Aug. 18, 1953 L. D. BARLEY 2,649,153

HYDRAULIC CUTTING MACHINE

Filed Sept. 4, 1948 2 Sheets-Sheet 1

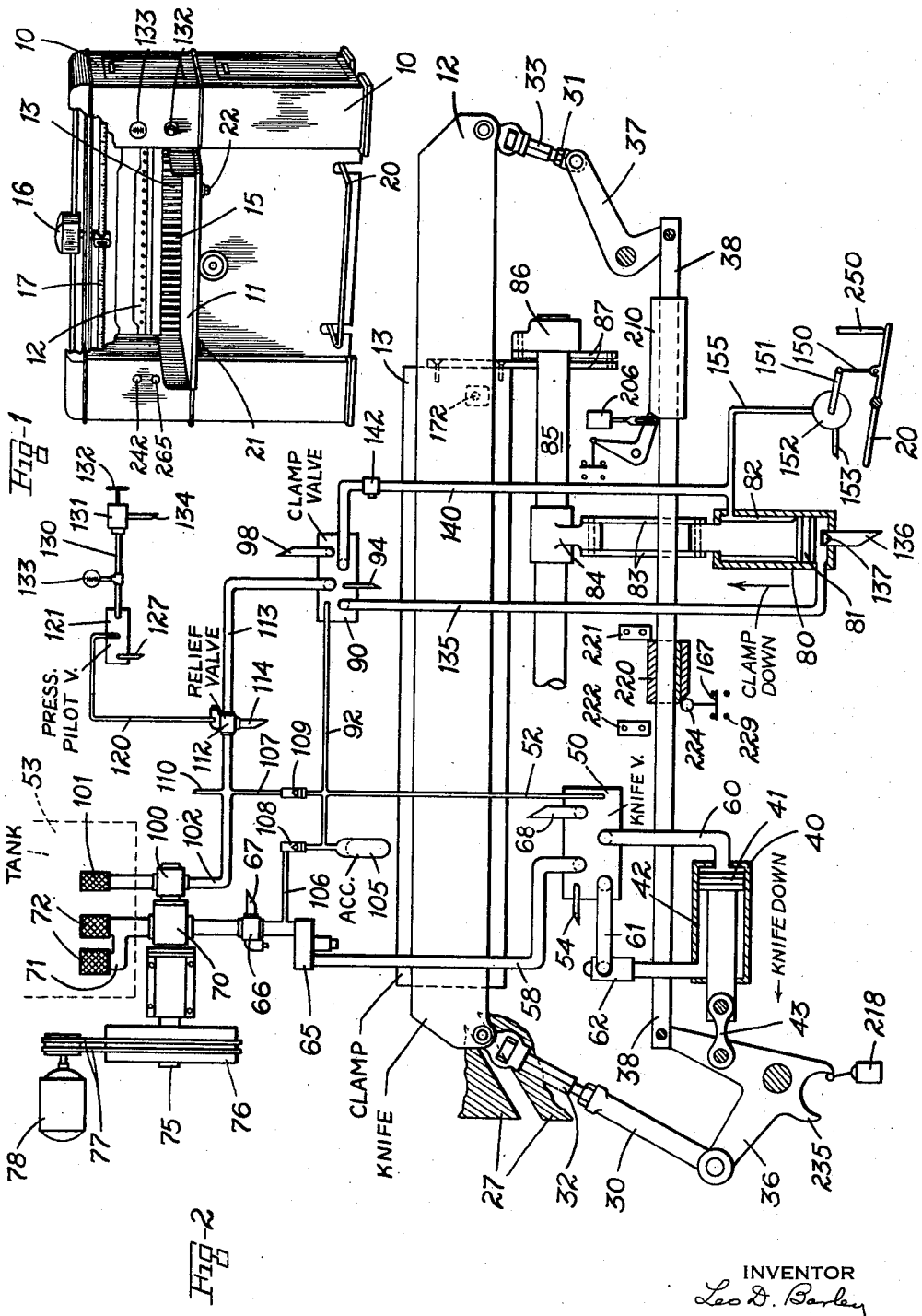


Fig-1

Fig-2

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2 Sheets-Sheet 2

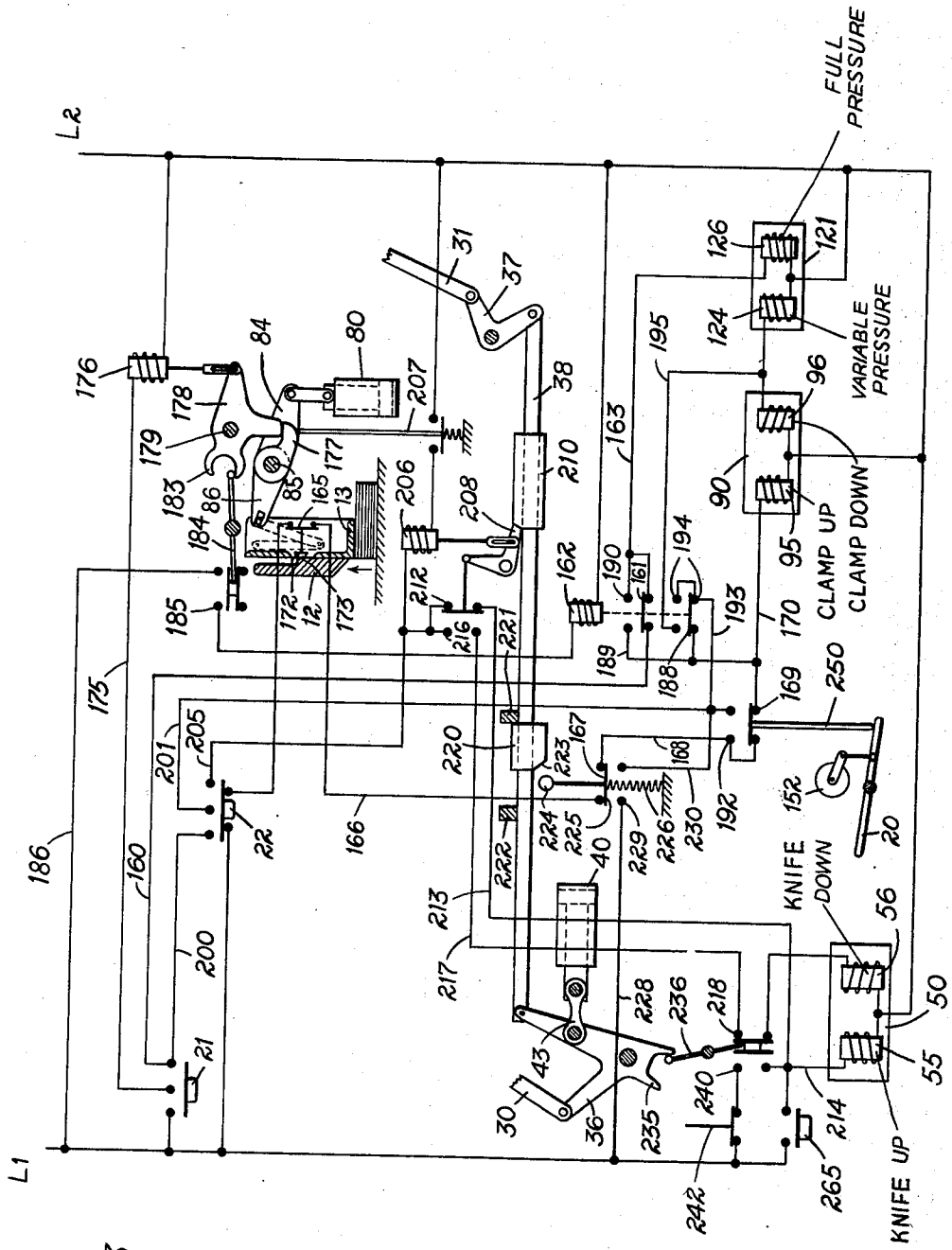


FIG-3

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HYDRAULIC CUTTING MACHINE

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Application September 4, 1948, Serial No. 47,833

18 Claims. (Cl. 164—54)

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This invention relates to cutting machines such as those used in the cutting of paper and the like.

In the cutting of paper and other sheet material it is customary to provide a drive for actuating the knife, the knife being operated usually by mechanical means in a succession of cutting strokes following each of which the pile may be moved either manually, or automatically by automatic control of the movement of a back gage or spacer. It is also customary to provide a clamp for compressing the pile or stack of sheet material and holding it securely during the cutting operation of the knife. This is desirably accomplished by moving the clamp into holding engagement with the pile in advance of the engagement of the knife with the pile, the clamp being retained in holding relation during the entire cutting stroke and during at least a portion of the return stroke, until the knife has cleared the pile.

In accordance with the present invention the entire operation of the cutter is preferably hydraulic, both with respect to the operation of the clamp, and the knife. While the clamp requires only a limited amount of power, the power required by the knife is quite substantial during the actual cutting of the pile, and it is further necessary that the operation of the clamp and the knife be fully coordinated at all points in the operating cycle.

In providing for the proper actuation of the knife by hydraulic motor means comprising a piston and cylinder, it is necessary to utilize a relatively high pressure pump, as well as a working piston of substantial area, in order to develop the necessary force for operating the knife in the actual cutting of the material, such operation giving rise to a peak demand for power substantially in excess of that required over the remainder of the working cycle. Also, in order that the cycle may not be prolonged or delayed, it is important as a practical matter that the knife travel on its working stroke at a substantial rate of speed, thus requiring a pump capable of developing a considerable horsepower in supplying fluid at the necessary pressure and rate of flow. Further, it is undesirable that the knife slow up appreciably upon engaging the pile, and it is important therefore that the hydraulic system be capable of supplying fluid at a substantially uniform rate both prior and subsequent to the engagement of the knife with the pile, this also placing definite requirements on the source of supply of hydraulic pressure fluid.

The present invention provides for meeting

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these conditions and makes possible a full hydraulic cutter which has adequate power to perform the necessary work operation, to accomplish that work operation at a desired high rate of speed, and without material reduction in rate of travel when the knife engages the pile. Furthermore this is accomplished with the use of an economical source of driving power, much less than that required for the interval during which the peak load exists. The clamp is likewise hydraulically actuated, and is correlated in its action so that it engages the pile in advance of the knife, and remains in engagement therewith until after the knife has withdrawn from the pile. In