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Hamkins et al.

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[54] **HAND GUARD FOR VERTICAL PRESS TUBE BENDER**

[75] Inventors: **Clark J. Hamkins**, Racine; **David V. Schaefer**, Burlington, both of Wis.

[73] Assignee: **Tenneco Inc.**, Racine, Wis.

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[52] **U.S. Cl.** **72/389**, 72/26, 72/415, 100/53

[51] **Int. Cl.** **B21d 55/00**

[58] **Field of Search** 72/389, 415, 416, 72/470, 25, 26; 100/53

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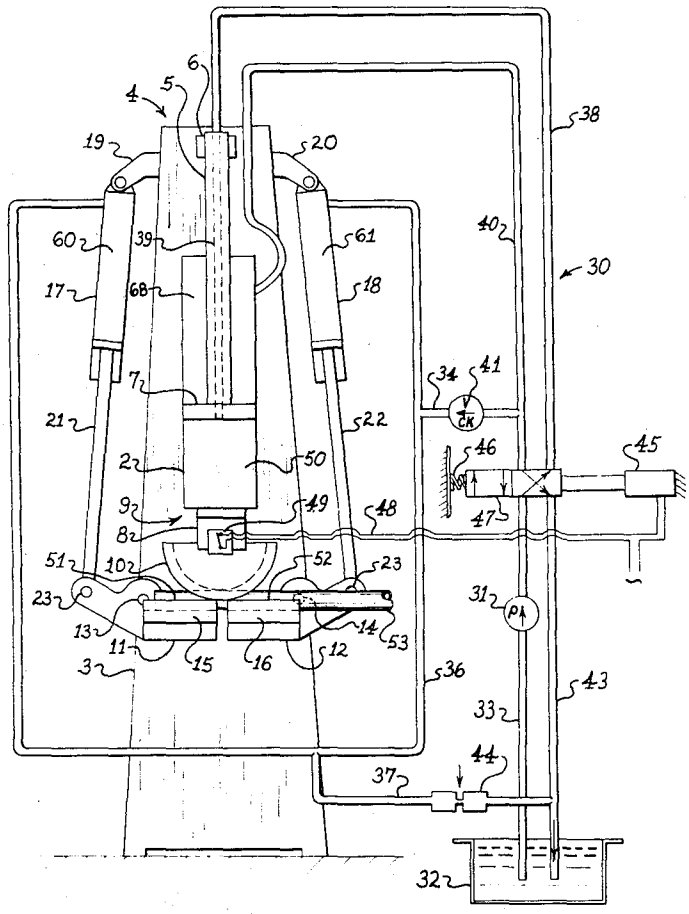
Primary Examiner—Charles W. Lanham
Assistant Examiner—Gene P. Crosby
Attorney—Thomas E. Torphy

[57] **ABSTRACT**

Obstruction sensing barrier members hinder placement of a tube bender operator's hand into injurious contact with the forming punch and wing dies of vertical press tube benders. Upon encountering a predetermined resistance to movement, such as a hand acting as an obstruction to continued movement of a barrier member, the barrier members serve to actuate an electrical switch which initiates selected control functions of the machine. The machine control functions affected by the barrier member actuated switch cause the machine to take a predetermined course of action intended to reduce injury. Cessation of movement of the bender tooling or return of the tooling to a desired position are two desirable courses of action.

