This invention relates to a swiveling tool support for an earth-working machine and, particularly, to a support, for a hoe, bucket, shovel, or other tool, capable of rotating completely through 360 degrees so that it may be positively braked to hold the tool at any desired angle in a horizontal plane with respect to the vertical axis of the support, the support being capable of installation on a boom so as to swing in the plane of the boom and the boom being rotatable and swingable on the earth-working machine.

Conventional earth-working machines for excavating pits, digging trenches and the like are normally provided with a boom which is liftable and lowerable in its own plane and swingable about a vertical axis out of said plane, the digging hoe, or bucket, being mounted on the end of the boom for pivotal movements in the plane of the boom to outer digging and lifting positions and inner lowering and emptying, or folded, positions. Such conventional machines are restricted in their application because the digging and emptying movements of the tool cutting, or digging, edges are confined to the plane of the boom. When conventional machines are provided with tool holding supports capable of turning the tool, they are usually subject to the following disadvantages. The mounting is such that the maximum angle of rotation is less than 360 degrees. When the tool is turned to a desired angular position, the braking means provided will not positively lock and hold the tool fixed in said position under heavy loads. For example, if the braking means is actuated by fluid pressure, a heavy load on the tool will exert differential pressures on opposite sides of the piston of the fluid pressure device allowing leakage of the pressure fluid to partially or fully release the brake. If the braking means is constituted by pawls meshing with teeth, the tool can only be locked in certain angular positions conforming to the meshing positions of the pawls and mating teeth. If the braking means are controlled by cubles these stretch with load and prevent positive locking. A further disadvantage of conventional tool supports is that their pivotal mounting structures for swinging the tool in the plane of the boom and for folding the tool toward and away from the boom are such that they fail due to clogging by dirt and debris, or rusting, and in certain angular positions of the tool the mechanism for folding, or closing the tool toward the boom cannot operate. It is a primary object of the present invention to provide a swiveling tool support for earth-working machines which will overcome the above-stated disadvantages of conventional tool supports.

An important object of the invention is to provide a tool support for earth-working machines capable of swiveling the tool completely through an angle of 360 degrees in either direction and about inclined axes lying in a vertical plane through the outer end of a boom on the machine.

Another object of the invention is to provide an improved tool support, of the above-described characteristics, which can be braked, or positively locked, in a desired position once it has been turned through a requisite angle.

It is a further object of the invention to provide a tool support, of the above-described characteristics, mounted in a sealed enclosing housing which enables continuous lubrication of the bearings and drive parts of the rotating support and protects said parts from contamination by slush, dirt, rust, etc.

Yet another object of the invention is to provide an improved tool support, of the above-described characteristics, in which the means for swinging the support with respect to the boom and for swinging the shovel, or tool, with respect to the support are so mounted as to minimize contamination by dirt, slush and the like and geometrically arranged to permit operation in any angular position of the tool and during rotation of the tool support.

A still further object of the invention is to provide a tool support, having the above-described characteristics, and in which drive means is provided for positively rotating the tool support, said means having a gear reduction train including a worm, the worm serving to positively brake and lock the tool in any desired angular position when the worm drive is stopped.

Still another object of the invention is to provide a swiveling tool support in which the drive is omitted, turning of the tool being effected by weight of the tool and/or swinging of the boom of the earth-working machine on which the tool support is installed, but in which, nevertheless, positive braking means is provided under control of the machine operator to lock the tool support in any desired angular position.

Yet another object of the invention is to provide an improved tool support, having the above-described characteristics, which is of simple construction, easy and inexpensive to fabricate, easy to install and use, and relatively free of extensive maintenance.

