

PATENT SPECIFICATION

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(54) IMPROVEMENTS RELATING TO JOINT ASSEMBLIES

(71) We, CATERPILLAR TRACTOR CO., a Corporation organised and existing under the laws of the State of California, United States of America, of 100 N.E. Adams Street, Peoria, State of Illinois 61602, United States of America, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to joint assemblies, and more particularly but not exclusively, to a joint assembly for a bucket assembly which is freely pivotable through 360°.

In general, excavators which provide as part of a bucket assembly a cylinder-operated bucket are well known. In such systems, application of fluid pressure to one of the other end of the cylinder opens and closes the jaws of the bucket. With the realization of the advantage of pivoting the bucket about a vertical axis, such advantage being well known, various means have been employed for allowing such pivoting. See, for example, the specifications of United States Patents Nos. 2,725,996, 2,837,846, 3,330,056, 3,413,029, 3,451,150, 3,462,029, 3,493,135, 3,510,018, and 3,517,960. The designs disclosed in the specifications of United States Patents Nos. 2,725,996, 2,837,846, 3,330,056, 3,462,029, 3,493,135, 3,510,018, and 3,517,960, however, cannot be said to allow free pivoting of the bucket since, in each case, the body of the cylinder and the hoses attached thereto (for supplying pressurized fluid to the cylinder) rotate with the bucket. The hoses, of course, by their very nature, do not allow free rotation of the bucket.

The Specifications of United States Patents Nos. 3,413,029 and 3,451,150 do provide means where such hoses do not interfere with such pivoting. However, in the apparatus of the Specification of United States Patent No. 3,413,029, the means provided, being positioned adjacent the

cylinder area of the apparatus, are not conveniently associated with the cylinders provided, but must communicate therewith through a plurality of hoses. And the device of the Specification of United States Patent No. 3,451,150 depends on pivoting of a piston within a cylinder, with the sealing problems attendant thereto.

According to the invention there is provided a joint assembly comprising a tubular member defining a longitudinal bore, a longitudinal shaft disposed within the said bore with part of the outer surface of said shaft in slidable contact with part of the inner surface of the tubular member, the shaft being rotatable about its longitudinal axis within the tubular member, a fixed frame so disposed at each end of the tubular member as to allow a degree of movement of the tubular member along the shaft and relative to the said frame, means for limiting rotary movement of the tubular member about its axis relative to the said frame, a lateral passage through the body of said tubular member, a passage in the shaft body, and an annular passage defined between the inner surface of the tubular member and the outer surface of the shaft and providing continuous communication between the passage in the tubular member and the passage in the shaft, irrespective of the position of rotation of the shaft relative to the tubular member.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which:

Fig. 1 is a side elevational view of a hydraulic excavating machine with a clamshell bucket attached to the end of a stick arm and incorporating a joint assembly according to the invention.

Fig. 2 is an enlarged side elevational view of the clamshell bucket assembly of Fig. 1 with the bucket in the closed position;

Fig. 3 is an enlarged front elevational view of the clamshell bucket assembly of Fig. 1;

Fig. 4 is an enlarged side elevational view of the clamshell bucket assembly of Fig. 1 with the bucket in a fully opened position;

Fig. 5 is an enlarged side view, partially in section, of the upper portion of the clamshell bucket assembly of Fig. 1, and showing the valve means and details of the swivel joint;

Fig. 6 is a cross-section taken along the line VI—VI of Fig. 5;

Fig. 7 is a cross-sectional side view of the swivel joint and the outer portion of the hydraulic cylinder and further showing the valve means of the joint assembly of Fig. 1;

Fig. 8 is a cross-section taken along the line VIII—VIII of Fig. 7.

