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Caywood et al.

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[54] **TRACTOR HYDRAULIC LIFT CONTROL VALVE**

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[73] Assignee: **Ford Motor Company,** Dearborn, Mich.

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[21] Appl. No.: **401,020**

Related U.S. Application Data

[63] Continuation of Ser. No. 232,807, March 8, 1973, abandoned.

[52] **U.S. Cl.** **91/446,** 91/447, 137/117, 137/596.12, 172/9

[51] **Int. Cl.** **F15b 11/08,** F15b 13/04

[58] **Field of Search** 172/2, 7, 9; 137/596.12, 137/596.13, 115, 117; 91/447, 446, 444

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[57] **ABSTRACT**

An automotive flow control valve for a tractor hydraulic lift system regulates the flow from a fixed displacement pump to a lift cylinder in accordance with the degree of movement of the control valve so that the rapidity of response to a signaled lift of the tractor hitch is generally in proportion to the amplitude of the lift signal. Upon flow to the hydraulic lift cylinder dropping to a predetermined small part of pump output, an unload valve diverts pump flow to sump.

2 Claims, 4 Drawing Figures

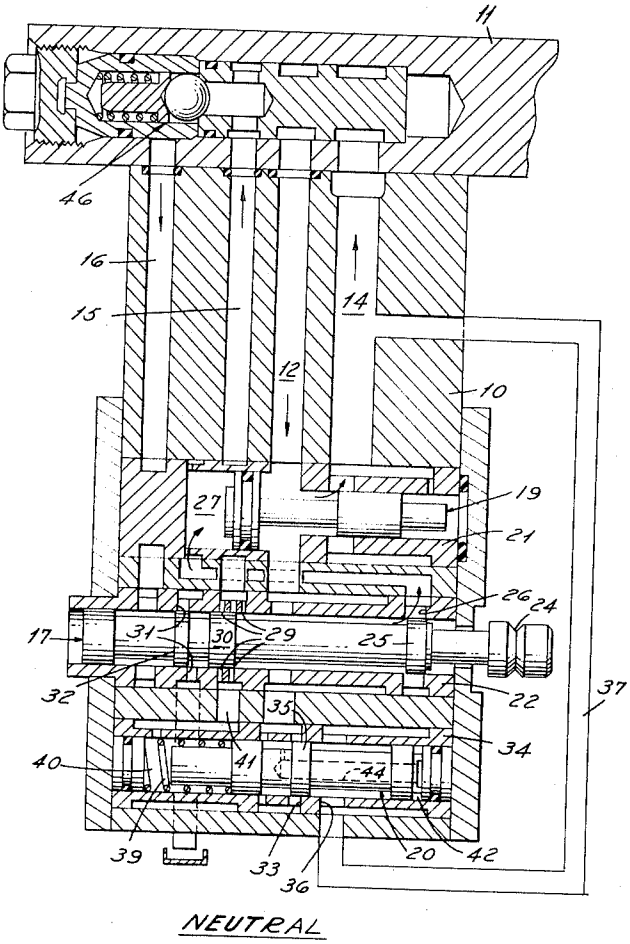
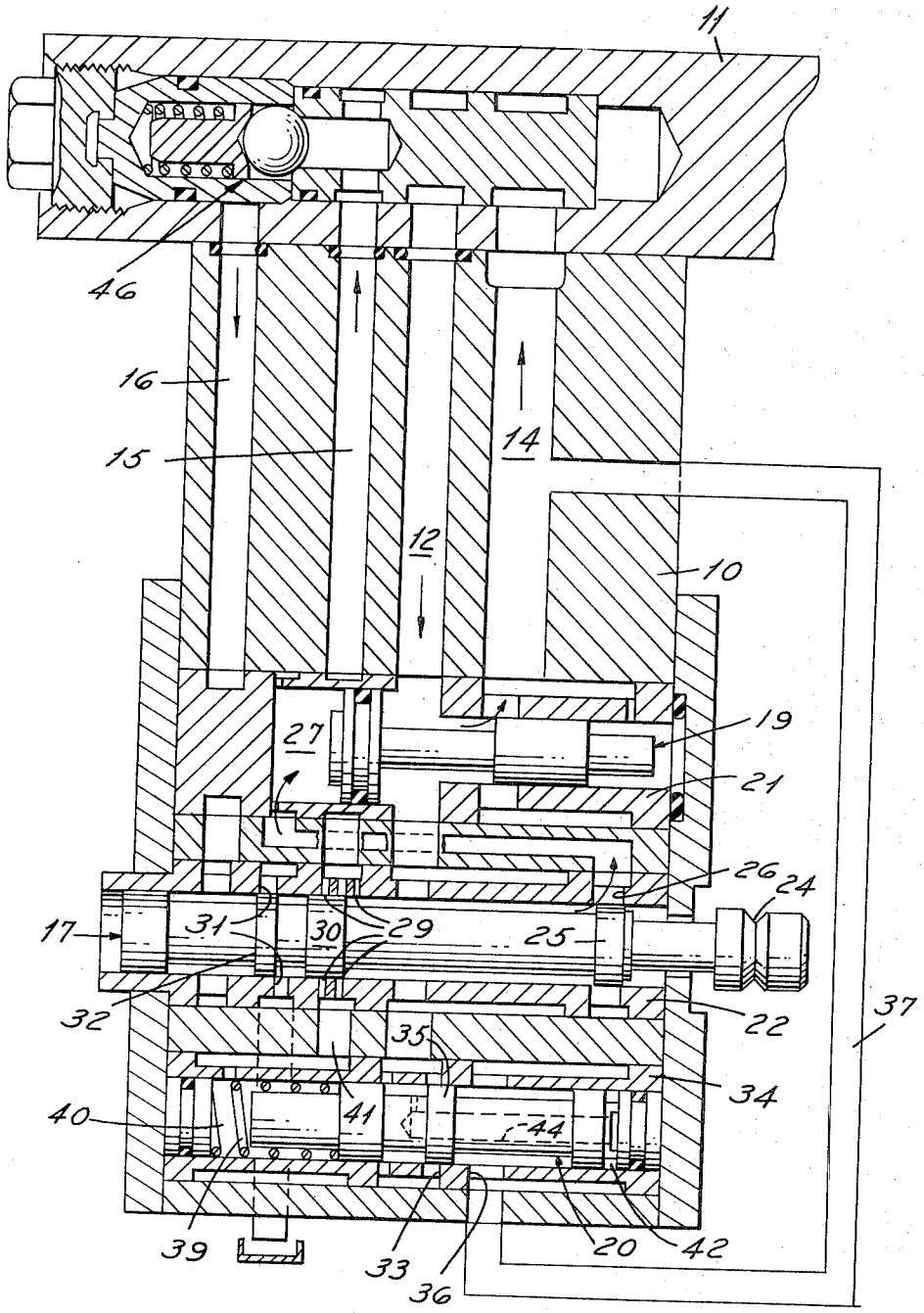
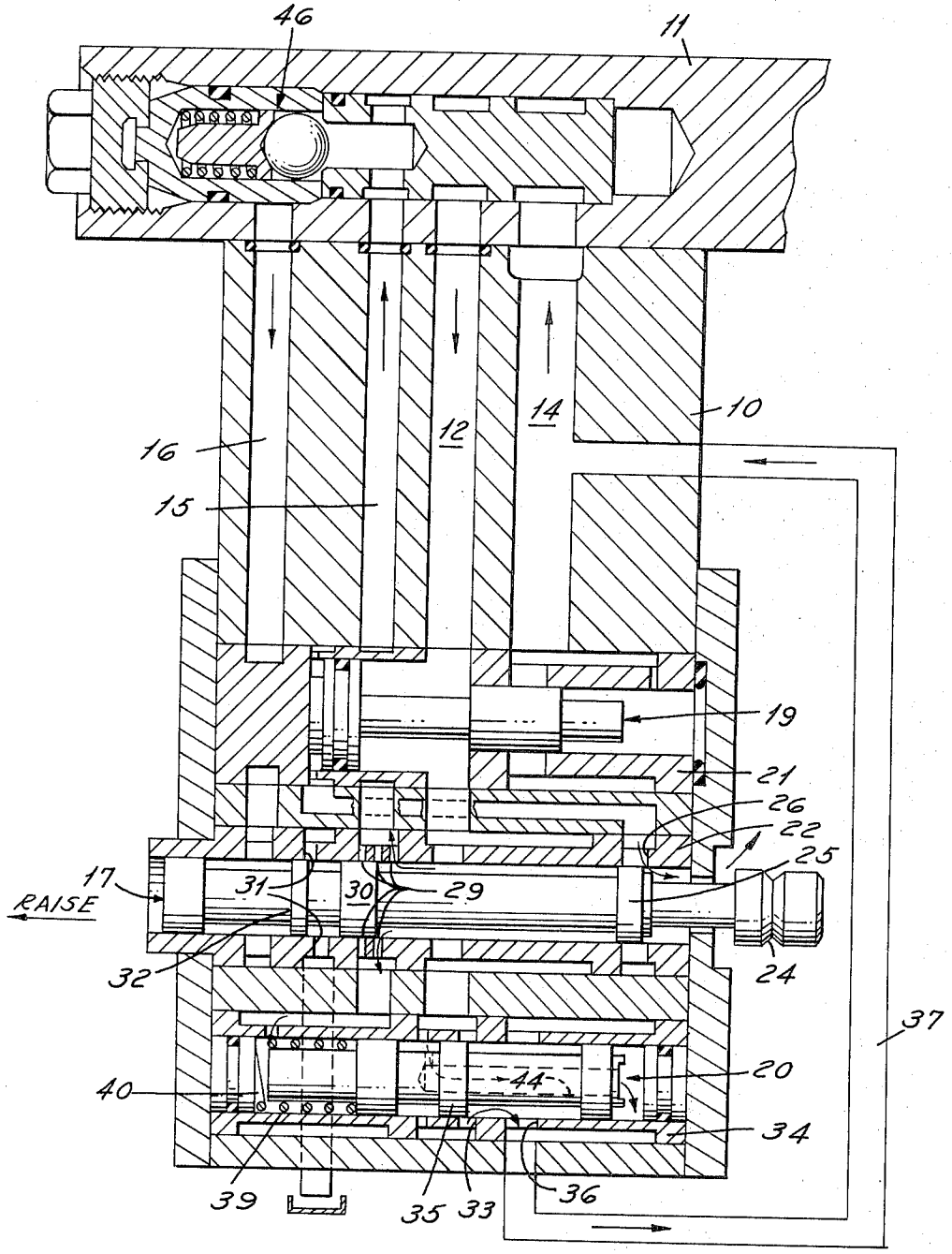