7 Claims, 4 Drawing Figures



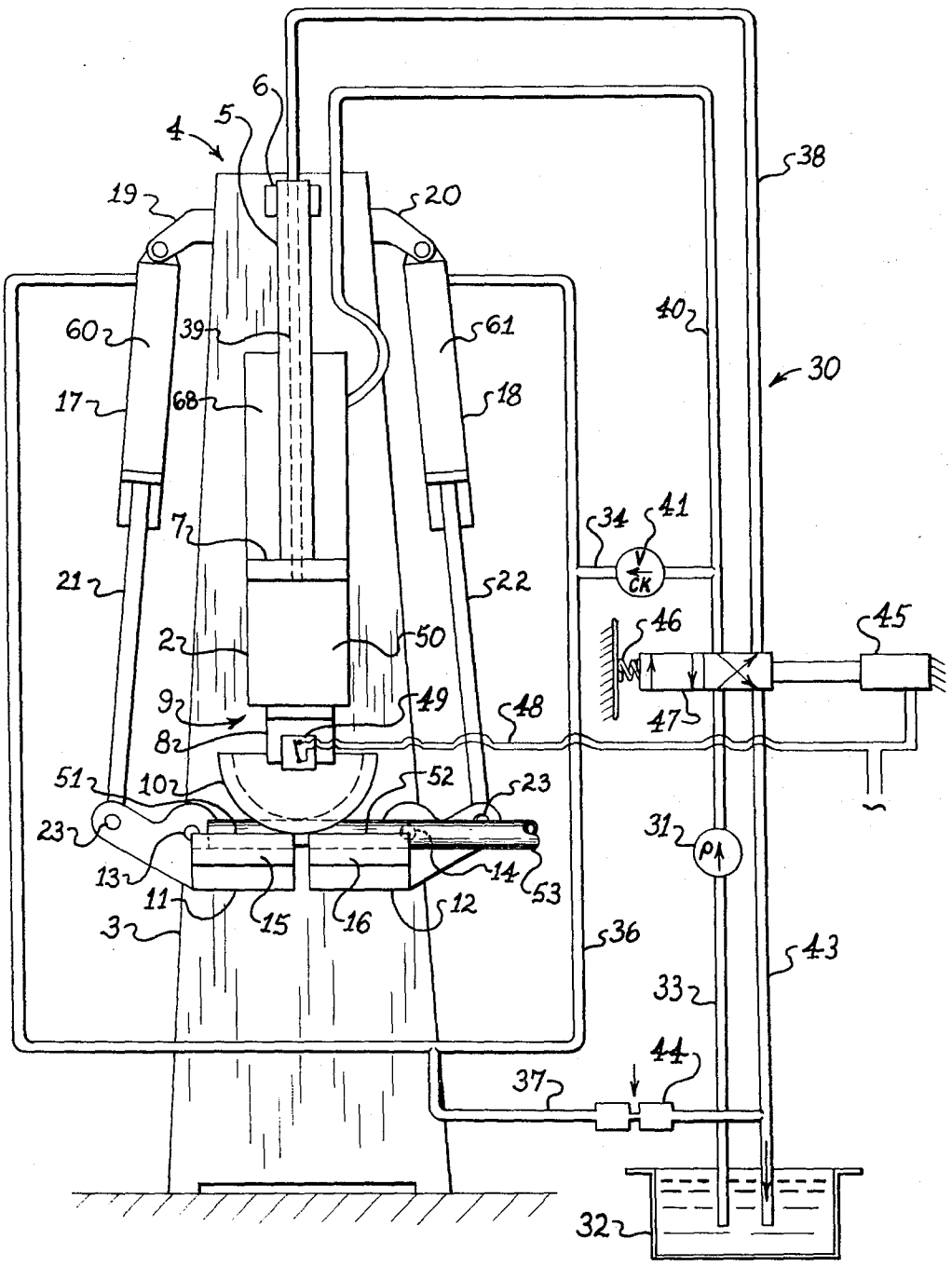

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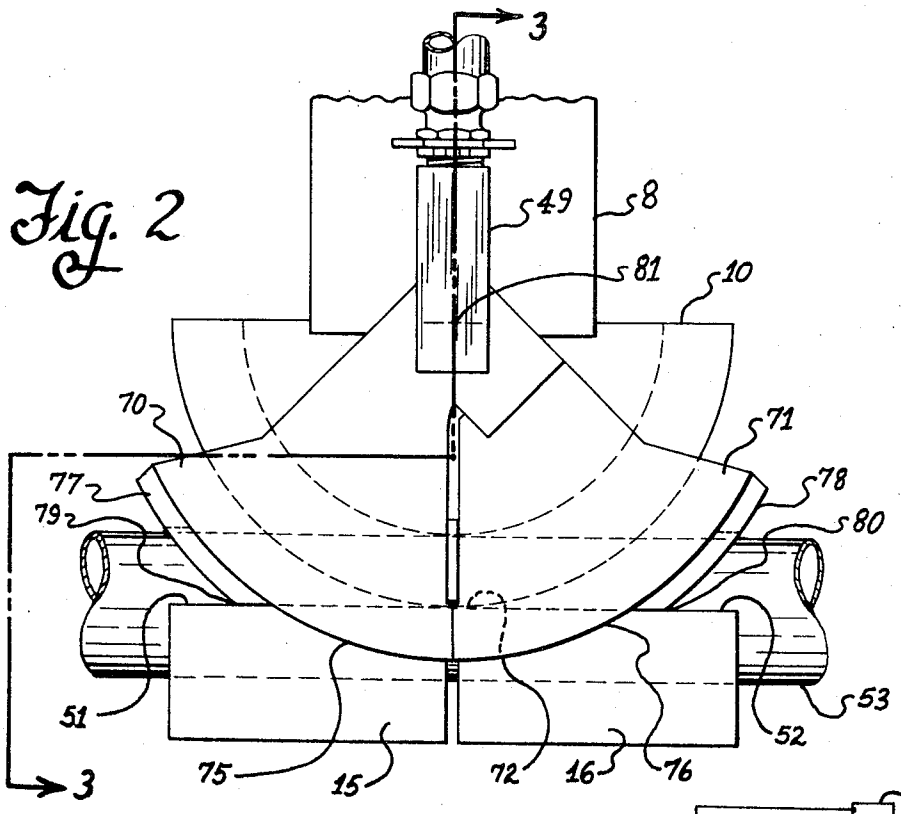
