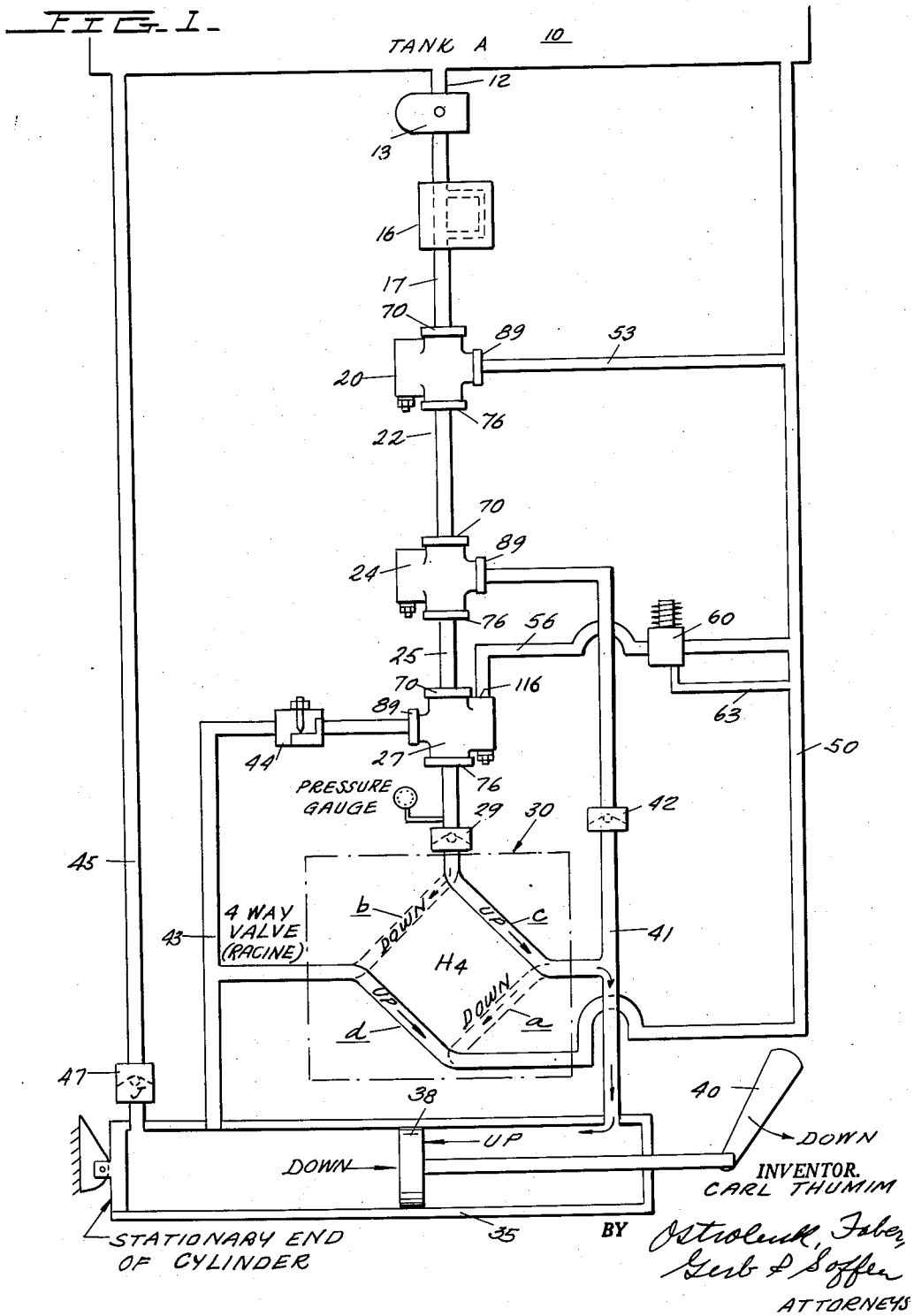
Jan. 3, 1961 C. THUMIM 2,966,889

HYDRAULIC CONTROL SYSTEM FOR CLAMP OF PAPER CUTTING MACHINE

Filed Feb. 4, 1957 3 Sheets-Sheet 1

FIG. 1.



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FIG. 1a.

