

April 21, 1964

R. W. DEAN ET AL

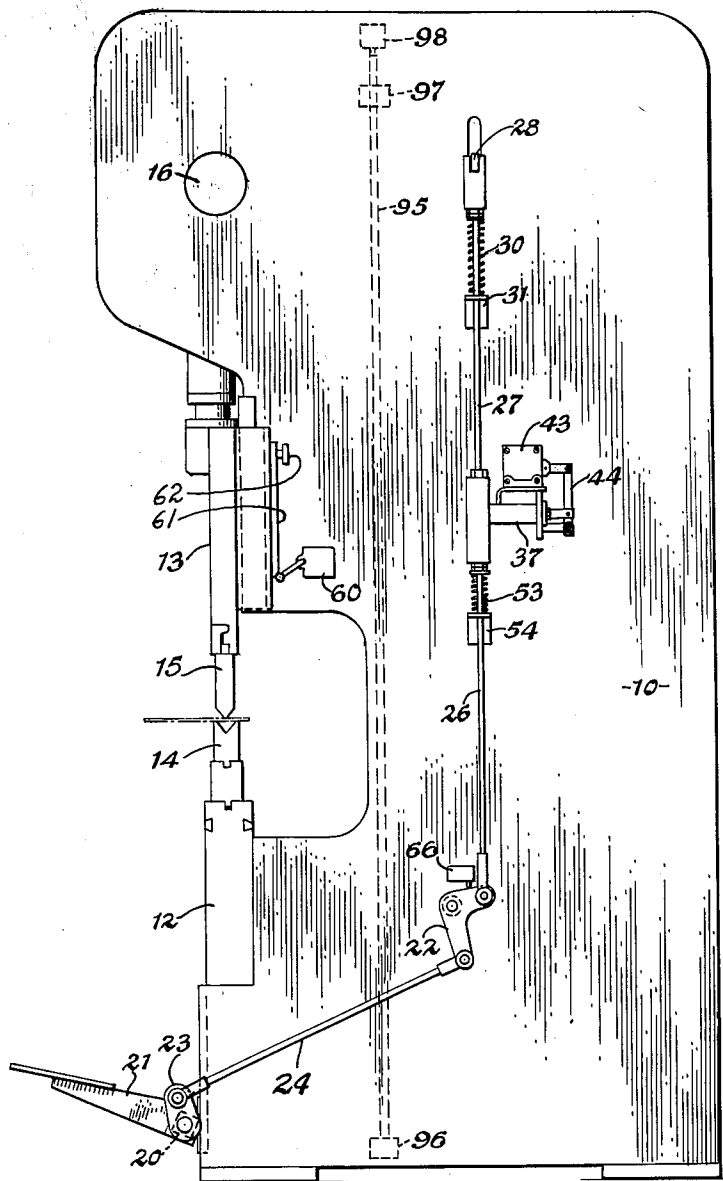
3,129,799

RAM ARRESTER FOR PRESS BRAKES

Filed Oct. 4, 1961

2 Sheets-Sheet 1

Fig. 1.