addition, the system is adequately protected against damage to itself in the event of an excessive load being applied to the knife, the hydraulic pressure being relieved at a predetermined maximum safe point so that no damage will be produced even in the event of a positive stop being interposed under the knife, and it thus becomes unnecessary to utilize fracture links or similar releasable elements customarily provided in cutters having mechanically driven knives. The cutter is furthermore completely interlocked so that both hands of the operator are required to be in a definite safe location before the knife can be set in motion on its cutting stroke. It is also possible to control the clamp independently of the knife, providing for downward movement thereof at a predetermined rate, as well as the stopping and return of the clamp from any position, under control of a treadle, in order to enable the operator properly to locate the pile in preparation for a subsequent cutting operation.

It is accordingly a principal object of the invention to provide a full hydraulic cutter in which the knife is operated rapidly and with a high degree of force throughout its entire stroke without requiring a source of driving power of correspondingly high horsepower output.

It is also an object of the invention to provide a drive source of relatively small output capacity for operating a hydraulic system for the actuation of the knife with the system providing for delivery of additional operating power to the hydraulic elements during the peak load conditions on the knife.

It is a further object to provide a hydraulic actuation cutter in which the operation of the knife and of the clamp are both accomplished by separate hydraulic mechanisms, the operation of which is fully coordinated throughout the entire cycle.

It is a still further object to provide a hydraulic cutter in which provision is made for relieving hydraulic pressure in response to an excessive load at such a point as to avoid damaging the mechanism.

Other objects and advantages will be apparent from the following description, the accompanying drawings, and the appended claims.

In the drawings:

Fig. 1 is a perspective view of a typical form of cutter employing the present invention, certain parts being broken away to better show the construction;

Fig. 2 is a schematic view of the cutter of the present invention illustrating the drive mechanism and the hydraulic equipment for actuating the knife and the clamp; and

Fig. 3 is a diagrammatic view showing the control circuits for use in the system.

Referring to the drawings, an illustrative form of cutting mechanism is shown at 10 including a housing enclosing the operating mechanism, a work receiving table 11, a cutting knife 12, and a clamp 13, located immediately rearwardly of the knife. A back gage is indicated at 15 and such back gage may also desirably be hydraulically actuated, such a construction being shown and described in copending application Serial No. 730,273, filed February 24, 1947 and assigned to the same assignee as this application. An indicator 16 travels with the back gage which moves across a suitable scale 17 at the front of the cutter thereby indicating the position of the back gage and the corresponding length of material which will be cut. A foot treadle is shown at 20 which is utilized for controlling the operation of the clamp independently of the knife, and the position of the safety buttons 21 for the left-hand and 22 for the right-hand are shown at opposite sides of and beneath the work table 11 in position such that the hands of the operator when actuating both buttons, as required in order for the machine to perform a cutting operation, are removed from the danger zone in the range of operation of the knife.

