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[11] **3,794,199**

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[54] **HYDRAULIC SELF-LEVELING DEVICE FOR A LOADER BUCKET**

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[51] **Int. Cl.** **E02f 3/86**

[58] **Field of Search** 214/762, 763, 764

[56] **References Cited**

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[57] **ABSTRACT**

A mechanically actuated single valve which has a sequence of opening and closing port connections controlled by a timed spool. The timing of the spool in conjunction with a priority system is such that upon actuation of the self-leveling valve, manual rollback of the bucket is no longer possible.

7 Claims, 4 Drawing Figures

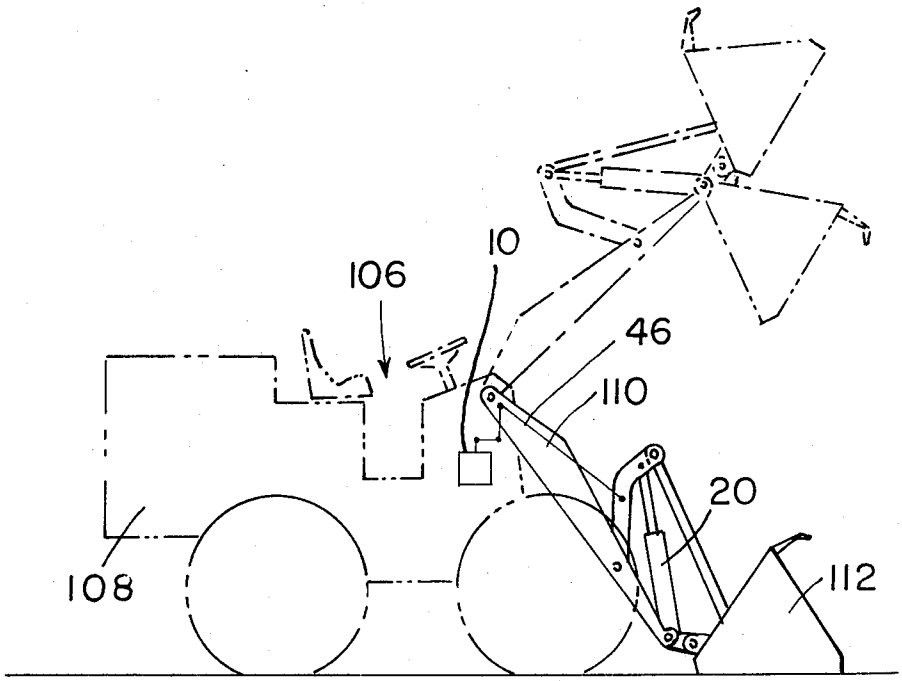
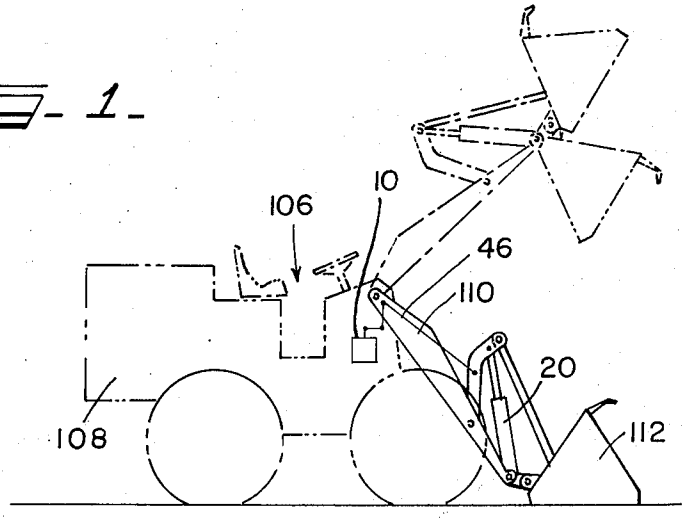


