; and

d. said other end of said hook has at least one cam surface on the lower side thereof, whereby when said bending shoe means is rotated through an unload cycle, said cam surface will engage the conduit and ride up on the conduit and move the hook to a position released from the conduit.

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