The knife 12 is indicated somewhat schematically in Fig. 2, being removably carried upon a knife bar in the usual way, and the knife bar being guided for reciprocating travel in guides such as 27 in the frame of the machine. A pair of links 30, 31 are secured to the knife bar and have non-circular connecting bars 32, 33 which are adjustable to provide for the accurate locating of the knife at the bottom of its stroke with reference to the cutting table, so that the knife will cut through the last sheet of paper and merely touch but not cut into the cutting stick provided below the knife. A suitable construction for this purpose is shown in copending application Serial No. 678,485, filed June 21, 1946, now Patent No. 2,451,636. Links 30 and 31 are actuated respectively by bell cranks 36, 37, the action of which is correlated by cross bar 38, extending across the machine from one crank to the other.

The knife linkage is actuated by a hydraulic motor indicated at 40 including a double acting piston 41 movable in cylinder 42 and connected to bell crank 36 by means of link 43. Thus it will be evident that movement of the piston toward the left as shown in Fig. 2 will cause a downward pull upon both links 30 and 31, causing the knife 12 to move downwardly and with a component of transverse movement, one end traveling downward at a faster rate than the other, thereby providing the desired double shearing action in the course of the work stroke. It will be understood that the mechanism is such that at the bottom of the stroke the knife assumes a position parallel with the cutting stick to thereby produce a uniform cut throughout the entire depth of the pile.

Selective control of the operation of the knife cylinder is obtained by means of a four-way knife valve indicated diagrammatically at 50, such valve conveniently being of the type known as a four-way open center valve, which is solenoid controlled and operated by pilot pressure. The pilot pressure is supplied through a pressure line 52 and is discharged back to the tank, indicated diagrammatically at 53, through discharge outlet 54. The "knife up" solenoid is indicated diagrammatically in Fig. 3 at 55 and the "knife down" solenoid at 56, both such solenoids being incorporated within the valve 50 and serving to selectively control the application of the pilot pressure from line 52 which is the power actually used to move the main valve body from one position to another away from center. The main fluid pressure supply line is shown at 58 leading into the knife valve 50, and connections 60 and 61 extend between the knife valve and the cylinder for supplying fluid thereto for actuating the knife on its down stroke and its up stroke, respectively. A counterbalance valve 62 is included in line 61 which allows free flow of the fluid from valve 50 to the lower or left hand side of piston 41 in the direction to raise the knife, but which maintains a back pressure to hydraulically counterbalance the sustained load of the knife thus controlling the return flow of the fluid from beneath the piston during the downward travel of the knife, to thereby regulate the rate of descent of the knife. This valve is adjustable and is preferably so set that it balances the weight of the knife so that a small pressure is developed above the piston during the downward travel of the knife, thereby causing the knife to move on its downward or cutting stroke at a substantially uniform rate, corresponding to the rate of supply of fluid to the piston. With a constant flow of fluid throughout the stroke, it follows that the piston and hence the knife continue to move at a substantially uniform rate even after engagement with the pile. With the system as described, the knife has a rate of travel on it working stroke of about 7 inches per second and a slightly greater rate of return movement.

Fluid is supplied to line 58 through a proportional filter 65 and through a pressure relief valve 66 which is set to relieve the pressure at a predetermined maximum, the pressure when relieved being discharged through vent 67 to the tank. This pressure relief valve thus assures against damage to the system, being set to carry the maximum load which the knife will encounter in a cutting operation, but relieving the system in response to an excess load so that even in the case of a solid obstruction in the path of the knife, the valve will merely open and release the pressure before damage occurs. A discharge line 68 returns the fluid from the side of piston 41 not under working pressure from the valve 50 back to the tank and likewise provides for flow of the entire supply of fluid to the tank without pressure when the valve 50 is centered, i. e., neither of its solenoids being energized. This provides for unloading the pump which supplies the fluid pressure when the knife is not in operation.

The main pump for supplying fluid for actu-

ating the knife is indicated at 70, being connected with supply lines 71 having filter openings 72 located in the sump tank 53. The pump 70 is of relatively large capacity, and is capable of supplying the fluid at the desired high pressure, for instance of the order of 1,000 pounds per square inch, and likewise at the desired high rate of flow, for example of the order of 33 gallons per minute. Such a pump, having this fluid output capacity, is rated at approximately 24 horsepower, and would normally require a correspondingly high output drive or motor, in order to be capable of developing the necessary power throughout the working stroke and maintaining the full rate of travel of the knife during its engagement with the work material. However in accordance with the present invention the pump shaft 75 carries an inertia means in the form of a fly-wheel 76 of sufficient mass as to be capable of imparting a substantial energy to the pump during the peak load period when the knife engages and passes through the work material on its cutting stroke. A fly-wheel having a weight of 300 pounds and an outer diameter of 19 inches and rotated at of the order of 1200 R. P. M., has been used successfully. The fly-wheel is suitably driven through V-belts 77 from an electric drive motor 78, the motor itself being of relatively small horsepower, satisfactory results having been secured with a pump as above described by the use of a motor of about 10 horsepower. The system therefore avoids the expense of installing and running a large capacity motor during the entire time, but makes it possible to actuate the pump without substantial or noticeable reduction in speed or output from a much smaller capacity motor by the use of an inertia means to which energy is supplied in the off-peak period of the cycle and from which energy is drawn during the peak load period of the cycle. The use of the fly-wheel as an inertia means is therefore important in the hydraulic system of the cutter, and makes possible the development of adequate power with an economical installation throughout.

The clamp 13 is actuated by a separate hydraulic motor which is supplied with hydraulic fluid under pressure from a separate pump, the hydraulic actuating system for the clamp thus being separate from that for actuating the knife. In the operation of the clamp it is desirable to be able to regulate the force with which the clamp engages the pile of work material in accordance with different types of material, etc. It is also desirable to provide for application of full hydraulic pressure to return the clamp on its upstroke, thus securing a uniform and maximum rate of withdrawal of the clamp, regardless of the particular operating pressure for which it has been set. Likewise it is important to provide for a rapid rate of downward travel of the clamp toward the pile but without requiring such a large capacity pump as to increase the power requirements or to increase the losses. It is also necessary to correlate the action of the clamp with that of the knife so that in the complete operation of the system, the clamp will engage the pile in advance of the knife, remain in engagement with the pile until the knife has withdrawn above the pile on the return stroke, and then return to a release position to enable the pile to be handled or shifted either under manual control or under automatic control of the back gage as above referred to.