INVENTORS
REEVE W. DEAN
WILLARD J. SHORT

BY

Christel & Bean
ATTORNEYS

April 21, 1964

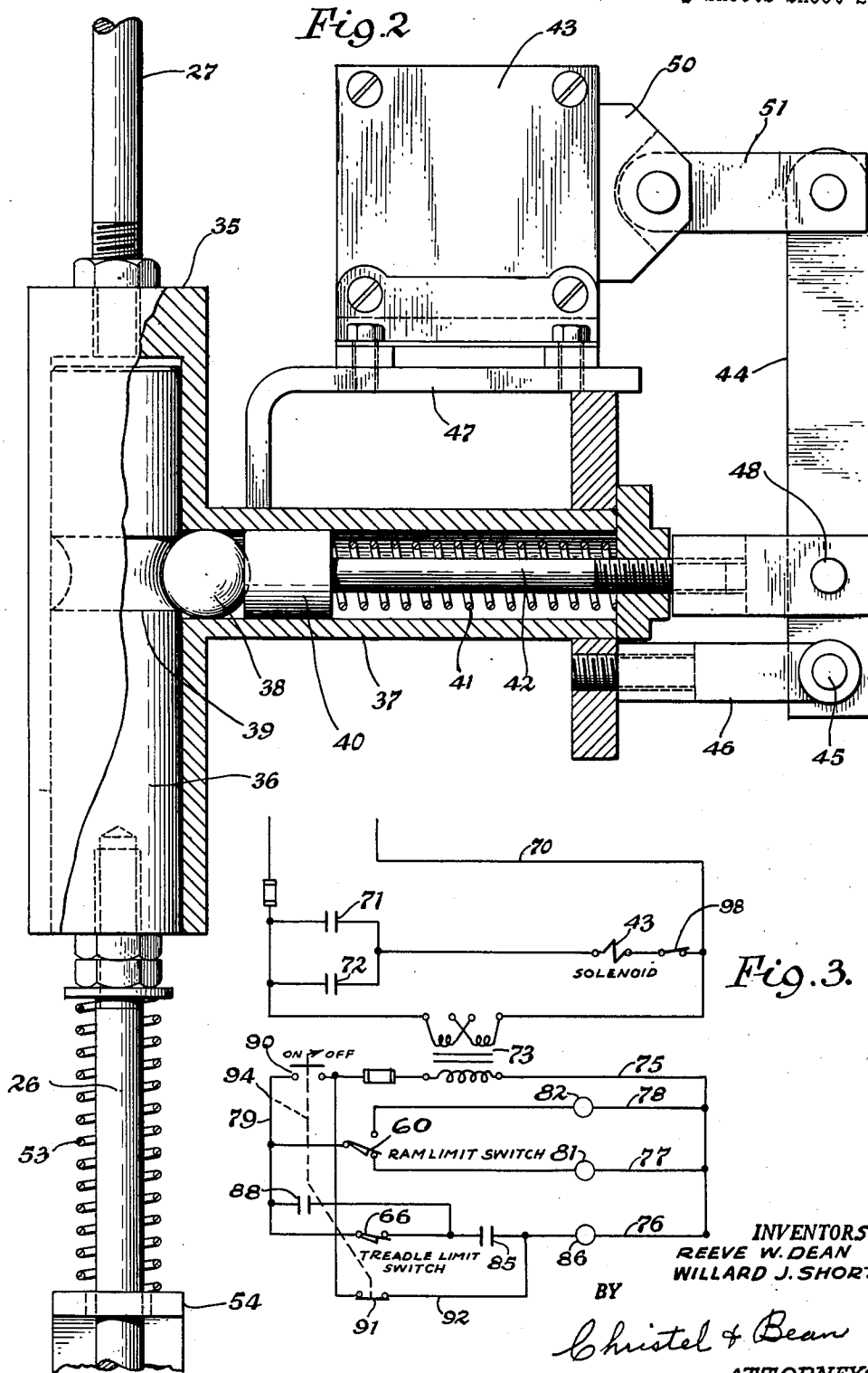
R. W. DEAN ETAL

3,129,799

RAM ARRESTER FOR PRESS BRAKES

Filed Oct. 4, 1961

2 Sheets-Sheet 2



1

3,129,799

RAM ARRESTER FOR PRESS BRAKES

Reeve W. Dean, East Aurora, and Willard J. Short, Tonawanda, N.Y., assignors to Niagara Machine & Tool Works, Buffalo, N.Y.

Filed Oct. 4, 1961, Ser. No. 142,955

6 Claims. (Cl. 192-129)

This invention relates to drive control means for power press brakes and analogous reciprocating machines for metal working and other purposes.

While the principles of the present invention may be employed in machines for various purposes, they are particularly applicable to power press brakes wherein a ram moves downwardly to a bed member whereby complementary die elements carried by the ram and bed member come together and thus effect metal bending operations. Conventional power press brakes include clutch means or clutch and brake means and a treadle or similar operator controlled device for starting and stopping the reciprocating movements of the ram of the press brake at will, most commonly by selective engagement and disengagement of the clutch.

