

[54] **APPARATUS FOR REGULATING THE DEPTH OF PENETRATION OF A PLOUGH**

[75] Inventor: **Johann Lipinski**, 1030 Vienna, Austria

[73] Assignee: **Alex Friedmann**, Vienna, Austria

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[58] Field of Search172/9, 7, 8; 91/390, 91/433

[56] **References Cited**

UNITED STATES PATENTS

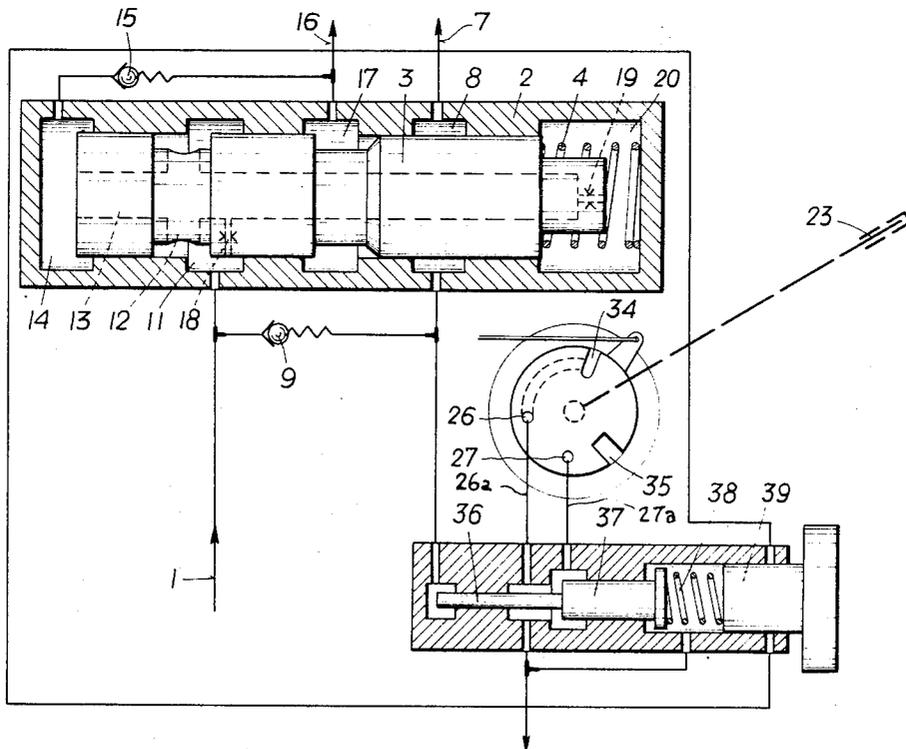
3,285,140	11/1966	Annat et al.	91/433 X
3,004,610	10/1961	Pomper et al.	172/7

