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Cantella

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[54] **HYDRAULIC CONTROL SYSTEM FOR HOLLOW PUNCHING MACHINES**

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Aug. 22, 1972 Italy 27735/72

[52] **U.S. Cl.** **83/530,** 83/533, 83/617, 83/639

[51] **Int. Cl.** **B26d 5/12**

[58] **Field of Search** 83/527, 530, 533, 541, 83/617, 639

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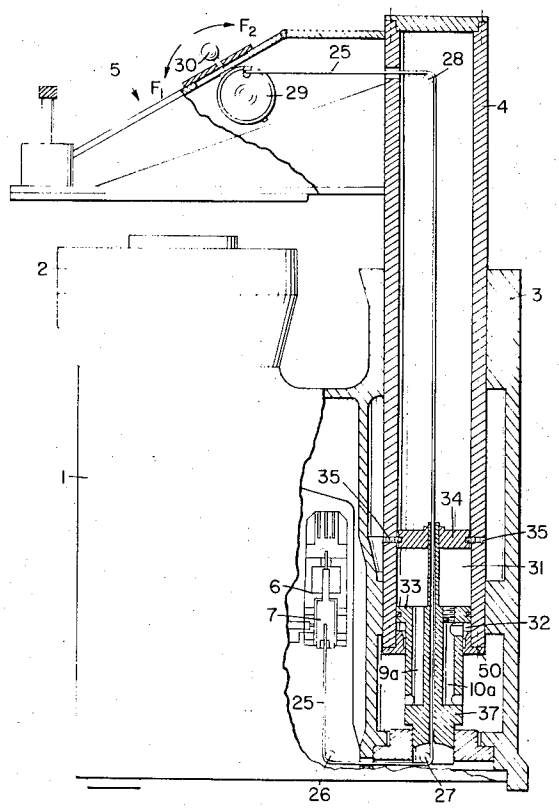
Attorney, Agent, or Firm—Robert E. Burns; Emmanuel J. Lobato; Bruce L. Adams

[57] **ABSTRACT**

A hydraulic control system for a punching machine having an overhanging head held in a raised position relative to a workpiece table by a hollow column which is movable downwardly lowering the head and upwardly raising the head. The column functions as a piston in an upright and defines therewith with two seals a two-chamber hydraulic cylinder to which hydraulic fluid under pressure is applied from a hydraulic circuit for executing the vertical reciprocable travel of the column or piston. The hydraulic circuit is provided with a control valve having a spool having a plurality of circumferential collars or lands coactive with internal annular lands in the valve body for effecting control of the hydraulic fluid for maintaining the piston-like column and therefore the head, in a raised position and lowering it and returning it to a raised position.