Fig. 1

Fig. 2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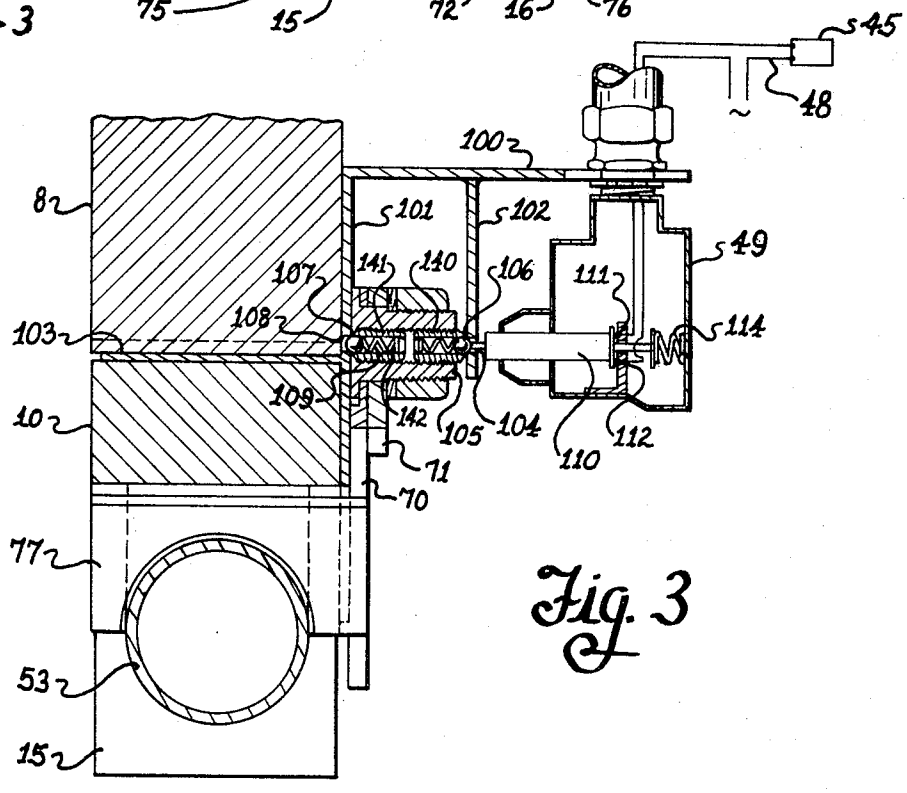
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Fig. 3