FIG. 1



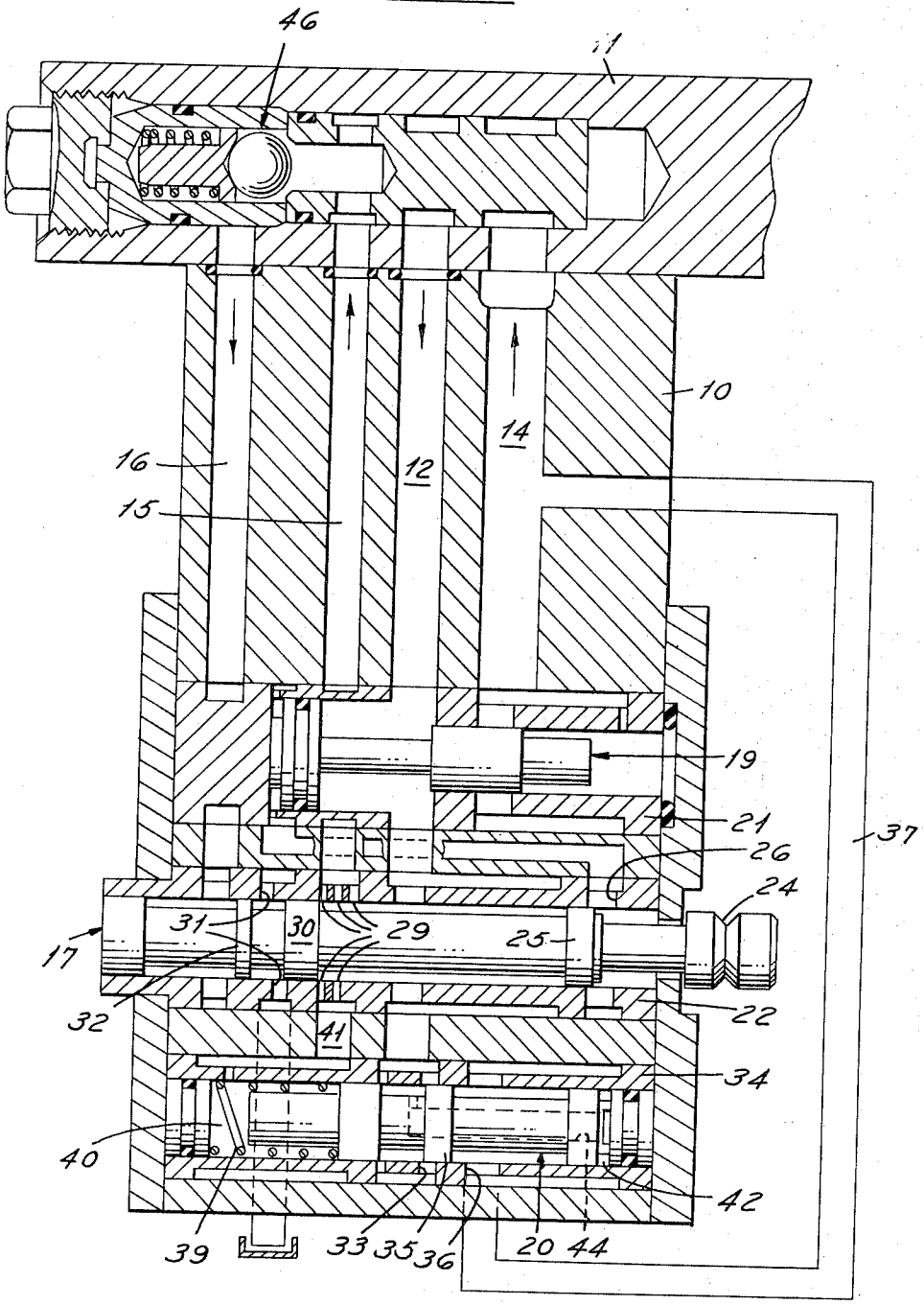
NEUTRAL

FIG. 2



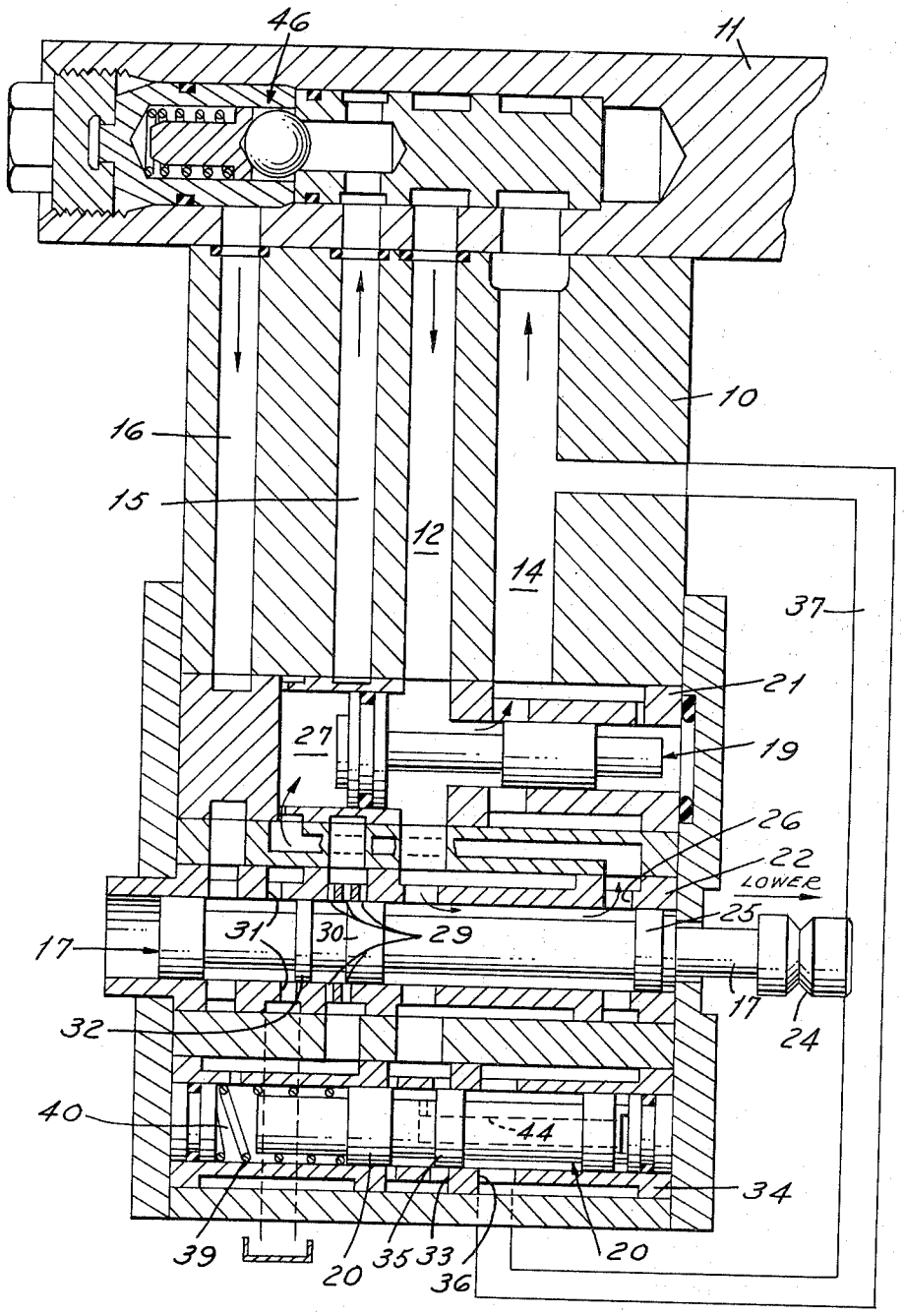
SLOW RAISE

FIG. 3



FULL RAISE

FIG. 4


46
11
10
16
15
12
14
37
21
27
19
26
22
LOWER
25
17
31
30
29
17
24
32
40
44
34
39
20
35
33
36
20

LOWER

TRACTOR HYDRAULIC LIFT CONTROL VALVE

This is a continuation of application Ser. No. 232,807, filed Mar. 8, 1973 now abandoned.

This invention relates to tractor hydraulic lift systems of the type in which the height of an implement hitch is automatically regulated by a hydraulic cylinder and control mechanism to maintain a uniform draft load or implement position, and more particularly to such a system in which an automatic flow control valve regulates the flow of fluid from a fixed displacement pump to the tractor lift cylinder in response to the amplitude of movement of the control valve.