The novel features that are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawings, wherein like reference characters indicate like parts throughout the several figures and in which:

FIGURE 1 is a plan view of a portion of the boom of an earth-working machine equipped with a tool support according to the invention;

FIGURE 2 is a side elevation of the upper portion of the tool support shown in FIGURE 1;

FIGURE 2a is a continuation of the view of FIGURE 2, showing the lower portion of the support including the tool attached thereto;

FIGURE 3 is an enlarged sectional view taken on line 3-3 of FIGURE 2 and looking in the direction of the arrows;

FIGURE 4 is a sectional view taken on line 4—4 of FIGURE 3, looking in the direction of the arrows;

FIGURE 5 is a reduced elevation view similar to FIGURE 2, but of a slightly modified embodiment and showing the tool support in a different position in which the unshown tool is lifted slightly and swung outwardly from the boom;

FIGURE 6 is a side elevation similar to FIGURE 2, but of another modified embodiment of the tool support;

FIGURE 7 is a sectional view taken on line 7—7 of FIGURE 6 and looking in the direction of the arrows; and

FIGURE 8 is a fragmentary sectional view similar to FIGURE 3, but showing still another embodiment of the invention.

Referring now more particularly to the drawings, in FIGURES 1—5 are shown embodiments of the invention suitable for operating at low torques and for application to heavy loads. In FIGURE 2a, a conventional digging
A pair of bent links 30 are pivoted at their ends about pins 32, 34 to the shaft 14 and the rod 18 of the hydraulic cylinder respectively. Thus, application of pressure fluid to the cylinder through nipples, or connections, 26 or 22 will tilt the tool 10 with respect to the support shaft 14 in one direction or the opposite so as to assist movements of other parts either in digging or emptying earth.

The upper end of support shaft 14 is rotatably supported in housing 36 by means to be later explained, the housing being pivoted to swing in the plane of the boom 38 when pressure fluid device 40, such as a hydraulic cylinder with ram 42 and connecting conduits 44, 46, is operated. In the embodiment illustrated the housing 36 is of cylindrical shape, although other shapes are possible, and is provided with diametrically opposed projecting stub axes 48 which are pivotally secured in openings 50 at the ends of the boom. A pair of spaced brackets 52, attached to the boom, and the housing 36, which also passes through an opening in projection 56 on the inner end of cylinder 40. The outer end of the ram 42 of the fluid pressure cylinder is pivoted at 58 to a pair of spaced brackets 60 having arcuate legs welded to the top of housing 36. Thus, application of pressure fluid through conduits 44 and 46 in one direction or the other will extend, or retract, the ram 42 to swing housing 36 in the plane of the boom so as to fold the tool at the bottom of shaft 14 toward the boom, or away from the boom, respectively.

FIGURES 2 and 2a show the tool support with the pressure device 40 actuated to approximately mid-position of ram 42 wherein the tool support shaft 14 is substantially vertical. FIGURE 5 illustrates a slightly modified form of the tool support with the pressure device 40 actuated so that ram 42 is somewhat withdrawn from the position of FIGURE 2 and the shaft 14 and supported tool are swung outwardly from the boom.

The means for rotatably supporting and driving the tool support shaft 14 are best shown in FIGURES 3 and 4. The cylindrical housing 36 is closed at its upper end by cap plate 62 having an opening 64 for passage of part of the forks 50 to the upper end of housing 36. The housing is supported by the housing annular sleeves 66 and the O-ring seal 68. The cap plate is secured by studs 70 and nuts 72. The housing is closed at its bottom plate 74 secured by cap screws 76 with interposed nuts 78. The bottom plate is provided with a large opening 80 for passage of a reduced diameter portion 82 of shaft 14. The shoulder of shaft 14 adjacent portion 82 also supports a ring seal 84 having a tongue extending between lips of seal 86 seated in an annular recess in bottom plate 74. The interior of housing 36 is shouldered at 88, 90 to seat and support the conical outer raceways 92, 94 of bearing devices including cone bearing 94, 96 and inner conical raceways 97, 98. The inner conical raceways cooperate with said bearings and frictionlessly support and engage reduced portions of shaft 14. A third pair of conical raceways 100, 102 with associated conical bearings 104 is disposed at the lower end of housing and seated on the bottom plate 74. The upper end of shaft 14 has threads 106 to receive a holding nut 108 which, when tightened to adjust raceway 97, is locked in place by the pin 110 in turn securely fastened by a snap metal band 112 surrounding the nut.