The clamp operating motor is indicated generally at 80 comprising piston 81 movable in cylinder 82. The piston is connected by links 83 with a crank 84 secured to cross shaft 85 suitably journaled in the frame of the machine. Crank 86 and linkage 87 is provided at either end of the cross shaft and connected to the clamp 13 to provide for direct reciprocation thereof in a vertical plane in response to the rocking movement of shaft 85. It will be seen that the mechanism is such that travel of the piston 81 upwardly as shown in Fig. 2 results in downward clamping movement of the clamp 13. It will also be seen that the area below the piston is considerably greater than that above the piston, providing for developing a higher pressure to hold the clamp against the pile than is required to raise the clamp, the small area above the piston making it possible to raise the clamp rapidly.

The clamp valve is shown at 90, suitably being of the type known as a four-way closed center valve, solenoid controlled and operated by pilot pressure. Pilot pressure is supplied by pressure line 92 and is discharged back to the tank through discharge outlet 94. The "clamp up" solenoid is indicated diagrammatically in Fig. 3 at 95, and the "clamp down" solenoid at 96. As in the case of the knife valve 50, the solenoids are incorporated in the valve and selectively control the application of the pilot pressure from line 92 which provides the power to move the main valve body. A discharge line 98 returns discharged fluid from the valve 90 back to tank 53.

The separate supply pump for supplying the clamp operating pressure is shown at 100, having a filtered intake 101 within the tank 53 and connected to supply line 102. As shown pump 100 is preferably mounted on the same shaft 75 as pump 70 and thus is driven by the same motor. The power requirements for operating the clamp being substantially less than for the knife, the pump 100 may provide for developing approximately the same high pressure, for example 1000 pounds per squire inch, but has an output capacity of only about 7.5 gallons per minute, thus requiring about 5 horsepower.

In order to provide a source of pilot pressure for operating the several valves, an accumulator 105 is connected with each of pumps 70 and 100 through pressure lines 106 and 107 respectively, check valves 108 and 109 being included in the lines to allow one way flow only, in the direction to maintain a full pressure supply in the accumulator. It will be noted that both lines 52 and 92 are connected with the accumulator to thereby assure that full operating pressure will be available at all times for the actuation of these valves. A separate connection 110 may also be provided from supply line 102 for the actuation of the controls for the automatic back gage or spacer, in accordance with the system disclosed in said above referred to application Serial No. 730,273.

A clamp relief valve 112 is connected in the main pressure supply line 102 and a connecting line 113 leads to the clamp valve 90, the relief valve having a discharge line 114 leading back to the tank 53. This pressure relief valve is adapted to release in response to the development of the maximum pressure that it is desired to have in the clamp system at any time, and furthermore to be capable of partial venting so as to produce any desired pressure between a minimum of substantially zero and the maximum.

In order to be able selectively and remotely to control the pressure with which the clamp is applied a pressure line 120 leads from the vent-

ing part of the relief valve 112 to a pressure pilot valve 121 which is also solenoid controlled. Solenoid 124 is shown diagrammatically in Fig. 3, and marked "Variable Pressure," and solenoid 126 is similarly shown and marked "Full Pressure," both such solenoids being incorporated in the valve 121. A discharge connection 127 leads from the valve 121 back to the tank, and is adapted to return pilot fluid released by the valve when set for minimum operating pressure, thus controlling the action of pressure relief valve 112 to discharge the main flow through line 114 and establishing minimum pressure in line 113. A connecting pressure line 130 leads from valve 121 to a manually adjustable valve 131, having a control handle 132 conveniently accessible to the operator, the pressure in line 130 being read on gage 133 located on the front of the machine, which is suitably marked to indicate the pressure for which the valve is set. Through the pilot action of valve 131, substantially the same pressure is established in line 113. A discharge line 134 leads from valve 131 back to the tank, the valve 131 thus functioning to relieve the pressure in the lines 130, 120, and 113 when it arrives at the value for which the valve had been set.

Actuation of pressure pilot valve 121 therefore either closes off the connection to relief valve 112, in which case full or maximum pressure is maintained in the system with excess fluid being discharged from relief line 114, or it opens the connection to valve 131, in which case the pressure in the entire clamp actuating fluid system is limited to that for which the manual control 132 is set. Thus either maximum pressure, or a predetermined variable pressure is selectively supplied to the line 113, and through it to the clamp actuating valve 90.

In response to the actuation of the "clamp down" solenoid 96, pressure fluid is supplied from line 113 through clamp valve 90 and pressure line 135 to the lower side of piston 81, in the direction providing for downward movement of the piston. In order to provide for more rapid introduction of the fluid to the space below the piston, to thus enable a faster rate of fall of the clamp prior to the time it engages the pile, a supply line 136 leads directly from tank 53 to the lower side of the piston, a check valve 137 being included in this line to allow free inward flow of the fluid but preventing outward flow. Since the area of the piston is relatively large, it would normally require a large volume of flow from the pump in order to enable the clamp to fall sufficiently rapidly without pulling away from the fluid, and this in turn would necessitate the use of a larger capacity pump 100. However through the provision of this direct supply line 136, the desired high rate of in-flow of the fluid is made possible without increasing the capacity of the pump, and without requiring the development of any additional power. It will be understood of course that when the clamp engages the pile, there is no further free flow, and pressure is then supplied through line 135 to develop the desired clamping pressure, check valve 137 at this time closing and preventing escape of fluid from the cylinder.

In response to the actuation of the "clamp up" solenoid 95, pressure fluid is supplied through line 113 to valve 90, and from that through line 140 to the opposite or upper side of piston 81, in the direction to cause the raising of the clamp. A metering check valve 142 is included in line 140 of such character as to allow free flow of the fluid in the direction toward cylinder 80, while restricting the flow of fluid in the opposite direction to a predetermined rate. Thus fluid is supplied without restriction to the upper side of piston 81 which has a relatively small area thereby providing for rapid filling of the cylinder and correspondingly rapid rise of the clamp. Downward movement of the clamp under the action of gravity however is controlled by the rate of flow of fluid in the reverse direction through metering valve 142 to thereby regulate and cushion the descent of the clamp to a rate sufficiently fast to avoid delay in the cycle but not so fast as to result in too sharp an impact upon engagement of the clamp with the pile. Reference is made to copending application Serial No. 654,157, filed March 13, 1946 now Patent No. 2,599,591, assigned to the same assignee as this application with respect to the features of hydraulic control of the clamp.

It will be understood from the foregoing description that adjustment of the manual control valve 131 provides for establishing a predetermined fluid pressure in the clamp hydraulic system which is effective upon the clamp when in engagement with the pile to thereby provide for clamping the pile with a predetermined force, such force being readily adjusted by operation of the manual control member 132. The controls are preferably such that the variable pressure condition is made effective only in the downward or working direction of operation of the clamp, the full or maximum pressure being uniformly established in the system through the proper actuation of the pilot pressure valve 121 when the clamp is being raised or moved to its inoperative position.

