The present invention relates generally to an improved earth digger, shovel, or the like of the type commonly referred to as "backhoes," and more particularly to an improved control mechanism therefor.

Backhoes conventionally utilize hydraulic mechanisms for maneuvering the earth digging element, as the specific digging operation indicates. In this connection, backhoes conventionally utilize a plurality of control levers, the actuation of which provides certain movements in the earth digging elements of the backhoe. While it is possible for an operator to become proficient in the operation of a device utilizing a plurality of control handles, levers, or the like, there is need for a unitary control which will permit the operator to move the earth digging element with the actuation of but a single lever arrangement. The single lever control enables an operator to become familiar with the apparatus without requiring extensive periods of training. With a single lever control, it is possible to arrange the mechanism so that the movements of the bucket or earth digging elements substantially resemble or coincide with the movement which the operator makes with the control lever. In other words, the hand motion or movement of the operator may be closely manifested by a corresponding action in the earth digging portion of the equipment.

Briefly, in accordance with the present invention, a control lever has been designed for use in connection with earth digging equipment, specifically backhoes, wherein the various hand and arm motions which the operator performs on the control lever will be manifested in similar movements of the earth digging mechanism. In this connection, the control lever has freedom for motion in four modes: a lateral tilting motion, a backward and forward tilting motion, an axial rotational motion of the handle, and an up-and-down motion of the control arm. Each of these movements of the control lever are adapted to independently actuate certain specific hydraulic mechanisms of the digging equipment, and there are no interference or cross-motions involved. In other words, movement of the control lever in one direction or mode will not cause a secondary reaction in a second motion or mode. In order to transmit the movements or motions of the control lever to a pilot control mechanism or the like, a plurality of flexible control wires or shafts are employed, these control wires being maintained within a flexible housing or the like.

Therefore, it is an object of the present invention to provide an improved control for monitoring the movement of earth digging equipment of the type commonly referred to as "backhoes" wherein the control comprises a single lever having a plurality of motions and movements possible therewith.

It is yet a further object of the present invention to provide an improved control for earth digging equipment such as backhoes, wherein the control comprises a single upright lever which is adapted for telescoping action, and also for pivotal movement about a certain plurality of axes, and wherein the motion imparted by the operator will be manifested in a similar motion by the earth digging elements of the backhoe.

One further object of the present invention will become apparent to those skilled in the art upon a study of the following specification, appended claims, and accompanying drawings wherein:

FIGURE 1 is a perspective view of an earth digger of the type commonly referred to as backhoes, and being mounted on a typical light tractor or other self-propelled conveyance and showing the control post in partially tilted disposition; and FIGURE 2 is a schematic diagram including partial detail views of the earth digging elements and the control mechanism therefor.

In accordance with the preferred modification of the present invention, the earth digging apparatus generally designated 10 includes a conventional light tractor 11 having drive wheels 12 and an operator's seat 13 which is capable of facing to the rear, as shown, for operation of the digger, or alternatively to the front for operation and driving of the tractor. The power digging portion of the mechanism 10 comprises a swing frame 15 which is mounted securely to the frame of the tractor 11 together with a reaching boom structure generally designated 17. The reaching boom 17 includes a primary boom member 18 together with a dipper stick 19. A bucket or dipper 20 is pivotally secured to the end of the dipper stick 19. The swing frame 15, which is shown in substantial detail in FIGURE 2, includes a central longitudinal shaft 22 which terminates in an upper cap 24 and a lower annular disk 25, the shaft 22 passing through the center of the annular disk 25. A pinion 26 is disposed at the end of the shaft 22 and is rigidly secured thereto. The shaft 22 together with the end plates 24 and 25 is free to rotate within the confines of the frame anchor member 16. The shaft 22 passes through a bore in the support plate 28, and the tongue 29 which extends outwardly from the plate 28 provides a pivotal anchor point for the boom 18, such as at the pivot line 30. In order to rotate the swing frame 15, the double acting hydraulic cylinder 32 is utilized to reciprocably move the rack gear 33 in controlling meshing relationship with the pinion 26. The mechanism for controlling the movement of the rack 33 is described in detail hereinbelow.

The primary boom 18 is pivotally pivoted about the pivot point 30 and is moved by means of the double acting hydraulic cylinder 35. The body of cylinder 35 is pivotally anchored to the boom structure as at 36, and the arm 37 of cylinder 35 which terminates in an eye 38, is pivotally secured to the pin 39. The pin 39 is secured within the pair of upward acting lugs 40, the lugs 40 being secured to the cap 24 of swing frame 15 as by welding or the like. In this manner, the length at which the arm 37 extends from the cylinder 35 determines the angle at which the boom 18 is held about the pivot point 30.