Referring to Fig. 1, a clamshell bucket assembly, designated generally by the reference numeral 10, is shown attached to the end of a stick arm 12 of an excavating machine 14. The stick arm 12 is fastened to the end of a boom 16, and the movement of the stick arm 12 is controlled by a hydraulic cylinder 18 carried on boom 16. Movement of the boom 16 is controlled by a pair of hydraulic cylinders, one of which is shown at 20. The assembly 10 is shown in larger detail in Figs. 2 to 4. Such assembly 10 includes a trunnion support assembly 22, a swivel joint assembly 24, a hydraulic cylinder 26, and a bucket 28. Trunnion assembly 22 is pivotally fastened to stick arm 12 by means of pin 30, and the swivel joint assembly 24 is pivotally mounted to trunnion assembly 22 by means of pin and plate assemblies 32, 34 which fasten to the swivel joint assembly 24 by means of a plurality of cap screws 36. The pivotal planes determined by pin 30, and pin and plate assemblies 32, 34, it should be noticed, are perpendicular. The particular construction of pin and plate assemblies 32, 34, can be seen in Figs. 5 and 6.

The swivel joint assembly 24 is shown in detail in Figs. 5, 6 and 7. As shown therein, pin and plate assemblies 32, 34 support a fixed joint frame 38. A longitudinal shaft 40 is disposed within the frame 38, the upper end of the shaft 40 having a stepped portion 42 on which is fixed, by means of nut 44, a support plate 45 and a sprocket 46. The frame 38 defines an annular shoulder 48 which is adapted to position the shaft 40 and support the entire weight of the shaft 40.

Disposed within the frame 38 is a tubular member 50, which defines a longitudinal bore 52. The shaft 40 is disposed within the bore 52 of the tubular member 50 with part of the outer surface thereof in slidable contact with part of the inner surface of the tubular member 50. The shaft 40 is rotatable about its longitudinal axis within the tubular member 50.

The frame 38 is disposed on either end of

the tubular member 50 in spaced relation with the said ends. The rotative movement of the tubular member 50 about its axis relative to the frame 38 is limited by means shown in Fig. 6. A pair of external longitudinal ears 54, 56 are defined by the tubular member 50, parallel to the longitudinal axis of the shaft 40, and an internal longitudinal rib 58 is defined by the frame 38, parallel to the longitudinal axis of the shaft 40, and disposed between the ears 54, 56. Through such means, tubular member 50 is allowed a degree of movement along the longitudinal axis of the shaft 40 and relative to the shaft 40, but the rotative movement of the tubular member 50 about its axis relative to the frame 38 is limited by ears 54, 56 and rib 58.

It will also be seen that with tubular member 50 being "free floating", none of the weight of the shaft 40 or any of the weight fixed to shaft 40 is supported by tubular member 50, but is totally supported, as described above, by frame 38.

As best shown in Fig. 7, tubular member 50 defines lateral passages 60, 62 through the body thereof, and shaft 40 defines shaft passages 64, 66. Annular passages 68, 70 are each defined between the inner surface of the tubular member 50 and the outer surface of the shaft 40. Passages 68, 70 are disposed in planes generally perpendicular to the longitudinal axis of the shaft 40.

Passage 68 is made up of (i) annular channel 72 formed in the inner surface of the tubular member 50, and (ii) annular channel 74 formed in the outer surface of the shaft 40. Likewise, passage 70 is made up of (i) annular channel 76 formed in the inner surface of the tubular member 50, and (ii) annular channel 78 formed in the outer surface of shaft 40. Passage 60 communicates with channel 72, and passage 66 communicates with channel 74, so that communication is provided between passages 60, 66 through annular passage 68. Likewise, passage 62 communicates with channel 76, and passage 64 communicates with channel 78, so that communication is provided between passages 62, 64 through annular passage 70. It will be seen that such communication between passages 62, 64 and between passages 60, 66, is provided continuously, irrespective of the rotative position of the shaft 40 relative to the tubular member 50.

Fixed to the bottom portion of shaft 40 by means of bolts 80 is hydraulic cylinder 26, as shown in Fig. 7. Suspended from the top of cylinder 26 by means of vertical links 82, 84, are jaws 86, 88 which make up the bucket 28 (Figs. 2—5). The ends of the links 82, 84 are pivotally mounted to the top of cylinder 26.

