

[54] SWING MECHANISM FOR PIVOTED MEMBER

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[57] ABSTRACT

A backhoe mounted on a wheeled vehicle and having a mechanism for swinging the backhoe boom structure to positions on either side of a central axis. The swing mechanism comprises a pair of expansible chamber motors and a valve means associated with each motor for controlling the flow of pressurized fluid thereto. Each motor is pivotally connected at one end to the vehicle frame and at the other end to the boom structure. Each valve means comprises a valve body fixedly attached to the vehicle frame and having a valve chamber with suitable connections to the source of pressurized fluid and the motor, a rotatable valve partition in the valve chamber, and an actuator arm for rotating the partition pivotally attached to the respective motor. As the motors operate to swing the boom, pivotal movement of each motor results in coordinated rotation of the valve partitions to control the flow of pressurized fluid through each of the valves.

21 Claims, 9 Drawing Figures

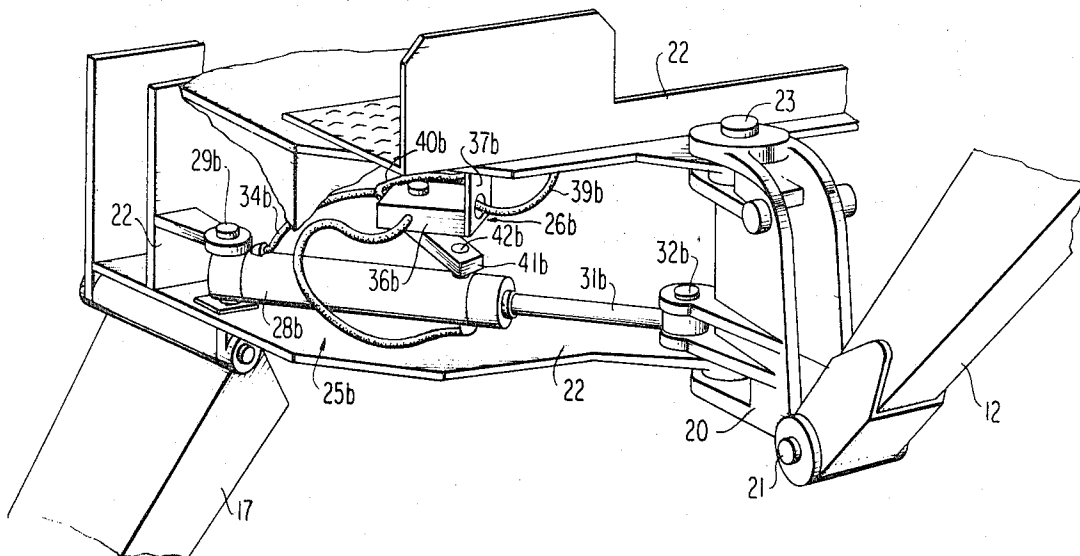
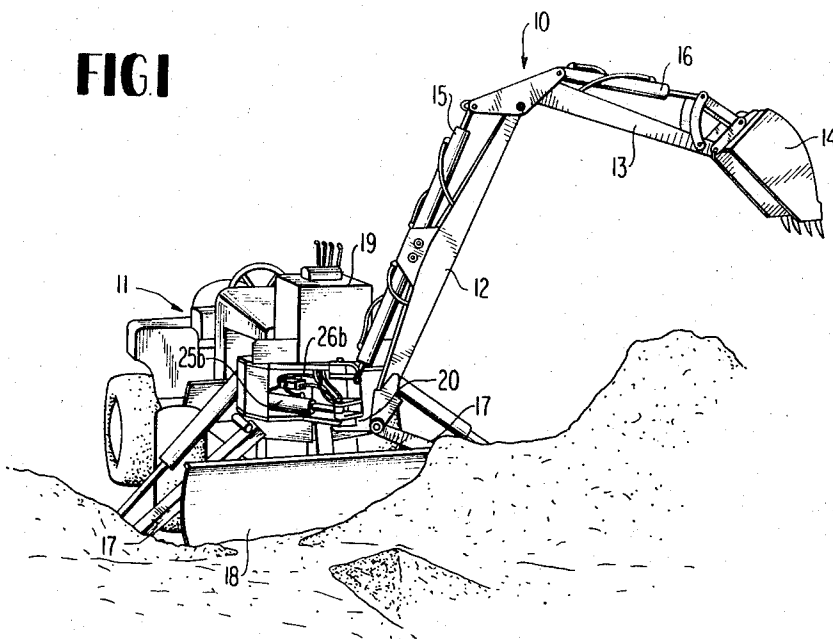
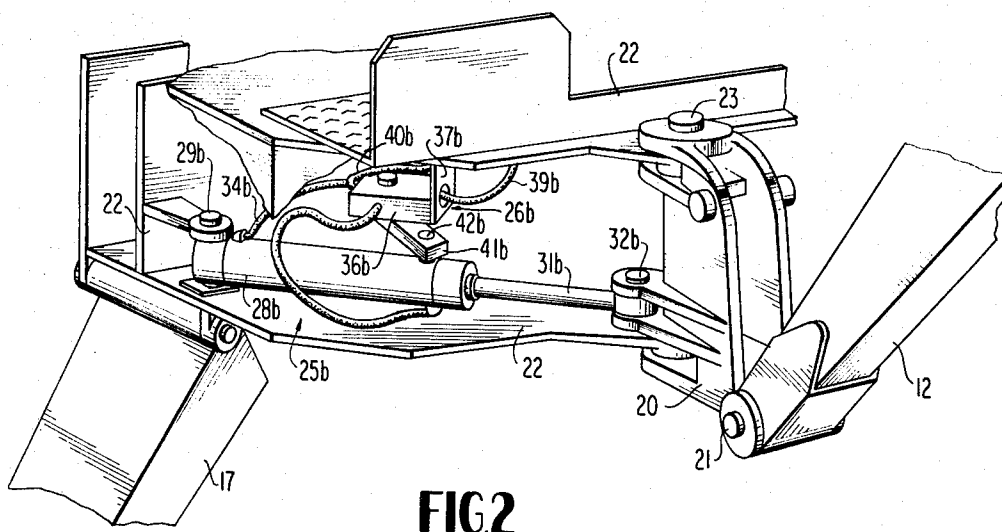