10 Claims, 8 Drawing Figures



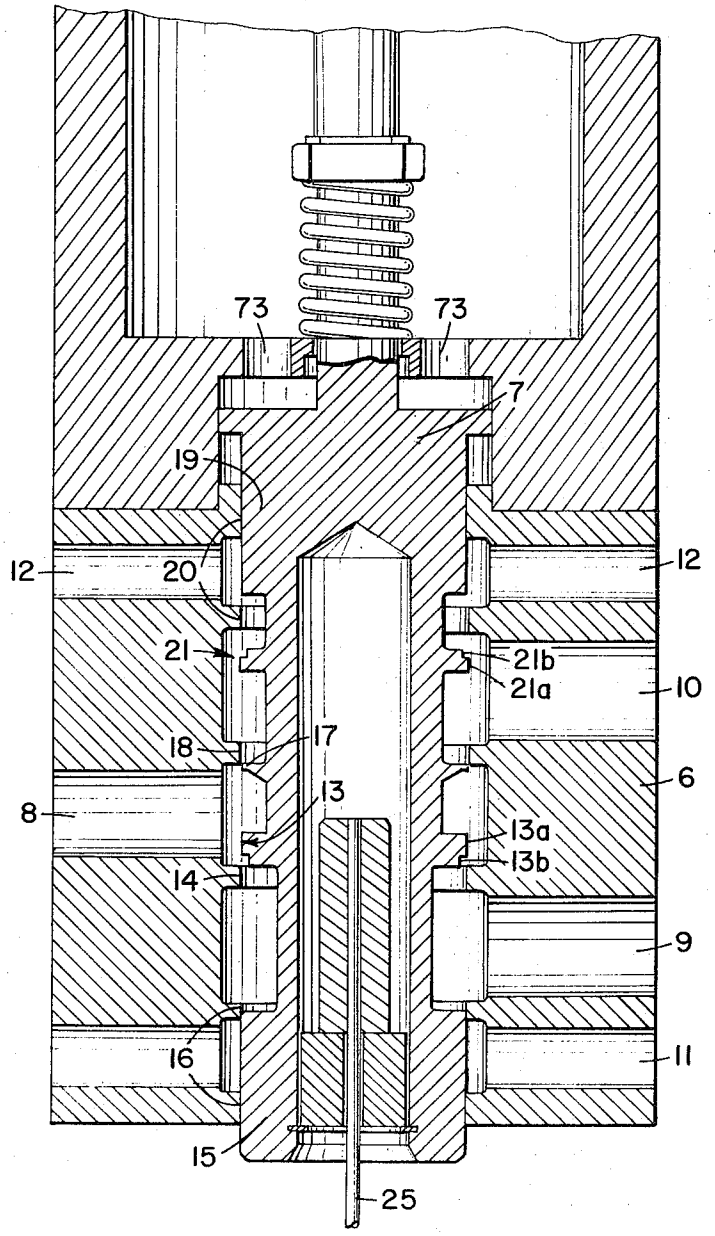


FIG. 1

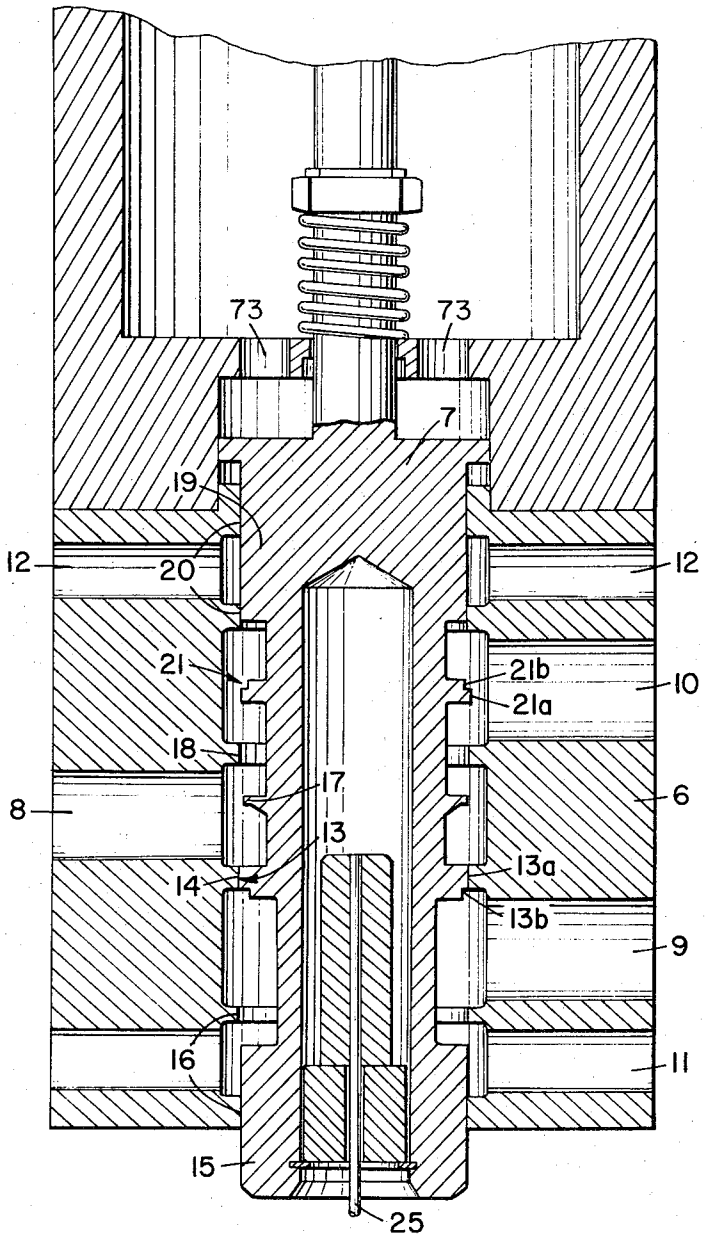


FIG. 2

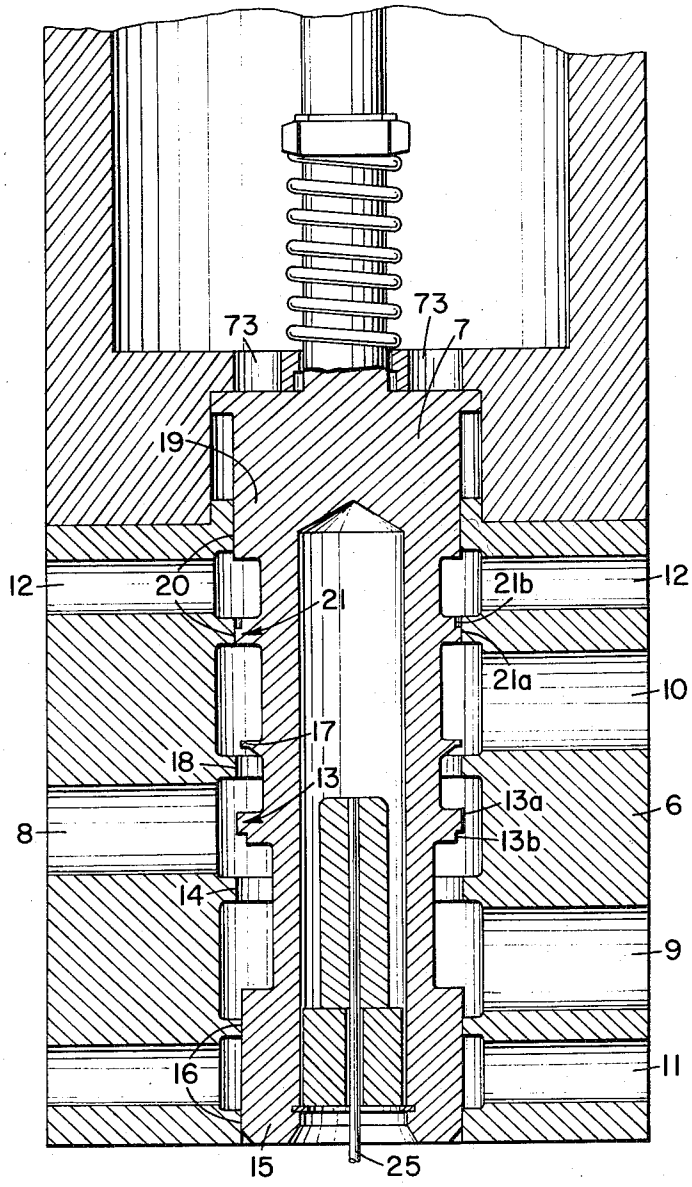
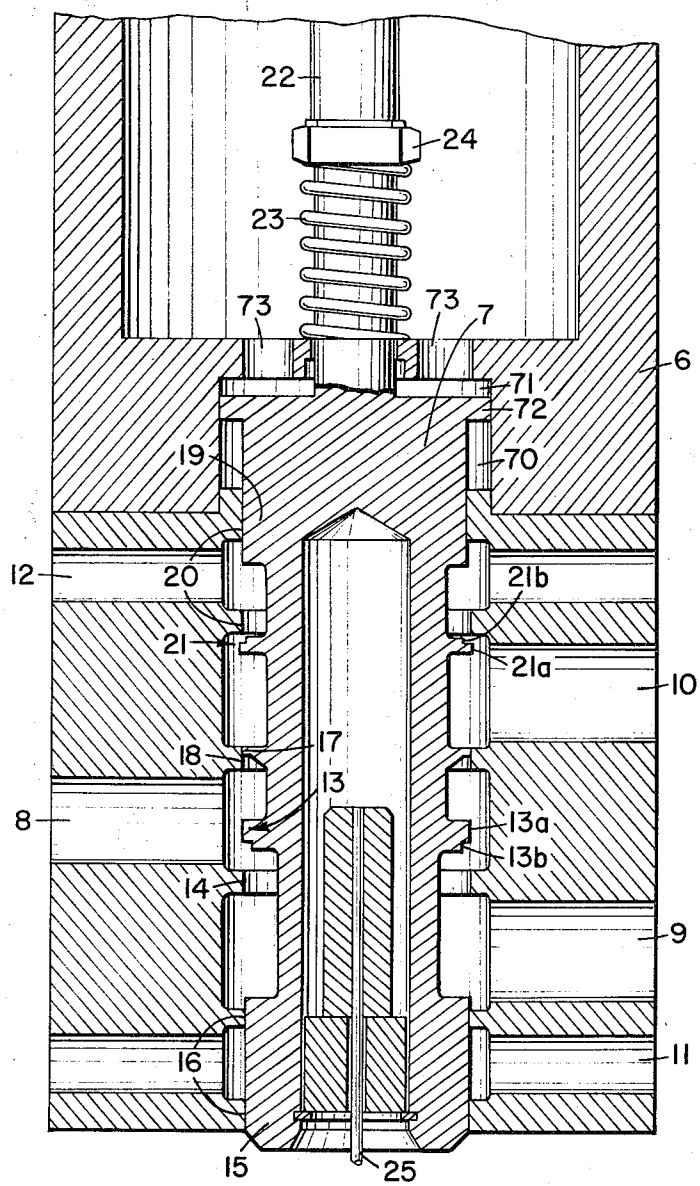


FIG. 3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73
73
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6
71
72
19
70
12
20
21b
21
21a
10
18
17
13
8
13a
13b
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9
16
11
15
25