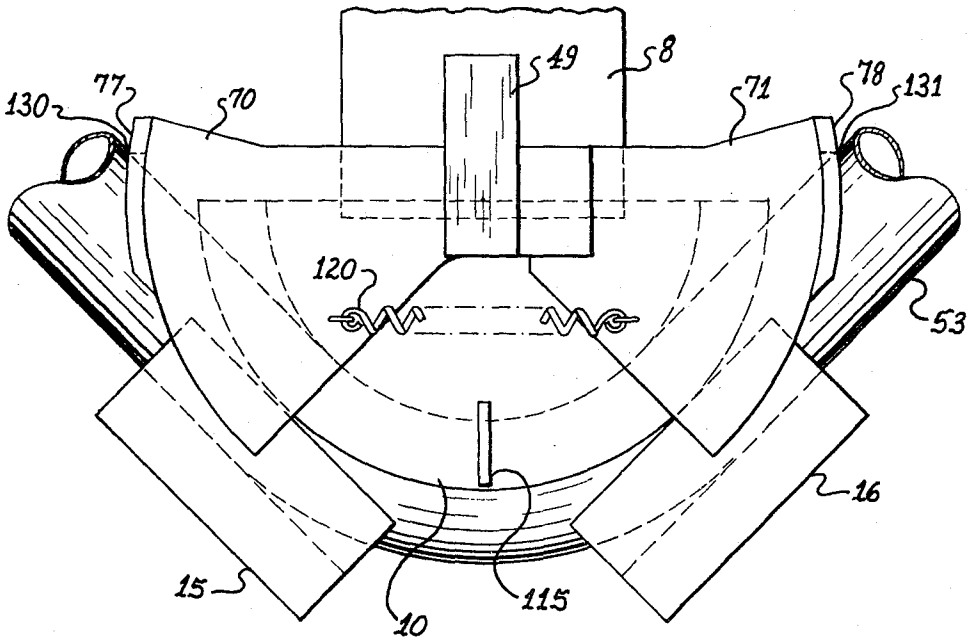

Fig. 4

HAND GUARD FOR VERTICAL PRESS TUBE BENDER

BACKGROUND OF THE INVENTION

This invention comprises an obstruction sensitive hand guard for vertical press tube benders.

Prior to this invention an effective, practical means of preventing pinch injury to operators of vertical press tube benders, such as those benders used to form automotive exhaust system conduits, was unknown.

Operators of vertical press tube benders are normally required to manually grip and maintain the tube to be bent in a desired position relative to the forming punch and wing dies while simultaneously actuating the press, usually by a foot-operated switch. Actuation of the foot switch causes the reciprocating ram mounted forming punch to descend a distance sufficient to firmly grip the pipe between the wing dies and the punch.

As the punch continues downward by the force of the ram the entrapped tube is forced to conform to the forming punch working surface by the action of the wing dies.

If the operator grips the tube too close to the tooling and maintains that grip too long after initiating the bend cycle with the foot switch a portion of his hand may become entrapped in the pinch points between the punch and a wing die or between the tube being bent and the punch. Also, if the operator accidentally has a hand in the area between the wing dies and punch upon actuation of a bend cycle his hand or fingers may become trapped between the punch and dies. Due to the great force with which the punch is driven downward by the ram such entrapment can cause severe injury to the operator's hand.

The object of this invention is to provide an effective, practical means for reducing such injuries.

SUMMARY OF THE INVENTION

The hand guard of this invention is comprised of two sweep type barrier members pivotally mounted adjacent, and parallel to, the frontal surface of a forming punch on a vertical press tube bender. A portion of each barrier member extends normal to that portion of the barrier member adjacent the front of the punch. This portion of each barrier member serves as a side barrier member adjacent and parallel to the working face of the punch.

