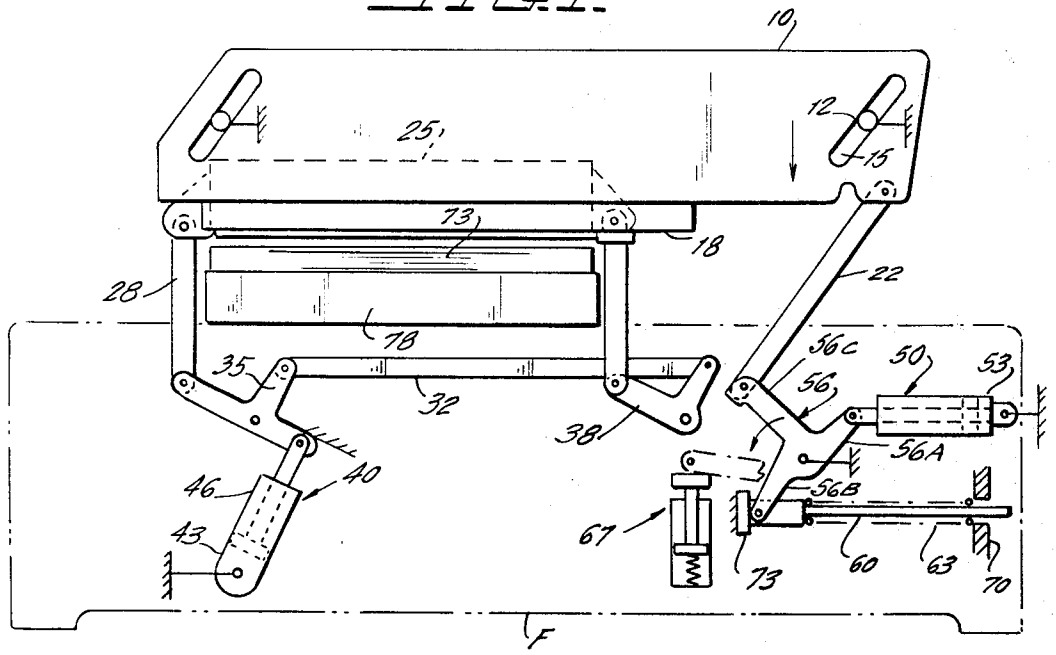
Nov. 12, 1968 C. THUMIM 3,410,166

ALL HYDRAULIC CUTTER WITH SPRING KNIFE RETURN

Filed March 10, 1966 4 Sheets-Sheet 1

FIG. 1.



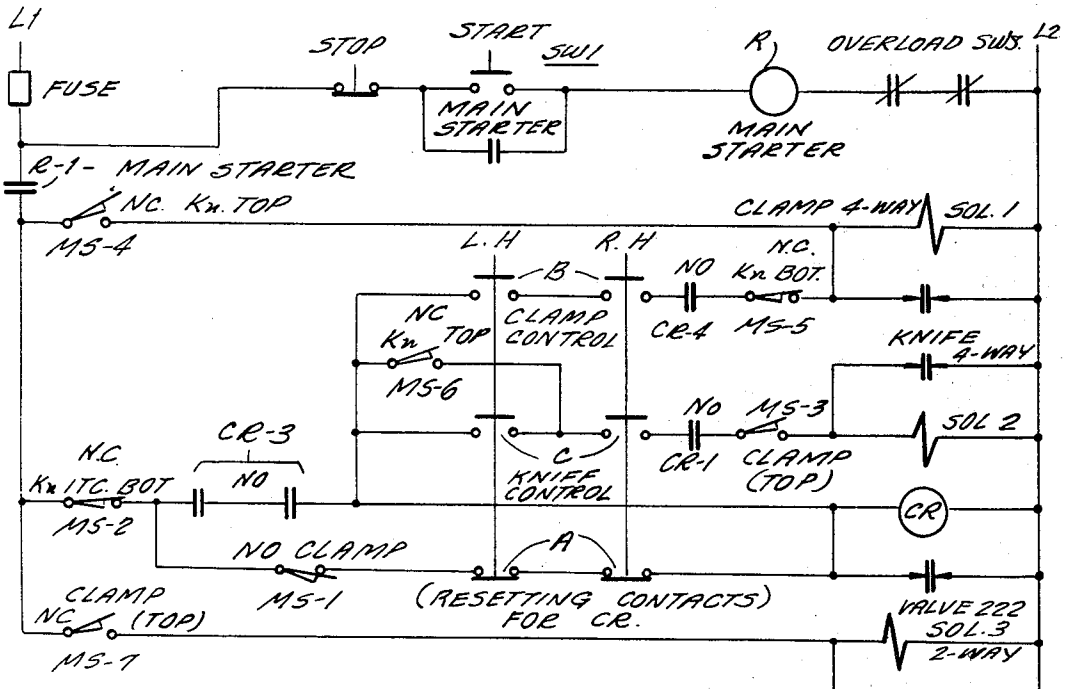


FIG. 5.