FIG. 4

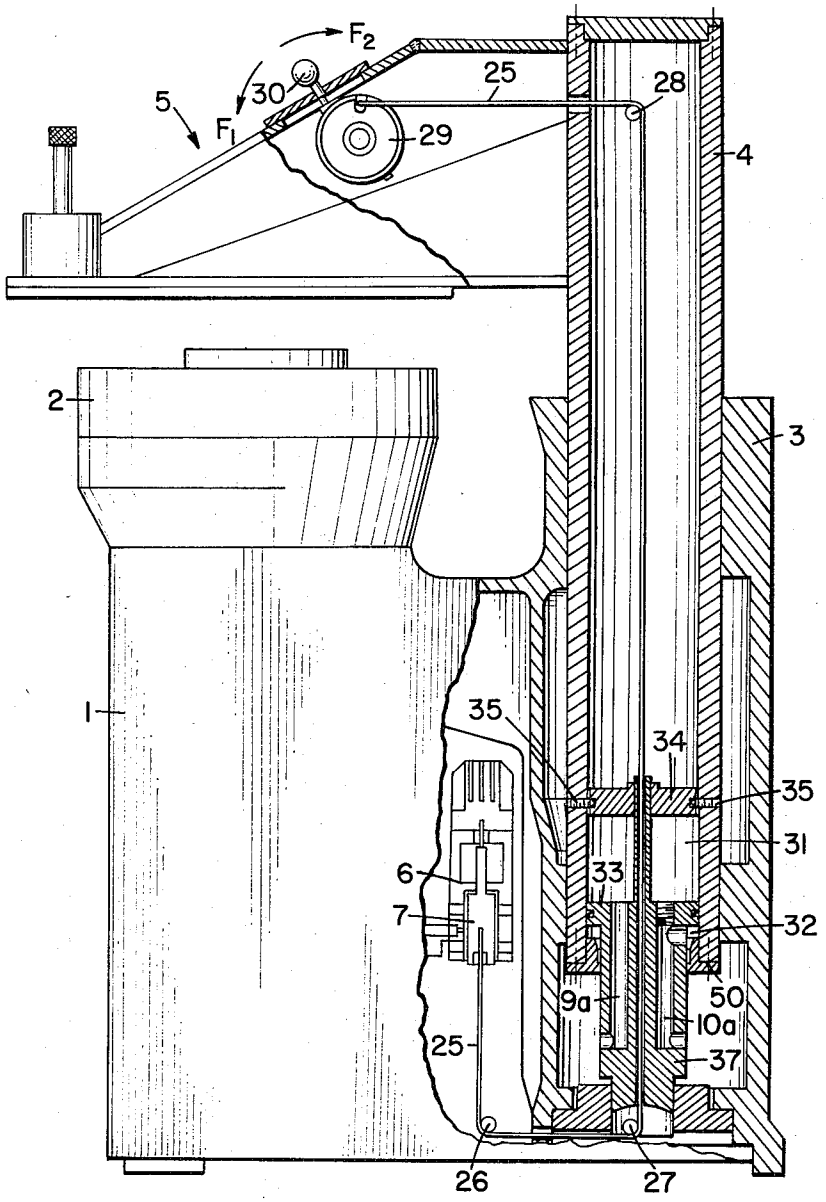


FIG. 5

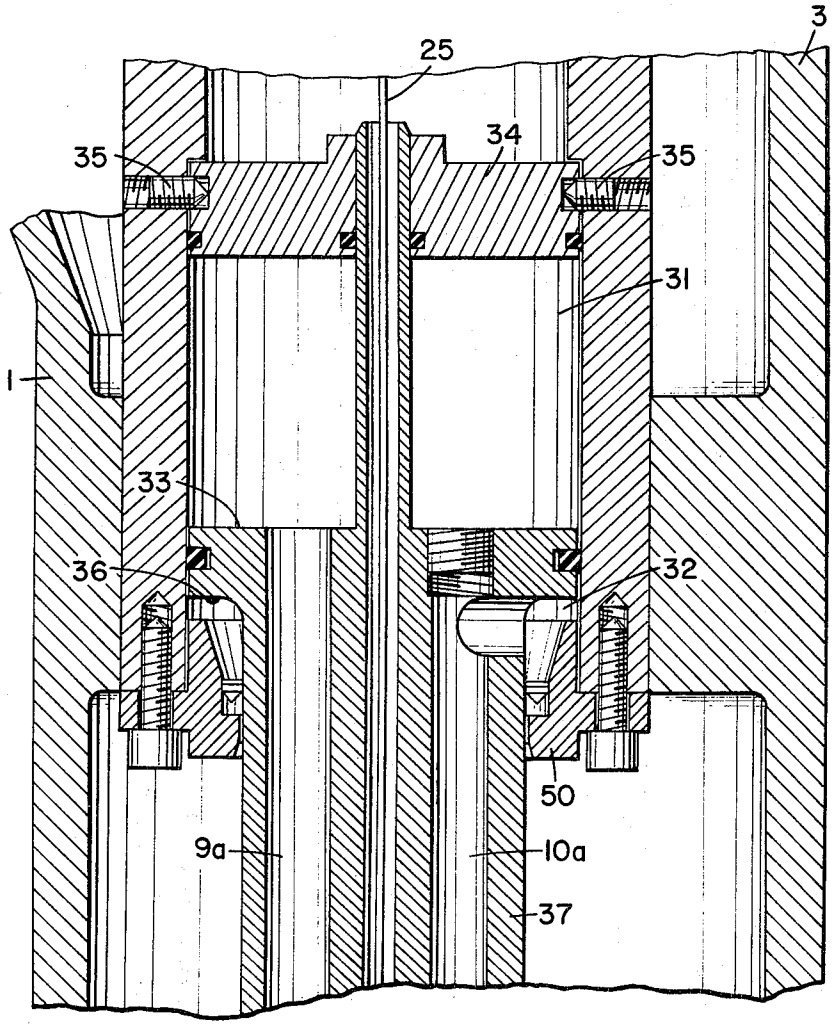
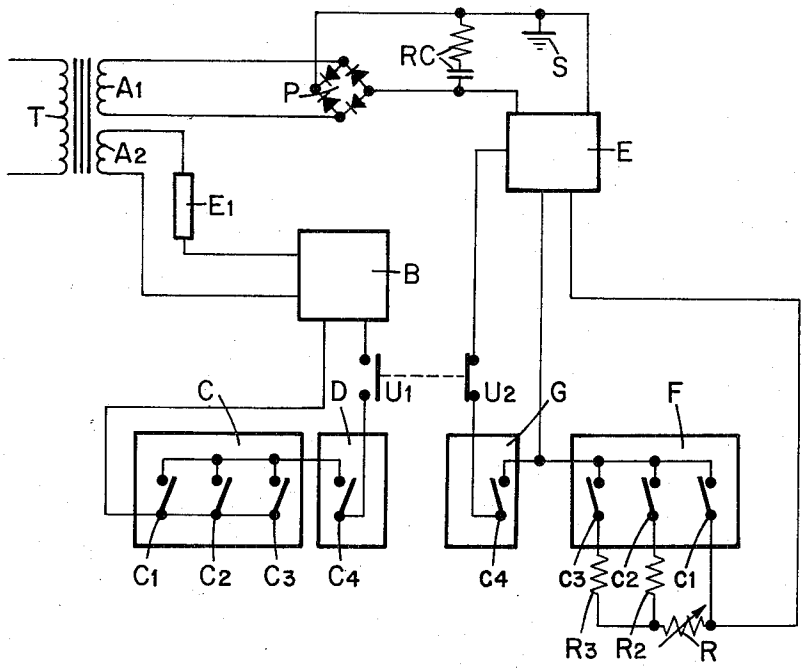