Since press brake operations most commonly involve the formation of angular bends in sheets of metal the metal work sheet is usually manually placed on the stationary die associated with the bed of the press brake and when the reciprocating ram which carries the punch moves downwardly to perform the bending operation the portion of the sheet which is being held by the operator moves sharply, usually upwardly. Since a large or at least a substantial portion of the work sheet normally extends out in front of the press brake at the operator's side, there is a marked tendency for whipping action as the punch carried by the ram engages the material on the die and performs the bending operation.

On light materials this whipping tendency is often sufficient to kink or deform the work sheet and in any event the whipping action is a very marked hazard to the operator. To overcome this hazardous condition it is common practice to jog or inch the ram by slipping the clutch or otherwise during the working stroke to slow down the ram and thus avoid the abrupt whipping up of the work sheet. This is of course a makeshift and is a nuisance to the operator and is at best an indefinite and uncertain procedure.

The present invention provides an automatic arrest mechanism and press brake control structure whereby the ram moves directly downwardly to a predetermined point where the punch carried thereby just engages or is about to engage the work sheet, whereupon the ram automatically comes to a full stop. At this point the operator must release the treadle or other control instrumentality and re-activate the same to continue the movement of the ram, that is, to perform the actual bending portion of the stroke of the ram.

This arrest period permits the operator to change his grip on the sheet, as by placing his hands underneath the extending portion of the sheet, and due to the brief time period required for full clutch engagement and the attaining of full ram speed the arrest slows the bending operation to a safe point. Furthermore, the arresting of the ram at the point of work engagement enables the operator to check the proper positioning of the sheet and its alignment with respect to the punch member before completing the stroke. This is particularly important in cases, for instance, where the bend is to be made along a scribed line on the sheet.

The mechanism and circuitry provided herein for arresting the press brake ram at a predetermined point in each working stroke may also be employed as a load

2

limiting device which operates to interrupt the transmission of driving power to the ram whenever the resistance of the work causes undue deflection of the frame of the machine or when such deflection indicates that the load on the machine exceeds the desired maximum loading.

The above and other objects and advantages inherent in and incident to practicing the present invention will be apparent to those skilled in the sheet metal working and allied arts from a consideration of the embodiment of the present invention which is illustrated in the accompanying drawings and described in the following specification. However, it is to be understood that this embodiment is disclosed by way of example only and that numerous mechanical and electrical variations and modifications may be effected within the scope of the present invention and without departing from the principles thereof. The invention is not limited to the exemplary embodiment or otherwise than as defined in the appended claims.

In the drawings:

FIG. 1 is a general side elevational view of a press brake equipped with one form of the automatic control means of the present invention;

FIG. 2 is an enlarged fragmentary elevational view, taken similarly to FIG. 1, showing a portion of the treadle rod mechanism of FIG. 1; and

FIG. 3 is a wiring diagram illustrating the electrical portions of the control arrangement of the illustrative embodiment of the invention.

Like characters of reference denote like parts throughout the several figures of the drawings and, referring particularly to FIG. 1, the numeral 10 designates a side frame member of a conventional power press brake having a bed 12 and a reciprocable ram 13, the bed and ram being provided respectively, with die and punch members 14 and 15. In FIG. 1 the numeral 16 designates a main drive or eccentric shaft which connects with ram 13 for reciprocation thereof in the usual manner.

The means for rotating drive shaft 16 is conventional and includes a clutch or clutch brake mechanism not illustrated herein but which may, by way of example, be of the general type illustrated in a copending United States patent application of Frederick E. Munschauer, Jr., Serial No. 122,828, filed July 10, 1961. In this type of press brake drive means the operator actuates a control member to engage the clutch and initiate rotation of drive shaft 16 and consequent reciprocation of ram 13 and the operator releases such control member to arrest rotation of drive shaft 16 and reciprocation of ram 13.