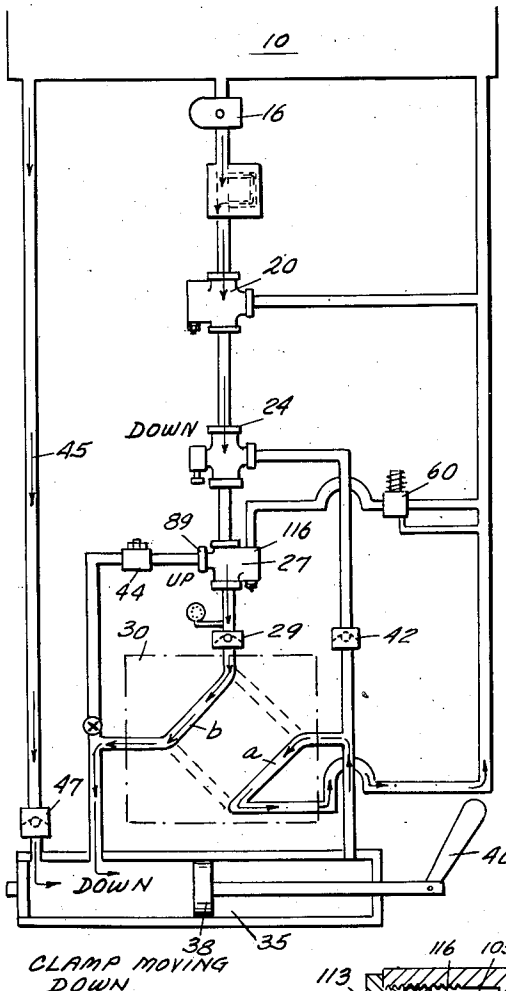


FIG. 1b.

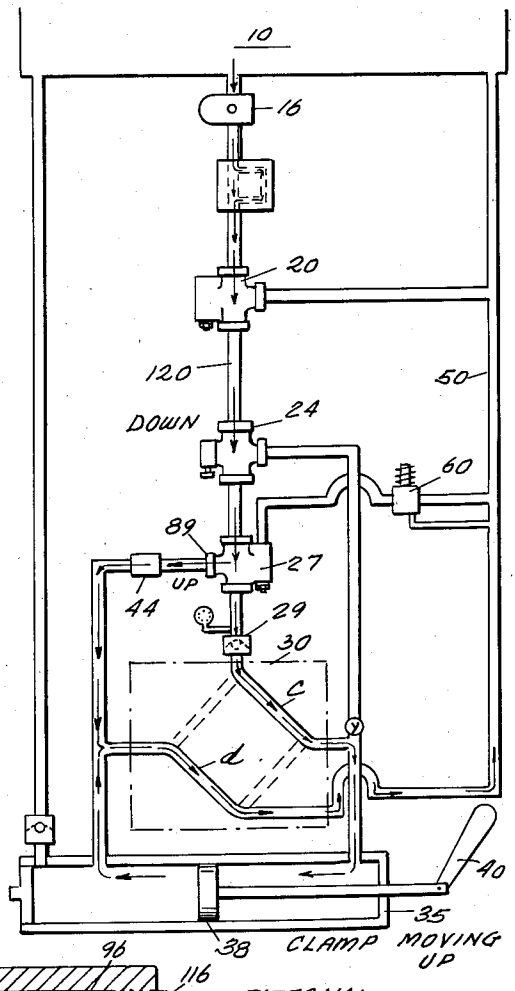
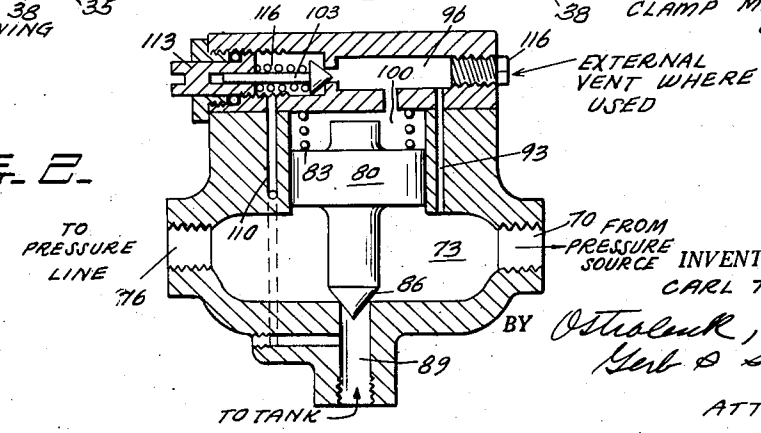


FIG. 2.