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ALL HYDRAULIC CUTTER WITH SPRING KNIFE RETURN

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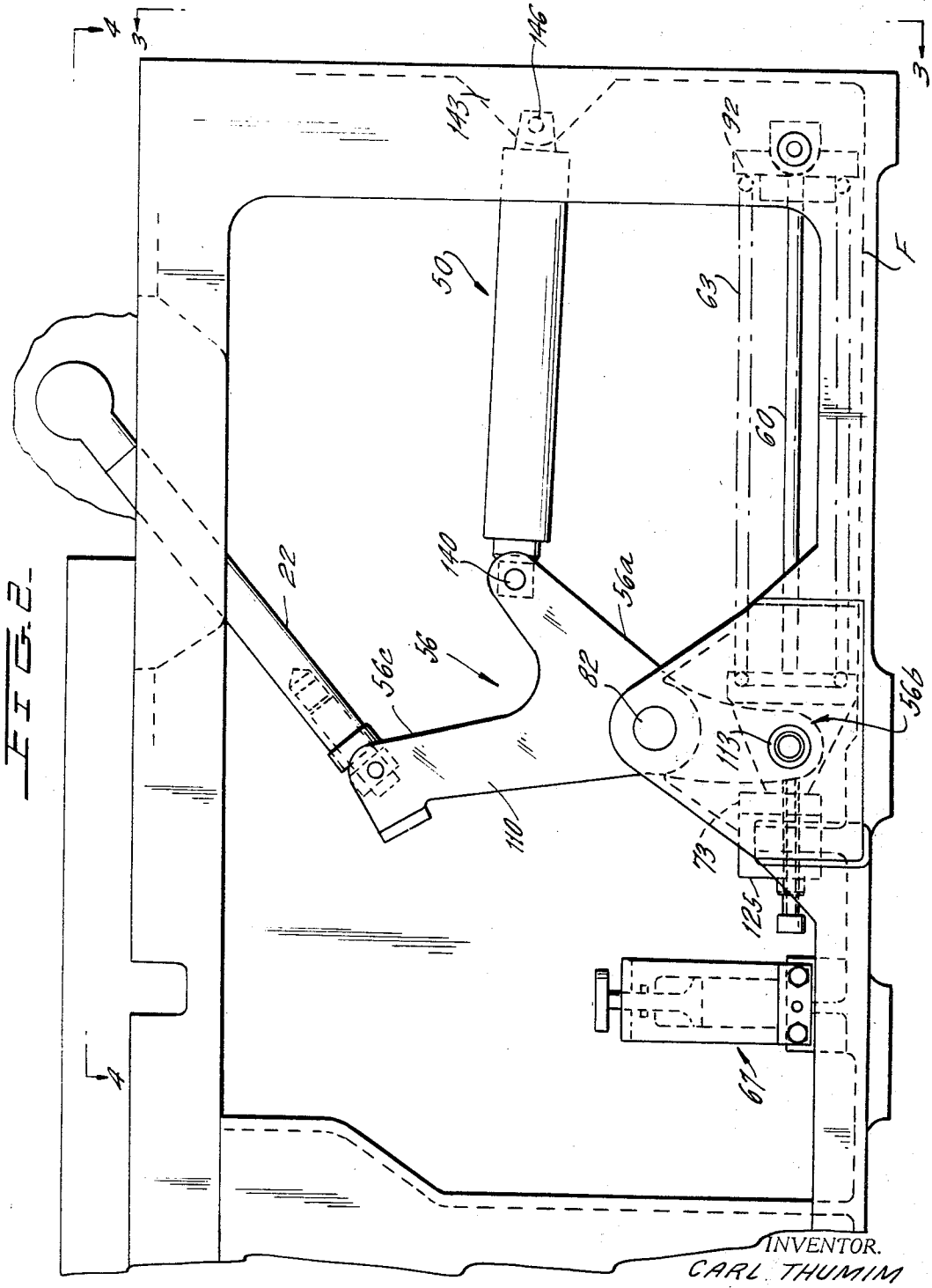


FIG. 2.