Cross tubes 90, 92 extend across the jaws 86, 88 respectively, and are fixed thereto

(Figs. 2 and 3). Link 82 extends downwardly from the top of cylinder 26 to end in bracket portions 94, 96. Bracket portion 94 is disposed between a pair of brackets 98, 100 welded to cross tube 90, and is held there by pin 102. Bracket portion 96 is disposed between a pair of brackets 104, 106 welded to cross tube 90, and is held there by a pin 108. A pin 110 passes through eye member 112 of piston rod 114 of cylinder 26, and through brackets 98, 104 as shown. End brackets 116, 118 are fixed to cross tube 90 adjacent its ends, and pin assemblies 120, 122 fasten end brackets 116, 118 to jaw 86. Like brackets are provided on cross tube 92 of jaw 88 and are similarly associated with the piston rod 114 of the cylinder 26. End brackets 124, 126 are fixed to cross tube 92 adjacent its ends and are pinned to end brackets 116, 118 respectively by means of pin assemblies 120, 122.

It will be seen that, as the piston rod 114 is moved outwardly of cylinder 26, or downwardly as shown in Figs. 2, 3 and 4, the cross tubes 90, 92 and jaws 86, 88 pivot about pin assemblies 120, 122 to open as shown in Fig. 4. It will be seen that, because of this particular linking system, the links 82, 84 are nearly parallel to the cylinder 26 and piston rod 114 when jaws 86, 88 are open. This arrangement of links and pins is such to provide suitable distribution of force throughout the bucket closing cycle. Since the links 82, 84 are in such position nearly parallel to the cylinder 26 and piston rod 114, the chance of bending the cylinder 26 and links 82, 84 is reduced.

It is to be noted that the entire weight of the bucket 28 is supported by shaft 40, and that tubular member 50 does not support any of this load.

Hoses 130, 132 are associated with the tubular member 50, as best shown in Figs. 6 and 7. The hoses 130, 132 each define an internal passage and are associated with the tubular member by coupling means 134, 136 which are the subject of the specification of our Patent Application No. 7264/76 Serial No. 1 448 842. Since the coupling means 134, 136 of hoses 130, 132 are identical, only one will be described in detail.

A bolt 138 is screw-threadedly connected to tubular member 50 and defines a longitudinal internal passage 140 which communicates with passage 62 of tubular member 50. A tubular coupling body 142 is disposed about the bolt 138 with part of the inner surface of the body 142 in slidable contact with part of the outer surface of the bolt 138. The tubular body 142 defines a lateral body passage 144, the hose 130 end being fixed to the tubular body 142 to provide communication between the internal passage of the hose 130 and the tubular body passage 144. An annular open

path 146 is defined between the inner surface of the tubular body 142 and the outer surface of the bolt 138, providing continuous communication therethrough of the tubular coupling body passage 144 and bolt passage 140, through a plurality of radial bolt passages 148. Meanwhile, a degree of movement of the tubular body 142, and the hose 130 fixed thereto, is allowed, about the longitudinal axis of the bolt 138, but still allowing such continuous communication. Such annular path 146 comprises an annular groove 150 formed in the inner surface of the tubular body 142.

Passage 66 communicates directly with a passage 160 in the head of cylinder 26 (Fig. 7) whereby passage 66 communicates directly with the head end of the cylinder 26. However, passage 64 communicates with a passage 162 in the body of the cylinder 26, which in turn communicates with valve means 164, which will now be described in detail. The valve means 164 are fixed to the head end of the cylinder 26, as shown in Fig. 7. The valve means 164 comprise a valve body 166 and a valve spool 168 associated therewith (Fig. 8). The valve body 166 defines a passage 170 which communicates with passage 162 and leads to valve spool 168. The valve spool 168 is shown in its first position in Fig. 8, which allows communication of passage 170 with a pipe 172 through a stepped portion 174 of valve spool 168. Pipe 172 communicates with the other, or rod end of the cylinder 26. However, movement of the valve spool 168 to the right to its second position will block off the passage 170, but open up the pipe 172 to a passage 176, also defined by valve body 166, which communicates with the head end of cylinder 26 through a passage 178. Resilient biasing means, comprising a helical spring 180, interposed between the valve spool 168 and valve body 166, bias the valve spool 168 in its first position.