It is also desirable to provide for control of the clamp in response to the operation of treadle 20, to enable the operator to bring the clamp to its lowered position, and to enable the operator to drop the clamp either wholly or in part, and is desirable when locating the pile and in determining the line at which the cut will be made. For this purpose the treadle is arranged with a link 150 which is connected to arm 151 of a by-pass valve 152 which has a discharge line 153 leading back to the tank 53. A supply line 155 connects directly with supply line 140, and the arrangement is such that treadle 20 which is normally biased to the raised position will open valve 152 to a greater or less extent as the treadle is depressed, thereby bleeding fluid from line 140 at a more or less rapid rate. The controls are preferably so arranged that when the treadle is depressed, the clamp valve 90 is in its central position where both lines 135 and 140 are closed, the fluid already present above piston 81 being retained therein, thus holding the clamp in its raised position. Upon actuation of treadle 20, fluid from line 140 is by-passed directly back to the tank, and by suitable manipulation of the treadle, the rate of such withdrawal of fluid can be controlled to allow the clamp to fall slowly, or rapidly, the latter taking place when the valve 152 is fully open with the entire fluid supply being thus discharged directly back to the tank. Also when fully depressed, the normal operating pressure of the clamp is applied in accordance with the setting of valve 131. The treadle may be stopped in any position, and upon release and return to its normal raised position, the valve 152 will be closed, pressure will be supplied to the upper side of the clamp piston, and the clamp will

return to its raised position. The treadle therefore provides for completely flexible control of the movement of the clamp by control of the clamp operating fluid, and independently of the cycling of the machine in the cutting of the pile.

The circuits for controlling the operation of the cutter are illustrated diagrammatically in Fig. 3. A source of electric control power is indicated at L_1, L_2, and the several parts of the mechanism which are important in providing for the control of the cycle are likewise indicated in a diagrammatic way. The left-hand button 21 and the right-hand button 22 are indicated as providing for control of the several circuits which will now be described in conjunction with the parts of the mechanism already described above.

Operation of the machine is initiated by the pressing of the left-hand button 21. Upon actuation, this button establishes a circuit for the actuation of the pilot pressure valve 121 to apply full pressure to the clamp which circuit may be traced from L_1, button 21, line 160 through back contacts 161 of relay 162 and line 163 to solenoid 126, the opposite side of which is directly connected to L_2. This provides for actuation of the pilot pressure valve 121 in the direction to close line 120 from the venting port of relief valve 112 and to establish full hydraulic pressure in the line 113 leading to the clamp directional valve 90. A circuit for the actuation of the "clamp up" solenoid 95 in the clamp directional valve 90 may be traced from L_1 through the back contacts of right-hand button 22, through the closed contacts of switch 165, through line 166 to switch contacts 167, line 168, normally closed switch contacts 169 and line 170 to one side of solenoid 95, the opposite side of which is directly connected to L_2. Thus immediately upon the pressing of the left-hand button, full pressure is applied to the upper side of piston 81 and the clamp is urged to its uppermost position against a stop formed by engagement of the piston 81 with bottom of cylinder 80. The system is thus normally in clamp up position and the clamp is immediately raised to take the load off the latch. Switch 165 is carried by the clamp itself and has an operating head 172 which projects through an opening in the face of the clamp so that the head may be engaged by a pad 173 on the knife bar 12 when the knife cutting edge rises above the lower edge of the clamp, which also defines the top of the pile when the clamp is on the pile. When however the knife edge extends below the clamp, i. e., when it is in cutting relation with the pile, or prior to the time when it has cleared the pile on its return stroke, head 172 projects through the opening and the switch contacts 165 remain open, for a purpose which will be explained more fully hereinafter.

The closing of the left-hand button also establishes a circuit through line 175 to a latch solenoid 176, and the pressure having now been withdrawn from the arm 177 associated with the clamp, solenoid 176 is able to rock the latch member 178 about its pivot 179 to a clearance position which will allow the clamp to fall, it being understood that when such movement occurs, the crank arm 84 of the clamp rotates in a counterclockwise direction about the axis of shaft 85.

As soon as the latch member 178 is withdrawn to its clearance position, its forked end 183 trips switch arm 184 of a snap action toggle switch to close its switch contacts 185, thereby establishing a circuit from L_1 through line 186 to cause the energization of solenoid 162. Upon energization, solenoid 162 is actuated and moves both its upper switch arm 161 and lower switch arm 188 to the raised position. Assuming that the right-hand button has not yet been actuated, there is no further change in the controls, the "clamp up" solenoid 95 and the full pressure solenoid 126 remaining energized, the circuit for the latter being now completed from switch contacts 169, line 189 and switch contacts 190 to line 163 and solenoid 126.

Upon the actuation of the right-hand button, a circuit is established from line 200, through the right-hand button 22, line 201, line 193, switch contacts 194 and line 195 to the clamp directional valve 90, with the "clamp down" solenoid 96 and variable pressure solenoid 124 being energized. Also the circuit for solenoid 126 is broken at the back contacts of the right-hand button. Since the circuit for energizing the up solenoid 95 was previously established through the back contacts of the right-hand button 22 this solenoid 95 and full pressure solenoid 126 will thereupon be released and the clamp directional valve will operate in the direction to supply fluid below piston 81, and the clamp will fall at the predetermined rate as established by the metering valve 142.

The pilot pressure valve solenoid 124 is energized from line 195, thereby connecting regulating or variable pressure valve 131 in the fluid circuit and providing for controlling the fluid pressure in line 113 in accordance with the pressure for which manual control 132 has been adjusted. The clamp thereupon descends at the predetermined rate until it strikes the pile, and is then pressed against the pile with a force determined by the variable fluid pressure so established in the clamp system.

Actuation of the right-hand button 22 also establishes a control circuit for initiating the operation of the knife, which may be traced from L_1 through left-hand button 21, line 200, right-hand button 22, line 205 and solenoid 206, through switch 207 to L_2. Switch 207 is normally open and is not closed until the clamp crank arm 84 and arm 177 have moved an appreciable distance, thus assuring that the clamp will have already progressed on its downward stroke and be certain to precede the knife. Solenoid 206 is connected to the latch 208 which cooperates with a fixed abutment 210 on the knife connecting rod 38 to retain the knife in its raised or inoperative position, but until the weight of the knife is taken from the latch, the solenoid is ineffective and the knife remains in latched position.