FIG. 1



SWING MECHANISM FOR PIVOTED MEMBER

BACKGROUND OF THE INVENTION

There are many requirements for strong, simple and accurate mechanisms for swinging pivoted members to selected positions in construction equipment such as backhoes, as well as in other types of machines in diverse fields. It is commonplace to utilize hydraulic motors, and thus a control system replete with operator controls and valves must be provided. When a pair of expansible chamber motors is utilized, the control system must insure that the two motors are motivated in the proper direction, changing direction at the required times. Otherwise, the motors could work against one another with obvious disastrous results, or the forces applied to the pivoted member will vary, thus affecting the rate of swinging and making precise positioning a great deal more difficult. Furthermore, in equipment such as backhoes, the arc of movement of the movable member must be about 180°. In order to provide an acceptably compact swinging mechanism, the two motors must cross over center, or reverse direction, at appropriate times during the swinging operation.

The prior art shows no swinging mechanism that can operate effectively within the above requirements. However, the mechanism of this invention solves the prior art problems effectively. The invention is described herein in the context of a backhoe swing mechanism, but this is only because in such an environment its features are best demonstrated. It should be realized, however, that the invention has a much more broad application.

SUMMARY OF THE INVENTION

This invention provides a mechanism for swinging a pivoted member to positions on either side of a central axis. The movable member is pivotally mounted on a frame at a first pivot point located on the central axis and also on the member axis. Second and third pivot points on the movable member are spaced from the first pivot point, and fourth and fifth pivot points are on the frame spaced from the first pivot point. A pair of expansible chamber motors is used to swing the movable member. One of the motors is mounted between the second and fourth pivot points, and the other between the third and fifth pivot points. By virtue of the relationship of the various pivot points, upon pivotal movement of the movable member, the motors will also pivot about the fourth and fifth pivot points on the frame.

Flow of pressurized fluid from a source to the motors is controlled for each motor by a separate valve means fixedly mounted on the frame. Each valve means comprises a valve body having suitable ports connected to the source of pressurized fluid to the motor, a valve chamber in the valve body in communication with the ports, and a valve actuator having a movable partition in the chamber and an actuator arm for moving the partition. The actuator arm is pivotally connected to the motor, and the pivotal movement of each motor during operation, with respect to the fixed valve body, results in rotational movement of the partition. Thus, as the swinging stroke of the member takes place, the flow of pressurized fluid to the proper side of the motor is automatically controlled. The partition also seals the pressurized fluid supply port at the proper moment as the respective motor pivots past dead center.