The lower edge of each side barrier member rests upon the top surface of a wing die during the actual bending cycle.

The frontal portion of each barrier member extends beyond the lower front edge of the forming punch and therefore the extending portion of each of the barrier members precedes the punch as it travels downward upon initiation of a bend cycle. Upon contact between the wing dies and the forming punch the extending portion of the barrier members cover the initial points of contact.

During the bend cycle the top surface of each wing die rolls or slides arcuately along the lower surface of the forming punch as the wing die is forced to pivot about its pivot point by the downward force of the ram. Therefore, the point of contact between the forming punch and each of the wing dies continually moves outwardly along the forming die as the bend cycle progresses.

As the side barrier members travel along the top surface of the wing dies, they are forced to sweep outwardly during the bend cycle causing the frontal portion of each barrier member to continually cover the pinch points or points of contact between the forming punch and a wing die.

Additionally, the side barrier members, traveling along or adjacent the top surface of the tube being bent, serve to prevent the operator from placing or maintaining his hands in a dangerous location near the working surface of the forming punch.

The barriers thus serve to prevent the operator from placing or maintaining his hands in injury causing areas, or pinch points, of the working tooling or work piece of the bender.

In the event an operator maintains a portion of his body in an area through which a barrier member is forced to travel during a bend cycle the bend cycle will be altered when the resistance to continued movement of the barrier member offered by that portion of his body exceeds a predetermined limit.

When the predetermined resistance to continued movement of the barrier member is exceeded, a spring loaded pivot means of the barrier members is displaced.

Displacement of the pivot means actuates an electric switch which causes the machine to take a preselected course of action to reduce injury.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic front view of a vertical press tube bender showing structure and hydraulic and electrical circuitry relevant to a preferred embodiment of the disclosed hand guard.

FIG. 2 is a partial front view showing the hand guard mounted on the bender.

FIG. 3 is a partially sectional side view of FIG. 2.

FIG. 4 shows the position of the hand guard barrier members and the bender tooling of FIG. 1 when a 90° bend has been placed in the tube.

DETAILED DESCRIPTION OF THE INVENTION

The structural portions of a vertical press tube bender relevant to this invention are shown in FIG. 1.

A vertical press tube bender 4 has a main frame 3 and is provided with a vertically reciprocal ram assembly 9 comprising a double acting hydraulic cylinder 2 and a punch holder 8 attached to the lower end of cylinder 2.

A stationary piston 7 within cylinder 2 is rigidly secured relative to frame 3 by a piston rod 5 which is attached to frame 3 by a bracket 6.

A forming punch 10 is removably attached to punch holder 8.

Wing die pads 11 and 12 are respectively pivotally mounted on a pair of journals 13 and 14 attached to the bender main frame 3. Wing dies 15 and 16 are mounted on pads 11 and 12 respectively.

Hydraulic reaction cylinders 17 and 18 are pivotally attached to brackets 19 and 20 respectively which are in turn fastened to main frame 3.

Each of the reaction cylinders 17 and 18 have a ram and piston assembly, 21 and 22 respectively, which reciprocates within it. The rame end of each assembly 21 and 22 is pivotally attached to wing die pads 11 and 12 respectively by pivot means 23.

Hydraulic circuitry 30, controlled by electrically operated control valves, provides the bender 4 with working power.

A pump 31 pumps working fluid from reservoir 32 via conduit 33. Conduit 33 terminates at a directional flow control valve 47. A conduit 40 connects control valve 47 with cylinder 2 above piston 7. A conduit 34 connects conduit 40 to conduit 36 which is connected above the piston to each reaction cylinder 17 and 18. Conduit 37 provides a return from conduit 36 to resevoir 32.

A conduit 38 communicates with cylinder 2 via flow passage 39 in piston rod 5 and piston 7 and is connected to control valve 47. Conduit 43 provides a return from control valve 47 to reservoir 32.