FIG. 1



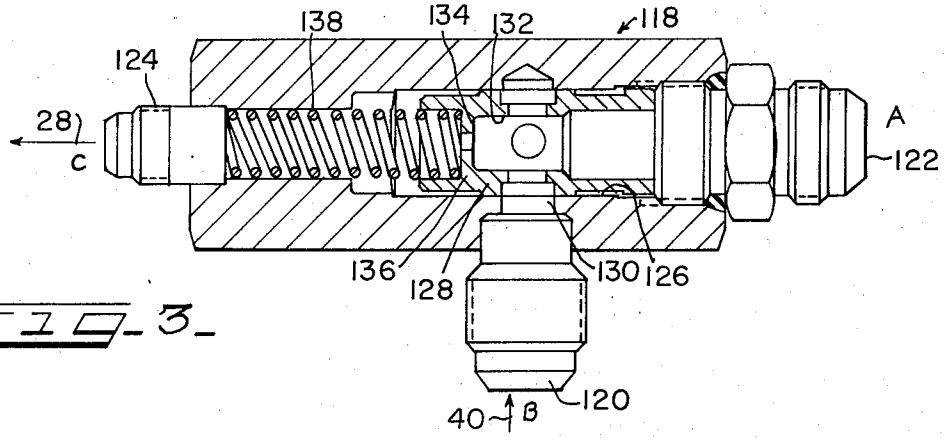


FIG. 3

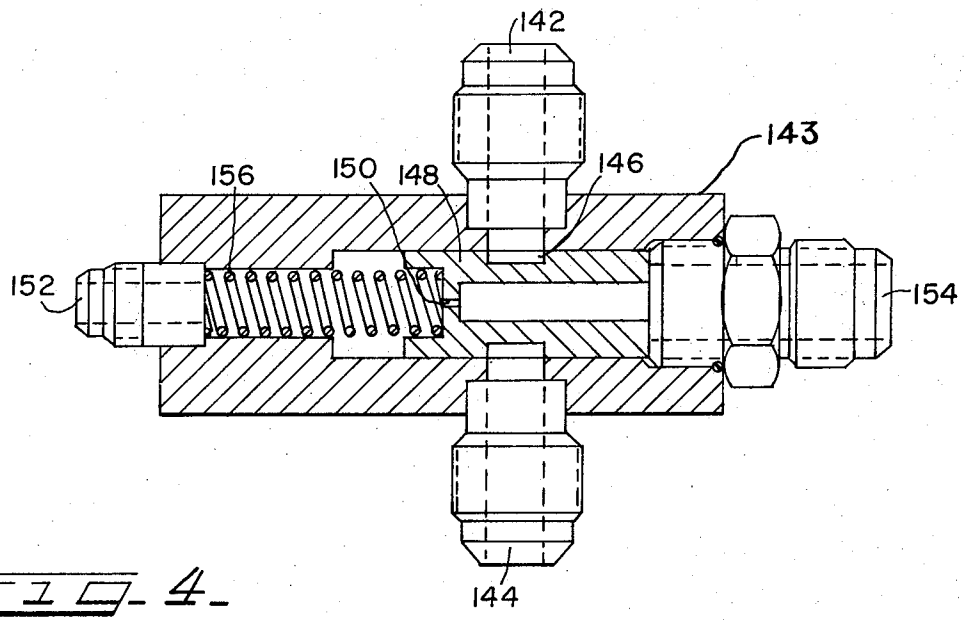


FIG. 4

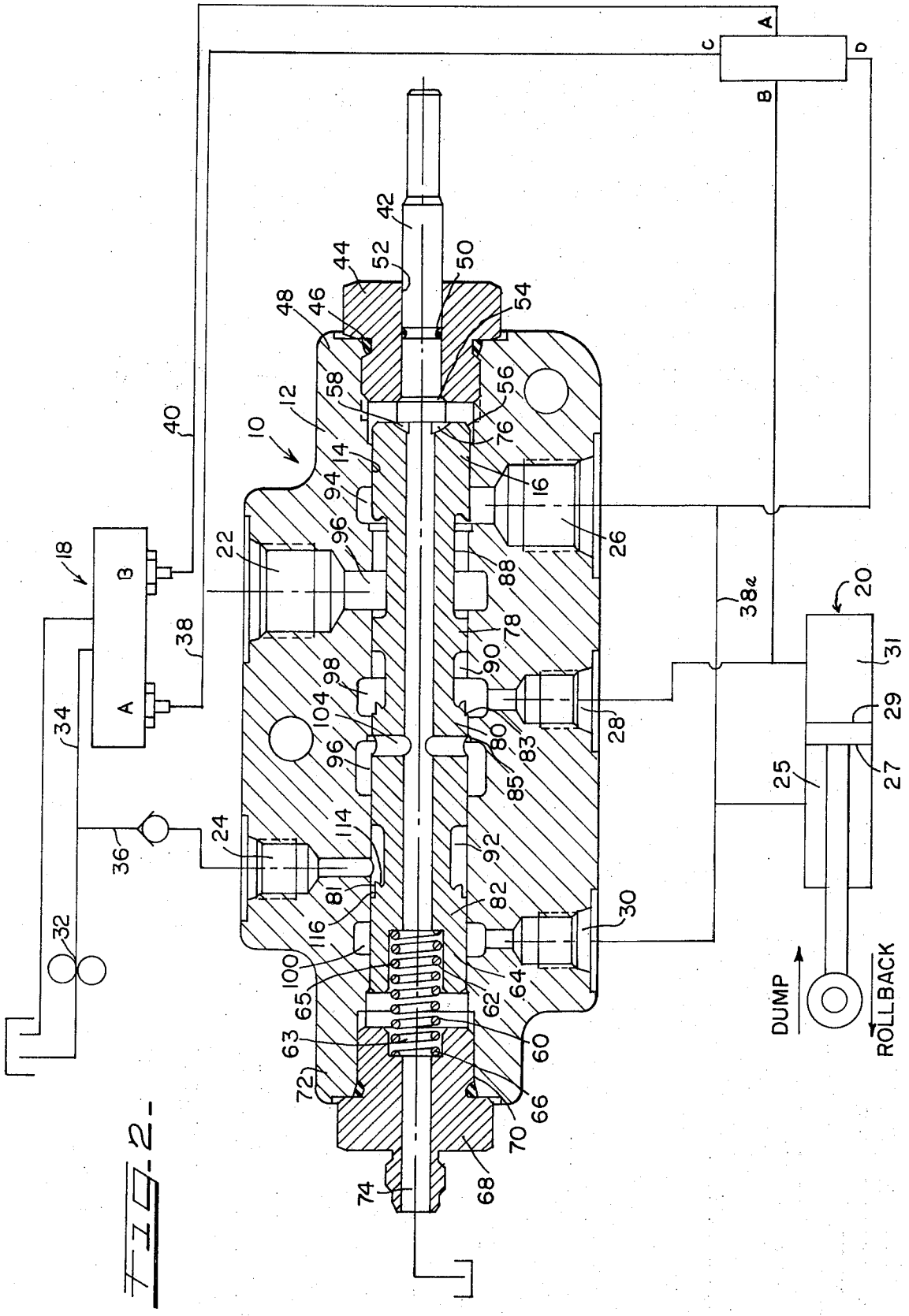


FIG-2-

HYDRAULIC SELF-LEVELING DEVICE FOR A LOADER BUCKET

BACKGROUND OF THE INVENTION

This application is related in subject matter to application Ser. No. 249,604 filed May 2, 1972.

This invention relates to material loaders including a prime mover and a loader frame having a boom and a bucket, and more particularly, to a self-leveling device for maintaining the bucket in a constant position relative to the boom during the working cycle.

As is well known in the art, assemblies of this nature comprise a self-propelled vehicle or support, the front end of which mounts a boom structure that is hydraulically actuated in a plane perpendicular to that of the vehicle. The boom of a front end loader, for example, carries a bucket which engages material as the tractor is driven forwardly, etc. As the boom is raised, the bucket containing the material must be reoriented in relationship to the ground or tilted back such that the maximum amount of material be maintained therein. As is apparent, the vehicle operator, during this series of maneuvers, is required to steer the vehicle, actuate the boom and maintain the bucket in the proper tilt-back orientation as the boom is raised. Obviously, the proper and continuous performance of these functions is not feasible, and error of the operator's judgement in regard to the bucket orientation could very easily result in the rolling back and dumping of the bucket load on himself. Accordingly, it is conventional to provide some sort of automatic self-leveling means for maintaining the bucket in the proper orientation. These have heretofore consisted mainly of mechanical linkages incorporated to some extent with the means for releasing the bucket for tilting. However, for the most part, these mechanical linkages have left much to be desired in the way of operational and cost considerations.

In accordance with the invention, a valve assembly is disclosed which automatically cuts out manual control and governs actuation of a double acting cylinder to achieve leveling thereof as the boom is raised. The assembly includes a high pressure pump for applying high pressure fluid through a circuitry system both to a manual fluid directional control and valve housing. The manual fluid directional control means is a standard open center manual type valve in which the operator by initiating movement of a spool can control the flow directions of both supply and return fluid. A feedback linkage which is connected or at least senses position of the bucket in relationship to the vehicle or prime mover is used to actuate a spool in the valve means. Upon actuation of the spool, the manual fluid directional control means is cut out of the hydraulic circuitry and fluid is redirected both into and out of the valve. The assembly further includes a priority system which insures the cutting out of the manual fluid directional control means during the period of self-leveling.

