SELF-LEVELING VALVE ATTACHMENT FOR LOADERS

Fig. 3

Fig. 5

Fig. 2

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This invention relates to hydraulically actuated materials handling equipment and concerns, more particularly, that class of devices known as front-end loaders.

A front-end loader includes a bucket or shovel pivoted at the end of a boom extending forwardly of the loader vehicle frame. Hydraulic actuators are conventionally employed to extend and lower the boom and to pivot the bucket on the boom.

In operation, the bucket is lowered to approximately ground level and the loader is driven so as to crowd the bucket into the material being loaded. The bucket is then tilted back and the load is lifted by raising the boom. Tilting the bucket forward on the raised boom bumps the load where desired.

Conventional loaders, care must be taken when elevating a full bucket to avoid back spill caused by swinging the backwardly tilted bucket. When using the full vertical reach of the boom, the bucket must be carefully tilted forwardly to keep the load from spilling. This sort of adjustment is time consuming and places additional demands on the loader operator.

Accordingly, it is the primary aim of the invention to provide a front-end loader having a self-leveling bucket. That is, a bucket which is automatically repositioned at the end of its boom to prevent spilling as the boom is raised.

It is also an object of the invention to provide a simple and economical valve attachment for achieving the self-loading function described above. A related object is to provide a valve attachment of this type which offers no interference with the normal use and operation of the loader and its controls.

A further object is to provide a self-leveling attachment of the above character which appreciably increases the lifting speed of the boom lift cylinders so that more powerful cylinders can be utilized without shortening the overall elapsed time of the loading cycle.

It is, moreover, an object to provide a self-leveling valve attachment that can be easily and economically embodied in virtually any standard hydraulically powered loader.

Other objects and advantages of the invention will become apparent upon reading the following detailed description and reference to the drawings in which:

FIGURE 1 is a side elevation of a loader embodying the invention and showing the boom and bucket in various alternate operating positions;

FIG. 2 is an enlarged fragmentary view, partially in section, of the controls embodied in the loader of FIGURE 1;

FIG. 3 is a fragmentary section taken approximately along the line 3–3 of FIG. 2;

FIG. 4 is a fragmentary section taken approximately along the line 4–4 of FIG. 2;

FIG. 5 is a fragmentary section taken approximately along the line 5–5 of FIG. 4; and

FIG. 6 is a schematic showing of the hydraulic circuit embodied in the loader of FIGURE 1.

While the invention will be described in connection with a preferred embodiment, it will be understood that I do not intend to limit the invention to that embodiment. On the contrary, I intend to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

Turning now to FIGURE 1, there is shown a front-end loader 10 in which is embodied the self-leveling valve attachment of the invention. In the illustrated embodiment, the loader 10 includes a frame 11 mounted on a tractor 12 that is supported by steering wheels 13 and drive wheels 14. A boom 15 comprising a pair of arms 16, only one of which is shown, is mounted for vertical swinging movement about a pivot point 17. A bucket 18 is carried at the extending end of the boom 15 for vertical tilting movement about a pivot 19.

For raising and lowering the boom 15, lift cylinders 21 and 22 (see FIGURE 6) are anchored to the frame 11 with each cylinder being coupled to one of the arms 16. Preferably, the lift cylinders 21, 22 are hydraulically actuated, double acting cylinders.

For tilting the bucket 18 forwardly and backwardly, a pair of dump cylinders 23 and 24 are mounted on each of the boom arms 16 and are coupled to the bucket 18. The dump cylinders 23, 24, are, like the lift cylinders, double acting hydraulic cylinders.

Providing a source of hydraulic fluid under pressure is a pump 25 (see FIGURE 6) driven from the power plant of the tractor 12 so as to draw fluid through a filter 26 from a reservoir 27. Fluid is returned to the reservoir 27 through sump connections 28 and 29.

In order to selectively direct fluid under pressure to either end of the lift cylinders 21, 22, a first control valve 30 is provided. The valve 30 is a four way, three position, spring centered valve manually controlled by an operator taking the form of a pivoted handle 31. As can be seen in FIGURE 6, swinging the handle 31 to the right in this figure couples the output of the pump 25 to the right hand or forward end of the lift cylinders 21, 22, so as to lower the boom 15. Pulling the handle 31 to the left couples the pump output to the left hand or inner hand of the lift cylinders 21, 22 so as to raise the boom 15. When the handle 31 is not operated, the spring centered valve 30 assumes its neutral position, illustrated in FIGURE 6, and the cylinders 21, 22 remain locked in their previously set positions.