In the operation of the system, pressure sources (not shown) are connected to hoses 130, 132. Assuming that the bucket 28 is opened, i.e. the jaws 86, 88 are apart, fluid pressure is applied to hose 130, through passages 62, 70, 64, 162, 170 and into pipe 172, to act on the rod end of cylinder 26. Valve spool 168, being biased into the position shown in Fig. 8, allows such communication, but blocks off passage 176 from this pressure. Such pressure on the rod end of cylinder 26 raises the piston rod 114, closing the jaws 86, 88. To open the jaws 86, 88 fluid pressure is applied to hose 132, through passages 60, 68, 66, 160 to the head end of the cylinder 26. The fluid pressure in the head end of cylinder 26 is also present in passage 178, and passage 176 of valve means 164. Such pressure is transferred into a pilot pressure chamber 181 by means of a pilot

pressure passage 182 in valve spool 168, to shift the valve spool 168 rightward (in Fig. 8) against the force of spring 180, closing off communication between pipe 172 and passage 170, and allowing communication between the pipe 172 and passage 176, i.e., between the rod end of cylinder 26 and the head end thereof. As fluid enters the head end of cylinder 26, fluid is expelled from the rod end and flows into pipe 172. This fluid then flows across the stepped portion 174 of valve spool 168, and into the head end of cylinder 26 by way of passages 176 and 178. In this manner, the fluid being expelled from the rod end of the cylinder 26 is added to the pressurized fluid being introduced into the head end of the cylinder 26 through passage 160, which establishes a super-charged condition in the head end of the cylinder 26. This condition forces the piston rod 114 out of the cylinder 26 very rapidly, and thereby opens the bucket 28 in an extremely short period of time. Under actual test it has been found that the bucket 28 can be opened in approximately 2/3 of a second in this manner.

The spring 180 will shift the valve spool 168 back to its rest position as soon as pressure in the head end of cylinder 26 and passages 176 and 178 is relieved. Since the valve means 164 are connected directly to the top portion of cylinder 26, response to the increased volume of fluid into the cylinder 26 is extremely rapid and no additional lines or hoses are needed.

It should be noticed that, while such operations are going on, the bucket 28, through the pivoting of shaft 40, is freely pivotable through 360° without the hindrance of hoses, etc. This is because of the novel swivel joint assembly 24 system described above. In addition, the coupling means 134, 136, provide a degree of pivoting of hoses 130, 132 relative to the swivel joint assembly 24 itself, allowing for even freer and more convenient use of the apparatus.

As shown in Figs. 2 and 4, stop means, comprising stop members 200, 202 are associated with jaws 86, 88, respectively. Stop members 200, 202 are positioned to contact each other to limit the opening movement of the jaws 86, 88 (Fig. 4). The stop members 200, 202 actually comprise extended portions of jaws 86, 88 respectively, with end portions that define flat surfaces 204, 206 which contact each other across the full flat surface of each to limit opening movement of the jaws 86, 88. Such positive stop means serve also to protect the links 82, 84 and cylinder 26 and piston rod 114 thereof, since there is no danger of the jaws 86, 88 contacting them upon the sudden opening of the jaws 86, 88.

Such positive stop means have the additional advantage that, in combination with

the quick opening provided by the valve means 164, the sudden positive stop of the opening jaws 86, 88 acts to clean the jaws 86, 88, resulting in more efficient use.