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FIG. 4.

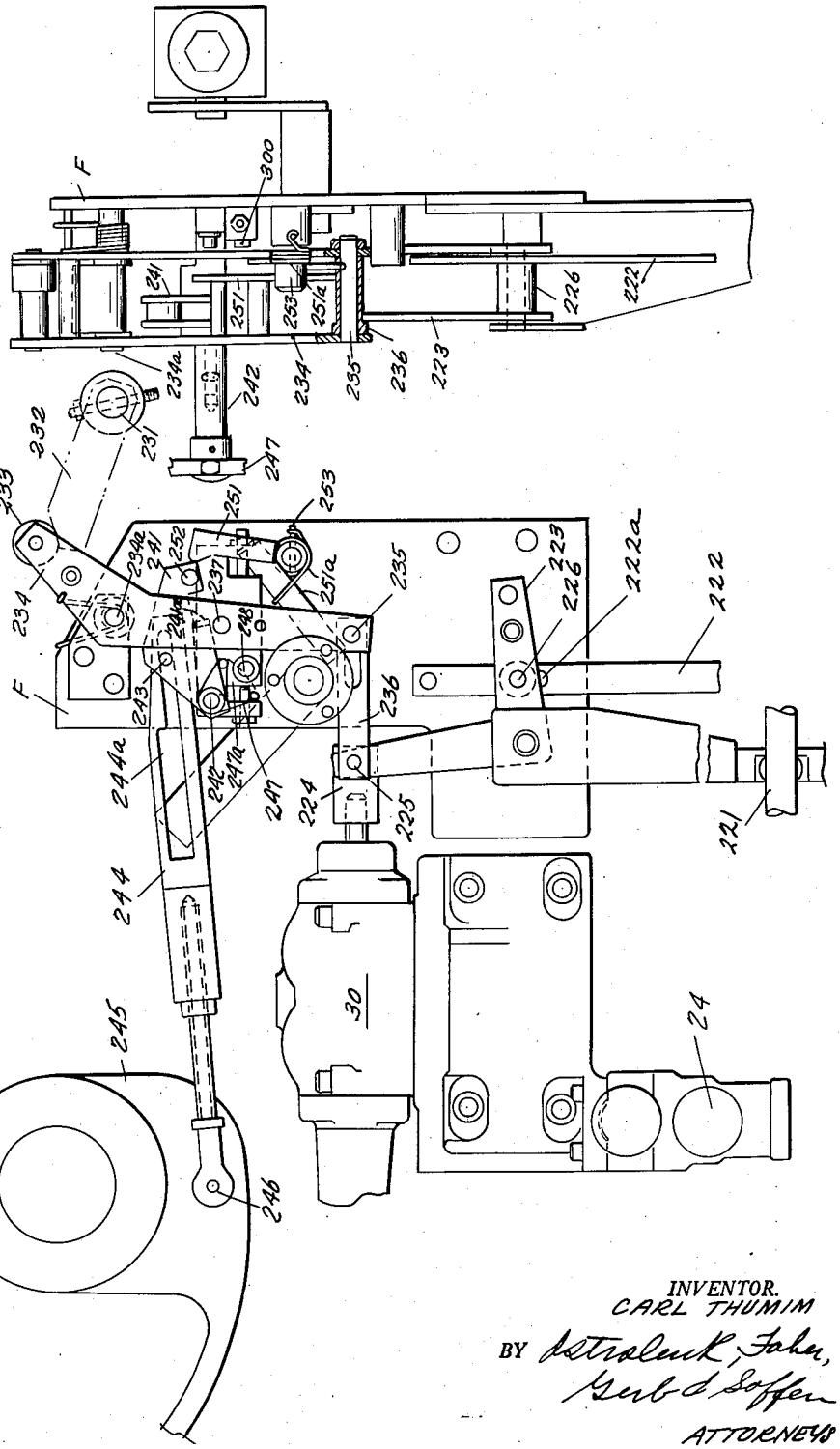


FIG. 3.