A parallel circuit leads from line 205 through switch contacts 212 controlled by the latch 208, lines 213 and 214 to the "knife up" solenoid 55 embodied in knife valve 50. Upon actuation, valve 50 is thus energized in the direction to cause the introduction of pressure fluid from pump 70 through line 61 to the left of piston 41, and the knife is accordingly raised to its uppermost position against a stop formed by engagement of piston 41 with the head of cylinder 40, thereby relieving the load on latch 208, and enabling the solenoid 206 to release the latch.

As soon as latch 208 is released, the switch associated therewith opens its contacts 212 and closes its contacts 216, thereby deenergizing the "knife up" solenoid 55, and energizing the "knife down" solenoid 56 through line 217 and closed switch contacts 218. Fluid pressure from pump 70 is thereupon supplied through line 58, valve

50 and line 60 to the right-hand side of piston 41, the piston traveling downwardly at the rate permitted by the escape of fluid from the opposite side of the piston through valve 62 until the knife strikes the pile after which the stroke continues at the same rate, that is, the rate determined by the rate of supply of fluid to the piston in the manner just described.

The operator may wish to stop the downward travel of the knife at an intermediate point in the stroke, and this may be accomplished by releasing either or both the left and right hand buttons, such release opening the energizing circuit for the "knife down" solenoid 56, the knife valve then returning to its center or neutral position where it blocks the flow to both sides of the knife piston, and allowing the fluid to flow freely back to the tank through vent 68, thereby providing for holding the knife in fixed position through a hydraulic block.

It may also be desirable to provide for maintaining clamp pressure upon the pile during this stoppage of the knife, and this may be accomplished after having released the right and left hand buttons, in the following manner. To accomplish this result a block 220 is frictionally mounted upon the knife connecting bar 38 and is movable over a relatively short travel between fixed stops 221 and 222, being frictionally carried by the connecting bar into engagement with one stop or the other, the bar continuing to travel through the stop after such engagement occurs. The block has a cam face 223 on its lower side which is adapted to engage the operating end 224 of a switch arm 225 which is normally urged into circuit closing relation with the contacts 167 by means of spring 226. Thus after the knife has started its downward travel and block 220 has moved into engaging relation with the operating end 224 of switch 225, a parallel energizing circuit for the clamp down solenoid 96 and variable pressure solenoid 124 is established from L_1 through line 228, switch contacts 229 and line 230, so that the clamp continues to be actuated against the pile notwithstanding release of either or both the left and right hand buttons.

When the knife reaches approximately the bottom of its stroke, or immediately prior thereto, an operating finger 235 carried by bell crank 36 is moved sufficiently far to cause the actuation of a snap action toggle switch 236 from the position shown where it has closed contacts 218 to its alternate position where it closes contacts 240. The opening of contacts 218 deenergizes the "knife down" solenoid 56, and for the extremely brief interval that the knife valve 50 requires to travel to its opposite position, the flow of hydraulic pressure is relieved. The bottoming of the knife piston 41 in the cylinder determines the maximum travel, and the knife connections 32 and 33 have previously been adjusted so that at this point the bottom edge of the knife has cut through the last sheet of paper and is in immediate contact with the cutting stick.

As soon as toggle switch 236 is tripped and switch contacts 240 closed, a circuit is established from L_1 through normally closed switch 242, switch 240 and line 214 to the "knife up" solenoid 55, and fluid pressure is thereupon supplied through line 61 in the direction to cause the raising of the knife. As soon as the knife has bottomed at the end of its working stroke it is safe for the operator to release the buttons since the knife can no longer cause injury to his hands, and the circuit for the knife up solenoid as just described is therefore completed directly from L_1 through toggle switch contacts 240, and not through either the left or the right hand buttons. Retention of the right-hand button will maintain the clamp in engagement with the pile, while release of the right-hand button however restores the circuits to their normal conditions and results in return movement of the clamp.

It is desired however to keep the clamp in contact with the pile until the knife has cleared the pile on its up stroke and this is accomplished in the following way. Immediately upon the return or upward movement of the knife, bar 38 moves toward the right as shown in Fig. 3 and carries block 220 with it, away from stop 222 and into contact with stop 221, the bar continuing to move through block 220 after the latter engages the stop. Upon withdrawal of the block 220 from switch operating member 224, spring 226 restores the switch to the position where its contacts 167 are closed, but the circuit for the energizing of the "clamp up" solenoid 95 and the full pressure solenoid 126 are not completed because knife 13 has not cleared the top of the pile and thus switch 165 is open. Accordingly the clamp remains without change, i. e., in contact with the pile, until the knife on its return stroke has risen above the bottom of the pile, at which time its pad engages the operating member 172, closing switch 165, and thereupon energizing both the "clamp up" solenoid 95 and solenoid 126. Full pressure is thereupon at once applied to the clamp in the direction to cause it to rise, with the result that the clamp returns to its upper position where it is again latched and locked by latch 178 which has been released by solenoid 176 which occurred upon release of the left-hand button so that it stands in latching relation. Toggle switch 184 thereupon returns to the position where it opens switch contact 185, deenergizing relay 162 and thereby solenoid 126 in valve 121 whereupon the pressure in line 113 drops to the minimum. Upon return of the knife to its raised position, it is also locked in place by latch 208 which is released by solenoid 206 and drops back to latching position upon release of the right-hand button.

The advantage of controlling the return movement of the clamp in the manner described above will be understood in view of the fact that the height of the pile will vary over a considerable range, and with the control constructed and functioning in the manner herein set forth, assurance will be provided that the clamp will remain in contact with the pile throughout the down stroke and for as much of the return stroke of the knife as is required to clear the pile, but as soon as the knife has cleared the pile, whether the pile is high or low, the clamp will promptly release and return to its raised position, thereby affording a maximum speed of operation of the entire machine consistent with good cutting practice.

In order to provide for the actuation of the clamp under control of the foot treadle 20, it is necessary to actuate the left-hand button 21, which first closes the "clamp up" solenoid 95 and full pressure solenoid 126 to raise the clamp, providing for release of latch 178 and the closing of the energizing circuit for relay 162 in the manner previously described. The switch 169 is so arranged that it normally remains in closed position when the treadle is not operated, but immediately upon the depression of the treadle, a connecting pin 250 provides for opening switch con-

tacts 169 providing for deenergization of the "clamp up" solenoid 95 and full pressure solenoid 126. The clamp directional valve 90 returns to neutral position in which it closes all ports, and the escape of fluid from above piston 81 is regulated directly under the control of the by-pass valve 152 in accordance with the extent of depression of treadle 20. It will be seen that the clamp can thus be stopped in any desired position merely by partially releasing the treadle but without completely doing so.