A cushioned stop 210 which is the subject of the specification of our Patent Application No. 7262/76 Serial No. 1 448 843, is fixed to the trunnion support assembly 22, as best shown in Figs. 2, 4 and 5. The cushioned stop 210 is positioned to contact the stick arm 12 if the bucket assembly 10 should pendulate in a wide arc toward the stick arm 12 (Fig. 2). In such situations, the cushioned stop 210 would absorb the force of the bucket assembly 10, and prevent it from striking the stick arm 12.

With particular reference to Figs. 5 and 7 of the drawings, an optional bucket rotating assembly 220 is shown for providing powered rotation of the bucket assembly 10. The powered rotating assembly 220 includes a hydraulic motor 222, sprocket 46, and a chain 224. A sprocket 226 secured to the shaft 228 of the hydraulic motor 222 drives the chain 224 and thereby rotates the sprocket 46. The sprocket 46 is secured to the stepped portion 42 of shaft 40 by a key 230. It can be seen therefore that rotation of the sprocket 46 by the chain 224 will cause shaft 40 of the swivel joint assembly 24 to rotate also. Thus, the entire bucket assembly 10 below the joint frame 38 rotates with shaft 40. However without the powered rotating assembly 220, the entire bucket assembly 10 can be rotated by hand in view of the construction of the swivel joint assembly 24.

WHAT WE CLAIM IS:—

1. A joint assembly comprising a tubular member defining a longitudinal bore, a longitudinal shaft disposed within the said bore with part of the outer surface of said shaft in slidable contact with part of the inner surface of the tubular member, the shaft being rotatable about its longitudinal axis within the tubular member, a fixed frame so disposed at each end of the tubular member as to allow a degree of movement of the tubular member along the shaft and relative to the said frame, means for limiting rotary movement of the tubular member about its axis relative to the said frame, a lateral passage through the body of said tubular member, a passage in the shaft body, and an annular passage defined between the inner surface of the tubular member and the outer surface of the shaft and providing continuous communication between the passage in the tubular member and the passage in the shaft, irrespective of the position of rotation of the shaft relative to the tubular member.

2. Apparatus as claimed in claim 1, wherein the said means for limiting rotary movement of the tubular member about its



pressure passage 182 in valve spool 168, to shift the valve spool 168 rightward (in Fig. 8) against the force of spring 180, closing off communication between pipe 172 and passage 170, and allowing communication between the pipe 172 and passage 176, i.e., between the rod end of cylinder 26 and the head end thereof. As fluid enters the head end of cylinder 26, fluid is expelled from the rod end and flows into pipe 172. This fluid then flows across the stepped portion 174 of valve spool 168, and into the head end of cylinder 26 by way of passages 176 and 178. In this manner, the fluid being expelled from the rod end of the cylinder 26 is added to the pressurized fluid being introduced into the head end of the cylinder 26 through passage 160, which establishes a super-charged condition in the head end of the cylinder 26. This condition forces the piston rod 114 out of the cylinder 26 very rapidly, and thereby opens the bucket 28 in an extremely short period of time. Under actual test it has been found that the bucket 28 can be opened in approximately 2/3 of a second in this manner.

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It should be noticed that, while such operations are going on, the bucket 28, through the pivoting of shaft 40, is freely pivotable through 360° without the hindrance of hoses, etc. This is because of the novel swivel joint assembly 24 system described above. In addition, the coupling means 134, 136, provide a degree of pivoting of hoses 130, 132 relative to the swivel joint assembly 24 itself, allowing for even freer and more convenient use of the apparatus.

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Such positive stop means have the additional advantage that, in combination with

the quick opening provided by the valve means 164, the sudden positive stop of the opening jaws 86, 88 acts to clean the jaws 86, 88, resulting in more efficient use.

A cushioned stop 210 which is the subject of the specification of our Patent Application No. 7262/76 Serial No. 1 448 843, is fixed to the trunnion support assembly 22, as best shown in Figs. 2, 4 and 5. The cushioned stop 210 is positioned to contact the stick arm 12 if the bucket assembly 10 should pendulate in a wide arc toward the stick arm 12 (Fig. 2). In such situations, the cushioned stop 210 would absorb the force of the bucket assembly 10, and prevent it from striking the stick arm 12.