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HYDRAULIC CONTROL SYSTEM FOR CLAMP OF PAPER CUTTING MACHINE

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2 Claims. (Cl. 121—38)

This invention relates to paper cutting machines and more particularly to a hydraulic pressure system and mechanical linkages for effecting control thereof for the purpose of lowering or raising the automatic clamps of such cutting machines.

It is an object of the invention to provide precise and accurate control for a paper clamp under various operating conditions. It is another object of the invention to provide a system wherein the weight of the clamp is utilized for a rapid initial downward stroke, followed by hydraulic pressure being applied to exert a suitable clamping force. It is an additional object to provide means for conserving power when the machine is standing idle with the clamp in raised position while at the same time preventing the hydraulic fluid from excessive heating. Other objects and features of the invention will be apparent from the detailed description to follow.

Briefly, my invention comprises a hydraulic pressure system having a four way valve under manual control wherein pressure operated valves are utilized to determine maximum pressures utilized in the raising and lowering of the clamp. A mechanical linkage system comprising a foot treadle is used to control the four way valve, so devised as to coact with a cutting knife operating mechanism to maintain the paper pile clamped regardless of the position of the knife.

A detailed description of the hydraulic circuit and the mechanical control system now follows in conjunction with the appended drawings in which:

Figure 1 shows a schematic diagram of the hydraulic system.

Figure 1*a* shows the path of pressure fluid when the clamp is moving down.

Figure 1*b* shows the fluid circuit when the clamp is moving up.

Figure 2 shows a section of the principal parts of a typical pressure relief valve as used in various portions of the hydraulic circuit.

Figure 3 shows an elevation of the principal components utilized in a mechanism for controlling the four way valve by means of a foot treadle and for effecting manual movement of the knife on conjunction with control of the clamp.

Figure 4 is an end view of the assembly of components shown in Figure 3.

Referring now to Figure 1, the hydraulic circuit comprises a tank **10** connected through a pipe **12** to a pump **13** which is connected, as shown, through a proportional filter **16** and a series of pressure relief valves **20, 24, 27** to a manually operable four way spool valve **30** shown diagrammatically only. A check valve **29** is inserted in the line between valves **27** and **30**.

The valve **30** controls a double acting hydraulic cylinder **35** having a "downside" and an "upside" as designated and having the piston **38** operating an arm **40** which will be understood to actuate the clamp. The ends of the cylinder are both connected to valve **30**, the down side of the cylinder being also connected to a prefill pipe **45** through a check valve **47**, which prefill pipe will be seen to connect directly to tank **10**.

Valve **24** connects to valve **30** by a line **41** having a check valve **42**. Valve **27** connects to a valve **30** by a line **43** having a needle valve **44** therein.

A vent pipe **50** connects a port of valve **30** to the tank and valve **20** has a connecting pipe **53** to the vent pipe, while valve **27** has a connecting pipe **56** to the vent pipe, there being a normally open two-way solenoid valve **60** inserted in pipe **56** which will be understood to be controlled by a limit switch (not shown) at the top of the path of travel of the clamp, the valve being energized to closed position when the clamp is moving down. A drain line **63** leads from one end of valve **60** to the vent pipe **50**.

Referring to the four-way valve **30**, which is of conventional construction, it will be understood that the channels symbolized by "*a*," "*b*," "*c*" and "*d*" direct fluid to either end of the cylinder **35**, under manual control depending upon whether it is desired to move the clamp up or down.

The valves **20, 24** and **27** are all of a standard commercial type of relief valve as shown in the sectional elevation of Figure 2. Thus, the port **70** may be connected to a source of oil pressure serving as an inlet for the valve, the oil going through the passage **73** and emerging at the port **76**. The oil within the passage **73** exerts its pressure against a piston **80** which is biased by a spring **83** to maintain closure of a valve head **86** so as to block a relief port **89**. Normally oil pressure is balanced on both sides of piston **80** by way of a passage **93** leading to a pressure chamber **96** which is connected with a chamber **100** at the rear face of the piston. Chamber **96** is closed by a spring biased by-pass valve **103** having a chamber **106** connected by a passageway **110** to the pressure relief outlet **89**. The biasing force of the spring **106** may be regulated by a threaded cap **113** to predetermine the pressure in passage **73** for opening valve **103** to unbalance piston **80** so as to vent passage **73** to outlet **89**. A closure plug **116** is utilized whereby chamber **96** is normally closed. However, for purpose of use of the above described relief valve to perform the functions of valve **27**, this plug is removed and the pipe connection **56** substituted. Although the valves **20, 24** and **27** are shown as identical in configuration, it will be understood that various commercial types which vary in physical structure may be utilized instead of identical valves. The general structure and operation of each of these valves, however, is exemplified in Figure 2.