In order to selectively direct fluid to either end of the dump cylinders 23, 24, a second control valve 35 is provided. This valve is a four way, three position, spring centered valve having an operator in the form of a pivoted handle 36. Swinging the handle 36 toward the right in FIGURE 6 couples the output of the pump 25 to the left hand or inner ends of the dump cylinders 23, 24 so as to tilt the bucket 18 forwardly. Pulling the handle 36 toward the left in FIGURE 6 couples the pump to the right hand or outer ends of the pump cylinders 23, 24 and tilts the bucket 18 back or rearwardly on the boom 15.

When the handle 36 is released, the spring centered valve 35 resumes its neutral position, shown in FIGURE 6, locking the dump cylinders 23, 24 in their previously set positions and holding the handle 36 erect.

It may be noted that the handle 36 is shown in FIGURE 2 pushed forwardly of its neutral, erect position.

In the preferred embodiment, the first and second control valves 30 and 35 are combined in a two spool, parallel circuit valve having a unitary valve body 37. The operating handles 31, 36 are pivoted on the valve body 37 and are coupled to their respective valve spools in the manner conventional with equipment of this type.

In accordance with the present invention, a third control valve 40 is attached to the valve body 37 for hydraulically coupling the lift and dump cylinders so that raising the boom 15 tilts the bucket 18 forwardly. In the preferred and illustrated embodiment, the valve 40...
is a six way, two position, spring located valve including a spool 41 slidably fitted in a valve body 42 that is directly connected to the valve body 37. In its non-operated, spring held position, the valve 40 simply provides passages between the valve 30 and its associated lift cylinders 21, 22 so that the lift cylinders can be controlled by manipulation of the control handle 31. When the valve 40 is operated, that is when the valve spool 41 is shifted to the left in FIGURES 2 and 6, the right hand or outer ends of the lift cylinders 21, 22 are hydraulically coupled to the left hand or inner ends of the dump cylinders 23, 24 through a passage 43 and a conduit 44. In addition, operation of the valve 40 couples a line 45 from the control valve 30, through passages 46 and 47, to rotate the left or the position shown of the lift cylinders 21, 22 and the right hand or outer ends of the dump cylinders 23, 24. A check valve 48 is interposed in the line 47 for reasons which will be made plain below.

In keeping with the invention, the control valve 40 is operated by a lost motion connection including a slotted line 51 which is loosely adapted to both the control handle 31 and the valve spool 41. In this way, valve operator 31 can be shifted to control the lift cylinders without out operating the control valve 40 so long as the link 51 remains slack. When the handle 31 is shifted fully in the direction for raising the boom 15, that is when it is fully to the left in FIGURES 2 and 6, the lost motion in the link 51 is taken up and the spool 41 is shifted to the left so as to operate the valve 40. In FIGURE 2, the full forward position of the control handle 31 is shown by the dashed lines 31a while the full rearward position of the handle is shown by the dashed lines 31b. At the latter point, the link 51 has been shifted to the left, as indicated by the dashed lines 51a, so as to operate the valve 40.

The operation of the structure thus far described can be best appreciated by briefly reviewing a typical operating cycle. To start a loading cycle, the boom 15 and bucket 18 are placed in the relative positions shown in solid lines in FIGURE 1. That is, the boom 15 is lowered and the bucket 18 is disposed approximately at ground level. The tractor 12 is then driven so as to crowd the bucket 18 into the material being loaded. The operator next pulls back on the control handle 35 so as to direct fluid from the pump 25 to the outer ends of the dump cylinders 23, 24 with the result that the bucket is tilted to the position shown in dashed lines 18a.

The operator then pulls back on the control handle 31 sufficiently far to operate the valve 30 but not the valve 40. Fluid from the pump 25 is thus directed to the inner ends of the lift cylinders 21, 22 and the boom is raised. However, when the boom reaches its 15b position the operator simply pulls the control handle 31 further toward the left, as seen in the drawings, so as to operate the control valve 40. Upon operation of the valve 40, fluid from the line 45 continues to be delivered to the left hand or inner ends of the lift cylinders 21, 22 while the check valve 48 blocks fluid from the valve 40 through the line 47. However, the fluid being exhausted from the right hand or forward ends of the lift cylinders 21, 22 is directed to the left hand or inner ends of the dump cylinders 23, 24 through the passage 43 in the control valve 40. Thus, continued lifting results in a forward tilting movement of the bucket 18 so that when the boom 15 reaches the 15c position, the bucket 18 assumes the position shown in dashed lines 18c. In other words, by directing the exhausting fluid from the lift cylinders to the dump cylinders, the open top of the bucket 18 remains substantially horizontal as the boom is lifted between its 15b and 15c positions.