Full depression of the treadle results in closing switch contacts 192 which thereupon establishes the same circuit as previously described for energizing the "clamp down" solenoid 96 and variable pressure solenoid 124, thereby establishing the predetermined desired pressure upon the clamp to hold it against the pile.

Full release of the treadle re-closes switch contacts 169 and restores the raising circuit for the clamp which then returns to its fully raised position. Complete control of the clamp is thus obtained by manipulation of the treadle.

It is frequently desirable to provide for the stopping of the knife at the bottom of its stroke, as when it is desired to adjust the position of the bottom edge of the knife, and in order to accomplish this, the switch 242 is provided in the supply line leading to switch contacts 240 of toggle switch 236. Switch 242 is normally closed, but when manually opened, will provide for stoppage of the knife at the bottom of its stroke, preventing the closing of the circuit to the "knife up" solenoid 55 upon the actuation of toggle switch 236. The knife can then be adjusted as desired, following which the restoring of switch 242 to the closed position will complete the up circuit for the knife and the cycle will continue from that point in the same manner as described above. Where it is desirable to inch the knife upward, as when changing knives, switch 242 may be released to open position and then manually closed in short repeated intervals so as to inch or jog the knife upward by small increments.

It may also be desirable at times to provide for immediate up travel of the knife from any actuated downstroke position and in order to provide for this operation a switch button 265 is included in a parallel circuit directly connected through line 214 to the "knife up" solenoid 55. Thus actuation of switch 265 will immediately energize the knife up solenoid, which returns the knife to its raised position. It is also preferable to incorporate a control for preventing repeat cycles unless the control buttons have been released in the meantime, a suitable control for such purpose being shown in Patent 2,182,018 owned by the assignee of the present application.

The system herein described thus provides a fully automatic hydraulic cutter with adequate power for operation of both the clamp and the knife throughout their cutting strokes, but without requiring the high capacity drive source which would otherwise be needed to develop the full peak load imposed upon the knife. The knife operation is fully coordinated with that of the clamp throughout the entire cycle of operation, and the clamp may likewise be independently controlled by the treadle without any corresponding travel of the knife. The pressure with which the clamp is applied is readily adjustable, and the clamp operation is controlled in direct relation to the height of the pile so that the clamp remains in contact with the pile, whatever its height, until after the knife has withdrawn above the top of the pile. The entire mechanism is thus highly economical, fully protected with regard to the safety of both the operator and the machine itself, and is completely flexible to accomplish whatever result may be desired in the normal operation of a cutter of this type.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A hydraulic cutter comprising a work table adapted to receive the material to be cut, a knife mounted for reciprocation with respect to said table, means for latching said knife in raised position, a clamp movable toward and away from said table to clamp the material in working position thereon, means to latch said clamp in raised position above said table, hydraulic means for actuating both said clamp and said knife, controls for operating said hydraulic means initially in the direction to raise both said knife and said clamp, and means for releasing said clamp latch and said knife latch while said clamp and knife are raised.

2. A hydraulic cutter comprising a work table adapted to receive the material to be cut, a knife mounted for reciprocation with respect to said table, means for latching said knife in raised position, a clamp movable toward and away from said table to clamp the material in working position thereon, means to latch said clamp in raised position above said table, reversible hydraulic means for actuating both said clamp and said knife, control means for actuating said reversible means in the direction initially to raise said knife and said clamp, means for releasing said latches while said knife and said clamp are in raised position, and means for thereafter reversing said power means to provide for travel of said knife and said clamp respectively into working relation with the work material.

3. A hydraulic cutter comprising a work table adapted to receive the material to be cut, a knife mounted for reciprocation with respect to said table, means for latching said knife in raised position, a clamp movable toward and away from said table to clamp the material in working position thereon, means to latch said clamp in raised position above said table, reversible hydraulic means for actuating both said clamp and said knife, control means for actuating said reversible means in the direction initially to raise said knife and said clamp, means for releasing said latches while said knife and said clamp are in raised position, means for thereafter reversing said power means to provide for movement of said knife and said clamp respectively into working-relation with the work material, and means preventing release of said knife latch until after the release of said clamp latch providing for engagement of said clamp with the work prior to engagement of the knife therewith

4. A hydraulic cutter comprising a work blade adapted to receive the material to be cut, a knife mounted for reciprocation with respect to said table, means for latching said knife in raised position, a clamp movable toward and away from said table to clamp the material in working position thereon, means to latch said clamp in raised position above said table, reversible hydraulic means for actuating both said clamp and said

knife, control means for actuating said reversible means in the direction initially to raise said knife and said clamp, means for releasing said latches while said knife and said clamp are in raised position, means for thereafter reversing said power means to provide for movement of said knife and said clamp respectively into working relation with the work material, and means for maintaining said clamp in pressure relation with the work until after the completion of the working stroke of said knife.

5. A hydraulic cutter comprising a work table adapted to receive the material to be cut, a knife mounted for reciprocation with respect to said table, hydraulic piston means for actuating said knife, means for supplying hydraulic fluid to said knife piston at a substantially uniform rate to maintain a uniform rate of travel of said knife on its working stroke, means for preventing the fall of said knife at a rate in excess of said uniform rate prior to its engagement with the work material, means for limiting the maximum pressure on said piston during the working stroke of the knife, a clamp movable toward and away from the table to clamp the work material in working position thereon, a hydraulic piston for actuating said clamp, means for operating said clamp in correlated relation with said knife to clamp the work material on said table while it is being cut by said knife, and adjustable means for varying the discharge of hydraulic fluid from said piston during the downward travel of said clamp to determine the rate of fall thereof.

6. A hydraulic cutter comprising a work table adapted to receive the material to be cut, a knife mounted for reciprocation with respect to said table, a clamp movable toward and away from said table to clamp the work material in working position thereon, a reversible hydraulic motor for actuating said knife, a separate reversible hydraulic motor for actuating said clamp, control means operative in response to the travel of said knife to its lowermost position for reversing its said hydraulic motor independently of said clamp motor to cause the return of said knife to its raised position, and means controlled by said knife upon its upward or return stroke for reversing said hydraulic motor for said clamp to cause return of said clamp to its raised position.

7. A hydraulic cutter comprising a work table adapted to receive the material to be cut, a knife mounted for reciprocation with respect to said table, a clamp movable toward and away from said table to clamp the work material in working position thereon, a hydraulic motor for operating said knife, a separate hydraulic motor for operating said clamp, means for operating said clamp in correlated relation with said knife to clamp the work material on said table while it is being cut by said knife, means for supplying full hydraulic pressure to actuate said knife on both its cutting and its return stroke, and means for selectively supplying full hydraulic pressure to said clamp to cause the raising thereof and for supplying a predetermined adjustable pressure to said clamp when in engagement with said work material.