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FIG. 4

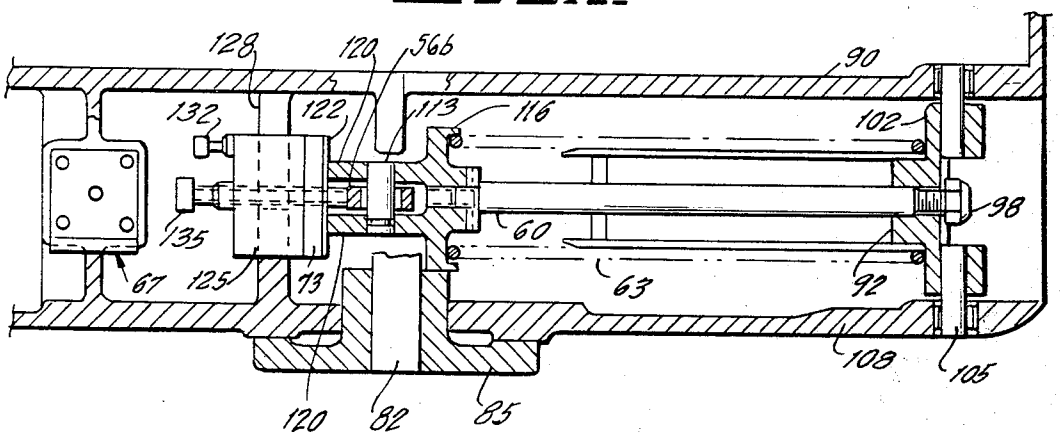
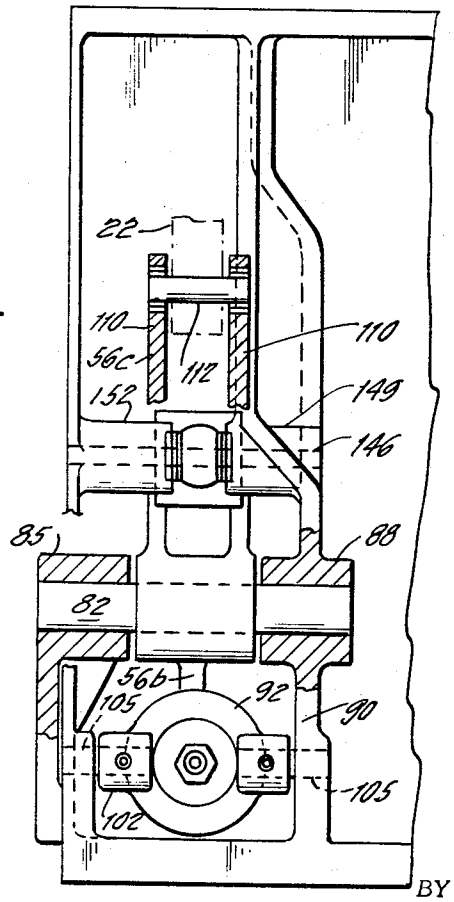


FIG. 3



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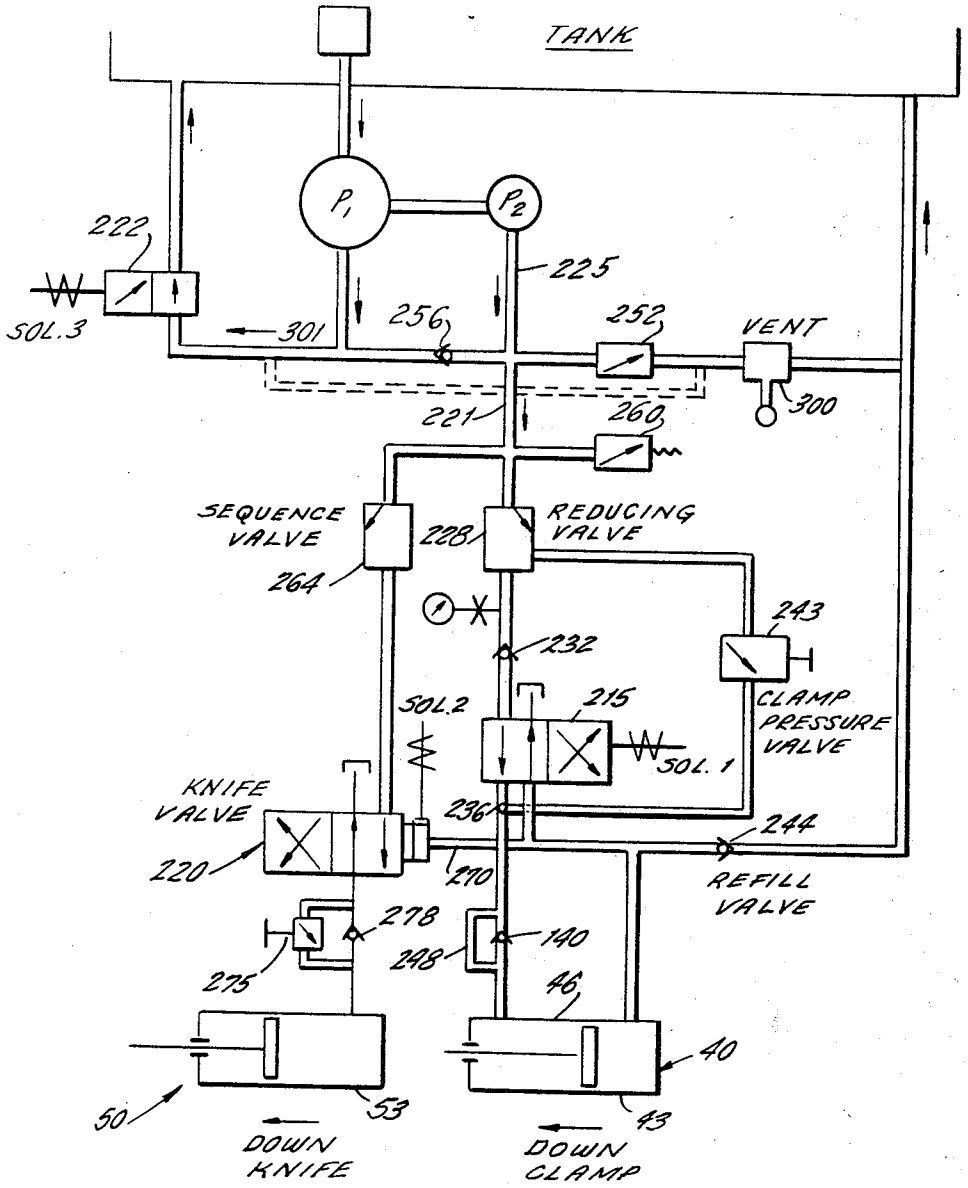
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ALL HYDRAULIC CUTTER WITH SPRING KNIFE RETURN