Check valve 41 assures one way flow from control valve 47 to reaction cylinders 17 and 18.

A variable resistance 44 provided in return conduit 37 controls the rate of return of fluid from reaction cylinders 17 and 18 to reservoir 32.

Electrically operated directional control valve 47 is illustrated as a two position four way valve indexable by solenoid 45 and spring 46 to specific positions to provide a desired direction of fluid flow to the various hydraulic components of the bender.

Normally, solenoid 45 would be connected to a source of electric current only. To practice the preferred embodiment of this invention as herein taught circuit 48 and switch 49 are placed in series with the original circuit used to energize and de-energize solenoid 45. Switch 49 is normally closed in operation of a bender equipped with a hand guard of this invention.

Operation of the bender commences with energization of solenoid 45, usually by the bender operator actuating a foot switch. Solenoid 45 then indexes control valve 47 to the position shown in FIG. 1 whereby pump 31 draws working fluid from reservoir 32 and, as indicated by the arrow at control valve 47, switches the fluid flow from conduit 33 to conduit 38 whereby the working fluid is forced into chamber 50 of cylinder 2. Consequently, cylinder 2, punch holder 8 and forming punch 10 are forced downward. As shown in FIGS. 1 and 2, forming punch 10 has just achieved contact with the top surfaces 51 and 52 of wing dies 15 and 16. In this position a tube 53 is entrapped between the working faces of forming punch 10 and wing dies 15 and 16. Continued downward movement of the forming punch will cause the wing die pads 11 and 12 to pivot at 13 and 14 respectively to the positions shown in FIG. 4.

The wing dies thus wipe the tube 53 about the working face of forming puch 10 to effect a bend in the tube.

Reaction cylinders 17 and 18, having chambers 60 and 61 filled with working fluid, offer, due to variable resistance to flow 44, a predetermined desired resistance of pivotal movement to wing die pads 11 and 12 to assure a smooth, controlled bend in tube 53.

If switch 49 is opened at any time during the above described portion of a bend cycle, solenoid 45 will be de-energized. Consequently, spring 46 will bias control valve 47 to its alternate position, causing cylinder 2 and forming punch 10 to retract upward away from the wing dies and the now bent tube. The retraction of the ram and punch upon completion of a bend in a bend cycle is normally initiated by conventional depth of bend control means (not shown).

To affect retraction of the forming punch fluid is pumped into chamber 68 of cylinder 2 and into chambers 60 and 61 of cylinders 17 and 18. The fluid in chamber 50 is displaced and returns to the reservoir. The fluid which was displaced from chambers 60 and 61 of cylinders 17 and 18 during the bend cycle is replaced forcing wing die pads 11 and 12 to return to their normal starting position as shown in FIG. 1. Cylinder 2 and forming die 10 continue to retract upward out of contact with the wing dies and the tube to allow removal of the tube. In the event the operator got his hand or other portion of his body caught between the forming punch and the wing dies, he could also remove it at this time.

To prevent accidental entrapment of an operator's hand in the working tooling, the hand guard of this invention, as shown in FIGS. 2 and 3, is mounted on the forming punch 10 and designed to actuate switch 49 under certain conditions.

Referring now to FIG. 2 two frontal barrier members 70 and 71 are shown mounted adjacent forming punch 10 and tool mount means 8. The forming punch 10 is shown in the position where the lower most surface 72 of its working face has just come into contact with the upper most surfaces 51 and 52 of wing dies 15 and 16 respectively and tube 53 is entrapped between punch 10 and wing dies 15 and 16.

The lower most surfaces 75 and 76 of frontal barrier members 70 and 71 respectively extend below the contact points or pinch points of the working tooling in this position. Each frontal barrier member has a side barrier member 77 and 78 which extends perpendicular to the frontal member. Each side barrier member lies parallel to the working face of forming punch 10 and each rests upon the top surface of a wing die as shown at 79 and 80. Optionally, each side barrier member may rest upon the top surface of the work piece or tube such as at points 130 and 131 as shown in FIG. 4.