According to the present invention, metering ports successively opened by the control valve regulate the flow of fluid to the lift cylinder in accordance with the amount of movement of the lift control valve. One end of a spring-biased automatic flow control valve is pressurized from the passage to the lift cylinder. Balanced against the spring and pressure is system pressure. The arrangement is such that position of the flow control valve is determined by the pressure drop across the metering ports, which determines the portion of total pump flow that passes to sump. Upon delivery of fluid to the lift cylinder dropping to a predetermined amount, preferably about 20 percent, the unload valve is operated to pass pump output entirely to sump, discontinuing the lift cycle and avoiding a possible condition of "hang-up" in which the pump continues indefinitely to pump a small quantity of fluid to the cylinder to make up for normal system leakage, passing the balance to sump and quickly overheating the oil.

Among the objects of the present invention are to provide an improved tractor hydraulic lift control system in which the flow of fluid to the lift cylinder is automatically regulated by a flow control valve in accordance with the degree of movement of a control valve, to provide such a system in which output of the pump is unloaded to sump upon flow to the cylinder decreasing to a small part of total flow, and generally to improve tractor hydraulic lift systems of the type described.

Other objects, and objects relating to details of construction and use will be more apparent from the detailed description to follow.

This invention is clearly defined in the appended claims. In the claims, as well as in the description, parts may at times be identified by specific means for clarity and convenience, but such nomenclature is to be understood as having the broadest meaning consistent with the context and with the concept of this invention as distinguished from the pertinent prior art. The best form in which has been contemplated applying this invention is illustrated in the accompanying drawings forming part of this specification in which:

FIG. 1 is a somewhat diagrammatic cross section of the valve block of the improved hydraulic lift control valve system, with the control valve in neutral position;

FIG. 2 is a view similar to FIG. 1 with the control valve in slow raise position;

FIG. 3 is a view similar to FIGS. 1 and 2 with the control valve in full raise position;

FIG. 4 is a view similar to FIGS. 1, 2 and 3 with the control valve in lower position.

The tractor with which the lift control valve system of the present invention is intended to be used is of the

type having an implement supporting hitch which is raised and lowered by a hydraulic cylinder to maintain uniform draft or fixed implement height. Hydraulic fluid under pressure is supplied by a constant displacement pump. The well-known Ford tractor is of this type.

Preferably, the valve system of the present invention is mounted within a lift cylinder body **10** which in turn is supported from a lift cover **11.** The lift cylinder body **10** has a passage **12** extending from the hydraulic pump to furnish hydraulic fluid under pressure to the valve assembly. This body also has a passage **14** extending from the valve assembly to sump. A cylinder inlet passage **15** and a cylinder outlet passage **16** also are located within the lift cylinder body.

The valve system includes a control valve **17,** an unload valve **19** and a flow control valve **20.** The unload valve is located within a bushing **21** pressed within a base in the cylinder body **10** and serving to unload the flow of hydraulic fluid from the pump directly to sump when hydraulic fluid is not required for the lift cylinder. When the unload valve **19** is positioned as is shown in FIGS. **1** and **4,** fluid under pressure from the pump passes through passage **12** past the unload valve and directly to passage **14** and thus to sump. When the unload valve **19** is positioned as indicated in FIGS. **2** and **3,** fluid from the pump entering through passage **12** is directed to the control valve **17** and the flow control valve **20** as will be explained.

The control valve **17** is received with a bushing **22** pressed into a base in the cylinder body **10,** as indicated in the drawings. The control valve **17** has a central neutral position, indicated in FIG. **1,** is moved to the right, as indicated in FIG. **4,** to cause lowering of the implement hitch by release of fluid from the hydraulic cylinder and is moved to the left, as indicated in FIGS. **2** and **3,** to admit fluid under pressure to the hydraulic cylinder and cause lifting of the implement hitch. The control valve has an extended grooved head **24** for mechanical control by linkage in a well known manner.

When the control valve **17** is positioned in either neutral or lower position, the land **25** of the control valve exposes a groove **26** in its bushing to admit fluid under pressure from the passage **12** to a chamber **27** at the left of the unload valve **19,** thus moving the unload valve to the unload position indicated in FIGS. **1** and **4.** Whenever the land **25** of control valve **17** covers the groove **26** of the bushing **22,** as in slow raise or fall raise position of the control valve, the chamber **27** to the left of the unload valve **19** is not pressurized and the pressure of fluid within the passage **12** will force the unload valve **19** to the left, thus cutting off the passage to sump **14** and supplying fluid under pressure to the control valve and flow control valve **20.** The groove **26** is opened by land **25** to release flow of fluid from chamber **27** to sump upon movement of the control valve to slow or full raise position.