This simple and reliable arrangement eliminates complex control systems and applies the force of the two motors to the movable member in a desirable manner.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a vehicle-mounted backhoe utilizing the swing mechanism of the invention;

FIG. 2 is a perspective view of a portion of the backhoe of FIG. 1 showing in detail one of the motors of the invention and its valve means;

FIG. 3 is a schematic showing of the one of the valve means of the invention in a first position;

FIG. 4 is a schematic showing of the other valve means of the invention in a second position; and

FIGS. 5-9 illustrate schematically the interrelationship of the elements of the invention during an operating cycle.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A conventional backhoe is composed of a boom structure 10 mounted on a wheeled vehicle 11 as shown in FIG. 1. Boom structure 10 normally consists of two boom arms 12 and 13 pivotally attached together. At the outer end of arm 13 is digging tool such as a shovel 14. Boom arms 12 and 13 are caused to define an oscillating motion to accomplish the digging in a known manner by a pair of hydraulic motors 15 and 17. This structure is well known in the art. Vehicle 11 has an engine and a mechanism for providing a supply of pressurized fluid, such as oil, in a closed system. Vehicle 11 is equipped with accessories such as stabilizing legs 17 and often with other implements such as a plow blade 18. Operating controls for the backhoe boom and the swinging mechanism therefor are provided on a console 19. Boom structure 10 is supported for swinging movement on a movable member 20, to which boom arm 12 is pivotally attached by means of a pivot connection 21 having a generally horizontal pivot axis. Member 20 is pivotally attached to the machine support frame 22 by means of a pivot connection 23 having a vertical pivot axis. Boom structure 10 must be movable to positions on either side of a central axis through pivot connection 23. The arc of movement is at least 90° on either side of the central axis. The swing mechanism is composed of a pair of cooperating double acting expansible chamber hydraulic motors 25a and 25b, only one of which is shown in FIGS. 1 and 2, for clarity. Each of the motors 25a and 25b is associated with a control valve means 26a and, respectively, 26b to control the flow of fluid through the motors.

FIG. 2 shows in detail motor 25b and its valve means 26b. Motor 25a and its valve means 26a are identical. Motor 25b consists of a cylinder element 28b which is pivotally attached to the vehicle frame 22 by a pivot connection 29b, and a piston element including a piston (not shown) inside cylinder 28b and a piston rod 31b connected to the piston and extending outwardly of one end of cylinder 28b. Piston rod 31b is pivotally attached to movable member 20 by means of pivot connection 32b. Pressurized fluid can be communicated to either side of the piston in cylinder 28b by a pair of cylinder lines 33b and 34b communicating with ports in the cylinder wall. While cylinder 28b is shown attached

to frame 22 and piston rod 31b to member 20, this arrangement can be reversed.

Valve means 26b comprises a valve body element 36b fixedly attached to frame 22 by an attachment plate 37b. The interior details of valve body 36b will be described below. Valve body 36b has four fluid ports, two of which receive lines 33b and 34b. The other two ports receive lines 39b and 40b, which are connected to the pressurized fluid supply system through controls manipulated by the backhoe operator. Valve body 37b has an interior chamber with which all the ports communicate, and the flow of fluid therethrough is governed by a valve element comprising a valve member in the chamber and a valve actuator arm 41b pivotally attached at one end to cylinder 28b by a pivotal connection 42b, and attached at the other end to the valve member. Movement of arm 41b rotates the valve member.

Motor 25a is identical to motor 25b, and comprises a cylinder element 28a pivotally attached to frame 22 by a pivot connection 29a. The piston element has a piston rod 31a attached to member 20 by a pivotal connection 32a. Valve means 26a comprises a valve body 37a fixedly attached to frame 22 and a valve element having an actuator arm 41a pivotally attached to cylinder 29a.