FIG. 6


T
A1
A2
P
RC
S
E
E1
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C
D
U1
U2
G
F
C1
C2
C3
C4
C4
C3
C2
C1
R3
R2
R

FIG. 7

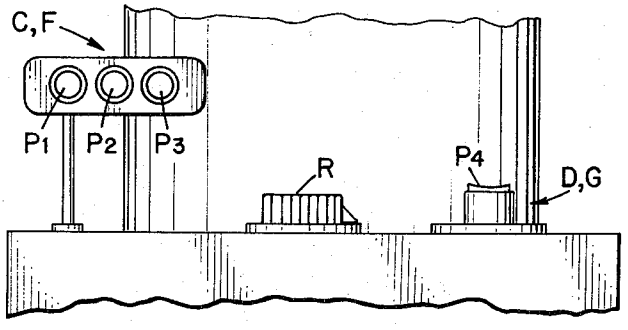
C,F
P1
P2
P3
R
P4
D,G

FIG. 8

HYDRAULIC CONTROL SYSTEM FOR HOLLOW PUNCHING MACHINES

BACKGROUND OF THE INVENTION

This invention relates generally to punching machines and to operating mechanism for hollow punching machines and, in particular, to hollow punching machines of the overhanging head type.

As is known, hollow punching machines of the overhanging type, generally used in the boot and shoe industry, have an operating mechanism by means of which the material being worked on is actually cut. The operating mechanism consists mainly of a hydraulic circuit in which a pump injected fluid circulates. The hydraulic circuit is provided with a valve which has a valve seal or valve element and is able to place a fluid inlet duct, machined in the body of the said valve, in communication with at least two outlet passages leading to a first chamber in a hydraulic cylinder, for raising a moving part, for example a plunger-like column, to which the head of the hollow punching machine is connected, as well as to a second chamber, for lowering the column or moving part, respectively.

Moreover, the operating mechanism is also provided with an electrical circuit, which the operator can control manually, to regulate the valve element and thus the flow of the fluid into one or the other of the outlet passages leading to the first or the second chamber in the cylinder, respectively.

One of the problems which occurs with the known type of mechanism lies in the fact that the downward speed of the moving part of the hydraulic cylinder - and thus of the head - is much faster than the upward speed. This slowness in the ascent of the moving part of the cylinder is the cause of an increase in production time and thus it adversely affects the cost of the pieces produced.

A second problem related to operating mechanisms of the aforementioned type is that, upon completion of the upward return stroke of the plunger-like column of the hydraulic cylinder, it comes to a halt almost instantaneously, since the valve element closes, almost instantaneously, the passage leading to the corresponding chamber in the cylinder. This causes oscillations by the moving column of the cylinder and, therefore, in the head of the machine, thereby causing the fluid to overheat. Oil is particularly affected in this way by oscillations, and the physical properties of the oil deteriorate; as a result of this the oil needs to be frequently changed.

A further problem experienced with mechanisms of the conventional type is derived from the fact that it is not possible to adequately and rapidly regulate the height of the table on the hollow punching machine to suit the depth of the punch used. Normally a threaded screw type mechanism is used, whereby the screw is manually turned by the operator by means of a handwheel. This obviously requires lengthy setting times and subsequent adjustments in order to be able to achieve precision for the depth wanted.

A further problem consists in the lack of punching precision, on hollow punching machines provided with known types of operating mechanisms, since the head on the hollow punching machine, on account of its weight, is apt to undergo a certain deflection, thereby accentuating the cutting operation in the front part of the machine, to the deteriment of that in the rear part.

It is known that this problem has been partially overcome by putting a potentiometer in the electrical circuit of the operating mechanism to obtain a delay in the return of the head, upon completion of the punching operation, thus giving the head more time in which to complete the punching operation. The potentiometer has to be set by the operator every time there is a change in the material being punched.

SUMMARY OF THE INVENTION

A principal object of this invention is to obviate all the problems to which reference has been made in the foregoing, in particular through an operating mechanism which offers the following features:

a. identical downward and return upward speeds for the head;

b. a gradual halt when the head of the hollow punching machine returns to its upward or raised position;

c. automatic and precise regulation of the head with respect to the workpiece table, before punching; and

d. the possibility of obtaining an automatic delay by simply depressing one of several pushbuttons with which the hollow punching machine is provided.

The subject of the invention is, therefore, an operating mechanism for a hollow punching machine and, in particular, for a hollow punching machine of the overhanging type having a hydraulic circuit for the operation of a hydraulic cylinder connected to the head of the hollow punching machine. The hydraulic circuit is provided with a valve with a valve element comprising a spool sliding in a valve body, able to place a fluid inlet duct in communication with two passages leading to a first chamber in the cylinder, for raising its moving part, a plunger-like column of the machine, as well as to a second chamber, for lowering the column. The valve spool is controlled by an electrical circuit. A principal feature of the operating mechanism is that the valve spool and the valve body have means, comrpising a plurality of coacting collars or annular lands, with which to place the inlet duct in communication, through a constriction, with the passage leading to the first chamber in the cylinder and to close a first discharge duct connected to said first chamber, as well as to place the inlet duct in communication with the passage leading to the second chamber in the cylinder and with a second discharge duct connected to the said second chamber, through a constriction, when the plunger-like column of the cylinder is at a standstill. Means are provided, in the form of annular lands, with which to place the inlet duct in communication with the passage leading to the second chamber and to close the second discharge duct, as well as to close, with respect to the inlet duct, the passage leading to the first chamber which, in turn, communicates with the first discharge duct, when the plunger-like column of the cylinder is travelling downwardly, corresponding to the punching operation, means with which to contemporaneously place the inlet duct in communication with the passages leading to the first and second chamber and to close both the first and the second discharge duct at the same time, when the column of the hydraulic cylinder is travelling upwards, corresponding to the return of the head of the hollow punching machine upon completion of the punching operation. The valve has means, comprising annular lands, with which to place

the inlet duct in communication with the passage leading to the first chamber in the cylinder and to close the first discharge duct, as well as, through a constriction, to place the second discharge duct in communication with the passage leading to the second chamber, which is closed with respect to the inlet duct when the plunger-like column in the cylinder, although still moving upwardly, is in the proximity of ending its stroke.