Turning now to the disposition of the dipper stick 19 relative to the boom 18, the double acting hydraulic cylinder 41 is utilized together with its arm 42 to control this angle. The dipper stick 19 is pivotally secured to the end of the boom by pin 43, the pin 43 passing through and being secured to the boom 18, and also passing through the mounting lug 44. In this connection, the mounting lug 44 receives the arm 42 at and about the pivot member 46, where indicated. A slot is provided in the lug 44 in order to receive the pin 46 therein, and accordingly an eye is provided at the end of the arm 42 in order to circumscribe the pin therein. In this connection, the disposition of the arm 42 determines the angle at which the dipper stick 19 and further the entire bucket 20.

Still another double acting hydraulic cylinder 50 is provided, this cylinder being secured within the area accommodating the pivot pin member 51 of the mounting lug 44. The arm 53 of the cylinder 50 is pivotally secured to the bucket 20 by means of the frame member generally designated 55. The frame 55 includes a lateral arm 56 together with an upright arm 57, each of the arms 56 and 57 being pivotally mounted relative to the...
The arm 56 is pivotally secured as at the pin 59, pin 59 being secured within the pair of parallel members 61. The upright member 57 is pivotally secured to the dipper block 19 by means of the pin member 56, while the members 56 and 57 are pivotally secured, one to another, such as at the pivot pin 62. The hydraulic arm 53 is pivotally secured to the member 56 as at 64, the arm 53 having an eye of the like for receiving the pin 64 therein. Thus, the angular disposition of the bucket 20 relative to the dipper stick 19 may be readily determined by means of the disposition of the arm 53 relative to the cylinder 50, the bucket 20 being pivotally secured to the lugs 60 by means of pivot pin 65. As indicated, pin 65 passes through the end of dipper stick 19.

As is conventional in backhoes and diggers of this type, the main frame of the digger carries a pair of symmetrically arranged laterally extending stabilizer elements such as the stabilizer 68, the stabilizer elements being adapted to be moved from a retracted transport position to a position stabilizing the tractor for digging by a pair of double acting stabilizer cylinders. One such cylinder is shown at 69.

Attention is now directed to the control post generally designated 70 and shown in substantial detail in FIGURE 2. The control post 70 includes three main sections, such as the lower section 71, the center section 72, and the upper section 73. The lower section 71 is mounted to the tractor frame 11 by the pivotal axis or shaft 74, a channel bracket being utilized, as indicated, to maintain the lower section 71 of the post 70 therein. Directional arrows 75 indicate the rotation possible about axis 74. The center section 72 is secured in pivotal relationship to the upper portion of the lower section 71 by means of the axis or pivot shaft 76, the pivot shaft 76 passing through both the bottom portion of center section 72 and the top portion of lower section 71 of post 70. Directional arrows 77 indicate the motion possible about pivot shaft 76. The upper section 73 is telescopically arranged for up-and-down reciprocating motion relative to the center section 72, as indicated by the directional arrows 78. The handle member 80 is mounted for axial rotation within the upper portion of the upper segment 75, as indicated. The directional arrows 81 indicate the mode for moving the handle 80.

Each of the individual members possible with the control post 70 are utilized to control the distribution of hydraulic fluid from a source of fluid under pressure to each of the individual actuating cylinders. The distribution block 81 is provided with a source of hydraulic fluid under pressure from the line 82, a return line 83 being provided to form the return path to the source of hydraulic fluid under pressure. The individual control valves or spools within the distribution block 81 such as at 85, 86, 87 and 88 are utilized to conveniently monitor the flow of hydraulic fluid under pressure to each of the individual double acting cylinders. Each of the control members 85, 86, 87 and 88 is actuated by a separate control wire which is held within a housing arranged coaxially with the wire. In this regard, the lower section of the control post 71 is provided with a laterally extending control bracket or ear 89 which provides to-and-fro movement of the control wire 90 within the housing 91. Similarly, the central section 72 of the post 70 has a laterally extending control bracket 93 to which is secured the control wire 94, the wire 94 being retained within the coxial housing 95. Further in this regard, the upper section 73 of the control post 70 has a laterally extending control bracket 99 to which is secured the control wire 100, the control wire 100 being coaxially retained within the housing 101. The handle 80 is provided with a radially extending bracket 103 to which is secured the control wire 104, the control wire 104 being maintained coaxially within the housing 105.