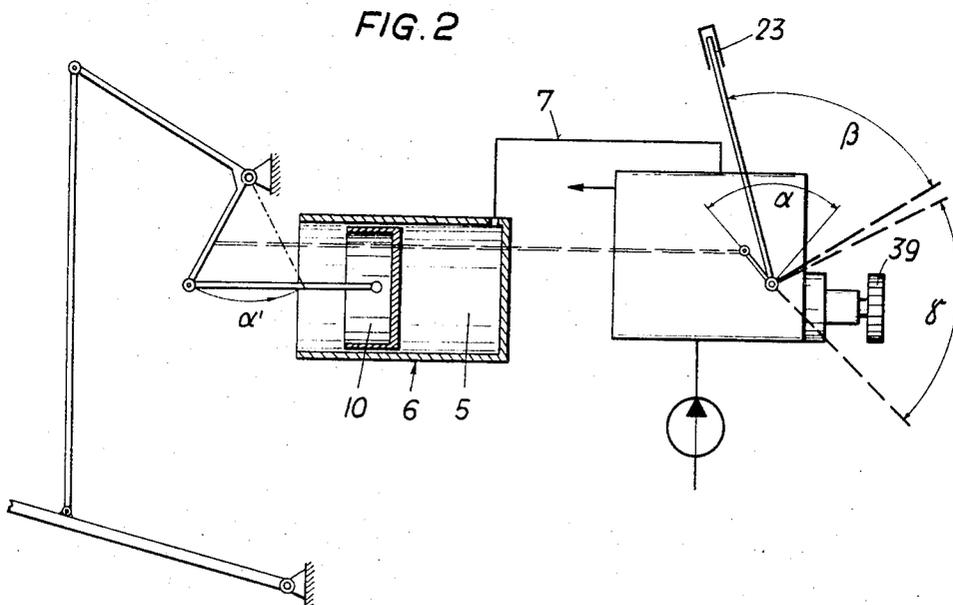
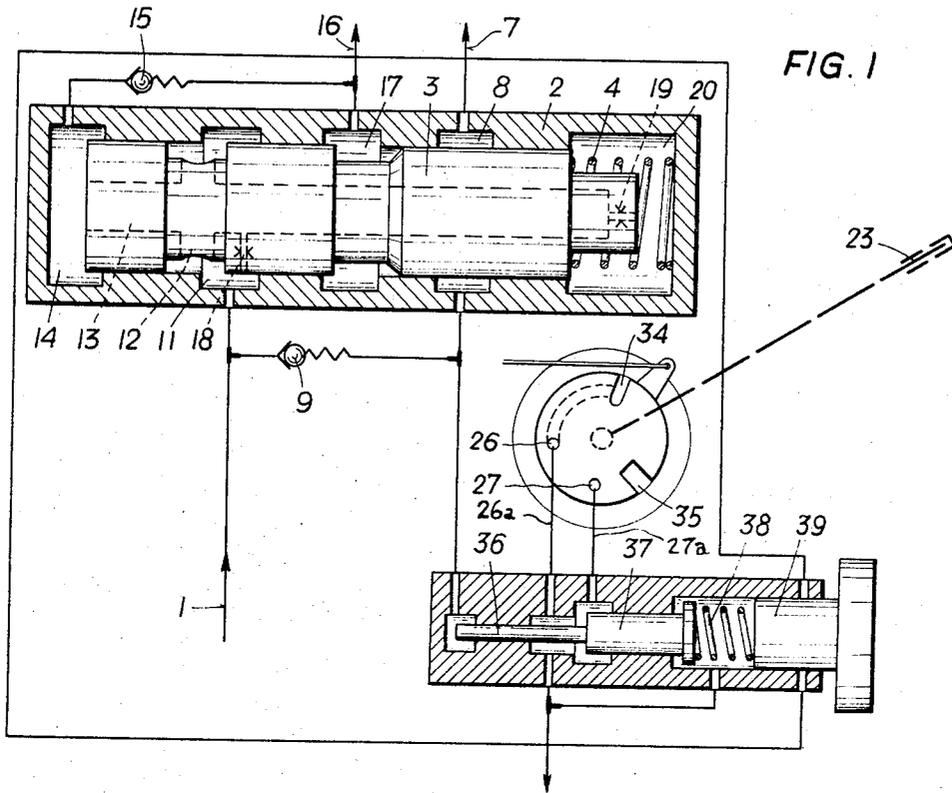
Primary Examiner—Robert E. Pulfrey
Assistant Examiner—Stephen C. Pellegrino
Attorney—Marvin R. Stern