Another principal feature of the mechanism is that the electrical circuit is provided with an automatic device for selecting the time lag prior to the commencement of the upward return travel of the head of the hollow punching machine. The automatic device has a damper working in conjunction with the valve seal whenever the plunger-like column of the cylinder is travelling in a downward direction.

BRIEF DESCRIPTION OF THE DRAWINGS

The characteristics of the invention will emerge more clearly from the following description presented as a nonlimiting example with reference to the accompanying drawings, in which:

FIGS. 1 – 4 are vertical section views of a hydraulic circuit valve, according to the invention, in its various working positions;

FIG. 5 is a side view, partly in section, of a hollow punching machine complete with an operating mechanism according to the present invention;

FIG. 6 is a fragmentary section view of a lower part of a cylinder and of two chambers in the cylinder in the machine of FIG. 5;

FIG. 7 is a schematic wireing diagram of the electrical circuit in the operating mechanism;

FIG. 8 is a view of the operating controls of the present invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

With reference to the aforementioned FIGS. and, in particular, to FIGS. 1 – 5, a hollow punching machine of the overhanging type can be seen and this essentially has a bedplate 1 which is provided with a workpiece table 2 on which the material or workpiece to be punched rests. The hollow punching machine also has an upright 3 inside which a column 4 slides vertically as will be seen more clearly hereinafter. The column 4 is integral with the head of the hollow punching machine generally designated as head assembly 5.

The operating mechanism provided on hollow punching machine comprises a hydraulic circuit, only a part of which is shown, since it is of a known type. The hydraulic circuit consists of a duct connected to a pump, not shown, which takes a suction from a tank containing the supply of hydraulic fluid for the hydraulic circuit and delivers the fluid to the hydraulic circuit under pressure. The duct is connected to a valve constituted by a valve body 6 and a valve spool or piston 7 slidable inside the valve body 6. The latter is integral with the bedplate 1 of the hollow punching machine while the valve spool 7 is linked, in a way which will be clearly described in due course, to the head 5 of the hollow punching machine. In particular, the hydraulic circuit is provided to operate a hydraulic cylinder connected to the head 5 of the hollow punching machine and, for this purpose, the valve spool 7 is able to place a fluid inlet duct 8 in communication with a passage 9 leading to a first chamber in the hydraulic cylinder, later described, so as to raise its piston-like column 4 as well as with a second passage 10 in order to move the column 4 downwardly.

The valve spool 7 and the valve body 6 have means with which to place the inlet duct 8 in communication, through a constriction, with the passage 9 to the first chamber in the cylinder and to close a first discharge duct 11 connected to the first chamber, as well as to place the inlet duct 8 in communication with a passage 10 leading to the second chamber in the hydraulic cylinder and with a second discharge duct 12, connected to the second chamber, through a constriction, whenever the moving column 4 of the cylinder is immobile; this is the condition illustrated in FIG. 1.

The above-described situation corresponds to a phase of immobility on the part of the hollow punching machine and, in particular, to the phase known as the retention of the head in a state in which it is not effecting any punching operation or its raised position. Again, with special reference to FIG. 1, it can be seen that the means with which the inlet duct 8 is placed in communication, through a constriction, with the passage 9 leading to the first chamber and the first discharge duct 11 is closed consist of a first ring-shaped circumferential land or collar 13 with which the valve spool 7 is provided and of a second circumferential, also ring-shaped land or collar 14 located on the inside of the valve body 6, at a point where the passage 9 leads to the first chamber. The difference in height or axial extent between the land or collar 13 and the land or collar 14 is staggered sufficiently to allow the forced circulation of the fluid. It can be seen that the first annular land 13 has two parts, 13*a* and 13*b*, respectively, of a different diameter. The diameter of the part 13*a* is roughly equal to the inside diameter of the second collar or land 14, while that of the part 13*b* is less than the inside diameter of the second land or collar 14. When the column 4 of the cylinder is at a standstill (FIG. 1), the part 13*b* is placed next to the second projection 14, thereby forming the previously mentioned constriction.

A third ring-shaped land or collar 15, is provided on the valve spool 7, and engaged with a first inwardly extending annular lands or inner collars 16 on the valve body 6, at axial points corresponding to the entry point of the first discharge duct 11, so as to close the discharge duct 11. The first pair of lands 16 are ring-shaped and their axial extent is a lot less than that of a third land 15. The lands 16 are spaced apart axially by a length which is less than the height or axial extent of the land 15, in such a way that the collar or land 15 is always engaged with at lease one of the lands 16.

Again, with special reference to FIG. 1, it can be seen that when the movable column 14 of the cylinder is immobile, the means for placing the inlet duct 8 in communication with the passage 10 leading to second chamber and with the second discharge duct 12, through a constriction, consist of a ring-shaped fourth collar or land 17 provided on the valve element or valve spool 7 and by a ring-shaped fifth land or collar 18, on the valve body 6. The difference in height or axial extent between the land 17 and the land 18 is staggered sufficiently to allow forced circulation of the fluid between the inlet duct 8 and the passage 10 leading to the second chamber, thereby forming the previously mentioned constriction. In particular, the fourth collar or land 17 decreases in thickness towards the

outer diameter and, corresponding to its profile, and its height or axial extent is less than that of the fifth collar or land **18.**

Finally, it can be seen from FIG. **1** that the passage **10** leading to the second chamber communicates with the second discharge duct **12** since further collars or ring-shaped lands described in the ensuing text, are staggered at various heights.

Reference will now be made in particular to FIG. **2,** wherein the valve consisting of the valve body **6** and the piston or spool **7** can be seen in a position relating or corresponding to the punching phase and corresponding to the downward stroke of the column **4** of the cylinder with which the head of the hollow punching machine is integral.

It can be seen that the operating mechanism forming the subject of the invention has means with which to place the inlet duct **8** in communication with the passage **10** leading to the second chamber and to close the second discharge duct **12,** as well as to close, with respect to the inlet duct, the passage **9** leading to the first chamber which, in turn, communicates with the first discharge duct **11.** The above mentioned means, particularly for placing the inlet duct **8** in communication with the passage **10** leading to the second chamber are composed of the fourth land **17** and the fifth land **18,** with the difference in height being sufficiently staggered to allow the free circulation of the fluid. It can be seen that the staggering in the height of the projections **17** and **18,** when the moving part of the cylinder is travelling downwards, is greater than when the piston of the cylinder is immobile, corresponding to the immobile phase of the head of the hollow punching machine.

The means for closing the second discharge duct **12,** as well as for closing, with respect to the inlet duct **8,** the passage **9** leading to the first chamber, consist of a sixth ring-shaped land **19** on the valve seal **7** which engages with a pair of lands **20** on the valve body **6,** corresponding to the entry point of the second discharge duct **12,** so as to close the discharge duct **12.** The aforementioned means are also constituted by the first land **14** and the second land **14** in contact or registry with each other at a point corresponding to part **13**a of the first land **13,** the diameter of which is roughly equal to the inside diameter of the second land **14.** It can also be seen that the third land **15** is disengaged from one of the two lands **16** and, in particular, from the one which in FIG. **2** is seen to be the upper land.