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FIG. 6.



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3,410,166

ALL HYDRAULIC CUTTER WITH SPRING KNIFE RETURN

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13 Claims. (Cl. 83—380)

ABSTRACT OF THE DISCLOSURE

A cutting machine of the guillotine type which includes a clamp operated entirely by a hydraulic system, and a knife operative in its cutting stroke by hydraulic means but returned to its rest position by spring biasing means. The hydraulic system includes a large capacity and a small capacity pump which are cumulative in effect when the knife and clamp are being operated but requires only the small capacity pump to retain the clamp in its upward or rest position between cutting cycles.

This invention relates to guillotine-type paper cutters, and more particularly to a cutter in which knife return is effected by a spring.

Among the objects of the invention are to provide a simplified hydraulic system and electric control circuitry for a hydraulic paper cutter; to provide for economy of operation by reducing the oil pressure and the quantity of oil circulating under pressure in the hydraulic system between cutting operations; to provide for operator safety in that two hands are required to effect actuation of the clamp and knife; to provide optionally for convenient operation in that once the knife has started moving the operator may free one hand; to provide an arrangement using a high capacity pump and low capacity pump in which both pumps provide pressure for actuating the clamp and the knife, thereby effecting a power saving and a simplicity of construction, but wherein only the low capacity pump is required to maintain the clamp in raised position.

Other objects and features of the invention will be apparent from the description that follows, a particular object being to provide a simple mechanism wherein a spring effects a return movement of the knife.

Referring to the drawings;

FIGURE 1 is a diagrammatic illustration of the mechanical arrangement utilizing hydraulic cylinders for operating the clamp and knife and showing the use of a spring for effecting knife return;

FIGURE 2 is a fragmentary illustration in elevation partially in section showing certain components of the knife actuating mechanism;

FIGURE 3 is an end view partially in section showing certain components illustrated in FIGURE 2;

FIGURE 4 is a plan view illustrating, partially in section, certain components shown in FIGURE 2;

FIGURE 5 is an electrical diagram showing circuitry control for the novel aspects of the invention; and

FIGURE 6 is a hydraulic circuit diagram illustrating the pump and valve arrangement to effect actuation of the knife and clamp.

Referring to FIGURE 1, a knife bar **10** is illustrated which will be understood to be reciprocal in a vertical plane being guide by fixed pins **12** acting in slots **15** of the knife bar in a conventional manner. The knife bar carries a knife **18** secured thereto and is actuated by a pull bar **22**, all in a conventional manner.

A clamp **25** is iliustrated which will be understood to be conventionally operated as by pull bars **28** acting through a link **32** and bellcranks **35** and **38** powered by a

double ended hydraulic cylinder **40** connected to bellcrank **35** and having pressure chambers **43** and **46**.

The arrangement for effecting actuation of the knife pull bar **22** is believed to be unique and comprises a single ended hydraulic cylinder **50**, having a pressure chamber **53** and a piston rod connected to a bellcrank lever **56** which is provided with three arms. Thus the arm **56A** is connected to the piston rod while the arm **56B** is connected to a rod **60** concentric within a compression spring **63** and arranged so that movement of the rod toward the right will compress the spring. The third arm **56C** is connected to operate the knife bar linkage in a conventional manner but is disposed so that upon swinging counter-clockwise when the cylinder **50** is put under pressure the end of the arm **56C** will abut a dash pot **67** which serves as a cushion and motion limit stop at the end of the knife stroke, as indicated by the phantom lines illustrating the limit of downward movement of arm **56C**. The rod **60** will be understood to be slidably supported in a fixed wall **70** which is part of the machine frame F indicated by the phantom line.

The outer end of rod **60** is disposed to abut a fixed rubber bumper pad **73** when the spring **63** is fully extended to serve as a cushion for limiting movement of the knife at top position.