In the illustrated instance a treadle shaft 20 is disposed along the bottom front edge of the press brake and is provided with a foot operated treadle 21. A bell crank 22 is pivoted to side frame 10 and one arm thereof is connected to a rock arm 23 on treadle shaft 20 by a connecting link 24, all as clearly shown in FIG. 1.

Operating movements of treadle 21 are conventionally transmitted upwardly to the clutch control means of the machine by a vertical treadle rod and in the present instance such treadle rod comprises a lower section 26 and an upper section 27 which are related and engaged in a manner which will presently be described more fully with particular reference to FIG. 2. The upper treadle rod section 27 is connected at its upper end with an arm 28 which controls the aforesaid clutch in a conventional manner. For present purposes it is sufficient to state that downward movement of the upper treadle rod section 27 engages the clutch to initiate rotation of drive shaft 16 and upward movement thereof disengages the clutch to arrest rotation of drive shaft 16.

The clutch mechanism is normally biased to disengaged position and therefore normally holds the vertical treadle rod in a raised position. However, because of the additional weight carried by the treadle rod sections 26 and 27 in the present instance, the upper treadle rod section 27 is preferably additionally biased to a raised, clutch disengaged position by a compression coil spring 30 which acts between the upper end of treadle rod section 27 and a bracket 31 fixed to side frame 10.

From the foregoing it will be seen that when the treadle rod sections 26 and 27 are connected for movement in unison downward movement of treadle 21 by an operator lowers the treadle rod sections 26 and 27 to engage the clutch and cause reciprocating movement of the ram. Conversely, release of the treadle 21 disengages the clutch and arrests movement of the ram. Means are provided whereby the treadle rod sections 26 and 27 are automatically disconnected to arrest ram movement and the mechanical portions of the disconnect mechanism will now be described with particular reference to FIG. 2.

The lower end of upper treadle rod section 27 has fixed thereto a hollow cylinder 35 which is open at its lower end and lower treadle rod section 26 has fixed to its upper end a plunger 36 which extends into cylinder 35. Cylinder 35 is provided with a lateral tubular extension 37 which contains a ball 38 which is guided for horizontal movement therein. Plunger 36 is provided with an arcuate groove 39 in which ball 38 is adapted to engage as illustrated in FIG. 2 and when thus engaged the lower and upper treadle rod sections 26 and 27 move vertically in unison.

A cylindrical block 40 which is likewise slidable in tubular extension 37 bears against ball 38 and biases the latter into groove 39 under the impetus of a compression coil spring 41. A rod 42 extends from cylindrical block 40 and is adapted to apply additional biasing force against ball 38 by energization of a solenoid indicated at 43 in FIG. 2. Solenoid 43 is supported on extension 37 by means of a bracket 47.

An operating lever 44 is pivoted as at 45 to a post 46 which is carried by tubular extension 37 and has pivotal connection with rod 42 as at 48 and is further connected with an armature 50 of solenoid 43 by way of a pivoted link 51. Thus when solenoid 43 is energized the attractive or holding force which it exerts on armature 50 imposes a counterclockwise torque on lever 44 as viewed in FIG. 2 which supplements the force of coil spring 41 tending to seat ball 38 in groove 39 of plunger 36.

The present arrangement is such that the armature 50 is in its "in" position with respect to solenoid 43 when the latter becomes energized and the solenoid normally serves merely to hold the armature in such "in" position. Since there is a minimum current draw and minimum heating when the armature is in the closed or "in" position, this arrangement provides optimum operating efficiency in this respect.

In FIG. 2, a compression coil spring 53 acts between a stationary bracket 54 on press brake side frame 10 and the upper end of lower treadle rod section 26, thus resiliently biasing the lower treadle rod section 26 upwardly.