The bushing **22** of the control valve **17** is supplied with a plurality of axially spaced metering holes **29** which are progressively uncovered by a land **30** of the control valve. When the control valve is moved to the left, fluid under pressure from the passage **12** enters through the holes **29** and passes to the cylinder inlet passage **15.** The metering holes **29** meter flow of fluid to the lift cylinder in accordance with the degree of movement of the control valve **17** in the lift direction

so as to make the speed of implement lift responsive to the degree of movement of the control valve.

A plurality of axially spaced metering holes **31** are provided in the control valve bushing **22** adjacent a land **32** of the control valve **17** to regulate speed of drop of the implement supporting hitch. The metering holes **31** are connected with the ram outlet passage **16** and are progressively uncovered by the land **32** of the control valve as it moves towards the right to cause lowering of the implement hitch. Fluid passing from the passage **16** flows into the control valve bushing **22**, along the valve, through the metering holes **31** and to sump, as indicated in FIG. **4**. Thus, the speed of drop of the hitch is responsive to the degree of movement of the control valve.

The automatic flow control valve **20** which is located within a bushing **34** pressed in the lift cylinder body **10**, serves to pass a portion of the output of the pump entering through passage **12** to sump. The flow control valve **20** operates only when the unload valve **19** is not passing the output of the pump directly to passage **14** and sump.

Fluid from the inlet passage **12** passes to the groove **33** in the flow control valve bushing **34**. As will be seen from the drawings, when the flow control valve is to the extreme right of its movement as in FIGS. **1**, **3** and **4**, a land **35** of the valve blocks passage of fluid from groove **33** to a groove **36** of the bushing **34** when the control valve **17** is positioned at neutral, full raise or lower.

When the control valve is positioned for a raise less than full speed raise, fluid from the passage **12** flowing through groove **33** and entering the groove **36** passes to the bypass **37** which communicates with the passage **14** to sump. The flow control valve **20** is biased to the right, as viewed in the drawings, by a spring **39** received within the bushing **34**. A chamber **40** at the left end of the flow control valve is connected with the cylinder inlet passage **15** by a passage **41** along the outside of the bushing **34** in order to communicate the pressure of the passage **15** to the left end of the flow control valve.

A chamber **42** within the bushing **34** at the right end of the flow control valve is pressurized by fluid from the passage **12** which passes through a passage **44** in the center of the flow control valve **20**. The arrangement is such that pressure within the chamber **40** and the spring **39** both tend to move the flow control valve to the right, as viewed in the drawings. Pressure within the chamber **42** at the right end of the flow control valve tends to move the valve to the left. The position of the valve is determined by a balancing of pressures on the valve.

Thus, as the pressure drop decreases over the metering holes **29** separating the passages **12** and **15**, the flow control valve will be forced to the right to block off diversion to sump of flow from the passage **12** through the flow control valve. If, on the other hand, the control valve is signaling for a slow raise or small correction of implement height, only a portion of the metering passages **29** will be uncovered and, therefore, there will be a greater pressure drop between the passage **12** and the passage **15**. Under these conditions, hydraulic pressure in the chamber **42** at the right end of the flow control valve will force the valve to the left, compressing the spring **39** and the land **35** uncovering the groove **33** to divert a portion of flow to sump through the bypass **37**. The arrangement is such that when the control valve **17** is positioned for slow raise, only a portion of the pump output entering through the passage **12** will be passed to the cylinder inlet passage **15**, the balance of the pump output being diverted to the sump passage **14**.