It can also be seen that fluid exhausted from the dump cylinders 23, 24 passes through passage 47 and the check valve 48 and is added, through the passage 46, to the fluid flow delivered through the line 45 from the pump 25. This added supply of fluid increases the fluid flow to the left hand or inner ends of the lift cylinders 21, 22 and therefore appreciably increases the lifting speed of the cylinders. In a commercial embodiment, it has been found that the lifting speed of the boom 15 increases 30% to 40% upon operation of the third control valve 40. Because of this speed increase, more powerful, but inherently slower moving, sluice action cylinders can be utilized so as to provide high initial or break out forces. Such slower acting cylinders are appreciably speeded up when the valve 40 is operated and hence the overall elapsed time for the loading cycle is not increased.

To continue with the final phases of the operating cycle, when the load is placed in the direction for raising at 18 at the bucket position 18b, the tractor 12 is driven to the desired loading position and the operator pushes the control handle 35 forwardly so as to direct fluid from the pump 25 to the left hand or inner hand of the dump cylinders 23, 24. As a result, the bucket is tilted to the position shown in dashed lines 18d and the control handle 31 is then pushed forwardly to lower the boom 15 and the loading cycle is complete.

Those skilled in the art will appreciate that the valve 40 comprises an extremely simple and economical attachment which can be easily installed on virtually any standard hydraulically operated loader. The valve 40 offers no interference with normal operation of the loader and comes into play only when its self-leveling function is desired and the control handle 31 is shifted fully into its boom raising position.

I claim as my invention:

1. In a materials handling vehicle having a vertically swingable boom carrying a vertically tiltable bucket, the combination comprising, a lift cylinder for hydraulically raising and lowering said bucket, a dump cylinder on said boom for hydraulically tilting said bucket forward and backward, a first control valve for selectively directing hydraulic fluid to either end of said lift cylinder, a second control valve for selectively directing hydraulic fluid to either end of said dump cylinder, a third valve for hydraulically controlling said lift and dump cylinders, said first control valve in said lift cylinder and said second control valve in said dump cylinder when said third control valve is operated so that raising said boom tilts said bucket forwardly, a first shiftable operator for said first valve, a second shiftable operator for said second valve, means resiliently holding said shiftable operators in non-operated position, and a lost motion connection between said first operator and said third valve so that said first operator can be shifted to raise and lower said boom without operating said third valve, said connection however causing operation of said third valve when said first operator is shifted fully in the direction for raising said boom.

2. In a materials handling vehicle having a vertically swingable boom carrying a vertically tiltable bucket, the combination comprising, a double acting lift cylinder for hydraulically raising and lowering said boom, a double acting dump cylinder on said boom for hydraulically tilting said bucket forward and backward, a first control valve for selectively directing hydraulic fluid to either end of said lift cylinder while exhausting fluid from the opposite cylinder end, a second control valve for selectively directing hydraulic fluid to either end of said dump cylinder while exhausting fluid from the opposite cylinder end, a third valve for directing hydraulic fluid from the lift cylinder to the dump cylinder when said third valve is operated so that raising said boom tilts said bucket forwardly, said third valve also, when operated, being effective to direct exhausted fluid from said dump cylinder as said bucket tilts forwardly to the lift cylinder so as to increase the rate at which said boom...
lift cylinder raises said boom, a shiftable operator for said first valve, and means connecting said operator and said third valve so that shifting said operator to raise said boom also operates said third valve.

3. In a materials handling vehicle having a vertically swingable boom carrying a vertically tiltable bucket, the combination comprising, a double acting lift cylinder for hydraulically raising and lowering said boom, a double acting dump cylinder on said boom for hydraulically tilting said bucket forward and backward, a first control valve for selectively directing hydraulic fluid to either end of said lift cylinder while exhausting fluid from the opposite end, a second control valve for selectively directing hydraulic fluid to either end of said dump cylinder while exhausting fluid from the opposite end, a third valve for directing exhausted fluid as the boom is raised from the lift cylinder to the dump cylinder when said third valve is operated so that further raising of said boom tilts said bucket forwardly, said third valve also, when operated, being effective to direct exhausted fluid from said dump cylinder as said bucket tilts forwardly to the lift cylinder so as to increase the rate at which said lift cylinder raises said boom, a shiftable operator for said first valve, and a lost motion connection between said operator and said third valve so that said operator can be shifted to raise and lower said boom without operating said third valve, said connection however causing operation of said third valve when said operator is shifted fully in the direction for raising said boom.

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