Each land **20** of the second pair is virtually ring- or annular shaped and of a height or axial extent which is a lot less than that of the sixth land **19.** The lands **20** of the second pair are axially spaced away from each other by a length less than the height of the sixth land **19,** in such a way that the latter is always engaged with at least one of the lands **20.**

Special reference will now be made to FIG. **3,** wherein the valve spool **7** and the valve body **6** are illustrated in a position relating or corresponding to the upward phase of the piston of the cylinder and thus of the head, upon completion of the punching operation. This situation prevails for most of the upward travel, at the end of which the situation illustrated in FIG. **4** then occurs. It can be seen that the operating mechanism forming the subject of this invention is provided with the means for placing contemporaneously the inlet duct **8** in communication with the passage **9** leading to the first chamber in the cylinder and with the passage **10** leading to the second chamber in the cylinder, as well as the means with which to close, at the same time, both the first discharge duct **11** and the second discharge duct **12,** when moving part, column **4,** of the cylinder is travelling upwards.

In particular, the means for placing the inlet duct **8** contemporaneously in communication with the passages **9** and **10** are constituted by the fourth land **17** and by the fifth land **18,** which are staggered one from the other.

With respect to the fifth land **18,** the fourth land **17** is in a virtually symmetrical position compared with that in which it is located when the movable piston of the cylinder is in the downward position, as illustrated in FIG. **2.** The above mentioned means also consist of the first land **13** and of the second land **14** which are staggered at a height greater than that at which they are staggered when the moving part or column of the cylinder is at a standstill, as shown in FIG. **1.** Again, with special reference to FIG. **3,** it can be seen that the means for simultaneously closing the first discharge duct **11** and the second discharge duct **12,** when the piston or column **4** of the cylinder is on the ascent, consist of the third land **15** in contact with the lands **16** of the first pair and of the sixth land **19** in contact with one of the lands of the second pair, respectively, the other land **20** of the said second pair being in contact with a seventh ring-shaped land **21** on the valve spool **7.** The seventh land **21** is staggered with respect to the other lands **10** of the second pair, when the piston of the cylinder is at a standstill (FIG. **1**) or is travelling downwardly, FIG. **2,** with the actual staggering height being less in the first instance than in the second. As can be seen, the seventh annular land **21** has two parts **21***a* and **21***b*, of different diameter. The diameter of the part **21***a* is roughly equal to that of the inside diameter of the other land **20** of the second pair, while the part **21***b* is of a diameter which is less than the inside diameter of the other land **20.**

Reference will now be made to FIG. **4** in which the valve body **6** and the valve spool **7** are illustrated in a position still corresponding to the ascent of the moving part of the cylinder but in proximity to its upper limit.

With reference to this figure, it can be seen that the mechanism forming the subjct of the invention is provided with means with which to place the inlet duct **8** in communication with the passage **9** leading to the first chamber in the cylinder and to close the first discharge duct **11.** The mechanism in question also has the means with which to place the second discharge duct **12** in communication, through a constriction, with the passage **10** to the second chamber, closed with respect to the inlet duct **8.** The means with which to place the inlet duct **8** in communication with the passage **9** leading to the first chamber and to close the first discharge duct consist of the first land **13** and the second land **14,** which are staggered from one another by a height or axial extent which is greater than that which occurs when the moving part of the cylinder is at a standstill (FIG. **1**) and less than when it is on the ascent (FIG. **3**). The above mentioned means are also composed of the third land **15** in contact with the land **16** of the first pair.

The means with which the second discharge duct **12** is placed in communication, through a constriction, with the passage **10** leading to the second chamber,

consist of the sixth land **19** disengaged from one of the lands **20** of the second pair and from the land **21,** staggered with respect to the other of the lands **20** of the second pair, so as to allow forced circulation of the fluid. In particular, the part **21***b* whose diameter is less than that of the seventh land **21** is disposed at a point corresponding to the said other land of the second pair, thus forming the previously mentioned constriction and allowing the forced circulation of the fluid. The passage **10** leading to the second chamber is closed with respect to the inlet duct **8** since the fourth land **17** and the fifth land **18** are in contact with one another.

With reference to FIGS. **1 – 5,** it can be seen that the valve spool **7** is provided with a rod **22** on its upper part, on to which is fitted a return spring **23,** the bottom of which is held by the valve body **6** and the top by a lock nut **24.**

The valve spool **7** is connected, in a known fashion, to an electromagnet, not shown, which controls its movement. The valve spool **7** is connected to the head of the hollow punching machine and, for this purpose, it is connected with the end of a connecting cable **25.** The cable **25** is disposed over pulleys **26** and **27** rotatably mounted on the bedplate **1** of the hollow punching machine at the same level and a pulley **28** which rotates in the column **4,** at a point corresponding to its upper limit, and on to a head pulley **29** which is rotatably mounted on the head **5** of the hollow punching machine. The head pulley **29** is provided with an operating handle **30.**

With special reference to FIGS. **5** and **6,** a description will now be given of the hydraulic cylinder integral with the head **5** of the hollow punching machine, as well as of the first and second chamber in the hydraulic cylinder. The moving part or piston of the cylinder consists of the column **4** of the hollow punching machine which slides inside the upright **3** of the hollow punching machine.

The said column **4** has, at its lower extremity, a sealing element or cover **50** which slides axially of piston **37** integral with the bedplate **1** of the hollow punching machine. Inside the piston **37,** there is a first duct **9***a* communicating with the passage **9** in the valve body **6** (the connection is not shown) and a second duct **10***a* communicating with the passage **10** in the valve body **6** (this connection too is not shown). The duct **9***a* opens into the first chamber **31** in the hydraulic cylinder, while the duct **10***a* opens into the second chamber **32** in the hydraulic cylinder. The first chamber **31** in the cylinder is formed by an upper end surface or wall **33** of the piston **37** which is greater in diameter than the remainder thereof, by the inner wall of the column **4** which, for this purpose is internally hollow and by a sealing member **34** fixed inside the column **4** at position axially spaced from the end surface **33.** The sealing member **34** has a disc shape and is held inside the column **4** by means of headless screws **35.** The second chamber **32** in the cylinder is formed by an upper surface of the sealing member or cover **50,** by the inner wall or surface of the column **4,** by the lower surface **36** of the part of the piston **37** which is greater in diameter and by the outer wall of the part of the piston **37** which is of a lesser diameter.

The first chamber **31** in the cylinder has an area covered by the fluid approximately twice that of the second chamber **32.** This is achieved by the fact that the area under consideration consists of the lower surface of the sealing member **34,** substantially circular in shape and of the upper wall or surface of the member or cover **50,** substantially the area in between two concentric circles. The ratio is thus dimensioned to be approximately 2:1.