The general arrangement of the elements of the invention is best shown schematically in FIG. 7. Swinging or pivotal movement of movable member 20 about pivotal connection 23 is to positions on either side of a central axis 45 passing through pivotal connection 23. Member 20 has a member axis 46, also passing through pivotal connection 23. Since in FIG. 7 member 20 is in the centered position, axes 45 and 46 are coincident. Pivotal connections 32a and 32b are equally spaced from member axis 46 and are identically but oppositely oriented with respect to pivotal connection 23. That is, the angle between member axis 46 and each of the pivotal connections 32a and 32b, measured about pivotal connection 23, is identical. In the embodiment illustrated, pivotal connections 23, 32a and 32b all lie on a straight line perpendicular to member axis 46, but this is only one of the possible arrangements. Pivotal connections 29a and 29b are equally spaced from central axis 45, and are identically but oppositely oriented from pivotal connection 23, that is, the angle between central axis 45 and each of the pivoted connections 29a and 29b, measured about pivotal connection 23, are equal.

It is important to note that as member 20 swings about pivotal connection 23, pivotal connections 32a and 32b each transcribe an arc, and thus cylinders 28a and 28b swing about pivotal connections 29a and 29b. Since valve bodies 37a and 37b are fixed to frame 22, swinging movement of cylinders 28a and 28b causes rotation of the valve member through valve actuator arms 41a and 41b.

FIGS. 3 and 4 show schematically the internal structure of the valve means 26a and 26b, which are identical, in two of the three operating positions. The third position will be described below. Looking to FIG. 3, valve means 26a comprises a valve body element 37a and a valve actuator element having an actuator arm 41a pivotally attached at one end to a pivotal connection 42a on the outer surface of cylinder 28a. Valve body 37a has a central valve chamber 47a of circular cross-section. Communicating with chamber 47a are a

pair of opposed pressure fluid ports 50a and 51a that are connected to the source of pressurized fluid through lines 39a and 40a. Depending upon in which direction it is desired to move member 20, one of these ports will serve as the pressurized fluid inlet and the other as the fluid return. A second pair of opposed ports 52a and 53a connects chamber 47a to cylinder 28a on both sides of the piston through lines 33a and 34a. Rotatably mounted in chamber 47a is a valve partition 55a that divides chamber 47a into two portions. Partition 55a is attached to actuator arm 41a and is rotated thereby.

As shown, pressurized fluid is provided from a source P to port 50a and thence, by reason of the position of partition 55a, outwardly through port 52a to cylinder 28a. As the piston moves, fluid is forced out of cylinder 28a from the other side of the piston, inwardly through port 53a and thence back to the pressurized fluid supply system through port 51a.

Partition 55a is of a width equal to or greater than the width of ports 50a and 51a. When partition 55a is in alignment with ports 50a and 51a, the ports are closed, preventing the pressurized fluid from flowing through motor 25a and rendering it ineffective.

Valve means 26b, shown in FIG. 4, is of identical construction and operation, having pressure fluid ports 50b, 51b, 52b and 53b, chamber 47b, partition 55b, and actuator 41b. As shown in FIG. 4, valve means 26b will operate motor 25b in the opposite direction from motor 25a, operated by valve 26a as shown in FIG. 3.

The operation of the invention will become evident from an inspection of FIGS. 5-9 and the following explanation:

In FIG. 5, member 20 is positioned 90° to the left of central axis 45, and it is desired to swing member 20 clockwise through a traverse of 180° to the position shown in FIG. 9. In FIG. 5 valve means 26a and 26b are both in the general arrangement shown in FIG. 4, and as such, when the operator manipulates his controls to initiate the swinging movement to the right, pressurized fluid will flow from the source P into valve bodies 37a and 37b through ports 50a and 50b, and thence to the upper ends 56a and 56b of cylinders 28a and 28b, respectively. This will force the pistons downwardly as indicated, causing both motors to pull on member 20 to cause swinging action. At the same time, cylinder 28a will swing counterclockwise, causing actuator 41a to rotate partition 55a counterclockwise toward the center position where ports 50a and 51a are sealed. Cylinder 28b will swing clockwise.

In FIG. 6, partition 55a has been rotated into alignment with ports 50a and 51a, thus sealing them and stopping the flow of pressurized fluid into motor 25a. Motor 25b, on the other hand, continues to operate because valve 26b is still generally in the arrangement shown in FIG. 4. Cylinder 28a continues to swing counterclockwise, while cylinder 28b has reached its clockwise limit and will now begin to swing counterclockwise.

