March 4, 1958 L. D. BARLEY 2,825,404

HYDRAULIC CUTTING MACHINE

Original Filed Sept. 4, 1948 2 Sheets-Sheet 1

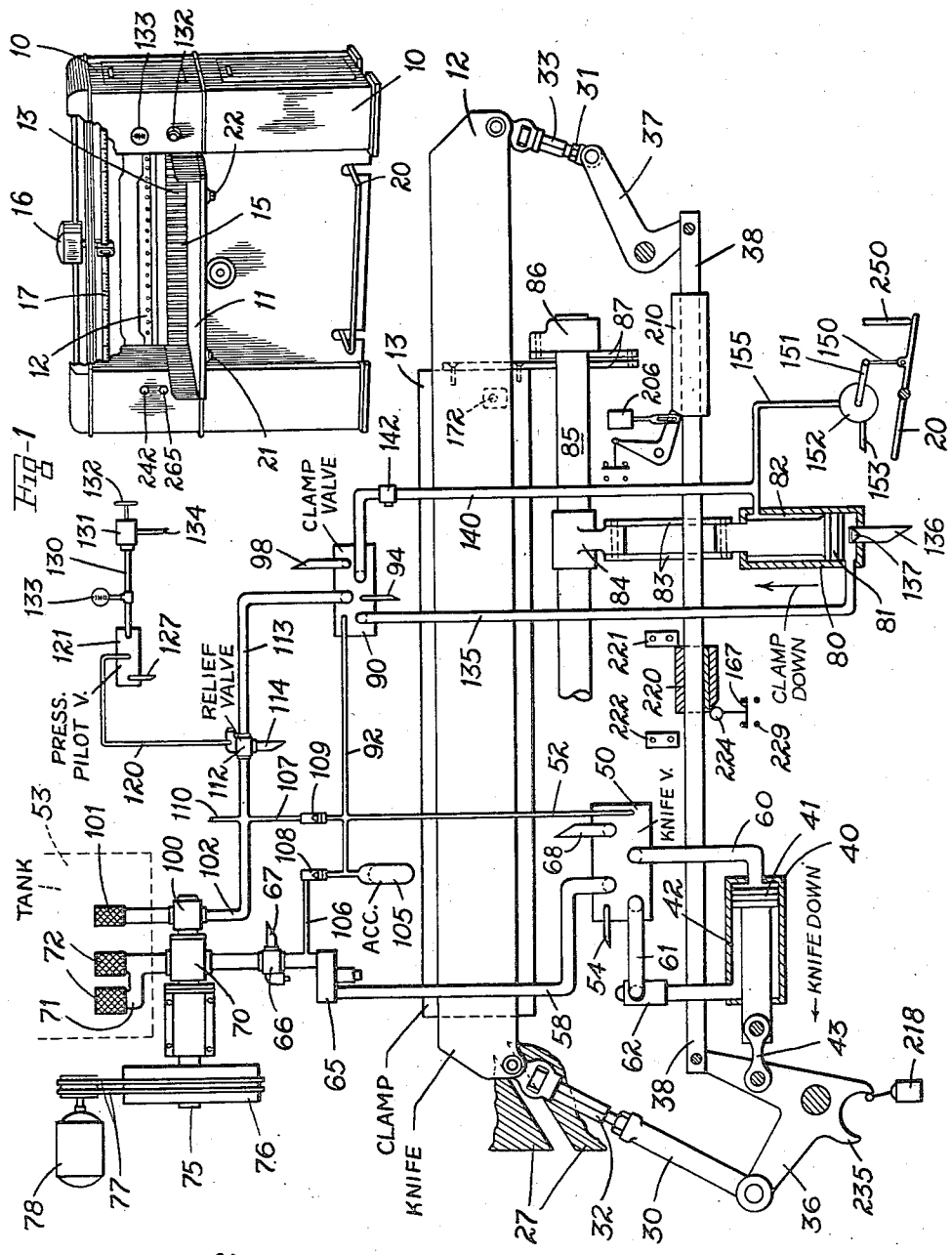


Fig-2

Fig-1

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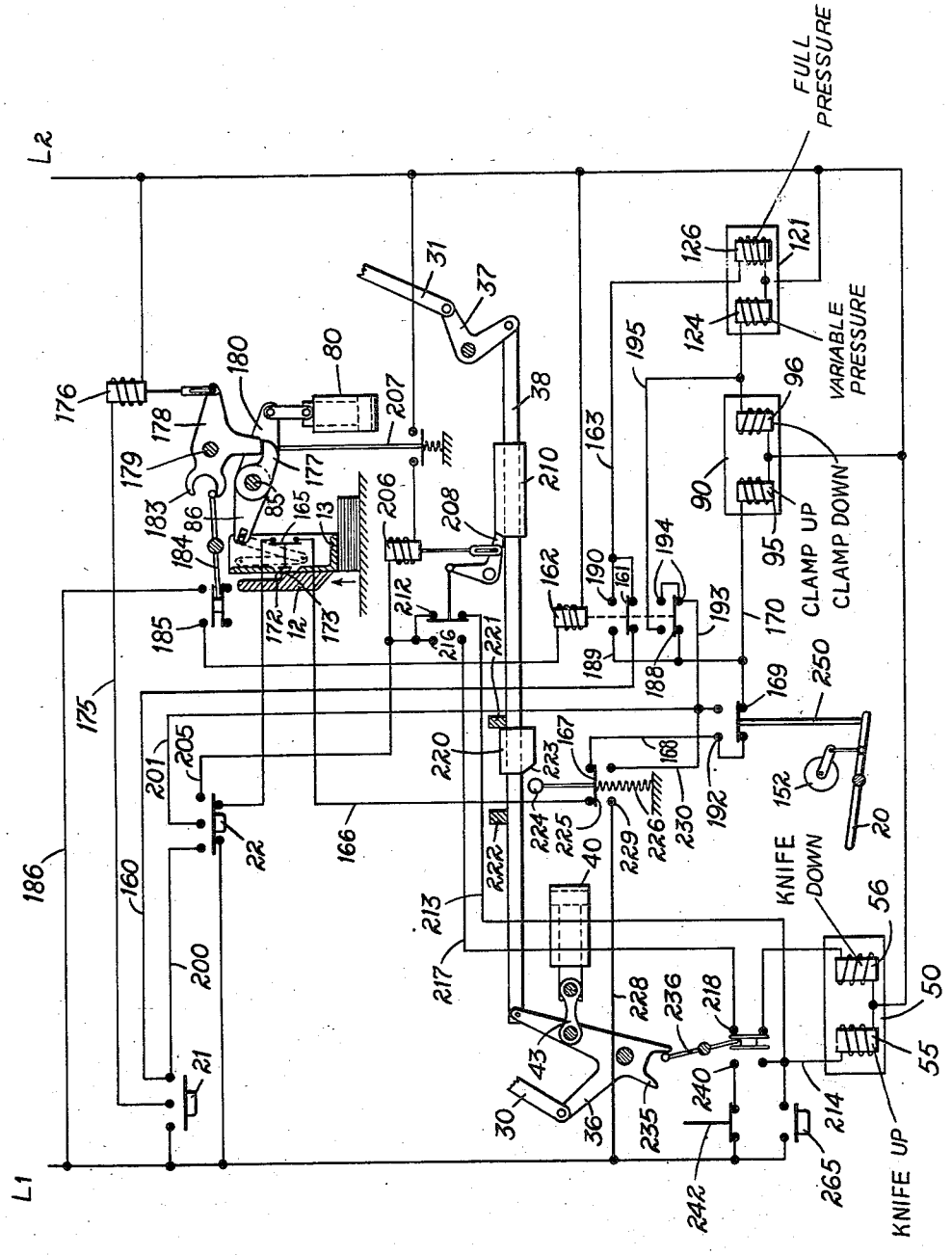


Fig-3

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2,825,404

HYDRAULIC CUTTING MACHINE

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Original application September 4, 1948, Serial No. 47,833, now Patent No. 2,649,153, dated August 18, 1953. Divided and this application February 13, 1953, Serial No. 336,725

7 Claims. (Cl. 164—54)

This invention relates to cutting machines such as those used in the cutting of paper and the like, and is a division of parent application Serial No. 47,833, filed September 4, 1948, now Patent No. 2,649,153.