Accordingly, an object of this invention is to provide an efficient economical self-leveling device for maintaining the proper bucket/ground orientation during the material handling cycle.

It is a further object of this invention to provide a self-leveling device which cannot be overridden such that rearward spilling of the bucket contents becomes impossible, above a given boom height.

Yet another object of this invention is to provide a self-leveling assembly which can be adjusted such that self-leveling becomes automatic at various boom heights.

Another object of this invention is to provide a self-leveling assembly which can be manually overridden, but only into a dump position, when in the self-level range.

Still another object of this invention is to provide a spool-type valve assembly for controlling the actuation of the bucket hydraulic cylinders automatically.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation of a material loader of the type mentioned with parts of the mechanism indicated;

FIG. **2** is a cross section view of the self-leveling valve;

FIG. **3** is a cross section view of a priority valve; and

FIG. **4** is a cross section of another priority valve.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to the drawings, and first to FIG. **1**, the material loader **106**, with which the invention is associated, includes a support vehicle means **108** and a boom means **110** upon which is mounted a bucket means **112** and a rodside working double acting hydraulic cylinder means **20**. A mechanical feedback linkage means **46** communicates movement of bucket means **112** to leveling assembly means **10**.

As shown in FIG. **2**, the leveling assembly means **10** herein shown in a one-spool valve assembly comprising a housing means **12** provided with a longitudinally extending bore means **14** in which the spool means **16** horizontally reciprocates. Upon actual movement of spool means **16**, the manual control means **18** is cut in or cut out of the hydraulic circuitry whereby control of a double acting fluid cylinder means **20** is assumed by valve assembly means **10**. As can be seen, longitudinally extending bore means **14** is intersected at axially spaced intervals by first and second port means **22** and **24** and third, fourth and fifth port means **26, 28** and **30**. As will later become more apparent, the above ports have been thus identified because in some instances they function as input ports while in others they function as output ports.

A power driven hydraulic pressure source, such as a pump **32** has its pressure side connected to manual control valve means **18** by line **34** and to valve means **10** by line **36**. It should be noted that valve **18** is of any conventional open-center type having a high pressure outlet means **38** and a dump line means **40** whereby fluid is selectively supplied to and exhausted from the opposite sides of hydraulic cylinder means **20**. As is apparent the functions of valve **18** are reversible, at which time system "A" which includes line means **38** and **38***a* assumes the function of system "B" which includes dump line **40** and vice versa. This occurs simply upon moving the control spool located therein. When being actuated such that dump command is given bucket **112**, high pressure fluid passes through "A" system, and return fluid to dump through "B" system. As is apparent, "A" and "B" systems perform the reversed function when a rollback command is given.

As shown in FIG. 2, spool means 16 is in a neutral position; in this position, the rod side 25 of hydraulic cylinder means 20 communicates with the manual control valve means 18 via system "A" consisting of line means 38 and 38*a*. As is evident, when spool means 16 is moved to the left from its neutral position into a working position by mechanical input lever means 42, high pressure fluid line 36 is opened and fluid line means 38 is closed. The sensitivity of the mechanical feed-back linkage means 46 of which lever 42 is the terminus must be designed such that it is compatible with the loader means 106 geometry and the characteristics of valve means 10. However, it must be understood that such mechanical linkages are well known in the art and that we, in no way, intend to limit the claims and scope of the invention herein disclosed.

Mechanical input shaft means 42 journals a plug means 44 which closes off bore means 14 against loss of high pressure fluid. Seal means 46, cutting off leaks, is provided between plug means 44 and end 48 of housing means 12. A second seal means 50 serves the same function between input shaft 42 and plug bore means 52. A shoulder means 54 on input shaft means 42 functions such that when in a neutral state, a seating means is provided to limit the rightward travel of input shaft 42. As is evident, when force is not being transmitted to input shaft means 42 to overcome spring means 60, spring means 60 maintains the fluid directing assemblage to the right, that is, keeps shoulder means 54 in a seated arrangement and spool 16 in a neutral position.

Spring centering mechanism 60 has a first end section means 65 positioned in a counterbore means 62 of end 64 of spool means 16. The second end means 63 thereof is positioned in a second counterbore 66 located in plug means 68. Plug means 68 closes off second end 70 of bore means 14 and a seal is formed with second end 72 of housing 12. As is apparent, spring means 60 yieldably holds spool means 16 in a neutral position as shown in FIG. 2. In this neutral position, high pressure fluid from manual control valve means 18 is in fluid communication with rod side 25 of hydraulic cylinder means 20 through high pressure line 38 via first port 22 and third port 26.