Turning now to the control system, it will be observed that pivotal rotation of the control post about the axis of pin 74 in accordance with the directional arrows 75 will cause reciprocatory movement of the wire 90 within the housing 91, and will accordingly control the disposition of the control post 70. Correspondingly, pivotal back-and-forth movement of the post 70 in accordance with the directional arrows 77 about the pivot 76 provides movement of the control wire 94, and accordingly a control is exercised on the valve member 87. Reciprocating up-and-down movement of the upper portion 73 of the post 70, in accordance with the directional arrows 78, will provide a control movement of the wire 100 within the housing 101, and a corresponding control movement of the valve control 86. Furthermore, axial rotation of the handle 80 in accordance with the directional arrows 81 provides a reciprocal to-and-fro motion of the control wire 104 within the confines of the housing 105, and a corresponding control action on the control valve 85.

The double acting hydraulic cylinder 32 is controlled by means of the lines 108 and 109; cylinder 35 is controlled by the lines 110 and 111; cylinder 41 is controlled by the lines 112 and 113, while cylinder 50 is controlled by the lines 114 and 115. In each instance, upon actuation or modification of the status of the control block 81, hydraulic fluid under pressure is supplied along the appropriate line to the cylinder, and thus the hydraulic pressure will force movement of the individual arms within the appropriate section 71 is pivotally connected to the control post 70.

The control block 81 is of a type having conventional design, is commercially available and may, for example, include a supply source of hydraulic fluid under pressure together with a group of lines extending out to the appropriate cylinder. Individual control elements 85, 86, 87 and 88 may be preferably spools having appropriate bores therein for communicating between the main supply channel and the individual hydraulic lines extending to the appropriate cylinders.

In operation, assume that the operator wishes to pivot the digging mechanism about the swing frame. In this connection, a clockwise rotation of the control post 70 is designed to supply fluid under pressure to the line 108, thus retracting the rack arm 33 into the cylinder 32, and thereby causing a corresponding clockwise rotation of the primary boom 18 and dipper stick 19 about the swing frame 15. Correspondingly, counterclockwise rotation of the control post 70 will cause fluid under pressure to flow along line 109, and this is designed to extend the rack 33 outwardly, and manifest a counterclockwise rotation of the boom structure 17 about the swing frame 15. If it is desired to pivot the boom 18 inwardly, the operator pulls the control post 70 inwardly about the pivot point 76 in the direction of the arrows 77. This operation causes fluid under pressure to flow in line 111, thus retracting arm 37 into the cylinder 35 and causing the boom 18 to pivot in a clockwise direction about the pivot point 30. Conversely, if the operator pushes the control post 70 outwardly in the opposite direction, fluid under pressure is provided in line 110, and the boom 18 is accordingly caused to pivot a counterclockwise direction or reach outwardly about the point 30.

If it is desired to move the dipper stick 19 downwardly, that is, pivot in a counterclockwise direction about the axis of pivot 41, the operator causes the control post downwardly at the handle 80, and causes the top portion 73 to telescopically recede into the center section 72, as indicated by the arrows 78. This action will cause hydraulic fluid to flow under pressure along line 111, to cylinder 41, and thus force the arm 37 outwardly, causing which is secured to the control wire 100, the control wire 100 being coaxially retained within the housing 101. The handle 80 is provided with a radially extending bracket 103 to which is secured the control wire 104, the control wire 104 being maintained coaxially within the housing 105.

In order to control the pivotal motion of the dipper
bucket 20 about its pivot points, the operator may rotate the handle axially about the control post, and receive a corresponding action in the bucket. For example, when the operator rotates the handle 80 in a clockwise rotational direction, hydraulic fluid under pressure is caused to flow in line 114, thus retracting the arm 53 into cylinder 50, and resulting in a clockwise rotation of the dipper bucket 20. A counterclockwise rotation of the handle 80 will conversely be reflected in a counterclockwise rotation of the bucket 20 about the dipper arm 19.

In each of the mechanical motions, movement of the control arm is manifested by a similar movement of the dipper bucket. In this connection, the reaction experienced on the dipper bucket is much the same as it would be if the operator were to manually hold a bucket by a pair of radially extending shafts. Thus, his actions in controlling the movement of the bucket are essentially the same with the control post as they would be with the imaginary bucket so held. It is this feature which enables an operator to become experienced in the operation of a backhoe without a great deal of training time being lost. The operator is quickly able to control the amount of movement of the control post and accordingly "jerky" operations are avoided.

In FIGURE 1, the disposition of the control post 70 corresponds to the disposition of the boom and dipper stick relative to the tractor. While the schematic diagram of FIGURE 2 illustrates the control post in vertical disposition, the immediate disposition of the boom dipper stick and a bucket are not intended to be reflected thereby. In this connection, the schematic disposition of the various elements in FIGURE 2 were arranged for convenience of draftsmanship.

It will, of course, be understood that various changes may be made in the form, details, arrangements and proportions of the parts without departing from the scope of the invention as set forth in the appended claims.