In operation, the chamber **43** is filled with oil under pressure to cause the clamp to come down against a paper pile resting on a table **78**, all in the usual manner. The invention contemplates knife actuation only after a predetermined degree of pressure is brought to bear by the clamp on the paper pile, and this feature will be subsequently explained in connection with the hydraulic circuit. Upon predetermined pressure being applied by the clamp, the knife is actuated by pressure conducted to cylinder chamber **53** which rocks the bellcrank **56** counter-clockwise operating the knife bar linkage and at the same time compressing the spring **63** via arm **56B** until the downward movement of the knife is stopped by arm **56C** abutting dash pot **67**. On the return stroke of the knife, pressure being exhausted from chamber **53**, the spring **63** expands to rock the bellcrank lever **56** clockwise, moving the knife upwardly until the end of rod **60** abuts rubber bumper **73**.

FIGURES 3, 4 and 5 show details of component construction and their relationship to each other insofar as essential elements are concerned. For example, in FIGURE 2 the three-arm bellcrank **56** is illustrated as pivotal on a pin **82** which is carried at one end in a plate **85** (FIGURE 4) fastened to the machine frame F and has bearing in a journal **88** machined into a wall **90** of the frame, as seen in FIGURE 3. The spring **63** has its outer end abutting in a cup **92** suitably pinned by means of pins **105** to the machine frame as generally illustrated in FIGURE 4. The rod **60** has a threaded end and bolt **98** thereon which abuts on the opposite side of cup **92** to limit spring expansion, it being understood that the rod is slidable in a bore through cup **92**, which cup has ears **102** (FIGURE 3) through each of which passes the pins **105** to provide a pivotal mount for the spring between the walls **90** and **108** of the machine frame.

The bellcrank lever **56** will be understood to be partially bifurcated so that the arm **56C** is in actuality a pair of parallel arms **110** between which the pull bar **22** is pivotally fastened as by pin **112** (FIGURE 3). The arm **56B** is secured by pin **113** to a cap **116** to which the rod **60** is fastened, the cap having bifurcated walls **120** between which the lower end of the arm is disposed. The outer edges of walls **120** about the rubber block **73** which has a metal facing **122** vulcanized to the rubber block in turn vulcanized to a metal block **125** carried in a bracket **128**. Bracket **128** is part of the machine frame and metal block **125** may be adjusted axially relative to

rod **60** by means of a screw **132** carried in the block and abutable with bracket **128** (FIGURE 4). A positive stop adjustable screw **135** is carried in block **125** the end of which may be abutted by the lower end of arm **56B** to effect a positive top position for the knife bar after the cushioning effect of rubber block **73**.

The piston rod for cylinder **50** (FIGURES 2 and 3) is pivotally secured between bifurcations of arms **56A** as by a pin **140** with the outer end of the cylinder being pivoted between ears, such as **143**, of the machine frame by means of a pin **146** having bearing support in collars **149** and **152**.

Referring to FIGURE 5, the electrical control circuitry is disclosed showing the main motor M to be controlled by the starting switch SW1 in a conventional manner, the power lines L_1 and L_2 being provided for actuation of the control circuitry for the motor and also for solenoid valves which control the oil pressure cylinders. The control circuitry has left-hand and right-hand buttons, designated as LH and RH, wherein the buttons must be pressed by the operator's two hands in order to actuate the clamp and knife. Solenoid SOL–1 controls a four-way valve for the clamp cylinder. Solenoid SOL–2 controls a valve for the knife cylinder and solenoid SOL–3 controls a two-way valve which provides for most of the oil being circulated in the hydraulic system under low pressure when not actuating the power cylinders, thereby effecting a power saving and reducing the heating effect of the circulating oil.

Various microswitches are disposed to be actuated by the knife and clamp. For example, MS–1 is a normally open switch which is closed by the clamp when the clamp is in an upper position; MS–2 is a normally closed switch which is opened by the knife when the knife reaches its bottom position; MS–3 is a normally closed switch which is opened by the clamp in upper position and closes when the clamp starts to move. MS–4 is a normally closed switch opened by the knife at upper position which closes once the knife has started to move. MS–5 is a normally closed switch opened by the knife when the knife reaches its bottom position. MS–6 is a normally closed switch opened when the knife starts its downward movement. MS–7 is a normally closed switch which is opened when the clamp reaches top position.

The securing of the several knife and clamp operated switches so as to be knife or clamp operated is well known as are switch constructions and no mechanical details are necessary herein.

All switches are shown for the condition in which knife and clamp are at rest at stroke top.

The relay coil CR is normally energized via contacts of normally released button switches LH and RH when the clamp and knife are in raised position in order to condition SOL–1 and SOL–2 for energization via relay CR contacts. Relay CR is deenergized when the knife completes its cutting stroke due to opening of MS–2 and MS–5. Thus, the solenoids cannot operate again until the relay is reset by releasing button switches LH and RH, and knife and clamp are in up positions, closing MS–2 and MS–1, respectively.

The main motor switch and starter system are shown at the top of FIGURE 5, being conventional in nature and having a contact R–1 which connects the control circuitry to power when the main motor is started, as effected by relay R.

Assuming the main motor is running, the manually operable LH and RH buttons released being spring biased to the position shown and relay CR is normally energized through switches MS–1 and MS–2 and contacts A. This closes all CR contacts CR1, CR3 and CR4. Switches MS–1, MS–2 and MS–5 are closed at this time since the clamp is in upper position as is the knife.