Frontal barrier members pivot about point 81. Therefore, as forming punch 10 advances downward to bend the tube during progression of a bend cycle, the frontal sweep members are caused to sweep outward as the lower surfaces of the side barrier members travel along the top surface of the wing dies.

FIG. 3 shows structure of the hand guard shown in FIG. 2 in greater detail. A bracket comprised of plate 100, pivot plates 101 and 102, and attachment plate 103 are rigidly connected together to form the basic mount means for the barrier members 70 and 71 and switch 49.

Attachment plate 103 extends between tool mount means 8 and forming punch 10 and is rigidly held in this position with pivot plate 101 lying adjacent the front face of each tool means 8 and forming punch 10.

Annular opening or recess 108 in plate 101 and annular opening or recess 104 in plate 102 have aligned axis perpendicular to plates 102 and 101. Barrier members 70 and 71 are mounted upon pivot member 105 and are capable of rotation about pivot member 105. Pivot member 105 is mounted and normally maintained coaxial with the aligned axis of openings 104 and 108.

Pivot member 105 is maintained in its normal position by yielding pivotal bearing members which are maintained symmetrical about the aligned axis of openings 104 and 108.

The yielding pivotal bearings are provided by commercially available assemblies. Each such assembly comprises a ball, such as 106 or 107, retained within a

cylindrical housing such as 140 and 141. Each cylindrical housing has a threaded outer surface and an inner bore having one at least partially closed end and one substantially open end. A bearing member, such as ball 106 or 107 is contained within the inner bore and biased toward the substantially open end of the bore by a compression spring, such as 142 in housing 141, placed within the bore between the at least partially closed end and the ball. One known source of such assemblies is Reid Tool Company of Muskegon Heights, Michigan.

Upon placement of pivot member 105, upon which barrier members 70 and 71 are mounted, between plates 101 and 102 the spring biased balls 106 and 107 are seated partially within openings 104 and 108 respectively.

Sensing stem 110 on switch 49 extends into opening 104. In the absence of an obstruction in opening 104 the sensing stem 110 is biased sufficiently far toward plate 102 to cause it to break contact at 111 and 112, thus de-energizing solenoid 45.

The presence of ball 106 in opening 104 forces sensing stem 110 into electrical contact at 111 and 112 and in normal operation of the bender the ball 106 remains present in opening 104.

However, in the event a barrier member encounters an obstruction during a bend cycle, the force of the obstruction is transmitted to the pivot points. When such an obstruction places a lateral force on the ball 106 which exceeds the force of the spring biasing the ball into opening 104 the ball is forced out of opening 104. Sensing stem 110 then advances into opening 104 by the urging of biasing means 114 and, due to the breaking of electrical contact at 111 and 112, solenoid 45 is de-energized. Consequently, flow control valve 47 of FIG. 1, indexed by spring 46, initiates the retract mode of the bend cycle.

Reseating of ball 106 within opening 104 restores electrical contact and thus renders the bender capable of normal operation.

The threaded housings containing balls 107 and 106 are threadedly engaged with a threaded bore symmetrical about the axis of pivot member 105. The force with which balls 107 and 106 are maintained within openings 108 and 104 respectively can be increased by advancing either or both housings toward their respective openings or decreased by screwing either or both housings away from the respective opening.

FIG. 4 illustrates that frontal barrier members 70 and 71 sweep out to continually cover the two points of contact between forming punch 10 and wing dies 15 and 16 and the closing spaces or pinch points between punch 10 and tube 53 as side barrier members 77 and 78 initially travel along the top surface of the wing dies and when, as shown, the depth of bend is great enough, along the top sur-face of the tube or work piece 53.

The side barrier members prevent operator injury in the event the operator inadvertently grips the tube too close to the tooling. Contact between the operator's hand and a side barrier member will remind him to move his hand. If for any reason his hand is not moved the bender will be placed in the retract mode of the bend cycle when the force of the obstrucing hand transmitted to the pivot point via the barrier member is sufficient to unseat ball 106 from opening 104.