It can be seen that inside the piston **37** a duct is provided through which the cable **25** slides inside the piston. The mechanism forming the subject of the invention also has a damper which operates in conjunction with the valve seal **7** when the moving part, column **4,** of the hydraulic cylinder is travelling downwardly. This damper consists, FIG. **4,** of two chambers **70** and **71,** filled with fluid, which communicate with each other through a controlled aperture. The delimitation of the chambers **70** and **71** is by means of a ring-shaped land **72** on the valve spool **7.** The controlled aperture is provided by the difference between the diameter of the projection **72** and the inside diameter of a cavity inside the valve **6.** Two overflow holes are shown at **73** for the fluid from the chamber **71.**

The operating mechanism for hollow punching machine forming the subject of the invention has an electrical circuit for the operation of the valve spool and for automatic return of the head of the hollow punching machine upon completion of the punching operation. The electrical circuit is shown in detail in FIG. **7.** The electrical circuit of the hollow punching machines is in itself of a conventional type.

In it there is a transformer T from which, through a first secondary winding A1 and a second secondary winding A2, two voltages are tapped. The voltage supplied from the first secondary winding A1 is generally approximately 24 volts while that from the second secondary winding A2 is approximately 110 volts. Both are alternating current voltages. The voltage supplied from the second secondary winding A2 is suitable for the excitation of an electromagnet E_1, for operating the valve spool **7.**

For this purpose, the electromagnet E_1 is connected to a conventional type of control circuit shown generally on FIG. **7** as block B. It is, for example, a static electronic switch. The control circuit in block B is connected to two sets of contacts C and D. In particular, the set of contacts C has three contacts C_1, C_2 and C_3 while the set of contacts D has one single contact C_4.

The voltage supplied from the first secondary winding A1 is rectified by means of a diode bridge P at the output of which there is an RC filter, ground S and a conventional type of circuit shown as block E for the de-energization of the electromagnet E_1. It can be seen that the circuits shown diagrammatically as block B and block E on FIG. **7** are interconnected and thus when one is energized the other is de-energized. This is done, for example, through a multiple contact relay, with a first set of its contacts being connected to the circuit B and a second set to the circuit E. When the first set of contacts are open, the second set is closed and vice versa. The interconnection is shown diagrammatically by dotted lines. In both circuits there are two contacts U_1 and U_2. When one is open, the other is closed.

In particular, the block E represents the circuit to which the automatic time delay selector device for the return of the head of the hollow punching machine upon completion of the punching operation, is connected. The device is provided with a first set of

contacts F and a second set of Contacts G. The set of contacts F consists of three contacts c_1, c_2 and c_3, while the second set of contacts G has one single contact c_4. The contacts C_1, C_2, C_3, c_1, c_2, c_3 are connected to a set of three pushbuttons P_1, P_2 and P_3. In particular, the contacts C_1 and c_1 are connected to the pushbutton P_1, while the contacts C_2 and c_2 are connected to the pushbutton P_2 and the contacts C_3 and c_3 are connected to the pushbutton P_3. The contacts C_4 and c_4 are connected to the one single pushbutton P_4. It can be seen too that corresponding to the first set of contacts F, there is a potentiometer R, already used in known electrical circuits for the operation of hollow punching machines, to regulate the time lag for the return of the head of the hollow punching machine upon completion of the punching operation.

Corresponding to the contacts c_2 and c_3, two resistors R_2 and R_3 are connected and these, which have different resistances constitute part of the automatic time delay selector device. No resistor is provided to correspond with the contact C_1 and thus the closing of this particular contact does not bring about any delay in the return of the head of the hollow punching machine.

The way in which the aforementioned operating mechanism functions is, therefore, as follows: assuming the machine to be at a standstill or in the head raised or immobile phase, the valve seal **7** and the valve body **6** are in the reciprocal position illustrated in FIG. **1.**

The fluid supplied by the pump is channelled into the inlet duct **8** and passes past the lands **13** and **14** which form a constriction, whence it goes through the passage **9** leading to the first chamber **31** in the cylinder, thereby creating the necessary pressure for the sustaining of the head.

This pressure is normally around 1.7 kg/cm². The fluid is also sent through the constriction created by the lands **17** and **18** which are only slightly staggered in the passage **10** leading to the second chamber in the cylinder, as well as to the second discharge duct connected to the second chamber. It can also be seen that the first discharge duct is fully closed. Depending upon the time lag required, one of the three pushbuttons P_1, P_2 or P_3 is now depressed to bring about, through the electromagnet E_1, the downward motion of the valve seal **7** inside the valve body **6** (FIG. **2**). In this way, the fluid goes from the inlet duct **8** into the passage **10** leading to the second chamber **32** in the cylinder, thereby creating the necessary pressure for the downward travel of the head of the hollow punching machine.

It can also be seen that the discharge duct **12** connected to the second chamber **32** is fully closed while the passage **9** leading to the first chamber is closed with respect to the inlet duct **8** and is connected to the fluid discharge duct **11** connected to the first chamber **31** in the cylinder. This is the phase when the material on the table of the hollow punching machine is actually punched. When the punching operation is over, the head of the hollow punching machine is carried back to its original position. This return commences after a certain time lag has elapsed and the actual time lag depends upon which of the three pushbuttons P_1, P2 or P_3 has been depressed. If, in fact, P_1 has been operated, the contacts C_1 and c_1 close and any time delay is practically nil.

If P_2 is operated, the contacts C_2 and c_2 close and a time lag is obtained which not only depends on the value of the potentiometer R resistance but also on the rating of the resistor R_2.

By depressing pushbutton P_3, the contacts C_3 and c_3 close and a time lag is obtained which not only depends on the value of the potentiometer R resistance but also on the rating of the resistor R_3, the value of which is not the same as that of the resistor R_2. In general, the rating of the resistor R_3 is higher than that of the resistor R_2.

It is obvious that at the same time that one of the three pushbuttons P_1, P_2 or P_3 is operated, it is also necessary, in accordance with the safety standards envisaged for these machines, to also depress the pushbutton P_4 and thereby bring about the closing of the contacts C_4 and c_4.

The phase corresponding to the upward return motion of the head on the hollow punching machine and, in the case in question, the upward return motion of the column **4** on the hollow punching machine is illustrated, with particular reference to FIG. **3.**

Once the electromagnet E_1 ceases to be energized, the valve seal **7** moves upwards, as a result of the pressure exerted by the return spring **23,** placing the inlet duct **8** in direct communication with the passage **9** leading to the first chamber **31** in the cylinder and the passage **10** leading to the second chamber **32** in the cylinder.

The first discharge duct **11** and the second discharge duct **12** are fully closed.

The pressure supplied by the infeed pump is the same in the first chamber as it is in the second chamber, despite the area over which the fluid flows being different and since the passages **9** and **10** are intercommunicating, the fluid passes from the passage **10** towards the passage **9,** through the projections **17** and **18** and the projections **13** and **14.** This fluid joins that supplied by the pump via the inlet duct **8** and, in the long run, it is as though the pump, now shown, has increased its delivery and this makes it possible for the upward return speed of the head to roughly be the same as that in the downward direction.