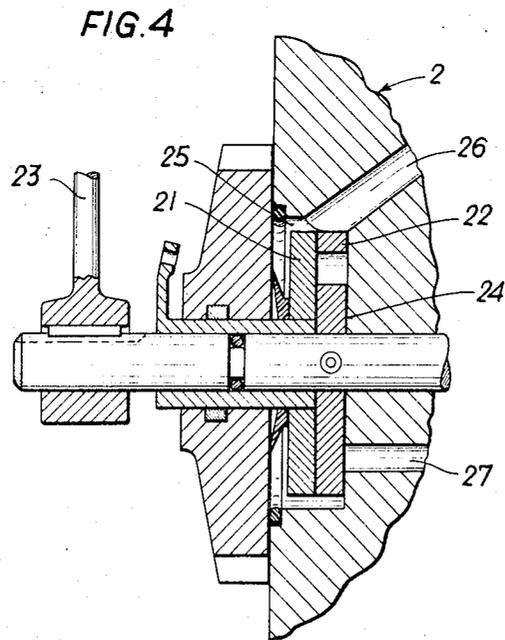
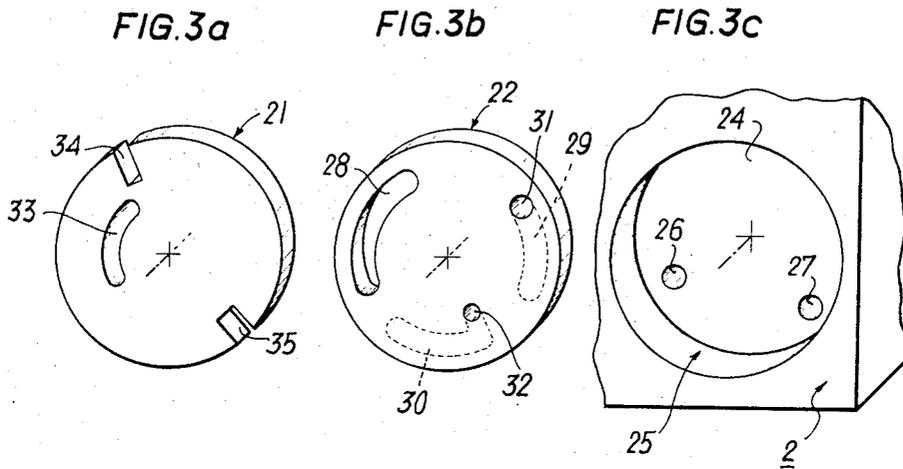
[57] **ABSTRACT**

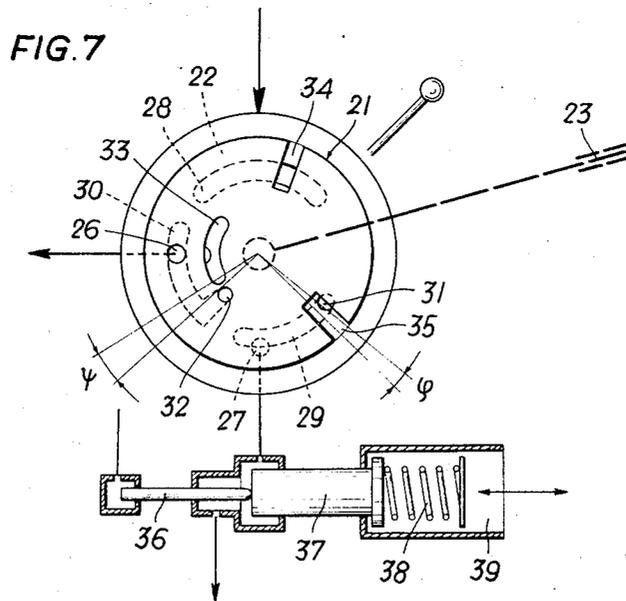
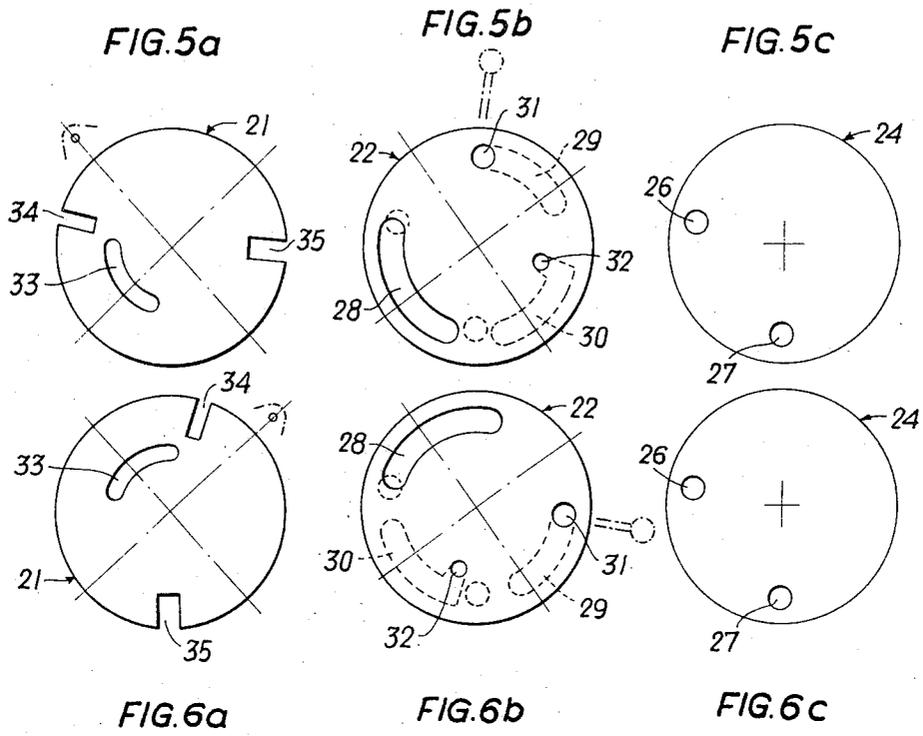
An apparatus for regulating the depth of penetration of a plow which is drawn by a tractor and lifted or lowered by a hydraulic piston-cylinder arrangement. The depth of penetration of the plow is regulated by controlling the pressure in the working chamber of the lifting cylinder.