Referring again to FIG. 1, a limit switch 60 is mounted on side frame 10 and is adapted to be operated by engagement of the lower end of a vertically adjustable block 61 carried by ram 13 against the limit switch operating lever. Limit switch 60 is of the double throw type and its control function will be described more fully later herein. Block 61 is mounted for vertical sliding movement relative to ram 13 and is held in adjusted position by a thumb screw 62. A treadle limit switch designated 66 is mounted on frame 10 just above the upper arm of bell crank 22 and is adapted to be closed when treadle 21 is in a raised position and open when the treadle 21 is away from a raised position.

Reference will now be had to the wiring diagram, FIG.

3. The numeral 70 designates a power supply line which will usually be 220 or 440 volts and the winding of solenoid 43 is interposed directly therein and is alternatively controlled by two pairs of shunt connected normally open contacts 71 and 72. Power supply 70 also has a parallel connection to the primary winding of a step down transformer 72 the secondary of which powers a control circuit comprising a main conductor 75 which includes three parallel conductors 76, 77 and 78 and a return conductor 79. The treadle limit switch 66 is interposed in parallel conductor 76 and ram limit switch 60 is adapted to alternatively connect either of the parallel conductors 77 and 78 to return conductor 79.

Parallel conductors 77 and 78 include windings 81 and 82, respectively. Winding 81 when energized closes contacts 71 to energize solenoid 43 and winding 82 controls a pair of normally open contacts 85 in conductor 76. Parallel conductor 76 includes a winding 86 which when energized closes the other pair of contacts 72 for energizing solenoid 43 and likewise closes a pair of normally open contacts 88 which are in conductor 76 but shunt connected around the treadle limit switch 66.

Means are provided for incapacitating the present automatic ram arresting circuitry and mechanism, such means comprising a pair of alternatively closable switches 90 and 91, the former being interposed in return conductor 79 and the latter in a shunt conductor 92 connected around the treadle limit switch as shown in the wiring diagram. A common manual operator for the switches 90 and 91 is schematically indicated at 94 and as illustrated the operator 94 is in the off position wherein the circuitry for the automatic arresting operation is shunted out.

When the automatic arresting operation is desired, operator 94 is manipulated to close switch 90 and open switch 91 and the operation of the arresting mechanism circuitry will now be described, it being understood that the switch 90 is now closed and switch 91 is open. The limit switches 60 and 66 are in the positions which they occupy initially before the operator depresses the treadle 21 to set the ram 13 of the press brake in motion.

It may be stated as a preliminary to the detailed description of operation that the spring 41 will cause the ball 38 to be moved into groove 39 when the ball and groove are in registry but is not of sufficient force to hold ball 38 in groove 39 against the tensile force in the treadle rod which is required to move the clutch mechanism to engaged position and hold the same in such position. The additional force against ball 38 applied when solenoid 43 is energized and is holding armature 50 in its left-hand position (the position illustrated in FIG. 2) is sufficient to retain ball 38 in groove 39 even as against the tensile force required for moving the clutch to engaged position and for holding the same in such position through the treadle rod 26, 27.

At the beginning of a cycle of operation the ram limit switch 60 is in the position illustrated and accordingly winding 81 is energized and contacts 71 are accordingly closed and solenoid 43 is energized to securely hold ball 38 in groove 39 whereby the lower and upper treadle rod sections 26 and 27 move in unison. At this time the treadle limit switch 66 is closed but the circuit thereof is open at the contact 85.

The operator now depresses the treadle which engages the clutch and shaft 16 rotates to move ram 13 downwardly under full power until the lower end of block 61 engages the operator of limit switch 60 to reverse the same. Block 61 will usually be adjustably set so that this reversal of switch 60 occurs just as the punch 15 meets the workpieces but preferably before any substantial bending takes place. Other critical ram arresting points may be selected if and as desired.