As thus far described, the tool support shaft is supported by the nut 108 through the bearings 94 and raceways 92, 97, from the shoulder 88 of the casing, and is free to rotate continuously through and beyond 360 degrees in either direction. The bearings not only provide for rotation with minimum friction but also operate to take thrust in both axial directions of the shaft, upward thrust being exerted by the shoulders adjacent part 82 of shaft 14 against the bottom plate 74, and the bearing raceways 100, 98, bearings 104, 96 and raceways 102, 94 to shoulder 90 of housing 36.

To rotate the shaft, there is provided drive means now to be described and including a spur gear 114 fixed to the upper end of a reduced portion of shaft 14, above threads 106, by splines 116 and the cap plate 118. Shims 120 are placed between the cap plate and the upper surface of the gear 114, the cap plate being securely fastened to the shaft by cap screws 122 and locking wire 124 passing through the heads of all the cap screws. A scribed pinion 126 is secured to the bottom end of shaft 128 by holding screw 130. The shaft passes through aperture 64 of the cap plate 62 and through the bore of a neck portion 134 of a gear reduction casing 136. A conventional motor 138 for rotating shaft 14 through the gear reduction device is provided and may be of any suitable type, as for example a fluid activated, rotary device, the pressure fluid being fed and returned through flexible conduits 140, 142 partially shown in FIGURE 1. However, should other sources of power than hydraulic pressure, or compressed air, be more suitable, then a suitable machine in which the tool support is installed, obviously such other source of power may be used to rotate the tool support shaft. Thus, if electric power is available, the motor 138 may be a reversible electric motor.

The motor drive shaft 144 carries a worm 146 which meshes with gear 148 fixed to the upper end of shaft 128 and within casing 136. Thus, worm 146, gear 148, pinion 126 and spur gear 114 form a gear reduction train useful for converting the high speed and low torque of motor 138 to low speed and high torque more suitable for rotating the tool support shaft 14 under heavy load. In this manner, high duty capacity is obtained.

A further feature of the described drive is that the 90 degree relation of the shafts of worm 146 and its meshing gear 148 and the resulting geometric relation of their teeth positively prevent the weight of a heavy load on the tool from rotating the shaft 14 when the worm is unthreaded. At such time angular motion of the rotation is opposed by the teeth of worm 146 since the worm teeth can turn only about their own axis not parallel to the axis of gear 148. This will be clear from observation of the similar gear 148a and worm 146a shown in FIGURE 7, turning the upper gear 148a in the plane of the paper tending to force the worm teeth in axial direction rather than to turn them about their axis. Thus, the worm serves as a positive braking means for holding the rotated support shaft 14 in any position to which the machine operator has driven the same by operation of the motor 138, it being merely necessary to stop flow of pressure fluid to the motor to hold the shaft in the selected angular position.

From the above description of the heavy duty embodiment of FIGURES 1-4, it will be apparent that the machine operator may control the machine in the conventional manner to turn, lift and lower the boom 38, swing the tool 10 toward and away from and in the plane of the boom by application of pressure fluid in the cylinder 40, and tilt the tool 10 toward or away from shaft 14 by applying pressure fluid in the appropriate direction in cylinder 20. When it is necessary, or desirable, to rotate the tool 10 of the boom, the operator need merely apply pressure fluid to motor 138, observing the amount of turn of the tool, and when the tool has reached the proper angle to then stop the flow of pressure fluid to motor 138. This will stop the drive to the worm 146 and the worm will hold and positively lock the shaft 14 from rotation out of the angular position to which it has previously moved. The variations of angular direction of the tool are useful, for example, in
digging a trench in a sloping hillside, the machine remaining stationary above or below the trench. When it becomes necessary to change the angle of the tool somewhat, for example, engage in a wedging direction under a heavy boulder, or the like, to lift and deposit it, such changes in the rotational angle of the tool are easily made by applying pressure fluid to motor 138 using valve controls in the cab of the machine.