Looking now to FIG. 7, member 20 has moved through 90° of rotation. The counterclockwise swinging of cylinder 28a continues causing further counterclockwise rotation of partition 55a past the center position to a position generally like that of FIG. 3. Pressure fluid now flows in through port 50a and thence through port 52a to lower portion 57a of cylinder 28a, forcing the piston upwardly, as illustrated. Valve 26b is still in

the arrangement of FIG. 4, and thus motors 25a and 25b are operating in opposite directions.

Rotation of member 20 continues to the position shown in FIG. 8, wherein partition 55b of valve means 26b is in the center position, halting the flow of pressure fluid to motor 25b, while motor 25a continues to operate. Cylinder 28a has now reached the extent of its counterclockwise swing, and begins to swing clockwise. Cylinder 28b continues to swing clockwise until the partition passes the center position and opens port 50b to allow fluid flow as shown in FIG. 3.

Member 20 is thus finally moved to the position shown in FIG. 9.

Of course, this mechanism is capable of moving member 20 to any position intermediate those of FIGS. 5 and 9. Furthermore, the mechanism can be designed to allow a greater or lesser arc than 180° for movement of member 20. Also, the placement of the various pivot connections is respect to one another can be altered to suit the particular circumstances, within the scope of the broad teachings of the invention.

Of particular importance is the fact that this mechanism applies the combined forces of motors 25a and 25b to a combined moment arm of substantially constant length throughout all portions of the operation. As the moment arm through which motor 25a operates decreases in length, that of motor 25b increases. But the total length remains substantially constant. Each moment arm varies in length from zero to the maximum, as shown in FIGS. 6 and 8. This arrangement provides a constant level of energy to swing member 20 at any position, and this provides a substantially constant rate of traverse, allowing the operator to more easily control and position member 20. This is quite a desirable characteristic, especially in equipment such as backhoes.

This invention provides a swing mechanism that is uncomplicated, reliable and effective. Control of the flow of pressure fluid to the motors is accomplished automatically without the use of fluid or electrical feedback or sensing systems. The mechanism is particularly well suited for use in construction equipment, although it has applications in other fields.

Many variations and modifications may become obvious from the foregoing description, but it should be understood that the scope of the invention is to be determined from the following claims.

I claim:

1. A swing mechanism for moving a pivoted member to positions on either side of a central axis comprising:
 - a frame upon which said member is pivotally mounted by a first pivotal connection on said central axis, the axis of said member also passing through said first pivotal connection,
 - second and third pivotal connections on said member spaced from said first pivotal connection and on opposite sides of said member axis,
 - fourth and fifth pivotal connections on said frame spaced from said first pivotal connection and on opposite sides of said central axis,
 - first and second expansible chamber motors, each of said motors comprising a motor cylinder element having fluid ports at the opposite ends thereof and a motor piston element having a piston rod extending out of said cylinder element, said first motor having one of said motor elements pivotally connected to said member at said second pivotal con-

nection and the other of said motor elements pivotally connected to said frame at said fourth pivotal connection, said second motor having one of said motor elements pivotally connected to said member at said third pivotal connection and the other of said motor elements pivotally connected to said frame at said fourth pivotal connection, said second motor having one of said motor elements pivotally connected to said member at said third pivotal connection and the other of said motor elements pivotally connected to said frame at said fifth pivotal connection,

first and second valve means associated respectively with each of said first and second motors for controlling the flow of pressurized fluid through each of said motors, each of said valve means comprising a valve body element and a valve actuating element, each said valve body element comprising a pair of first valve ports in communication with a pressurized fluid supply system and a pair of second valve ports in communication with said two cylinder ports respectively, and a valve chamber in said valve body, said first and second valve ports also being in communication with said valve chamber, each said valve actuating element comprising a rotatable valve member mounted in said valve chamber and having partition means for dividing said chamber into two portions to selectively control the flow of pressurized fluid through said valve ports, and an actuator arm connected to said valve member to rotate said valve member, each said valve body element being fixedly attached to said frame and each said valve actuating element being pivotally connected to the respective one of said motors such that each said valve member is moved in response to pivotal movement of the respective one of said motors with respect to said frame.

2. The swing mechanism of claim 1 wherein said second and third pivotal connections are equally spaced from said first pivotal connection and are at equal angles from said member axis.