Referring now to Figure 1*a*, the hydraulic circuit set up within the system for actuating the clamp in a downward direction is illustrated. Thus, oil from tank **10** is pumped through valves **20, 24** and **27** and check valve **29** to four-way valve **30** and thence to the downside of the cylinder through channel "*b*". Egress of oil from the upside of the cylinder takes place through channel "*a*" to the tank.

At the initial movement of the piston **38**, check valve **47** opens because of the suction effected, and a large oil flow from the tank occurs through prefill pipe **45**. Thus, downward movement of the clamp takes place rapidly until contact is made with a paper pile. At this time the valve **27** is ineffective because its inlet and outlet are connected to each other at the point "*x*" through channel "*b*" of valve **30** (Fig. 1*a*), and thus disconnected from vent line **50**. Inasmuch as the valve **27** is for pressure relief when the clamp is moving upward, it is not desired to have it effective in clamp descending operation. The valve **60** is energized to closed position at this time, valve **24** controlling pressure for clamping.

Due to the weight of the clamp, which aids in its

descent, the motion of the clamp is too rapid for the discharge rate of the pump when the check valve 47 opens. Accordingly, there is a partial vacuum in the line at the section 120 indicated in Figure 1*b* between valves 20 and 30.

When the clamp contacts the paper pile, pressure in the line from the pump builds up to a degree regulated by valve 24, and such pressure building up in the down end of the cylinder effects closure of check valve 47, resulting in clamping force on the pile.

Valve 24 may be set to crack at any desired maximum clamping pressure up to any desired value such as 750 pounds per square inch. However, valve 20 is set to crack at the top value above mentioned, the maximum allowable pressure in the system.

In the course of the downward stroke, the amount of oil sucked into the downside of the cylinder decreases as the velocity of the clamp approaches the pump capacity until finally the clamp stops against the paper pile, at which time heavy pressure is exerted by the pump, depending on the setting of valve 24. During the period that the clamp is moving down, the only retardation of motion is by way of restriction afforded through the channel "*a*" of valve 30. At the end of the downward motion, the piston moves to the extreme right-hand of the cylinder cutting off flow of oil to the channel "*a*" and thus to the tank and enters the closed end section of the cylinder which serves as a buffer.

From the above description it will be apparent that there are two sources of oil supply for the downside of the cylinder when the clamp is descending, one source being from the pump and the other directly from the tank, thus affording rapid descent until the paper pile is engaged by the clamp.

When it is desired to move the clamp down slowly by means of a foot pedal, slow operation of valve 30 may permit oil from the upside of the cylinder to escape. Owing to leaks in the vent line of valve 24, for example in the spring controlled orifices or pistons used, some oil may escape and affect the accuracy with which the clamp can be controlled. Accordingly, where very accurate control is required, the check valve 42 is provided in the line between valve 30 and valve 24 so that oil may escape by way of valve 30 only.

Referring now to Figure 1*b*, the path of pressure fluid in the system for upward movement of the clamp is illustrated. In this instance it will be seen that oil from the tank passes through the pump 16 and thence through the valves 20, 24, 27, 29 and 30 (channel "*c*") to the upside of the cylinder, moving piston 38 to the left. The downside of the piston exhausts through channel "*d*" and pipe 50 to the tank. At this time the valve 24 is ineffective because its inlet and outlet are connected to each other at the point "*y*".

When the clamp reaches its topmost position, it operates the limit switch (not shown) to open the circuit to the solenoid of valve 60 which effects a reduction in the pressure at which the valve 27 will open. The opening of valve 27 affords an oil flow through the needle valve 44 effecting a back pressure to maintain the clamp in uppermost position. Thus, the flow from valve 44 goes to channel "*d*" of valve 30 affording a back pressure to maintain the clamp in upward or standby position. This arrangement conserves power when the machine is standing idle and also minimizes heating of the oil which would otherwise occur. Valve 44 may be set in the range of from 80 to 120 pounds per square inch for the purpose described above.