In order to prevent hangup of the system (continued bypass of most of the oil through the flow control valve and bypass **37**) when the control valve is permitting only a small amount of fluid to pass to the cylinder inlet passage **15** with resultant overheating of the oil, the land **25** of the control valve **17** is so located that when the land **30** is permitting only about twenty percent of fluid from the inlet passage **12** to flow to the lift cylinder, the balance flowing to sump through the flow control valve **20**, the land **25** of the control valve will uncover the groove **26** so as to pressurize the chamber **27** at the left of the unload valve **19** and unload the system.

A check valve **46**, which may be of the spring-pressed ball type, may be located in the lift cover **11** in the path of fluid from the cylinder inlet passage **15**, and prevents a backflow of fluid through that passage. Check valves of this type are well known in tractor hydraulic lift systems.

The lift control valve system of the present invention is a metering system in that the rate of lifting and lowering of the tractor hitch is a function of the degree of movement of the control valve **17**, thus producing a slow lifting of the hitch due to minor corrections of draft or implement position in the operation and yet providing a full flow for rapid lift when a massive correction is demanded as in lifting an implement at the end of a row.

We claim:

1. In a tractor assembly including an implement supporting hitch and a hydraulic lift system for controlling the height of the hitch, which lift system includes an oil sump, a hydraulic lift cylinder, and a fixed displacement pump; an improved control valve assembly for interconnecting the various parts of the hydraulic lift system comprising:

a lift cylinder body having a control valve opening, a flow control valve opening and hydraulic lines to the pump, the lift cylinder and sump;

a mechanically actuatable spool-type control valve;

first bushing means mounted within said control valve opening and receiving for movement said spool-type control valve, said first bushing means having ports and passages for selectively hydraulically interconnecting said lines to the lift cylinder, the pump and the sump in accordance with the position of said spool-type control valve in said first bushing means, the interconnection of said lines of the lift cylinder and the pump including a plurality of oil metering holes which are progressively uncovered by movement of said spool-type control valve in a selected direction;

a flow control valve;

second bushing means mounted within said flow control valve opening, said second bushing means having ports and passages for hydraulically interconnecting said lines to the pump and to the sump in accordance with the position of said flow control valve in said second bushing means;

a spring engaging one end of and biasing said flow control valve to a normal position within said sec-

ond bushing means at which position said lines to the pump and the sump are not interconnected;

a first hydraulic chamber at the unsprung end of said flow control valve;

a second hydraulic chamber at the sprung end of said flow control valve;

a first hydraulic line interconnecting said first hydraulic chamber and said line to the pump; and

a second hydraulic line interconnecting said second hydraulic chamber and said line to the lift cylinder;

whereby when said spool-type control valve is moved in said first bushing means to uncover progressively said oil metering holes thereby interconnecting said lines to the pump and the lift cylinder, the lower initial hydraulic pressure on said line to the lift cylinder is applied through said second hydraulic line to said second hydraulic chamber while the full pressure within said line to the pump is supplied by the first hydraulic line to the first hydraulic chamber thereby resulting in movement of said flow control valve against said spring to interconnect said lines to the pump and said line to the sump to permit diversion of oil directly to the sump from the pump during times when only a small amount of oil is being metered through said oil metering holes to said line for the lift cylinder.

2. The improved control valve assembly of claim **1** wherein:

said lift cylinder body also has an unload valve opening therein; wherein

an unload valve is mounted for movement in said unload valve opening; said unload valve having a central hydraulic chamber which is located in said hydraulic line to the pump, said central hydraulic chamber also being connectable upon movement of said unload valve to said hydraulic line to the sump,

a third hydraulic chamber formed at one end of said unload valve,

a third hydraulic line having one end connected to said third hydraulic chamber,

said first bushing means having an opening connectable from the pump by said third hydraulic line to said third hydraulic chamber;

said spool-type control valve having a portion thereon for opening and closing said opening in said first bushing means to said third hydraulic chamber;

whereby when said spool-type control valve uncovers said opening, fluid pressure in said third hydraulic chamber moves said unload valve thereby to connect said central hydraulic chamber and said line from the pump to said line to the sump.

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