FIG. **4** shows the position between the valve body **6** and the valve spool **7** when the head of the hollow punching machine is in the proximity of its upper limit. In particular, this value, according to a preferred for of embodiment, is chosen at about 2.5 mm from the limit. The cable **25,** which slackens at the time the head **5** starts to move downwardly, is fully taut when the head returns upwards and this causes the valve seal **7** to be displaced in a downward direction. Provision is made in this way for the passage **10** to be placed in communication with the second discharge duct **12,** through a constriction formed by the land **21** and by one of the lands **20.**

The inlet duct **8** is only in communication with the passage **9** leading to the first chamber in the cylinder and, therefore, there is a drop in the upward speed of the head; this speed continues to decrease since the passage created by the lands **13** and **14** gets continually smaller as the valve spool **7,** moved by the cable **25,** carries on moving downwardly; the valve spool **7** comes to a halt once the head **5** has reached its uppermost point. This occurs when the passage created by annular lands **13** and **14** is such that the necessary pressure for the sustentation of the head can be maintained. This pressure is controlled and maintained along the passage created between the annular lands **17** and **18** (FIG. **1**).

The passage aperture is automatically regulated since the delivery of the fluid supplied by the pump will only pass when the pressure matches that which is exercised by the weight of the head **5** acting on the area of the first chamber **31** in the cylinder.

With the foregoing, oscillations on the part of the head of the hollow punching machine due to the brusque stop which takes place upon completion of the upward return travel, can be avoided. As can be seen, the first discharge duct **11** is fully closed.

A further characteristic of the operating mechanism forming the subject of this invention is that it is possible to regulate the position of the head **5** on the hollow punching machine, with respect to the table **2,** by simply moving the handle **30** connected to the pulley **29.** When, in fact, the handle is turned in one direction or the other, the head pulley **29** rotates around its own axis and this causes a greater or a lesser amount of the cable **25** to be wound on to the head pulley **29.** This either causes the valve seal **7,** fastened to the cable **25,** to be lowered or raised and thus the head **5** to be raised or lowered by a given amount.

When, if it is wished to lower the head, all that need be done is to move the handle **30** counter-clockwise, as shown by F_1 on FIG. **5.** This causes the cable **25** to be wound on to the pulley **29** and the valve seal **7** to be lowered inside the valve body **6.**

The fluid passes from the inlet duct **8** to the passage **10,** while the passage **9** is placed in communication with the first discharge duct **11.** Once the valve body **6** and the valve spool **7** have been lowered in accordance with the requirements, they resume the position shown in FIG. **1.** If it is wished to raise the head, the lever **30** has to be moved in a clockwise direction, as shown by the arrow F_2 on FIG. **5.** This causes the cable **25** to slacken and the valve seal **7** to be moved upwards inside the valve body **6.** Should this displacement exceed 2.5 mm, the passage **10** is placed in communication with the passage **9** and, for the reasons stated above, the head is raised. When, instead, the displacement is less than 2.5 mm, the passage **10** is placed in communication with the second discharge duct **12.**

It is obvious that the value of 2.5 mm given herein is not absolutely definite since it is dependent upon the dimensions envisage for the valve body **6** and for the valve spool **7.** Also, for the operation described above, the valve spool **7** returns to the position inside the valve body **6** shown in FIG. **1,** once the head **5** of the hollow punching machine has been raised by the desired amount.

Modifications and variants can be made to this invention without there being any deviation from the basic design or from the protection afforded thereto.

What I claim and desire to secure by Letters Patent is:

1. In a punching machine having an overhanging head, a movable column vertically movable for lowering said head from a raised position and raising said head to said raised position, a hydraulic cylinder for reciprocable driving of said column means defining a hydraulic circuit for providing fluid under pressure to said cylinder for lowering and raising said head, an electrical control circuit, the improvement which comprises a valve in said hydraulic circuit for controlling application of hydraulic fluid to said cylinder maintaining said head in a raised position and for selectively lowering and raising said column thereby lowering and raising said head, said valve comprising a valve body and a valve spool reciprocable therein controlling flow of fluid under pressure into said cylinder for lowering and raising said head, said valve spool having an axial extension actuated under control of said control circuit for effecting travel of said spool for control of application of hydraulic fluid under pressure to said cylinder for lowering the column, means connected to said head and to said valve spool displacing said spool in a direction, as said column is raised, for controlling flow of hydraulic fluid under pressure to said cylinder for regulating the speed of raising said column and maintaining it in said raised position, adjust means coactive with said means connected to said head and to said valve spool for variably adjusting the position of said spool relative to said valve body thereby variably setting the raised position of said column and said head, and said valve body and said spool each having a plurality of coacting, axially spaced annular lands defining flow paths controlling application of said hydraulic fluid to said cylinder for lowering and raising said column thereby lowering and raising said head.

2. In a punching machine according to claim **1,** in which said lands on said valve body are disposed internally thereof and said lands on said spool are disposed circumferentially thereof, said lands being disposed relatively axially to and in operation are in and out of registry in dependence upon the axial movement and axial position of said spool and said lands defining a flow path for hydraulic fluid under pressure to maintain said column in a raised position maintaining said head in said raised position.

3. In a punching machine according to claim **1,** in which said means connected to said spool and to said head comprises a cable.

4. In a punching machine according to claim **3,** in which said adjust means comprises a pulley on said head for variably coiling said cable thereon.

5. In a punching machine according to claim **1,** in which said piston comprises a hollow column, supporting said head, said cylinder comprising interior surfaces of said hollow column, a seal within said column, a seal on an end of said column, and including an upright in which said column is reciprocable.

6. In a punching machine according to claim **1,** including damping means having a controlled orifice controlling flow of hydraulic fluid therethrough damping the axial movement of said column as it approaches a rest position in corresponding to said raised position.

7. In a punching machine according to claim **6,** in which said damping means comprises means defining two chambers communicating through said controlled orifice.

8. In a punching machine according to claim **1,** in which said control circuit comprises electromagnetic means coacting with said spool extension for actuating said spool.

9. In a punching machine according to claim **8,** in which said control circuit comprises delay devices for variably delaying the return of said column from a lowered position to the raised position thereof.

10. In a punching machine having a movable column, a hydraulic cylinder for moving said column to a raised position, lowering said column and restoring it to said raised position, a hydraulic circuit having hydraulic fluid under pressure for supply to said cylinder for moving said column, a control valve in said hydraulic cir-

cuit comprising a stationary valve body, a spool movable axially in said valve body and having a plurality of circumferential, annular lands axially spaced thereon, said valve body having a plurality of annular lands axially spaced for coacting with the lands on said spool, said valve body lands comprising one land more than the lands on said spool, means on said valve body defining passages connected to said hydraulic fluid circuit for supply of hydraulic fluid to said hydraulic cylinder for raising and lowering said column therethrough, means comprising an electromagnet and a return spring for activating said spool axially to positions in which the lands on said spool and body are disposed relatively to define flow paths for fluid from and to said passages to lower and raise said column, a workpiece support member, and an overhanging head movable relative to said table by said column, and means to variably position said spool in said valve body to define variably a raised rest position of said overhanging head relative to said table.

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