It will be appreciated that as soon as the clamp commences a descending motion, the solenoid of valve 60 is once more energized since the limit switch (not shown) is disengaged.

To summate the operation of the system, for movement of the clamp, pressure fluid is fed from the pump through the passageways 73 of the valves 24 and 27 and thence to the multi-way valve 30 to be conducted to either end of the cylinder, depending on the direction of movement of the piston desired. It will be noted that connection conduit means between the vent ports 89 and a respective end of the cylinder 35 is provided. Thus, when the multi-way valve is in the position shown in Fig. 1*a* it connects the through passageway 73 of valve 27 to the vent port 89 through channel "*b*" of multi-way valve 30, thus rendering valve 27 ineffective because any opening of the vent valve head 86 (Fig. 2) will obviously merely connect the vent port 89 with the through passageway 73, thereby "short circuiting" any vented flow. However, by comparison with Fig. 1*b*, it will be noted that the vent port of valve 27 is now connected through channel "*d*" of the multi-way valve 30 and, therefore, excess pressure can vent to drain line 50. Accordingly, pressure relief valve 27 is ineffective when pressure is fed to the "down" end of the cylinder, but effective when the pressure is fed to the "up" end of the cylinder. In a similar manner, the pressure relief valve 24 is ineffective by being "short circuited" through channel "*c*" of the multi-way valve 30 when pressure is being fed to the "up" end of the cylinder, but effective through channel "*a*" of the multi-way valve for venting purposes to drain line 50 when pressure is being fed to the "down" end of the cylinder, all of which will be understood by comparison of Figs. 1*a* and 1*b*.

Attention is invited to Figures 3 and 4 showing the mechanism used for actuating the spool valve 30. It is understood that a foot treadle (not shown) is utilized for this purpose, being pivoted on shaft 221 and connected to a link 222 to effect clockwise rotation of a bell crank 223, having duplicate sides, by means of a connecting pin 226. The bell crank is in turn connected to a block 224 through a pin 225. Block 224 will be understood to be attached to the spool (not shown) of valve 30. When the foot treadle is actuated, block 224 is pulled to the right, thus shifting the valve spool to direct fluid for moving the clamp (not shown) downwardly. Appropriate slots such as 222*a*, and additional lost motion slots as will be apparent in other elements for effecting independent action are provided so that when the foot treadle is operated other linkage elements are not moved. Likewise, movement of other linkage elements do not affect the foot treadle.

In manual operation of the knife, a handle (not shown) is keyed to shaft 231 to effect clockwise rotation. Cam 232 mounted on shaft 231 engages a roller 233 to rotate a lever 234 against a torsion spring counterclockwise. Lever 234 has duplicate sides pivoted on pin 234*a* carried by the machine frame F. A pin 235 connecting lever 234 with a link 236 is disposed to pull on a double link 236, having a lost motion slot 236*a* to effect independent action, which in turn pulls the pin 225 to the right to actuate the valve spool, thus permitting the clamp to descend.

When the lever 234 reaches its extreme counterclockwise position, a latching cam 241*a* carried by latch 241 which is rotative on an adjustable pin 242 drops to engage the pin 237 carried by lever 234 to hold the lever 234 in clamp down position. Therefore, even if cam 232 should be rotated in a counterclockwise direction as by the knife operating handle understood to be keyed to shaft 231, the clamp will remain locked against the paper pile.

Adjustment of latch 241 is obtained by shifting the pin 242 which is carried in a block 248 by means of screws (not shown) and then clamping the block 248 in position by means of bolts 300. In case the knife is stopped on the way down by the operator due to a false start and it is desired to unclamp the paper pile, rotation of a handle 247 pivoted on an extension of pin 242 will actuate a finger 247*a* into position under latch 241, rotating the latch 241 counterclockwise out of latching position.