With particular reference to Figs. 5 and 7 of the drawings, an optional bucket rotating assembly 220 is shown for providing powered rotation of the bucket assembly 10. The powered rotating assembly 220 includes a hydraulic motor 222, sprocket 46, and a chain 224. A sprocket 226 secured to the shaft 228 of the hydraulic motor 222 drives the chain 224 and thereby rotates the sprocket 46. The sprocket 46 is secured to the stepped portion 42 of shaft 40 by a key 230. It can be seen therefore that rotation of the sprocket 46 by the chain 224 will cause shaft 40 of the swivel joint assembly 24 to rotate also. Thus, the entire bucket assembly 10 below the joint frame 38 rotates with shaft 40. However without the powered rotating assembly 220, the entire bucket assembly 10 can be rotated by hand in view of the construction of the swivel joint assembly 24.

WHAT WE CLAIM IS:—

1. A joint assembly comprising a tubular member defining a longitudinal bore, a longitudinal shaft disposed within the said bore with part of the outer surface of said shaft in slidable contact with part of the inner surface of the tubular member, the shaft being rotatable about its longitudinal axis within the tubular member, a fixed frame so disposed at each end of the tubular member as to allow a degree of movement of the tubular member along the shaft and relative to the said frame, means for limiting rotary movement of the tubular member about its axis relative to the said frame, a lateral passage through the body of said tubular member, a passage in the shaft body, and an annular passage defined between the inner surface of the tubular member and the outer surface of the shaft and providing continuous communication between the passage in the tubular member and the passage in the shaft, irrespective of the position of rotation of the shaft relative to the tubular member.

2. Apparatus as claimed in claim 1, wherein the said means for limiting rotary movement of the tubular member about its



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axis relative to the frame comprises a pair of external longitudinal ears defined by the tubular member, parallel to the longitudinal axis of the shaft, and an internal longitudinal rib defined by the frame and parallel to the longitudinal axis of the shaft and disposed between the ears.

3. Apparatus as claimed in claim 1 or 2, wherein the said frame is configured to position the shaft therein and totally to support the weight of the shaft, with none of the weight of the shaft being supported by the tubular member, when the shaft axis is vertical.

4. Apparatus as claimed in any of the preceding claims, including a second lateral passage through the body of the tubular member and a second passage in the shaft body and a second annular passage defined between the inner surface of the tubular member and the outer surface of the shaft and providing continuous communication between the second passage in the tubular member and the second passage in the shaft irrespective of the position of rotation of the shaft relative to the tubular member.

5. Apparatus as claimed in claim 4, wherein the first mentioned and second annular passages are each disposed in planes generally perpendicular to the longitudinal axis of the shaft.

6. Apparatus as claimed in claim 4 or 5, wherein the first and second annular passages comprise annular channels formed in the inner surface of the tubular member.

7. Apparatus as claimed in claim 4, 5 or 6, wherein the first and second annular passages comprise annular channels formed in the outer surface of the shaft.

8. Apparatus as claimed in any of claims 4 to 7, including a cylinder having a rod movable to first and second positions by means of fluid pressure applied to one end or the other end thereof respectively, means for selectively applying said fluid pressure through the first passage in the tubular member and the first mentioned annular passage and the first passage in the shaft to the one end of the cylinder, and through the second passage in the tubular member and the second annular passage and the second passage in the shaft, and valve means connecting the second passage in the shaft with the one end and other end of the cylinder and adapted to allow direction of fluid pressure from the second passage in the shaft to the one end of the cylinder, the valve means being arranged to automatically cut off fluid pressure to the other end of the cylinder simultaneously with the application of fluid pressure to the one end of the cylinder and at the same to allow communication between the other end of the cylinder and the one end of the cylinder so that the fluid flow in the other

end of the cylinder aids the fluid flow directed to the one end of the cylinder.