The tool closing cylinder 20 and cylinder 36, both being mounted at the upper end and upper side of the boom, are relatively removed from earth debris, slush, and the like, being dug by the tool carried at the bottom of shaft 14. Cylinder 20 being directly affixed to the rotating shaft is thereby enabled to tilt, or close, the tool in any angle of rotation of the shaft.

It will be noted that the bearings and gears enclosed in housing 36 and casing 136 also are free from contact with slush, debris and other contaminating matter, suitable seals being employed at all openings in accordance with good engineering practice to retain the lubricant inside and dirt outside. The bearings and gears are thus sealed from the atmosphere and operate in lubricating grease periodically applied under high pressure through the zerk fitting 150. Such lubricant fills the entire housing 36, covers the bearings and gears therein and enters the worm gear casing 136 through opening 64 in the cover 62 and through the bore of the casing necking the shaft 14.

Thus, both means and the reduction gear drive for the shaft are constantly maintained with lubricated through a single fitting. A lubricant relief plug 152 is threaded in an opening in the upper surface of casing 136 for expelling grease when the interior of the gear casing is filled.

The lower bearings surrounding shaft 14 may be adjusted after wear by removal of the bottom plate 74 to subtract or add shims 78. Adjustment of the upper bearings is possible upon removal of top plate 62 and turning of the holding nut 108. In the initial adjustment of the bearings, shims are added or subtracted to achieve the desired thrust without play.

The modification illustrated in FIGURE 5 is in all respects identical with that of FIGURES 1-4 except that sub axles, or trunnions 48 are omitted and a pair of brackets 132 having semicylindrical portions are welded to the housing 36. The boom 38 is secured between said brackets on pivot 153.

In FIGURES 6 and 7, there is shown a modified embodiment of the tool support adapted for use with lighter loads. In this embodiment, the tool support is constructed and operates essentially the same in all respects, as described for the embodiments of FIGURES 1-5, except as indicated below. The gears 114, 126 and 148 are omitted and a large diameter gear 149a which directly meshes with the worm 144c is substituted for gear 114 on the upper end of shaft 14. An opening 154 is formed near the upper edge of the wall of housing 36a to communicate with the interior of a cylindrical housing extension 156 for enclosing worm 146c and disposed tangent to cylinder 36a. The gear and worm mesh in opening 154. Extension 156 may be cast integral with housing 36 or formed separately and attached thereto. The cylinder 156 is closed by end plate 158 secured by tool screws 160. The worm shaft 144c is received in a bearing socket in plate 158 and thrust is taken by spacer sleeve 162 and thrust bearings 164. The opposite end of the worm shaft 144c is splined at 166 to a coupling 168 fixed to the end of the drive shaft of the motor 138a. The motor closure plate 170 is secured to an annular flange 172, which in turn is secured to one end of extension cylinder 156 by any suitable means, such as screws 173. Another spacer sleeve 174 and thrust bearings 176 are retained at the adjacent end of worm shaft 144c by an abutment collar on flange 172.

It will be apparent that the modification illustrated in FIGURES 6 and 7 will operate in all respects like that described for the heavy duty embodiments of FIGURES 1-5, the omission of certain gears from the speed reduction device changing the speed reduction obtained, but the worm 146a still being effective, because of its right angled disposition to the gear 148a, to exercise braking friction and locking that will prevent rotation of the tool support shaft 14 under lighter loads.

In FIGURE 8 is illustrated still another embodiment of the invention which is in all respects similar in structure and mode of operation to that described and illustrated in FIGURES 1-5, except that gear 114 and pinion 126 are omitted, as are all positive means for rotating the shaft, and a brake drum 178 is substituted for gear 114.