A longitudinally extending channel means 74 extends directly through plug means 68 and spool means 16, groove means 76 being provided at end 56 of spool 16.

The spool means 16 is provided with a series of land means; first means 78, second means 80 and third means 82. Separating said axial spaced land means are first, second and third groove means 88, 90 and 92. Correspondingly adjacent to said spool groove means and land means are a plurality of first, second, third, fourth and fifth spool bore groove passage means 94, 96, 98, 100 and 102. As is apparent from a consideration of FIG. 2, passage means 94, 98, 100 and 102 are extensions of the correspondingly adjacent port means.

It can be seen that when the spool 16 is shifted to the left from a neutral position shown in FIG. 2, third port means 26 will be closed by land means 86 and the groove means 88 will place fifth port 30 and second port 24, via high pressure line 36, in direct fluid communication with pump 32. Thus, high pressure fluid will flow through self-leveling means 10 to fluid cylinder means 20. Simultaneously therewith, grooved means 90 opens fourth port 28 such that low pressure hydraulic fluid from hydraulic cylinder means 20 passes into passage means 96 and therefrom, via spool bore means 104, into channel means 74 and subsequently to dump (not shown).

As will be apparent from a consideration of the structure shown in FIG. 2, the effective area means 27 on rod side 25 of hydraulic means 20 is smaller than the effective area 29 on head side 31 thereof. Thus, if during the self-leveling period, the operator were to mistakenly actuate manual control valve 18 opening system "B" to high pressure fluid such that the pressure in hydraulic cylinder 20 of the head side 31 and the rod side 25 is the same, it is apparent that because of the unequal effective areas involved, it would be possible to roll the bucket back. In order to avoid such consequences, a sequence or priority valve means 118, as shown in FIG. 3, is included in the system.

Priority valve means 118 includes a first port means 120, a second port means 122 and a third port means 124, all of said port means entering into a common bore chamber 126. Reciprocatively carried in bore 126 is a shuttle spool means 128 having a port means 130 which intersects bore means 132. Transversely extending bore means 132 of shuttle valve 128 has a restricted means 134 at 136 such that as fluid passes from right to left, a pressure drop is created thereacross. A centering spring means 138 maintains said valve means 128 in a position such that fluid passes from port 120 through 122. However, at the advent of fluid passage through port 124 from port 122 the resulting pressure drop created across restriction 134 causes the shuttle spool 128 to shift against spring 138 and thereby close off port 120. By this means, it is apparent that as soon as port 28 opens to dump upon the shift means 16, shuttle means 128 will cut off port 120 such that if the operator attempts to drive high pressure fluid through system "B," it will be of no consequence.

Another priority valve system is shown in FIG. 4, which when not in a self leveling range, is in a neutral position as shown. Flow is possible from port means 142 and 144, in housing means 143 by passing around the annulus means 146 in the spool means 148. Both roll back and dump manual commands are possible. When the self leveling valve moves to the self-leveling position, port means 22 and 26 are blocked. The small hole means 150 in the sequence valve spool means 148 permits port means 152 and 154 to be at the same pressure. Thus, spool 148 remains in the neutral position as shown, by the spring force means 156. Should the operator give a manual rollback command ports 22 and 152 would effectively go to dump pressure. Ports 26 and 154 would remain at effectively high pressure. This pressure differential from port 154 to 152 will overcome the spring 156 and shift the sequence valve spool 148 toward port 152. Thus blocking off the flow from port 142 to 144. This prevents head side 31 of cylinder 20 from seeing high pressure and rolling back. When the operator releases the manual rollback command, ports 152 and 154 again are subjected to the same pressure and the spring force returns the spool 148 to the neutral position.

In the operation of a loader system incorporating a self-leveling means as described, the work cycle begins with the positioning of the boom in a float position and the filling of the bucket. As the boom means 106 (as shown in FIG. 1) is raised, the amount of leveling nec-

essary to keep the bucket **112** properly aligned increases. Thus, up to a certain boom height, bucket orientation problems are minor. As is apparent, even if the bucket is rolled back such that it dumps, the load falls in front of the vehicle and not on the operator. However, as the boom is progressively raised, dependent upon the loader system assembly, the dangers inherent with rollback increases. It should be noted that the operator may, to get a maximum bucket load initially after filling, roll the bucket back as far as possible before raising the boom. Thus, when the boom reached a certain elevation the material in the bucket would spill back on the operator. Therefore, above a certain height, it is desirable that an automatic self-leveling means performs the leveling function.