6 Claims, 13 Drawing Figures









APPARATUS FOR REGULATING THE DEPTH OF PENETRATION OF A PLOUGH

This invention relates to an apparatus for regulating the depth of penetration of a plough which is drawn by a tractor and which may be lifted or lowered by a hydraulic piston-cylinder arrangement. In connection with such ploughs the level of which can be varied by means of a piston-cylinder arrangement of the tractor normally it is necessary to lower the plough gradually until the desired depth of penetration is reached; this procedure, however, requires some experience. Furthermore, methods and apparatus are known whereat the depth of penetration is being reduced as a function of an increasing reacting force put up to the plough moving through the soil to avoid an overload of the tractor and drawbar. Such apparatus for instance may operate in dependence of power or traction, and in case of exceeding a predetermined power or traction value the plough is being lifted.

It has also been suggested to regulate the depth of penetration of a plough in dependence of the pressure in the working chamber of the lifting cylinder. The plough is being held at its level by the piston in said lifting cylinder, and the reacting forces put up to the plough in the soil cause a variation of the lifting force for holding the plough which results in a variation of the pressure within the lifting cylinder. An increase of the aforesaid reacting forces may cause a decrease of the lifting force and of the pressure in the working chamber of the lifting cylinder, or an increase of these values, which depends upon the construction of the plough. In case of a plough of conventional construction, the said reacting forces cause an uplift of the plough, and an increase of the reacting forces will reduce the lifting force necessary for holding the plough, and the pressure in the working chamber of the lifting cylinder. A primary disadvantage encountered in the heretofore known methods and systems for controlling the depth of penetration of a plough in dependence of the reacting forces put up to the plough in the soil is that the lifting and lowering movement of the plough is uncontrollably great which often may lead to an unwanted complete withdrawal of the plough from the soil.

It is, therefore, a primary object of the invention to avoid the aforesaid disadvantages and to provide a novel apparatus for regulating the depth of penetration of a plough which is drawn by a tractor and which may be lifted or lowered by a hydraulic piston-cylinder arrangement, comprising a control piston controlling the supply of hydraulic fluid to the lifting cylinder, said control piston being loaded against a force by a hydraulic control pressure setting up in one of its associated working chambers (control pressure chamber), adjustment of the control piston resulting from variation of a constriction in a connection of the control pressure chamber with a drain in dependence of the pressure in the working chamber of the lifting cylinder, a medium throttling position of said constriction causing an intermediate position of said control piston in which the working chamber of the lifting cylinder is closed, control means being connected in series before said constriction and consisting of a first slide which may be moved at will, and a second slide cooperating with said first slide and being moveable in dependence of the lifting level of the plough, the control ports of said slides in

one relative position thereof connect the control pressure chamber with a drain, and in another relative position thereof block the outlet of the control pressure chamber whereat the distance between said two relative positions determines the lifting range of the plough within which the lifting level of the plough can vary in dependence of the pressure in the working chamber of the lifting cylinder, and the constriction means which controls the outlet in dependence of the pressure in the working chamber of the lifting cylinder is on one hand influenced by the pressure in the working chamber of the lifting cylinder and on the other hand by an adjustable force counteracting to the force exerted by said pressure, such as a spring having an adjustable support.

