(12) UK Patent Application (19) GB (11) 2 368 573 (13) A

(43) Date of A Publication 08.05.2002

(21) Application No 0026533.0

(22) Date of Filing 31.10.2000

(71) Applicant(s)
J C Bamford Excavators Limited
(Incorporated in the United Kingdom)
Rocester, UTTOXETER, Staffs, ST14 5HP,
United Kingdom

(72) Inventor(s)
John Moses
Norman Charles Hadley

(74) Agent and/or Address for Service
Forrester Ketley & Co
Chamberlain House, Paradise Place, BIRMINGHAM,
B3 3HP, United Kingdom

(51) INT CL^7
E02F 3/38

(52) UK CL (Edition T)
B8H HCN HFB H320 H340 H403 H430 H557

(56) Documents Cited
US 5964301 A **US 5535533 A**

(58) Field of Search
UK CL (Edition S) **B8H HAY HCN HEA HFB**
INT CL^7 **E02F 3/22 3/28 3/36 3/38**
ONLINE: EPODOC, WPI, JAPIO

(54) Abstract Title
A machine with working arm and having inclined tilt levers

(57) A machine (10) having a working arm (25), is characterised in that first ends (58) of rear tilt levers (55, 56) are spaced closer together than intermediate portions of the rear tilt levers (55, 56). The arrangement enhances operator visability and simplifies construction of the working arm.