Thus, when the loader system is actuated and the boom is being raised at a certain predetermined height in the preferred embodiment, the mechanical linkage means **46** causes the engagement of the leveling valve means **10** at a height of about tractor hood height. As previously stated, simultaneously with the actuation of leveling means **10,** manual valve means **18** is deactuated. Upon engagement of leveling valve means **10,** spool means **16** begins to slide to the left of the drawing as shown in FIG. **2** whereupon fifth port **30** opens as third port **26** closes, followed very shortly thereafter by the opening of dump port **28.** Upon the opening of dump port **28,** a pressure drop is created as previously stated, across shuttle means **128** with the subsequent movement thereof and cutting off of flow from system "B." Thus, attempted operator actuation of rollback command by manual spool means **18** becomes substantially impossible. At the top of the raising cycle or wherever the operator chooses to stop the upward movement of boom means **110,** the self-leveling valve means **10** assumes a static or equilibrium position. In this steady state position spool means **16** shifts to the right such that port **28** is cut off, however, the juncture of edge **83** and edge **85** is just sufficient to terminate flow therebetween. Thus, only the slightest movement of mechanical input means **42** will be sufficient to shift spool means **16** to the left with the immediate removal of control for manual spool means **18.**

A further aspect of the timing of spool means **16** involves the identical feathering of metering notch means **81, 81***a* and **81***b*. Without such feathering means upon opening of the corresponding land means, a pressure peak would result causing the bucket to jump or chatter, etc. The notch means **81,** which is identical to the others, comprises a generally "V" like indentation on the surface of the land means **82** having a squared base means **116** extending horizontally from the face means **114** of groove means **92.** The timing arrangement of the notch means **81, 81***a*, and **81***b* is such that the working side of hydraulic cylinder means **20** is pressurized before the exit port side opens. That is, as shown in FIG. **2,** port means **30** opens prior to port means **26,** thereby avoiding pressure peaks, etc.

What is claimed is:

1. A valve assembly which automatically cuts out manual control and governs actuation of the double acting fluid cylinder means of a work bucket to achieve leveling thereof upon boom raising comprising:

a fluid pump means pumping high pressure hydraulic fluid;

a manual fluid direction control means;

a movable mechanical feed back linkage connected to the bucket, and to said valve assembly means;

a valve means including:

a housing means having a longitudinally extending bore means intersected at axially spaced intervals therealong by first, second, third, fourth and fifth port means, said first port means being connected to said manual fluid direction control means and said second port means being connected directly to said fluid pump means, said third and fifth port means being connected to said double acting fluid cylinder means on the rod side thereof and said fourth port means being connected to said double acting fluid cylinder means on the head side thereof;

a valve spool means axially movable in said bore means from a neutral position blocking fluid from all port means except said first and said third port means;

a link means connected to said valve spool means for transferring force from said mechanical linkage means to shift said spool means, blocking said first port means, to an operating position communicating said pump means with said rod side via said second and said fifth port means, and to open said head side via said fourth port means to dump, whereby said manual fluid direction means is cut out and said bucket is automatically maintained level to said boom; and

a priority system means blocking the operation of said manual fluid control when said valve spool is in a working position.

2. The valve assembly of claim **1** wherein said spool means has a longitudinal extending channel means connecting a fluid reservoir means with said fourth port means.

3. The valve assembly of claim **2** wherein said spool means has a plurality of axially spaced apart circumferentially extending groove means communicating corresponding adjacent port means when said spool means is in a working position.

4. The valve assembly of claim **3** wherein said spool means has a plurality of axially spaced apart circumferentially extending land means covering corresponding adjacent port means when said spool is in a neutral or equilibrium position.

5. The valve assembly of claim **4** wherein said spool includes a plurality of axially spaced apart circumferentially extending groove and land means include both first and second groove means and, first and second land means, said first groove means communicating said first port with said third port and said first land means covering said fourth port means and said second land means covering said second and fifth port means, when said spool means is in said neutral position.

6. The valve assembly of claim **5** wherein:

said bore means has a plurality of spaced apart circumferentially extending groove means positioned adjacent said port means; and said land means of said spool have feathered edge means.

7. A valve assembly of claim **6** wherein said longitudinally extending bore means has first and second end means each being provided with first and second stop means respectively, said first stop means carrying said mechanical link means and said second stop means having a channel means therein.

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