Thereby the range within which the depth of penetration of the plough in the soil can vary in dependence of reacting forces put up to the plough is being limited. Within this limited range the depth of penetration varies automatically in such a way that traction is being kept about equal, it is avoided, however, that in case of extreme decrease of said reacting forces the plough will penetrate into the soil too deeply in an undesired manner, and that in case of excessive increase of said reacting forces the plough will be completely withdrawn from the soil which would entail a portion of the soil being left unplowed. Within said limited penetration-depth range the tractor operates with constant traction, and after reaching the limits of said range a change in traction is accepted to avoid an undue discontinuity of soil treatment.

Preferably the two slides which are moveable relatively to each other are flat rotary slides, the control ports of said slide cooperate with control ports of said second slide, said control ports of said second slide communicating with the control pressure chamber and cooperating with control ports in the slide face, one of said latter control ports communicating with said constriction means being adjustable in dependence of the pressure in the working chamber of the lifting cylinder, and the other one communicating uncontrolledly with a drain chamber.

If now by a decrease of the throttling effect the control pressure in the control pressure chamber causes movement of the plough beyond the predetermined limiting position, opposite motion of the control piston is being initiated by blocking the outlet of the control pressure chamber. The same applies to the case where upon increase of the throttling effect in the outlet of the control pressure chamber the other predetermined limiting position is being reached, in which case again an opposite motion of the control piston is being initiated by opening the outlet of the control pressure chamber to the drain chamber. Thereby a balanced condition is achieved in the limiting positions until the plough is brought back to an intermediate position within the limited penetration-depth range. The level of said range can be changed by adjusting said first slide which may be moved at will, whereupon said second slide which is moveable in dependence of the lifting level of the plough, and thereby also the plough itself, will follow up the position chosen by said first slide. To this end said second slide has one control port which in one limiting position of the penetration-depth range becomes aligned with a control port of said first slide which communicates with the constriction means being

adjustable in dependence of the pressure in the working chamber of the lifting cylinder, and another control port communicating with the control pressure chamber and in the other limiting position of the penetration-depth range becoming aligned with a control port of said first slide which communicates with a control port in the slide face connected to the drain chamber, whereat the angular displacement of the control ports of said second slide with respect to the control ports of said first slide determines the penetration-depth range of the plough.

The penetration-depth range shall be chosen so that the mechanical resistance of the soil put up to the plough can essentially be equalized, that, however, excessive lifting and lowering motion of the plough is avoided. Therefore the aforesaid angular displacement shall correspond to a penetration-depth range of the plough which is less than the maximum penetration depth, preferably about half the penetration depth of the plough.

The control ports of said first slide may be formed as slots which in all of said slide's positions for controlling the level of the plough in dependence of the pressure in the working chamber of the lifting cylinder communicate with the constriction means adjusted dependence of the pressure in the working chamber and with the control port in the slide face connected to the drain chamber, respectively.

In a preferred embodiment of the apparatus according to the invention said second slide is provided with a control recess communicating with the control pressure chamber, and said first slide has a control slot which upon rotation of said first slide to a range of positions, where the connection between the control pressure chamber and the constriction means adjusted in dependence of the pressure in the working chamber of the lifting cylinder is cut off, communicates with the control port in the slide face connected to the drain chamber. Thereby it becomes possible to obtain either automatic control of the penetration depth of the plough in dependence of the mechanical resistance of the soil put up to the plough, within a range between predetermined levels of penetration, or a manual control of the depth of penetration of the plough, whatever is desired, by means of a single hand lever and only one set of rotary slides.

Features and advantages of the invention will become apparent from the following description of an embodiment thereof given, by way of example, in conjunction with the accompanying drawings in which:

FIG. 1 is a partly sectioned side elevation of an apparatus constructed in accordance with the present invention showing the control piston for controlling supply and drain of hydraulic fluid to and from the working chamber of the lifting cylinder.

FIG. 2 is a schematic diagram showing the connections between the lifting cylinder with the piston for holding the plough and the apparatus of the present invention.

FIGS. 3a, 3b and 3c are isometric views of the two rotary slides and the slide face, resp., when taken apart.

FIG. 4 is a fragmentary sectional view of the slide face with assembled rotary slides.

FIGS. 5a, 5b and 5c are side elevational views of corresponding positions of the two rotary slides and the

slide face for manual operation and the uppermost position of the plough.