As the knife approaches the bottom of its stroke, a

hook 244*a* formed in a slot in a link 244 is shifted to the right to drop over a pin 243 which is carried by latch 241. When the knife starts on its upward stroke, lever 245 which is part of the knife linkage rotates clockwise to pull pin 246 connecting to link 244 to the left. Thus, hook 244*a* pulls on pin 243 to rotate latch 241 to the disengaged position, at which time a pin 252 carried by the latch 241 pushes on the underside of the link 244 to disengage pin 243 from hook 244*a*. At this time the pin 237 should move immediately to the left due to the return spring in valve 30. If lever 237 is still being held in clamp down position by the manual operating handle, it would be possible for latch 241 to again engage the pin 237 which is not desirable for the clamp would remain locked on the pile after the knife reached the top of its stroke. To avoil such malfunction, an auxiliary interlocking latch 251 is provided which is biased by a spring 251*a* to rotate on a pin 253 toward the underside of pin 252 to hold latch 241 out of engagement. Thus, when cam 232 disengages roller 233 as the operating handle is lifted up, lever 234 moves clockwise due to the return spring (not shown) which will be understood to be in valve 30. When lever 234 reaches its extreme clockwise position, pin 235 engages an extension 251*a* of latch 251 to disengage it from pin 252. Simultaneously, pin 237 has moved under latch 241, this being the normal disengagement position.

Slot 222*a* permits working the valve 30 by hand without moving the foot treadle. The slot in link 236 permits working valve 30 by foot without moving lever 234 and causing it to be latched. If the latter should occur, the clamp would not rise if the foot treadle were released. Hook 249*a* engages pin 243 at the beginning of the up stroke of the knife. After the pin is disengaged, it rides in the slot of link 244 for the rest of the stroke.

The power stroke of the knife is effected by conventional means and need not be described herein.

Having thus described my invention, I am aware that various changes may be made without departing from the spirit thereof, and accordingly I do not seek to be limited to the precise illustrations herein given except as set forth in the appended claims.

1. In a system for actuating the clamp of a paper cutting machine, a double-ended piston motor 35 having a reversibly movable piston 38, a pressure relief valve 24, 27, for each end of the motor, a multi-way valve 30, a source of pressure fluid 16, said multi-way valve being connected to feed pressure fluid to and from either end of said motor from said pressure source, said pressure relief valves having connection means to said multi-way valve, said multi-way valve being operable to render one of said pressure relief valves effective to relieve pressure at one end of said cylinder while rendering the other pressure relief valve ineffective to relieve pressure at the other end of said cylinder, depending upon which end of said cylinder is being fed with pressure fluid, wherein the pressure relief valve at that end being fed with pressure fluid is effective to relieve pressure and the other pressure relief valve is ineffective to relieve pressure, said pressure relief valves 24, 27 each having three ports 70, 76, 89, each pressure relief valve comprising a through passage 73 between two of said ports 70, 76, said pressure relief valves being connected in serial order between said pressure source 16 and said multiway valve 30, wherein fluid from said pressure source passes directly through said pressure relief valves by means of said through passages, the third port of each of said pressure relief valves being closed by a pressure relief element operable to open said port upon predetermined excess pressure in said pressure relief valve, said third port 89 of each of said pressure relief valves being connected to a respective end of said double-ended motor and said multiway valve being effective in one position to connect said third port 89 of one of said pressure relief valves with the through passageway 73 thereof, and in another position to connect said third port of said other pressure relief valve with said through passageway 73 thereof, whereby to alternately render one pressure relief valve effective while the other is rendered ineffective for pressure relief purposes, depending upon the position of said multi-way valve and the end of the double-ended motor to which pressure is being fed.

2. In a system for actuating the clamp of a paper cutting machine, a double-ended piston motor 35 having a reversibly movable piston 38, a pressure relief valve 24, 27, for each end of the motor, a multi-way valve 30, a source of pressure fluid 16, said multi-way valve being connected to feed pressure fluid to and from either end of said motor from said pressure source, said pressure relief valves having connection means to said multi-way valve, said multi-way valve being operable to render one of said pressure relief valves effective to relieve pressure at one end of said cylinder while rendering the other pressure relief valve ineffective to relieve pressure at the other end of said cylinder, depending upon which end of said cylinder is being fed with pressure fluid, wherein the pressure relief valve at that end being fed with pressure fluid is effective to relieve pressure and the other pressure relief valve is ineffective to relieve pressure, said system including a tank 10 and pre-fill means 45, 47 for establishing direct communication for fluid flow from said tank to one end of said cylinder for effecting rapid movement of said piston in one direction of travel thereof, said connection means for one of said pressure relief valves 27 having a restriction means 44 therein to maintain pressure on the piston when said piston is stationary at the end of travel in the same direction.

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