Upon reversal of ram limit switch 60, winding 81 is deenergized and winding 82 is energized. The deenergization of winding 81 causes contact 71 to open and sole-

5

noid 43 becomes deenergized. This removal of the additional holding force against ball 38 causes the same to be unseated due to the tension in treadle rod 26, 27 and upper treadle rod section 27 moves upwardly under the force of coil spring 30 and the spring means in the clutch which normally biases the same to disengaged position. While the reversal of ram limit switch 60 at this mid point in the descent of the ram energizes winding 82 and thus closes contacts 85 in parallel conductor 76, it has no immediate effect on solenoid 43 since the treadle 21 is depressed and consequently treadle limit switch 66 is now open.

With the ram now stopped at the point determined by the position of adjustment of block 61 the operator can shift his hands or check the position of the work sheet or make such other preparations as may be required or desirable prior to continuing the downward movement of the ram and performing the actual bending operation.

To complete the down stroke of the ram it is necessary for the operator to release the treadle 21 whereupon the plunger 36 moves upwardly in cylinder 35 until ball 38 again moves into groove 39 and when the treadle reaches its fully raised position bell crank 22 closes treadle limit switch 66.

At this point armature 50 of solenoid 43 is in the left-hand or "in" position with respect to the solenoid winding, and winding 43 is then energized by closure of the parallel conductor circuit 76 through treadle limit switch 66, thus energizing winding 86 and closing contacts 72 to reenergize solenoid winding 43.

At the same time the energization of winding 86 closes the shunt contacts 88 around treadle limit switch 66 to establish a holding circuit so that the operator may now depress the treadle 21 a second time to complete the bending and return operation of the ram, contacts 88 continuing the energization of winding 86 even through treadle limit switch 66 opens during the first part of the second depression of treadle 21.

As the ram moves upwardly block 61 moves away from the operator of limit switch 60 which again reverses to the position illustrated in the wiring diagram thus energizing winding 81 to close contacts 71 and maintain energization of solenoid 43 even though the reversal of ram limit switch 60 deenergizes winding 82 and causes contacts 85 to open, thus deenergizing winding 86 and opening contacts 72 and 88.

The disconnecting action as between lower and upper treadle rod sections 26 and 27 which occurs automatically upon deenergization of solenoid 43 by operation of ram limit switch 60 may further be utilized to provide a load limit safety feature so that the clutch for drive shaft 16 is automatically disconnected when a given load is exceeded. A simple means of obtaining a load indication is by the degree of vertical stretch of the frame of the press brake.

Referring to FIG. 1, the numeral 95 indicates a vertical rod which is fixed at its lower end to the side frame 10 of the press brake as at 96 and is slidably mounted at its upper end by means of a bearing 97 fixed to the upper portion of the press brake side frame 10.

A limit switch 98 is disposed above the upper end of rod 97 in such position that it is normally maintained closed by rod 97. When excessive frame stretch causes limit switch 98 to move upwardly with respect to the upper end of rod 95, the operating button of the limit switch is released and switch 98 opens. As shown in FIG. 3, the maximum load limit 98 is directly in series with solenoid 43 and thus arrests ram 13 in the same manner as when block 61 engages ram limit switch 60. Load limit switch 98 will automatically close whenever excessive strain is removed from the press brake side frame.

We claim:

1. In a power operated press brake having a ram and power means for reciprocating said ram to effect work-

6

ing and return strokes, a manually operable member and a control member for rendering said power means selectively operable and inoperable, each of said members having off and on positions and each being resiliently biased to off position, yieldable means normally connecting said members for joint movement between off and on positions but releasable under the force normally required to move said control member to on position and hold the same thereat, electromagnetic means and a circuit therefor normally energized to prevent release of said members, limit switch means actuatable by said ram at a predetermined point in its working stroke to open said circuit whereby said yieldable connection releases and said control member returns to off position, and alternative circuit means for said electromagnetic means energizable by return of said manual member to off position, whereby return of said manual member to off position establishes reconnection of said members and energization of said electromagnetic means whereby subsequent movement of said manual member to on position moves said control member to on position to complete a working stroke.