FIGS. 6a, 6b and 6c are side elevation views of corresponding positions of the two rotary slides and the slide face for manual operation and the lowermost position of the plough.

FIG. 7 is a schematic partly sectioned side elevation showing the arrangement of the rotary slides with the slide face, with the first rotary slide which may be adjusted at will in the position for automatic operation.

Referring to FIG. 1 of the drawings, the apparatus is being supplied continuously with hydraulic fluid through a supply line 1. In a housing 2 there is slidably supported a control piston 3 on which a restoring force is exerted by a coiled spring 4. The working chamber 5 of a lifting cylinder 6 as shown in FIG. 2 is connected to an annular control recess 8 via a conduit 7. Said recess surrounds the control piston which in the position shown in FIG. 1 closes the recess. A check valve 9 will open only in the direction from supply line 1 to control recess 8 but will stay closed in case of excess pressure in the working chamber 5 of lifting cylinder 6; then the working chamber of the lifting cylinder is sealed off and lifting piston 10 is blocked in its position. Hydraulic fluid from the supply line 1 also flows into a second control recess 11 which in the neutral position of control piston 3 via a radial bore 12 thereof communicates with an axial bore 13 within said control piston. The left end of said axial bore opens out into a chamber 14, as shown in FIG. 1, which chamber is connected to a return line 16 via a pressure holding valve 15. With this return line 16 there is also connected a third annular control recess 17 surrounding the control piston 3. In the outermost right position of control piston 3 which causes lowering of the plough recess 17 communicates with recess 8 whereby hydraulic fluid can flow out of the working chamber 5 of lifting cylinder 6. In the left position of control piston 3 which causes lifting of the plough the connection between radial bore 12 and control recess 11 is cut off and the hydraulic fluid supplied through supply line 1 can reach the axial bore 13 of control piston 3 only through a throttle 18. For this reason more hydraulic fluid is supplied via check valve 9 and conduit 7 into working chamber 5 of lifting cylinder 6.

From axial bore 13 of control piston 3 hydraulic fluid flows through another throttle 19 into pressure control chamber 20 which is located at the right end of the control piston as shown in FIG. 1 and which contains the coiled spring 4. In dependence of the outlet conditions a hydraulic pressure will build up in the pressure control chamber 20 which pressure adds to the force of spring 4, and the resulting force will counter-balance the hydrostatic pressure from the other side of the control piston in its neutral position.

In the drain conduit 26a of control pressure chamber 20 a constriction means 27a is provided the throttling cross section of which is controllable by different control signals. If the throttling cross section is being reduced the pressure in the pressure control chamber 20 will rise whereby the control piston 3 is brought into position LIFT, and if the throttling cross section is being increased the pressure in control chamber 20 will drop whereby control piston 3 is brought into position LOWER. Next to the pressure control chamber 20 in

its drain conduit there is an arrangement of rotary slides, and thereafter a throttling cross section is provided which is controllable in dependence of the pressure in working chamber 5 of lifting cylinder 6.

FIG. 3 shows the slide arrangement when taken apart. Reference numeral 21 designates a slide (second slide) which is adjusted in dependence of the lifting level of the plough by means of a feedback mechanism, and reference numeral 22 designates a slide (first slide) which can be adjusted at will by means of a hand lever 23 to choose the penetration depth of the plough. The two slides are arranged coaxially in a recess 25 which is provided in housing 2 and has a slide face 24. Slide face 24 is shown in FIG. 3c and has two outlet ports. One port, 26, thereof is connected directly with the drain, and the other one, 27, is connected with the constriction which is controlled by the pressure in the working chamber 5 of lifting cylinder 6. The first slide 22 shown in FIG. 3b has on its face opposite slide face 24 in recess 25 three arcuate control sectors. One of said sectors is a slot 28 passing through the slide, while the other two sectors are formed by grooves facing the slide face 24 whereat groove 29 at one of its ends through a port 31 opens to the other face of the slide, and groove 30 opens to the other face of the slide through a port 32 offset radially inwardly with respect to the groove. On said other face of slide 22 rests the second slide 21 shown in FIG. 3a which has a slotted port 33 in the form of a sector, and two radial control slots 34 and 35 which are open to the circumference, too. The second slide 21 is being rotated clockwise if the plough is lowered, and counterclockwise if the plough is lifted. FIG. 4 shown an axial section through the slides and the surrounding portion of housing 2 from which it can be seen that the control pressure chamber 20 lying at one end of control piston 3 communicates with the recess 25 which surrounds the circumferences of both slides and the front face of the second slide 21. Therefore slotted port 33 and radial control slots 34 and 35 of slide 21 always are filled with hydraulic fluid flowing off from pressure control chamber 20.