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 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, now Patent No. 2,649,155, 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 opera-

tion 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, 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 its 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 actuating 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 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 is then 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 lines **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 square 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 venting 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 suitable 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 **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 inflow 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 lefthand button 21 and the righthand 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 lefthand 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 righthand 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 lefthand 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 lefthand 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 counter-clockwise 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 righthand 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 righthand button, a circuit is established from line 200, through the righthand 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 righthand button. Since the circuit for energizing the up solenoid 95 was previously established through the back contacts of the righthand 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 con-

trolling 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 righthand button 22 also establishes a control circuit for initiating the operation of the knife, which may be traced from L_1 through lefthand button 21, line 200, righthand 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 righthand 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 righthand button will maintain the clamp in engagement with the pile, while release of the righthand 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 lefthand 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 righthand 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 lefthand 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 contacts **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 recloses 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 invention.

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. In 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 and a clamp movable toward and away from said table to clamp the work material in position thereon, the combination of separate hydraulic motor means for actuating said knife and said clamp respectively, a hydraulic pump of relatively small capacity for supplying fluid under pressure to said clamp actuating motor, a separate hydraulic pump of relatively large capacity for supplying fluid under pressure to said knife actuating motor, a common continuously operating drive motor for driving said pumps having a capacity sufficient for continuous actuation of said small capacity pump but insufficient for continuous actuation of said large capacity pump at the full capacity thereof, means for operating said clamp in correlated relation with said knife to clamp the work material on said table in advance of the cutting thereof by said knife utilizing energy supplied entirely by said drive motor, and inertia means associated with said drive motor for supplying additional power thereto during the cutting stroke of said knife to maintain the speed of travel thereof by maintaining operation of said large capacity pump at full capacity.

2. In 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 and a clamp movable toward and away from said table to clamp the work material in position thereon, the combination of hydraulic motor means for actuating said knife, hydraulic motor means for actuating said clamp, a high pressure high capacity hydraulic pump for supplying fluid to said knife motor, a separate high pressure low capacity pump for supplying fluid to said clamp motor, a common drive operating continuously for actuating said pumps and having a capacity sufficient for continuous actuation of said low capacity pump but insufficient for continuous actuation of said high capacity pump at the full capacity thereof, means for operating said clamp in correlated relation with said knife to clamp the work material on said table in advance of a cutting stroke of said knife utilizing energy supplied entirely by said drive, and a fly-wheel forming part of said drive for supplying additional power to said knife actuating pump during the cutting stroke of said knife to maintain the speed of travel thereof by maintaining operation of said high capacity pump at full capacity.

3. In 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 and a clamp movable toward and away from said table to clamp the work material in position thereon, the combination of hydraulic motor means for actuating said knife, hydraulic motor means for actuating said clamp, a high pressure high capacity hydraulic pump for supplying fluid to said knife

motor, a separate high pressure low capacity pump for supplying fluid to said clamp motor, a common drive operating continuously for actuating said pumps and having a capacity sufficient for continuous actuation of said low capacity pump but insufficient for continuous actuation of said high capacity pump at the full capacity thereof, means for operating said clamp in correlated relation with said knife to clamp the work material on said table in advance of a cutting stroke of said knife utilizing energy supplied entirely by said drive, a fly-wheel forming part of said drive for supplying additional power to said knife actuating pump during the cutting stroke of said knife to maintain the speed of travel thereof by maintaining operation of said high capacity pump at full capacity, valve means for controlling the operation of said motors, an accumulator for storing fluid pressure for actuating said valve means, and means for supplying pressure fluid to said accumulator for both said pumps.