3. The swing mechanism of claim 1 wherein said fourth and fifth pivotal connections are equally spaced from said first pivotal connections and are at equal angles from said central axis.

4. The swing mechanism of claim 1 wherein said fourth and fifth pivotal connections are a greater distance from said central axis than are said second and third pivotal connections from said member axis.

5. The swing mechanism of claim 1 wherein said first, second and third pivotal connections are disposed on a straight line perpendicular to said member axis.

6. The swing mechanism of claim 1 wherein the pivot axes of said pivotal connections are parallel to one another.

7. The swing mechanism of claim 1 wherein said cylinder elements are attached to said frame and said piston rods are attached to said member.

8. The swing mechanism of claim 1 wherein said first valve ports are opposite one another and said second valve ports are opposite one another and at substantially right angles to said first valve ports.

9. The swing mechanism of claim 1 wherein said partition is of a width at least equal to the width of each of said first valve ports whereby said partition means seals said first valve ports when aligned therewith.

10. The swing mechanism of claim 9 wherein said partition means seals said first valve ports when said pivotal connections of the respective said motor are aligned with said first pivotal connection.

11. The swing mechanism of claim 1 wherein the axis of rotation of said partition means and the axis of rotation of said pivotal connections of its respective said motor are parallel, and wherein said actuation arm is pivotally connected with the pivot axis parallel to the axis of rotation of said partition means.

12. The swing mechanism of claim 1 wherein said valve bodies are in a plane spaced from and parallel to the planes of pivotal movement of said motors.

13. An earthworking machine comprising:

a vehicle having a frame,

an earth working implement pivotally mounted on said vehicle at a first pivotal connection and movable to positions on either side of a central axis passing through said first pivotal connection, said implement having an axis also passing through said first pivotal connection.

second and third pivotal connections on said implement on opposite sides of said implement axis, said second and third pivotal connections being equally spaced from said first pivotal connection and at equal angles from said implement axis,

fourth and fifth pivotal connections on said vehicle frame on opposite sides of said central axis, said fourth and fifth pivotal connections being equally spaced from said first pivotal connection and at equal angles from said central axis,

first and second expansible chamber motors pivotally connected respectively between said second and fourth pivotal connections and between said third and fifth pivotal connections, each said motor having a double acting piston element operating in a cylinder element having pressurized fluid ports at opposite ends,

first and second valve means associated respectively with said first and second motors, each of said valve means comprising a valve body element and a valve actuating element, each said valve body element being fixedly attached to said vehicle frame and comprising a central chamber, a first pair of valve ports communicating with said chamber and with a source of pressurized fluid, and a second

pair of valve ports communicating with said chamber and with said cylinder ports, and each said valve actuating element comprising a valve member rotatably mounted in said chamber and having partition means for dividing said chamber into two portions to control the flow of fluid through said valve ports, and a valve actuator attached to said valve element and pivotally attached to its respective said motor to rotate said valve member in response to pivotal movement of said respective motor.

14. The earthworking machine of claim 13 wherein said fourth and fifth pivotal connections are a greater distance from said central axis than are said second and third pivotal connections from said implement axis.

15. The earthworking machine of claim 13 wherein the pivot axes of said pivotal connections are parallel to one another and are perpendicular to the planes of pivotal movement of said motors.

16. The earthworking machine of claim 13 wherein said cylinder elements are attached to said frame and said piston rods are attached to said implement.

17. The earthworking machine of claim 13 wherein said valve chamber is of circular cross section and wherein said first valve ports are substantially opposite one another and said second valve ports are substantially opposite one another and at right angles to said first valve ports.

18. The earthworking machine of claim 13 wherein said partition is of a width at least equal to the width of each of said first valve ports whereby said partition seals said first valve ports when aligned therewith.

19. The earthworking machine of claim 18 wherein said partition seals said first valve ports when said pivotal connections of the said respective motors are aligned with said first pivotal connection.

20. The earthworking machine of claim 13 wherein the axis of rotation of each said valve member is parallel to the pivot axis of the pivotal connection of said actuator arm to said motor.

21. The earthworking machine of claim 13 wherein each said valve body lies within the region defined by two planes perpendicular to the plane of pivotal movement of its respective said motor and defining the limits of said pivotal movement.

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