8. A hydraulic cutter comprising a work table adapted to receive a pile of material to be cut, a knife mounted for reciprocation with respect to said table, a clamp movable toward and away from said table to clamp the material in working position thereon, means for actuating the knife on a working and a return stroke of movement, separate power operated means for causing the clamp to engage the pile in advance of the knife with a predetermined force, and means controlled in accordance with the height of the pile for controlling said power operated means to maintain the clamp in contact with the pile until after the knife has cleared the pile on its return stroke.

9. A hydraulic cutter comprising a work table adapted to receive a pile of material to be cut, a knife mounted for reciprocation with respect to said table, a clamp movable toward and away from said table to clamp the material in working position thereon, means for actuating the knife on a working and a return stroke of movement, separate power operating means for moving said clamp in pressure engagement with the pile in advance of the knife with a predetermined force, and means carried by the clamp and adapted to be engaged by the knife for controlling said power operated means to effect the return movement of the clamp and providing for initiating the return movement of the clamp immediately following the knife clearing the top of the pile.

10. A hydraulic cutter having a work table adapted to receive the material to be cut, a knife mounted for reciprocation with respect to said table, a clamp movable toward and away from said table to clamp the work material in working position thereon, hydraulic motor means for actuating said knife on a cutting stroke and on a return stroke, separate hydraulic motor means for actuating said clamp into clamping engagement with the pile of work material and for returning said clamp to an inoperative position, common control means for said knife actuating motor and said clamp actuating motor for producing a cycle of operation of both said knife and said clamp to provide for cutting the work material while the same is held in clamped relation by said clamp, and additional manually operable means for modifying the action of said control means to interrupt the travel of said knife at an intermediate point of its stroke while retaining said clamp in clamping engagement with the work material.

11. A hydraulic cutter having a work table adapted to receive the material to be cut, a knife mounted for reciprocation with respect to said table away from and back to an inoperative position, a clamp movable toward and away from said table to clamp the work material in working position thereon, hydraulic motor means for actuating said knife on a cutting stroke and on a return stroke, separate hydraulic motor means for actuating said clamp into clamping engagement with the pile of work material and for returning said clamp to an inoperative position, control means for producing a cycle of operation of both said knife and said clamp to provide for cutting the work material while the same is held in clamped relation by said clamp, and means controlled in response to movement of said knife away from said inoperative position providing for maintaining said clamp in clamping engagement with the pile during stoppage of the travel of said knife at an intermediate point in its operating stroke.

12. In a hydraulic cutter having a work table adapted to receive a pile of material to be cut and a knife mounted for reciprocation with respect to said table, the combination of a clamp movable toward and away from said table to clamp the work material upon said table, hydraulic motor means for actuating said clamp into clamping position against said pile and providing for returning of said clamp to an inopera-

tive position, means for latching said clamp in said inoperative position, means for initially actuating said hydraulic motor means in the direction to raise said clamp enabling said latch to be released, and means controlled by release of said latch for reversing the action of said hydraulic motor means to provide for movement thereof into clamping engagement with the work material.

13. A hydraulic cutter comprising a work table adapted to receive the material to be cut, a knife mounted for reciprocation with respect to said table, reversible hydraulic means for actuating said knife on a forward cutting stroke and a return stroke, means for normally reversing the action of said motor in response to the knife reaching the bottom of its working stroke to provide for immediate return movement thereof, and additional control means settable in advance of the actuation of said knife for disabling said normal control to provide for stopping the knife at the bottom of its stroke.

14. A hydraulic cutter comprising a work table adapted to receive the material to be cut, a knife mounted for reciprocation with respect to said table, reversible hydraulic means for actuating said knife on a forward cutting stroke and a return stroke, means for normally reversing the action of said motor in response to the knife reaching the bottom of its working stroke to provide for immediate return movement thereof, control means for disabling said normal reversing means to provide for stopping the knife at the bottom of its stroke, and additional means for manually controlling said hydraulic means providing for the jogging motion of said knfe.

15. A hydraulic cutter comprising a work table adapted to receive the material to be cut, a knife mounted for reciprocation with respect to said table away from and back to an inoperative position, reversible hydraulic means for actuating said knife on a forward cutting stroke and a return stroke, means for normally reversing the action of said motor in response to the knife reaching the bottom of its working stroke to provide for immediate return movement thereof, control means for disabling said normal reversing means to provide for stopping the knife at the bottom of its stroke, and additional independently actuated means for controlling said hydraulic means to return the knife to said inoperative position.

16. A hydraulic cutter having a work table adapted to receive the material to be cut comprising a knife mounted for reciprocation with respect to said table, a hydraulic motor for actuating said knife from a source of fluid pressure, a clamp movable toward and away from said table to clamp the work material in working position thereon, a hydraulic piston for actuating said clamp from a source of fluid pressure, valve means for controlling the application of said fluid pressure to one side of said piston to provide for actuation of said clamp into engagement with said work material on said table, valve means for controlling the discharge of fluid from the opposite side of said piston to provide for control of the rate of fall of said clamp from an inoperative position into engagement with said work material, manually operated means for adjusting the

position of said second mentioned valve providing for predetermining said rate of fall of the clamp, and means for controlling the operation of said knife actuating motor to cause the cutting of the work material while held by said clamp upon said work table.

17. A hydraulic cutter comprising a work table adapted to receive the work to be cut, a knife mounted for reciprocation with respect to said table, hydraulic means for actuating said knife to cause it to perform a working stroke in the cutting of the work material and to perform a return stroke to an inoperative position, a clamp movable toward and away from said table to clamp the work material thereon during the working stroke of said knife, hydraulic motor means for actuating said clamp, solenoid operated control means for both said knife and said clamp for establishing correlated operation thereof in the cutting of the work, a toggle switch actuated by said knife at the bottom of its stroke for rapidly reversing said control means for said knife to provide for immediate return of said knife to said inoperative position following completion of its working stroke, an additional switch means controlled in response to the return movement of said knife for separately reversing said control means for said clamp.

18. In a hydraulic cutter having a work table adapted to receive a pile of material to be cut and a knife mounted for reciprocation with respect to said table, the combination of a clamp movable toward and away from said table to clamp the work material upon said table, hydraulic motor means for actuating said clamp in clamping position against said pile to provide for return of said clamp to an inoperative position, means for latching said clamp in said inoperative position, means for initially actuating said hydraulic motor in the direction to raise said clamp enabling said latch to be released, and a toggle switch controlled by release of said latch for rapidly reversing the action of said motor providing for movement of said clamp into clamping engagement with the work material.

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