4. In 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 and a clamp movable toward and away from said table to clamp the work material in position thereon, the combination of hydraulic motor means for actuating said knife, hydraulic motor means for actuating said clamp, a high pressure high capacity hydraulic pump for supplying fluid to said knife motor, a separate high pressure low capacity pump for supplying fluid to said clamp motor, a common drive operating continuously for actuating said pumps and having a capacity sufficient for continuous actuation of said low capacity pump but insufficient for continuous actuation of said high capacity pump at the full capacity thereof, means for operating said clamp in correlated relation with said knife to clamp the work material on said table in advance of a cutting stroke of said knife utilizing energy supplied entirely by said drive, a fly-wheel forming part of said drive for supplying additional power to said knife actuating pump during the cutting stroke of said knife to maintain the speed of travel thereof by maintaining operation of said high capacity pump at full capacity, and a pressure relief valve connected in the line between said clamp actuating pump and said clamp motor for controlling the pressure developed by said clamp independently of said knife actuation.

5. In 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 and a clamp movable toward and away from said table to clamp the work material in position thereon, the combination of hydraulic motor means for actuating said knife, hydraulic motor means for actuating said clamp, a high pressure high capacity hydraulic pump for supplying fluid to said knife motor, a separate high pressure low capacity pump for supplying fluid to said clamp motor, a common drive operating continuously for actuating said pumps and having a capacity sufficient for continuous actuation of said low capacity pump but insufficient for continuous actuation of said high capacity pump at the full capacity thereof, means for operating said clamp in correlated relation with said knife to clamp the work material on said table in advance of a cutting stroke of said knife utilizing energy supplied entirely by said drive, a fly-wheel forming part of said drive for supplying additional power to said knife actuating pump during the cutting stroke of said knife to maintain the speed of travel thereof by maintaining operation of said high capacity pump at full capacity, a pressure relief valve connected in the line between said clamp actuating pump and said clamp motor for controlling the pressure developed by said clamp independently of said knife actuation, and a manually controlled pressure pilot valve for controlling the setting of said pressure relief valve.

6. In 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 and a clamp movable toward and away from said table to clamp the work material in position thereon, the combination of separate hydraulic motor means for actuating said knife and said clamp respectively, a hydraulic pump of relatively low capacity for supplying fluid under pressure to said clamp actuating motor, a separate hydraulic pump of relatively high capacity for supplying fluid under pressure to said knife actuating motor, a common continuously operating drive motor for both of said pumps having a capacity sufficient for continuous actuation of said low capacity pump but insufficient for continuous actuation of said high capacity pump at the full capacity thereof, means including a pair of separate control valves for operating said clamp and said knife in correlated relation causing said clamp to clamp the work material on said table in advance of the cutting stroke of said knife utilizing energy supplied entirely by said motor, inertia means associated with said drive motor for supplying additional power thereto during the cutting stroke of said knife to maintain the speed of travel thereof by maintaining operation of said high capacity pump at full capacity, and means operable with said control valve for said knife motor for freely discharging said fluid pressure when said knife is not in operation to unload said knife-actuating pump between the strokes of said knife enabling the restoring of energy to said inertia means.

7. In 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 and a clamp movable toward and away from said table to clamp the work material in position thereon, the combination of separate hydraulic motor means for actuating said knife and said clamp respectively, a hydraulic pump of relatively low capacity for supplying fluid under pressure to said clamp actuating motor, a separate hydraulic pump of relatively high capacity for supplying fluid under pressure to said knife actuating motor, a common continuously operating drive motor for both of said pumps having a capacity sufficient for continuous actuation of said low capacity pump but insufficient for continuous actuation of said high capacity pump at the full capacity thereof, means including a pair of separate control valves for operating said clamp and said knife in correlated relation causing said clamp to clamp the work material on said table in advance of the cutting stroke of said knife utilizing energy supplied entirely by said motor, inertia means associated with said drive motor for supplying additional power thereto during the cutting stroke of said knife to maintain the speed of travel thereof by maintaining operation of said high capacity pump at full capacity, said control valve for said knife having an open center position providing for free discharge of said fluid pressure when said knife is not in operation to enable the restoring of energy to said inertia means between the strokes of said knife.

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