For operation, manual buttons LH and RH are pressed to complete a circuit through MS–2, contacts B, contacts CR3 and 4 and MS–5 to energize the clamp control valve solenoid SOL–1. This opens a four-way valve **215** (FIGURE 6) to direct oil pressure to the chamber **43** of clamp cylinder **40** (FIGURES 1 and 6). After the clamp starts to move it releases switch MS–1 which will not close again until the clamp returns to its top rest position. The A contacts of the pushbuttons LH and RH open to break the circuit to relay CR which, however, remains energized through MS–2 and CR3. The clamp also releases MS–3 which then closes energizing control valve solenoid SOL–2 through MS–2, contacts C, CR1, CR3 and MS–3.

Although the clamp is moving, the knife cannot move until the clamp pressure on the paper pile has reached a predetermined value, thus providing an interlock to prevent the knife from starting its motion before the paper pile is fully clamped. This is under non-electric hydraulic control as will be later described. Assuming the predetermined pressure has been built up by the clamp on the paper pile, and since SOL–2 is energized, it opens a four-way valve **220** (FIGURE 6) to pressurize chamber **53** of knife cylinder **50**. The knife commences moving downwardly thereby permitting closure of switch MS–4 which locks clamp solenoid SOL–1 in energized condition independently of relay CR contact CR4, although the relay remains energized. Continued movement of the knife to bottom position opens switches MS–2 and MS–5 to deenergize the relay CR and SOL–2. Accordingly, all CR contacts open, SOL–2 is deenergized and oil pressure ceases to chamber **53** of knife cylinder **50**, but MS–4 remains closed, SOL–1 remains energized, the clamp maintains pressure.

The valves **215** and **220** are of a commercial type which are moved in one direction by their solenoids but have internal springs (not shown) which move them in the opposite direction when their solenoids are deenergized.

Oil pressures ceasing to flow to cylinder **50** and it being understood that the valve **220** is then actuated to its alternate position by internal spring bias, exhaust of cylinder **50** occurs through valves **275** and **220** upon such deenergization of SOL–2. Spring **60** (FIGURE 1) which was compressed as the knife came down, by virtue of the rocking of bellcrank **56**, expands to move the knife to top position. At top position the knife opens switch MS–4 to deenergize clamp valve solenoid SOL–1 thereby permitting reversal (due to its internal spring) of the four-way valve **215** which controls clamp movement. Such reversal effects movement of the valve to conduct oil under pressure to chamber **46** (FIGURE 1) of cylinder **40** effecting raising of the clamp, chamber **43** exhausting. When the clamp reaches top position, relay CR could reset due to closing of MS–1, but the knife cannot recycle since buttons LH and RH are being held depressed which thereby prevents energization of relay CR due to the open contacts A. Both hands must be removed from buttons LR and RH in order to reset the relay in energized condition. Thereafter, the machine can be recycled by pressing both buttons again.

The circuitry provides for a necessity that both hands of an operator start the cycling of the machine but after being started one hand can maintain the cycling if so desired. In order to accomplish this the normally closed switch MS–6 may be disposed to be closed when the knife starts its downward movement and the switch shunts the contact C of the LH button. The clamp solenoid SOL–1 remains energized through MS–4 after the knife starts down. The LH button may then be released. By maintaining the RH button depressed SOL–2 will remain energized to complete the knife cycling. Switch MS–6 is, of course, maintained open by the knife at top position so that two hands are required to start the cycle. If MS–6 is not supplied, both hands must be kept on the buttons for full cuttings strokes.

The function of MS–7 and SOL–3 is explained below in detail.

Referring to the hydraulic diagram of FIGURE 6, the system comprises a twin pump having a high capacity section P1 and low capacity section P2 wherein the high capacity section has a discharge volume of approximately ten times that of the low capacity section. Flow from both sections are used in parallel via outlet tube **221** for obtaining rapid action during machine cycling. However, P1 has its output shunted through a valve **222** to the tank, the valve **222** being normally open between cycling operations. At that time P2 maintains the clamp in top position through line **225**, reducing valve **223**, check valve **232**, four-way valve **215**, line **236**, and check valve **140**. Two-way valve **222** is biased internally to open when SAL–3 (FIGURE 5) is deenergized upon opening of MS–7 when the clamp reaches top position. As the clamp starts down MS–7 closes to close valve **222** via SOL–3 so that full pumping capacity of P1 and P2 is used in clamping and cutting.

The valve **228** is a pressure reducing valve which places a maximum limit on the outlet pressure of pumps P1 and P2 regardless of inlet pressure. In commercial practice such maximum pressure would be about 1200 pounds at the outlet even though pump pressure may rise to about 1500 pounds. Valve **228** can be adjusted for variable outlet pressures.

An auxiliary relief valve **243** is connected so as to control clamp pressure when the clamp is moving down but has no affect when the clamp is in top position.