Brake shoes 180 are positioned for engagement with the brake drum upon application of any suitable power means such as the fluid pressure rams 182 under control of the operator in the cab of the machine. To rotate the tool support shaft 14 of the FIGURE 8 embodiment through any desired angle, there being no positive drive means, the operator must depend on the weight of the tool and/or the swinging of the boom and tilting of the housing 36. With experience obtained by trial, a skillful operator may control the boom 38, the shaft housing 36, tilt cylinder 40 and the tool closing cylinder 20 in various degree and combination to cause swinging movements such that the weight of the tool will rotate the shaft 14 into a desired angulation thereto. The platform of the plane of the boom, at which instant the operator will apply pressure fluid to engage the brake shoes 180 and clamp the brake drum 178 fixed to the shaft 14, thereby fixing the tool at the desired angle. Should it become necessary to change this angle, similar manipulations of the boom, the shaft housing, and the tool will enable relative rotation of the tool with respect to the housing until the tool properly oriented. In this embodiment of the invention the structure is simplified and less costly to fabricate and install, although a little more difficult to operate and use.

Although certain specific embodiments of the invention have been shown and described, it is obvious that many modifications thereof are possible. The invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

What is claimed is:

1. A swiveling tool support for attachment to the boom of an earth-working machine, comprising a housing, means for pivotally attaching said housing for swinging movement in the plane of a boom, a tool support shaft having an upper end disposed in said housing and a lower portion protruding therefrom, bearing means supporting said shaft for rotation about its own axis through an angle of 360 degrees, braking means to retain said shaft locked against rotation, and means on the lower portion of said shaft for pivotally supporting an earth-working tool.

2. A swiveling tool support according to claim 1, wherein said braking means comprises a drive worm and a coercing gear connected to said tool support shaft, whereby the worm acts as a brake when the worm is not driven.

3. A swiveling tool support according to claim 1, wherein said braking means comprises a drum secured to the upper end of said tool support shaft, brake shoe means for engaging said drum, and power actuating means for moving said shoe means into and out of engagement with said drum.

4. A swiveling tool support according to claim 2, wherein said braking means comprises a speed reduction device engaging said gear reduction mechanism including said worm.

5. A swiveling tool support according to claim 4, wherein said gear mechanism for driving the shaft comprises a motor having a drive shaft coupled to said worm.
3,386,295

gear train forming said gear reduction mechanism are enclosed in a casing disposed outside said housing and secured thereto, said casing having a neck portion whose bore communicates with said housing through an opening in the latter for passage of a shaft of said gear train.

7. A swiveling tool support according to claim 6, wherein said housing is provided with a lubricant receiving fitting for injecting lubricant to the tool support shaft and said bearing means, said fitting serving also to lubricate said worm and portion of the speed reducing gear train in the casing by passage through said opening of the housing and bore of the neck portion of the casing.

8. A swiveling tool support according to claim 7, wherein said speed reducing gear train includes a pinion fixed to the lower end of said gear train shaft, and a mating gear within said housing fixed to the upper end of the tool support shaft.

9. A swiveling tool support according to claim 1, wherein said bearing means include cone-shaped bearings and races arranged to withstand thrust in the axial directions of said tool support shaft.

10. A swiveling tool support according to claim 5, wherein said motor and drive shaft are positioned outside of said housing with the drive shaft aligned perpendicular to the axis of said tool support shaft, said worm being fixed to a worm shaft disposed within an extension to said housing and aligned with and coupled to the drive shaft, and a gear coaxial with and secured to said tool support shaft at its upper end and meshing with said worm.

References Cited

UNITED STATES PATENTS

3,027,026 3/1962 Couquet ___________ 27—103
3,042,234 7/1962 Davis ___________ 214—141
3,069,033 12/1962 Ferwerda ___________ 214—141
3,135,403 6/1964 Przybylski et al. ___________ 214—141
3,224,608 12/1965 Yadon et al. ___________ 214—141
3,319,803 5/1967 Northcott ___________ 214—141

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