What is claimed:

1. Power operated material handling apparatus comprising:
(a) a main support frame, a swing frame pivotally mounted on the main frame, a boom frame secured to said swing frame, and material handling elements carried on said boom frame;
(b) first hydraulically actuated means for pivoting said swing frame about a vertical axis relative to said main support frame, second hydraulically actuated means for pivoting said boom frame about a horizontal axis adjacent said swing frame, third hydraulically actuated means for pivotally moving said material handling elements about a pivot axis disposed in a horizontal plane along said boom frame and in spaced relationship to said main frame, and fourth hydraulically actuated means for pivotally moving said material handling elements about a horizontal axis disposed in spaced relationship to the free end of said boom frame, and
(c) control means for energizing said first, second, third and fourth hydraulically actuated means, said control means including a substantially upright post arranged about a substantially vertical axis and having a handle rotatably journaled along the top thereof, said control post having a first pivot axis for pivoting a portion of said control post about said substantially vertical axis, a second pivot axis disposed in a plane normal to said first axis and being disposed transversely through said post for pivoting a portion of said control post thereabout, and a portion of said post being mounted in telescoping relationship with the remainder thereof to provide relative movement therebetween, and coupling means for energizing said hydraulically actuated means, said coupling means being cooperatively associated with said control post and being responsive to the disposition of each of said control means.

2. The apparatus as defined in claim 1 being particu-
6. The apparatus as defined in claim 5 being particularly characterized in that the movement of said control post about said pivot is reflected in a similar direction in said material handling elements.

7. Power operated material handling apparatus comprising:

(a) a main support frame, a swing frame pivotally mounted on the main frame, a boom frame said to said swing frame, and material handling elements carried on said boom frame;

(b) first hydraulically actuated means for pivoting said swing frame about a vertical axis relative to said main support frame, second hydraulically actuated means for pivoting said boom frame about a horizontal axis adjacent said swing frame, third hydraulically actuated means for pivotally moving said material handling elements about a pivot axis disposed in a horizontal plane along said boom frame and in spaced relationship to said main frame, and fourth hydraulically actuated means for pivoting said material handling elements about a horizontal axis disposed in spaced relationship to the free end of said boom frame, and

(c) control means for energizing said first, second, third, and fourth hydraulically actuated means, said control means including a post mounted for rotation about a vertical axis and having a handle journaled in the free end thereof, said control post being adapted for movement about a plurality of axes whereby each movement of said control post and said handle corresponds to the resultant movement of said swing frame, said boom frame and said material handling elements.

8. A backhoe comprising:

(a) a main support frame;

(b) power digging means mounted on said main support frame, said power digging means including a boom pivotally mounted for rotation about a vertical axis and also for rotation about a first horizontal axis adjacent said vertical axis, a dipper stick pivotally attached at one end thereof to the free end of said boom for movement about a second horizontal axis, and a bucket pivotally attached to said dipper stick for movement about a third horizontal axis,

(c) respective power means for moving said boom, dipper stick and bucket about said axes, and

(d) means for controlling said power means comprising a handle and means coupled to said handle for actuating said power means, said handle being mounted for pivotal rotation about a vertical axis to effect movement of said digging means about said vertical axis, said handle also being mounted for rotation about two spaced horizontal axes for effecting movement of said boom about said first horizontal axis and said bucket about said third horizontal axis respectively, said handle further being mounted for movement in the same general direction as said dipper stick for effecting movement of said dipper stick about said second horizontal axis.

9. A backhoe comprising:

(a) a main support frame;

(b) power digging means mounted on said main support frame, said digging means including a swing frame pivotable about a vertical axis, a boom pivotally attached at one end thereof to said swing frame for movement about a first horizontal axis, a dipper stick pivotally attached at the other end of said boom for movement about a second horizontal axis, and a bucket pivotally attached to the other end of said dipper stick for movement about a third horizontal axis,

(c) respective power means for moving said swing frame, boom, dipper stick and bucket about said axes, and

(d) a single control unit comprising a first section mounted at its lower end on said main support frame for rotation about a vertical axis, means responsive to movement of said lower section for causing movement of said swing frame about its said vertical axis, a center section pivotally attached at its lower end to the upper end of said lower section for movement about a horizontal axis, means responsive to motion of said center section for causing pivotal movement of said boom about said first horizontal axis, a handle, first means for supporting said handle on said center section for movement relative thereto generally in the direction of said dipper stick, means responsive to such movement of said handle for causing motion of said dipper stick about said second horizontal axis, second means for supporting said handle for movement relative to said center section generally in the direction of motion of said bucket, and means responsive to such movement of said handle for causing pivotal movement of said bucket about said third horizontal axis.

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