It is readily apparent that any obstruction to continued movement of a frontal barrier member will have a similar effect.

It will be obvious to those skilled in the art of bending with vertical press benders that alternate safe courses of action, other than initiation of the retraction mode of the bend cycle, may be initiated. For instance, use of a three position control valve in lieu of two position control valve 47 of FIG. 1 could be used to cause the machine to dwell in its present position upon de-energization of solenoid 45 by opening switch 49. Using a three position control valve the spring would bias the valve into position whereby flow from the pump would immediately be returned to reservoir 32 via return conduit 43 by the valve.

Alternately, a completely separate valve connected upstream of pump 31 with conduit 33 and downstream of valve 47 to conduit 43 could be actuated by either opening or closing switch 49 to cause the bender to dwell by returning working fluid flow to reservoir 32.

While the barrier members herein described may be made from any of a great variety of suitable materials such as metal, wood, plastic, etc., one preferred material is Plexiglas which is durable, easy to work with, and transparent. Transparency of the barrier members enable the operator to visually monitor progressive coactance of the forming punch with the wing dies and the work piece.

A barrier member positioning guide is shown at 115 of FIG. 4. The guide 115 is attached to plate 101 and positioned on the vertical centerline of the front face of the forming punch, which defines the line of movement of the punch. Guide 115 prevents the barrier members 70 and 71 from hitting each other as they return by spring 120 or, optionally, by gravity to the position shown in FIG. 2 after being in a position such as that shown in FIG. 4.

Only those structural, hydraulic and electrical components of a vertical press tube bender necessary to adequately disclose a preferred embodiment of the obstruction sensitive hand guard of this invention have been shown and described herein. Upon having the opportunity to peruse this disclosure it will be obvious to those persons familiar with vertical press benders that a plurality of alternate methods of initiating a safe course of action of the bender upon either opening or closing switch 49 to initiate such action may be used without departing from the spirit and scope of this invention.

We claim

1. A hand guard for a press bender, said bender having a reciprocally movable ram, punch means and wing die means for bending a work piece, said hand guard comprising:

a. barrier means mounted to reciprocally move with said ram and move pivotally with respect to said ram to substantially cover the pinch points between said work piece, said punch means and said wing die means during a normal bending operation of said bender;

b. said barrier means being yieldingly mounted in relation to said ram whereby the position of said barrier means in relation to said ram will shift when said barrier means encounters an obstruction to the normal pivotal movement of said barrier means or the normal reciprocal movement of said barrier means with said ram; and

c. control means responsive to such shift in position of said barrier means relative to said ram to alter operation of said bender.

2. The invention defined in claim **1** together with projecting means attached to said barrier means, said projecting means being arranged to contact a surface of said wing dies for causing said barrier means to continually cover said pinch points.

3. The invention defined in claim **1** together with projecting means attached to said barrier means, said projecting means being arranged to contact a surface of said work piece being bent for causing said barrier means to continually cover said pinch points.

4. The invention as defined in claim **1** in which:

a. said barrier means is mounted at a pivot axis on said ram;

b. said control means including electrical switch means responsive to a non-rotary shift in position of said barrier means in relation to said pivot axis; and

c. said electrical switch means being effective to cause stopping or reversal of movement of said ram.

5. The invention as defined in claim **1** in which:

a. said barrier means is pivotally mounted on a pivotal bearing member yieldingly axially biased into a recess, said bearing member being axially movable when said barrier is laterally displaced; and

b. said control means is responsive to axial movement of said bearing member.

6. The invention as defined in claim **1** in which:

a. said bender is a vertical press bender having a vertically movable punch and two oppositely rotating wing dies, said wing dies being positioned on opposite sides of the line of movement of said punch; and

b. said barrier means comprises two barrier members extending toward opposite sides of the line of movement of said punch and rotatable in opposite directions to cover the pinch points associated with said opposite wing dies.

7. The invention as defined in claim **6** in which said barrier members are transparent to provide an unobstructed view of said punch, wing dies and work piece.

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