The apparatus of the present invention allows two different methods of operation for controlling the position of the plough. One method of operation is to exactly position the plough with only small tolerance upon a level preselected by the position of the hand lever 23. In FIG. 2 the angle α is the angle of adjustment of the second slide 21 corresponding to the total range of adjustment of the plough which is connected with said slide by means of a feedback mechanism. For the manual control of the depth of penetration of the plough hand lever 23 may be rotated within an angle β . For the other method of operation, namely automatic control of the depth of penetration, hand lever 23 may be rotated within an angle γ . When using that latter method of operation, second slide 21 will be caused to follow to the position selected by hand lever 23, too, however with the provision that this primary control is superimposed by a control in dependence of the mechanical resistance of the soil put up to the plough so that within a predetermined tolerance range the plough can be retracted by a certain amount in case of highly increasing mechanical resistance of the soil.

FIG. 5 shows the relative positions of the two slides with respect of the slide face for manual operation and the uppermost position of the plough. The usable angular range for manual positioning of slide 22 is limited by arc length of slot 28 which has to allow communication with drain port 26 in slide face 24. Follow-up control of the plough is achieved by the fact that control piston 3 only will stay in its neutral position if the drain of control pressure chamber 20 is being throttled in a predetermined manner. The necessary throttling cross section is obtained by the control slot 34 of slide 21 cooperating with the edge of slot 28 in slide 22. As long as the position of the plough preselected by hand lever 23 is not reached exactly, or after any readjustment of hand lever 23, resp., the drain cross section of control pressure chamber 20 is passingly either fully open or completely closed whereby control piston 3 is brought into position LOWER or into position LIFT, resp., for a period of time until second slide 21 moves its control slot 34 over the end of slot 28 in slide 22 so that the drain of control pressure chamber 20 is being throttled properly whereupon control piston 3 will balance in its neutral position. Operation of the apparatus in case of the lowermost level of the plough with the relative positions of the two slides with respect to the slide face as shown in FIG. 6 is analogous.

For an explanation of automatic operation, reference is made to FIG. 7. In this case control slot 34 of slide 21 and slot 28 of slide 22 are inoperative. Groove 30 of the first slide 22 communicates with drain port 27. Sector-shaped control port 33 of the second slide 21 cooperates with port 32 which communicates with groove 30 of slide 22, and control slot 35 of slide 21 cooperates with port 31 which communicates with groove 29 of slide 22. In this case of the preselected level of the plough has a predetermined tolerance range within which the plough may adjust itself in dependence of the mechanical resistance of the soil, and said tolerance range is determined by the sum of angles ϕ and ψ shown in FIG. 7. Port 27 in slide face 24 is not a direct drain but leads through a constriction means which is controlled in dependence of the pressure in the working chamber 5 of the lifting cylinder 6 and which comprises a small plunger 36 with a cooperating throttle element 37 in the drain, said plunger 36 being loaded by the pressure in the working chamber of the lifting cylinder. The throttle element 37 is loaded by a spring 38 on its end opposite the plunger 36. The other end of said spring rests on an adjustable support 39. By adjustment of said support different plough weights can be compensated so that the tolerance range always will lie symmetrical with respect to the level being set by means of hand lever 23. If due to the soil conditions the reacting forces put up to the plough will rise and tend to lift the plough, there will be a reduction of pressure in working chamber 5 of lifting cylinder 6. As a result of such reduced pressure plunger 36 and throttle element 37 in the arrangement of FIG. 7 will be shifted to the left, and the drain of hydraulic fluid from control pressure chamber 20 of control piston 3 will be reduced. Thereby control piston 3 comes passingly into its position LIFT, however, for the most for such a period of time until one end of slotted port 33 in slide 21 moves over port 32 in slide 22 whereby control pressure chamber 20 is connected directly with the drain.