2. In a power operated machine having reciprocating means and power means for moving said reciprocating means to effect forward and return strokes, a manually operable member and a control member for rendering said power means selectively operable and inoperable, each of said members having off and on positions and each being resiliently biased to off position, yieldable means normally connecting said members for joint movement between off and on positions but releasable under the force normally required to move said control member to on position and hold the same thereat, electromagnetic means and a circuit therefor normally energized to prevent release of said members, limit switch means actuatable at a predetermined point in the forward stroke of said reciprocable means to open said circuit whereby said yieldable connection releases and said control member returns to off position, and alternative circuit means for said electromagnetic means energizable by return of said manual member to off position, whereby return of said manual member to off position establishes reconnection of said members and energization of said electromagnetic means whereby subsequent movement of said manual member to on position moves said control member to on position to complete a working cycle.

3. In a power operated press brake having a ram and power means for reciprocating said ram to effect working and return strokes, a manually operable member and a control member for rendering said power means selectively operable and inoperable, each of said members having off and on positions and each being resiliently biased to off position, clutch means normally connecting said members for joint movement between off and on positions but releasable automatically under a force less than that required to move said control member to on position and hold the same thereat, electromagnetic means adapted when energized to prevent release of said clutch means and a circuit therefor, limit switch means actuatable by said ram at a predetermined point in its working stroke to open said circuit whereby said clutch means releases and said control member returns to off position, and alternative circuit means for said electromagnetic means energizable by return of said manual member to off position, whereby return of said manual member to off position establishes reconnection of said members by said clutch means and energization of said electromagnetic means whereby subsequent movement of said manual member to on position moves said control member to on position to complete a working stroke.

4. In a power operated machine having reciprocating means and power means for moving said reciprocating means to effect forward and return strokes, a manually operable member and a control member for rendering said power means selectively operable and inoperable, each of said members having off and on positions and

each being resiliently biased to off position, clutch means normally connecting said members for joint movement between off and on positions but releasable automatically under a force less than that required to move said control member to on position and hold the same thereat, electromagnetic means adapted when energized to prevent release of said clutch means and a circuit therefor, limit switch means actuable at a predetermined point in the working stroke of said reciprocating means to open said circuit whereby said clutch means releases and said control member returns to off position, and alternative circuit means for said electromagnetic means energizable by return of said manual member to off position, whereby return of said manual member to off position establishes reconnection of said members by said clutch means and energization of said electromagnetic means whereby subsequent movement of said manual member to on position moves said control member to on position to complete a working cycle.

5. In a power operated press brake having a ram and power means for reciprocating said ram to effect working and return strokes, a manually operable member and a control member for rendering said power means selectively operable and inoperable, each of said members having off and on positions and said control member being resiliently biased to off position, means normally connecting said members for joint movement between off and on positions but releasable under the force normally required to move said control member to on position and hold the same thereat, electromagnetic means normally energized to prevent release of said members, means actuable by said ram at a predetermined point in its working stroke to deenergize said electromagnet whereby said

connection releases and said control member returns to off position, and actuable by return of said manual member to off position and subsequent movement to on position and adapted to establish reconnection of said members and movement of said control member to on position to complete a working stroke.

6. In a power operated machine having reciprocating means and power means for moving the same to effect forward and return working cycles, a manually operable member and a control member for rendering said power means selectively operable and inoperable, each of said members having off and on positions and said control member being resiliently biased to off position, means normally connecting said members for joint movement between off and on positions but releasable under the force normally required to move said control member to on position and hold the same thereat, electromagnetic means normally energized to prevent release of said members, means actuable at a predetermined point in the cycle of said reciprocating means to deenergize said electromagnet whereby said connection releases and said control member returns to off position, and means actuable by return of said manual member to off position and subsequent movement to on position and adapted to establish reconnection of said members and movement of said control member to on position to complete a working cycle.

References Cited in the file of this patent

UNITED STATES PATENTS

1,761,121	Graves et al. -----	June 3, 1930
2,362,343	Bath -----	Nov. 7, 1944
2,594,909	Georgeff -----	Apr. 29, 1952
2,840,135	Fowler -----	June 24, 1958