When valve **215** is shifted by its internal spring (SOL–1 deenergized) pressure from pump P2 is maintained in chamber **46** of cylinder **40** to hold the clamp in its upper position and pump P1 is shunted to the tank as previously mentioned. Sufficient clamp holding pressure is provided by adjustment of a relief valve **252** so that there is enough force exerted by cylinder **40** to just maintain and balance the clamp weight at the top of its stroke. This has the affect of maintaining pump section P1 at a low pressure which effects a saving of power and minimum of temperature rise in the circulating oil.

Upon energization of SOL–1, oil under pressure from valve **220** is conducted to chamber **43** to move the clamp down. The clamp drops initially of its own weight, oil being sucked into chamber **43** via the usual prefill valve **244**. Speed of clamp drop can be regulated by the flow control valve **248** which has a needle valve for adjustment. The check valve **232** prevents bounce of the clamp at each end of its stroke. The flow shunt to tank through valve **222** for pump P1 is closed by closing of MS–7 and energization of SOL–3.

Thus, when the clamp starts to move down, the combined capacity of the pumps sends a large flow of oil to the system. Oil from pump P1 goes through check valve **256** which otherwise prevents oil from pump P2 from shunting through valve **222** when the clamp is held in raised position.

A relief valve **260** insures the system against excessive pressure.

As previously mentioned, the valve **228** maintains a pressure to clamp control valve **215** within certain limits for operation of the clamp and a similar valve **264** performs the same function for knife power. However, valve **264** is a so-called sequence valve which requires a predetermined pressure to be exerted on it before passing the oil through to the knife control valve **220**. In commercial operation such pressure may be pre-set at about 1350 pounds. As was previously mentioned in connection with description of FIGURE 5, the energization of solenoid SOL–2 is without affect on control of valve **220** prior to a predetermined clamp pressure being brought to bear on the paper pile. The pipe connection **270** in FIGURE 6 from pressure chamber **43** to a pilot piston with which valve **220** is conventionally provided effects the desired function. Thus, when the clamping pressure begins to build up in chamber **43** oil pressure for actuating the pilot piston of valve **220** can then pass from line **270** to actuate valve **220**. Oil under pressure from line **225–221** and valve **264** can then be directed to flow control valve **275–278** to the cylinder chamber **53**.

Valve **275** can be manually closed so that flow can take place to chamber **53** only through check valve **278**, but oil will then not be able to return to the tank through valve **220**. This serves the purpose of permitting the operator to adjust the knife. Thus, cylinder **50** will pull the knife down when the buttons LH and RH are pressed, but when released, oil cannot exhaust from chamber **53** through closed valve **275** back to valve **220**, although valve **220** has shifted to exhause position due to de-energization of SOL–2 and the internal spring in valve **220**. Accordingly, the knife will be hydraulically locked in place. When valve **275** is opened, spring **60** (FIGURE 1) will raise the knife forcing oil from chamber **53** through valve **275** and thus through valve **220** and ultimately back to the tank.

It will be seen from the above that the system provides a simplicity and a power saving over systems which use respective pumps for the clamp and for the knife. In the present system both pumps are working at all times when hydraulic power is required for clamping and cutting, but only the output of the smaller pump section P2 is required when the machine is idling.

When the clamp is in top position, a cam operated valve **300** opens the exhaust of relief valve **252** to the tank so that the low pressure (approximately 150 p.s.i.) prevails when the clamp is up, thus further reducing the motor load and therefore the heating effect on the oil.

Alternatively, **300** may be omitted and the exhaust of **252** piped to **301** where the operation of **222** will connect **252** to tank.

All switches of the control circuitry are of conventional construction and it will be understood that although they are described as separate switches, they may be of well known combined construction.

Likewise all valves are of well known conventional and commercially obtainable construction hence detailed description of their mechanical construction is not required.

Although there has been described a preferred embodiment of this novel invention, many variations and modifications will now be apparent to these skilled in the art. Therefore, this invention is to be limited, not by the specific disclosure herein, but only by the appending claims.

What is claimed is:

1. In a paper cutting machine of the guillotine type, a knife actuating mechanism comprising a single-ended power cylinder means, a knife bar for supporting a knife, linkage means connecting said single-ended cylinder means to said knife bar for actuating said knife bar in a cutting stroke when pressure is applied to said cylinder means, a spring means connected to said linkage means and adapted to be stressed thereby when said knife bar is performing a cutting stroke in order to effect a return movement of said knife bar when pressure is released from said cylinder means; said linkage means comprising a bellcrank having three arms and a fixed pivot therefor, one arm being connected to said cylinder means for effecting pivotal action of said bellcrank lever when said cylinder means is provided with pressure, a second arm being connected for actuating said knife bar, and a third arm being disposed to stress said spring means.

2. In a machine as set forth in claim **1**, and further including a dashpot disposed to be abutted by said second arm to limit downward movement of said knife bar.