In the contrary case, namely an increase of pressure in working chamber 5 of lifting cylinder 6, for instance when passing a depression on the surface of the soil, plunger 36 will open throttle element 37 against the restoring force of spring 38 so that the pressure in the control pressure chamber 20 will decrease, and control piston 3 passingly will come into its position LOWER. Lowering of the plough, however, only is possible as long as control slot 35 of slide 21 is at least partly aligned with port 31 of slide 22, because if the drain were cut off completely by means of control slot 35 and port 31 the pressure in pressure control chamber 20 would rise until control piston 3 again would come into its position LIFT.

The apparatus of the present invention allows either a precise and strict control of the level of the plough, or preselection of a mean level whereat in dependence of the mechanical resistance of the soil the plough may automatically perform small lifting and lowering motions within a predetermined tolerance range.

Although the invention has been described in terms of a certain specific embodiment, it will be understood that other arrangements may be devised by those skilled in the art which likewise will fall within the scope and spirit of the invention.

What I claim is:

1. An apparatus for regulating the depth of penetration of a plough which is drawn by a tractor and which may be lifted or lowered by a hydraulic piston-cylinder arrangement, comprising a control piston controlling the supply of hydraulic fluid to the lifting cylinder, said control piston being loaded against a force by a hydraulic control pressure setting up in one of its control pressure chamber, adjustment of the control piston resulting from variation of a constriction means in a connection of the control pressure chamber with a drain in dependence of the pressure in the working chamber of the lifting cylinder, a medium throttling position of said constriction means causing an intermediate position of said control piston in which the working chamber of the lifting cylinder is closed, control means being connected in series before said constriction means and consisting of a first slide which may be moved at will, and a second slide cooperating with said first slide through control parts and being moveable in dependence of the lifting level of the plough, the control ports of said slides in one relative position thereof connecting the control pressure chamber with a drain, and in another relative position thereof blocking the outlet of the control pressure chamber whereat the distance between said two relative positions determines the lifting range of the plough within which the lifting level of the plough can vary in dependence of the pressure in the working chamber of the lifting cylinder, and the constriction means which controls the outlet in dependence of the pressure in the working chamber of the

lifting cylinder is on one hand influenced by the pressure in the working chamber of the lifting cylinder and on the other hand by an adjustable force means counteracting to the force exerted by said pressure.

2. An apparatus as claimed in claim 1, wherein said two slides which are moveable relatively to each other are flat rotary slides, the control ports of said first slide cooperating with control ports of said second slide, said control ports of said second slide communicating with the control pressure chamber and cooperating with control ports in the slide face, one of said latter control ports communicating with said constriction means being adjustable in dependence of the pressure in the working chamber of the lifting cylinder, and the other one communicating with a drain chamber.

3. An apparatus as claimed in claim 1, wherein said second slide has one control port which in one limiting position of the penetration-depth range becomes aligned with a control port of said first slide which communicates with the constriction means being adjustable in dependence of the pressure in the working chamber of the lifting cylinder, and another control port communicating with the control pressure chamber and in the other limiting position of the penetration-depth range becoming aligned with a control port in said first slide which communicates with a control port in the slide face connected to the drain chamber, whereat the angular displacement of the control ports of said second slide with respect to the control ports of said first slide determines the penetration-depth range of the plough.

4. An apparatus as claimed in claim 3, wherein said angular displacement corresponds to a penetration-depth range of the plough which is less than the maximum penetration depth, preferably about half the penetration depth of the plough.

5. An apparatus as claimed in claim 1, wherein the control ports of said first slide are formed as slots which in all of said slide's positions for controlling the level of the plough in dependence of the pressure in the working chamber of the lifting cylinder communicate with said constriction means adjusted in dependence of the pressure in the working chamber and with the control port in the slide face connected to the drain chamber, respectively.

6. An apparatus as claimed in claim 1, wherein said second slide is provided with a control recess communicating with the control pressure chamber, and said first slide has a control slot which upon rotation of said first slide to a range of positions, where the connection between the control pressure chamber and the constriction means adjusted in dependence of the pressure in the working chamber of the lifting cylinder is cut off, communicates with the control port in the slide face connected to the drain chamber.

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