9. Apparatus as claimed in claim 8, wherein a bucket is connected to the said shaft and comprises a pair of openable and closable jaws, the cylinder being associated with the jaws to open and close them.

10. Apparatus as claimed in claim 9, wherein said cylinder extends downwardly from and is supported by said shaft, said jaws are associated with the shaft and supported thereby, and the rod of said cylinder is movable to a first position by means of fluid pressure applied to said one end thereof to open the jaws, and is movable to a second position by means of fluid pressure applied to the said other end thereof to close the jaws.

11. Apparatus as claimed in any of claims 8 to 10, wherein said valve means comprises a valve body and a valve spool associated therewith and movable to a first position to allow direction of fluid pressure from the second passage in the shaft to the said other end of the cylinder, and movable to a second position to cut off said fluid pressure to the other end of the cylinder and to allow communication between the other end of the cylinder and the one end of the cylinder.

12. Apparatus as claimed in claim 11, comprising means for resiliently biasing the valve spool in its first position, and means for moving the valve spool against the resilient biasing means to its second position.

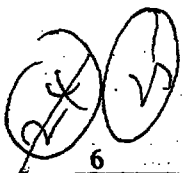
13. Apparatus as claimed in claim 12, wherein the means for moving the valve spool against the resilient biasing means to its second position comprises means for directing pressurized fluid from the one end of the cylinder to the valve spool.

14. Apparatus as claimed in claim 12 or 13, wherein the resilient biasing means comprises a spring interposed between the valve spool and the valve body.

15. Apparatus as claimed in any of claims 8 to 14, wherein the said valve means is fixed to the said one end of the cylinder.

16. Apparatus as claimed in any of the preceding claims, including a hose defining an internal passage, and a coupling interconnecting the hose end and the said tubular member, said coupling comprising means for providing a degree of movement of the hose end relative to the tubular member, meanwhile providing continuous communication of the hose internal passage with a passage in the tubular member.

17. Apparatus as claimed in claim 16, wherein the coupling comprises a longitudinal bolt screw-threadedly connected to the tubular member and defining a longitudinal internal passage which communicates with the passage in the tubular member and a radial passage com-



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municating with the longitudinal passage, a tubular coupling body disposed about the bolt with part of the inner surface of the body in slidable contact with part of the outer surface of the bolt, the coupling body defining a lateral coupling body passage and being connected to the hose end to provide communication between the internal passage of the hose and the coupling body passage, and an annular passage being formed between the inner surface of the coupling body and the outer surface of the bolt so as to provide continuous communication therethrough between the coupling body passage and the bolt radial passage while allowing a degree of movement of the coupling body, and the hose end fixed thereto, about the longitudinal axis of the bolt.

18. Apparatus as claimed in claim 17, wherein the said annular passage comprises an annular groove formed in the inner surface of the tubular coupling body.

19. Apparatus as claimed in any of the preceding claims, wherein a bucket is connected to the said shaft and comprises a pair of openable and closable jaws, means for opening and closing the jaws, and stop means associated with the jaws comprising a pair of stop members, one associated with each jaw, the stop members being positioned to contact each other to limit the

opening movement of the jaws.

20. Apparatus as claimed in claim 19, wherein the stop members comprise extended jaw portions the ends of which are positioned to contact each other to limit the opening movement of the jaws.

21. Apparatus as claimed in claim 20, wherein the said end portions define flat surfaces which contact each other across the full flat surface of each to limit the opening movement of the jaws.

22. Apparatus as claimed in any of the preceding claims, wherein the said tubular member of the joint assembly is pivotally attached to an arm, and including a bucket connected to the said shaft, and cushion stop means arranged to limit the pivoting of the joint assembly in the direction of the arm.

23. Apparatus as claimed in claim 22, wherein the cushion stop means comprise a cushioned stop fixed to the joint assembly and positioned to contact the arm.

24. A joint assembly substantially as hereinbefore described with reference to the accompanying drawings.

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