3. In a machine as set forth in claim **1**, said spring means being a compression spring, a rod through said spring, an end of said rod being connected to said third arm, said spring having an end abuttable by a portion of said rod to be compressively stressed thereby when said bellcrank lever is pivotally actuated by said cylinder, and a resilient bumper means disposed adjacent the third arm to be abutted thereby for effecting a stop position in up-

ward movement of said knife bar as effected by said spring.

4. In a machine as set forth in claim 1, including a dashpot disposed to be abutted by said second arm to limit downward movement of said knife bar, said spring means being a compression spring, a rod means through said spring, an end of said rod means being connected to said third arm, said spring having an end abuttable by a portion of said rod means to be compressed thereby when said bellcrank lever is pivotally actuated by said cylinder means and a resilient bumper means disposed adjacent the third arm to be abutted thereby for effecting a stop position in upward movement of said knife bar as effected by said spring.

5. A control circuit for a guillotine type paper cutter having a clamp and knife, comprising a knife control solenoid, a clamp control solenoid, a relay and respective contacts of said relay in series circuit with said solenoids and another contact of said relay in series circuit with said relay, a pair of manually operable switches each having a first contact element in series circuit with said relay, and having a second contact element in series circuit with said knife control solenoid, and having a third contact element in series circuit with said clamp control solenoid, said first contact element being normally closed, said second and third contact elements being normally open and requiring manual force to be held closed while said first contact element is being held open, clamp operated switch means, knife operated switch means, said switch means having switches connected in said circuit to said relay and said solenoids wherein said relay is energized when the clamp and knife are in raised position through said other contact of said relay and said first contact element of said manually operable switches; and wherein said solenoids are energized when said manually operable switches are manually operated and the circuit through said first contact element of said manually operable switches is then broken; and wherein said relay and said solenoids are then energized through said clamp and knife operated switch means and said respective contacts.

6. The control circuit of claim 5, wherein energization of said knife control solenoid and said clamp control solenoid causes said knife and clamp, respectively, to move toward a cutting and clamping position, respectively, and de-energization of said respective solenoids causes said knife and clamp to return toward their resting positions; and wherein said respective contacts of said relay are normally open, and are only actuated to their closed circuit conditions in response to energization of said relay; whereby if said relay becomes de-energized, said respective contacts thereof will revert to their normally open condition to open the series circuits with said solenoids to cause de-energization thereof to effectuate the return movement of said knife and clamp.

7. A control circuit as set forth in claim 5, said knife operated switch means comprising a switch responsive to knife return movement and connected to de-energize said clamp control solenoid, and said knife operated switch means having a switch connected to de-energize said knife control solenoid when said knife reaches the end of a cutting stroke, said relay being de-energized when said knife control solenoid is de-energized, wherein said relay is again energize upon release of manual force on said manually operable switches.

8. A control circuit as set forth in claim 5, one of said switch means comprising a switch shunting a contact element of one of said manually operable switches and being operable upon initial cutting movement of said knife to shunt said contact element so that said one manually operated switch may be released.

9. A control circuit as set forth in claim 7, said knife operated switch means comprising a switch connected to shunt the second contact element of one of said manually operated switches after the knife starts a cutting movement so that said one manually operated switch may be released.

10. A hydraulic system for operating a clamp of a paper cutter comprising a high volume pump and a low volume pump having separate outlets connected in parallel, a normally open shunt valve connected to conduct fluid to a tank from the outlet of said large volume pump, a check valve connected between the outlets of said pumps whereby outlet fluid from said large volume pump only can pass to said shunt valve, an outlet means from said pumps, and valve means connecting said outlet means to conduct fluid pressure to and from clamp cylinder means, control means having elements responsive to initial clamp movement toward a paper pile from a rest position for closing said shunt valve whereby fluid pressure is supplied to said valve means from both pumps, said control means comprising said valve means whereby said clamp is maintained in said rest position by discharge from only said low volume pump through said valve means with outlet flow of said high volume pump being shunted through said shunt valve.

11. The hydraulic system of claim 10, wherein said control means includes an energizable solenoid which closes said normally open shunt valve in response to energization thereof, said solenoid being energized in response to one of said elements being operated in response to initial clamp movement toward a paper pile, whereby if said solenoid is de-energized during operation of said clamp said shunt valve will revert to its normally open condition to conduct fluid from the outlet of said large volume pump to said tank, whereby only outlet fluid from said low volume pump will be discharged through said outlet means to operate said clamp.

12. In a paper cutting machine, a reciprocable clamp, hydraulic means for moving said clamp down and returning it to its starting top position, a reciprocable knife, hydraulic means for moving said knife down for cutting, spring means for returning said knife to its starting top position and holding it there, pump means for supplying high pressure and volume of oil to move said clamp and knife downwardly and for supplying low volume to hold said clamp in its top position.

13. In a paper cutting machine as set forth in claim 12, said pump means including a high volume pump and a low volume pump having separate outlets connected in parallel, shut valve means for conducting fluid from said high volume pump to a tank when said clamp is in its top position, and control means for closing said shunt valve means when said clamp and said knife are to be moved downwardly whereby the combined output of said high volume pump and low volume pump will be utilized to move said clamp and knife downwardly.

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