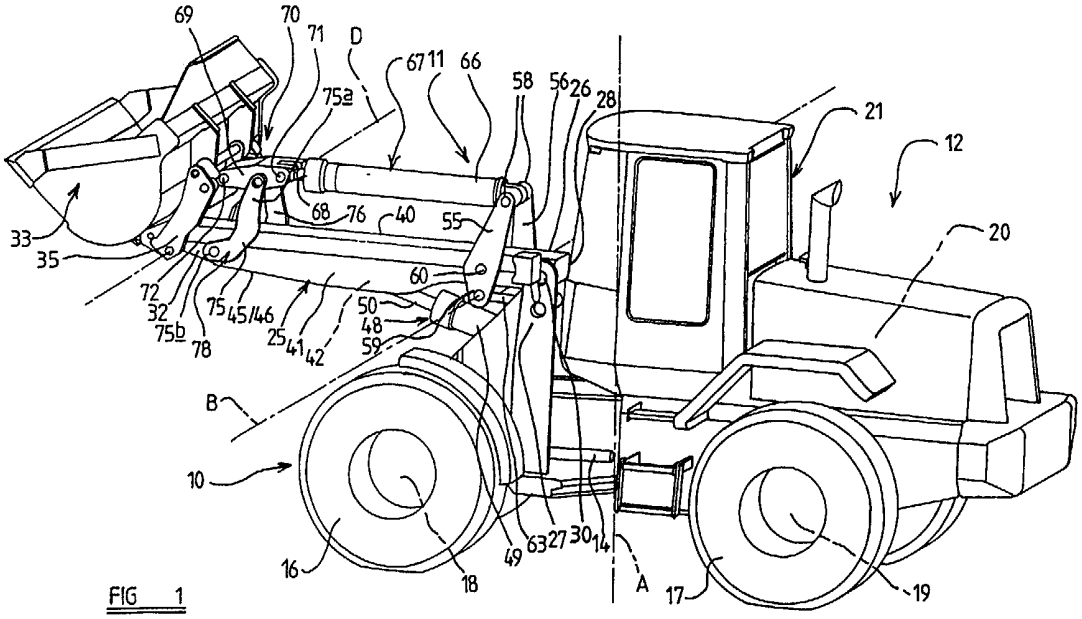

FIG 1

GB 2 368 573 A

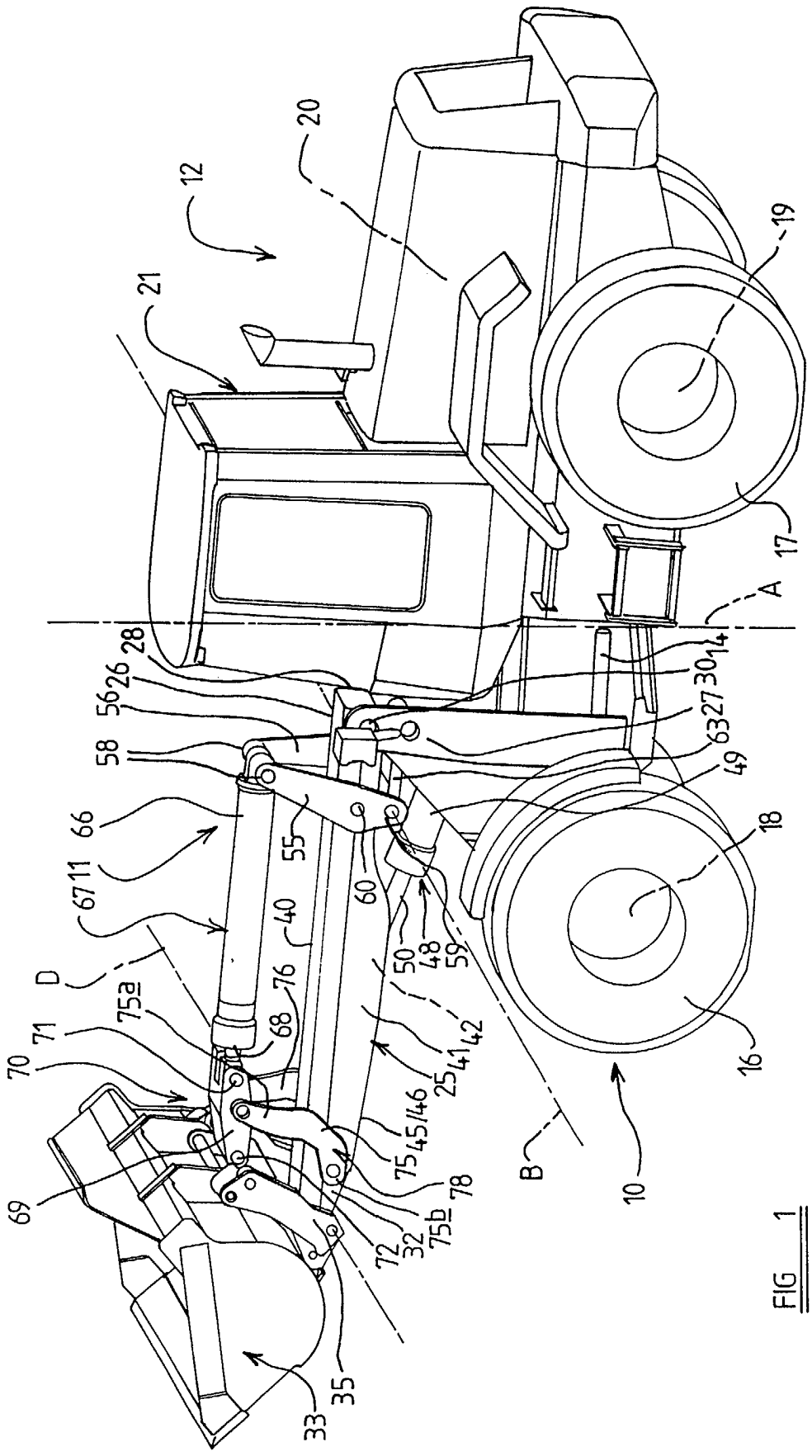
12
20
21
19
17
A
28
56
26
58
66
67
11
D
75a
71
70
69
33
35
72
32
75b
78
75
45
46
25
41
42
50
48
59
60
55
40
76
68
14
30
27
63
49
18
16
10
B

FIG 1

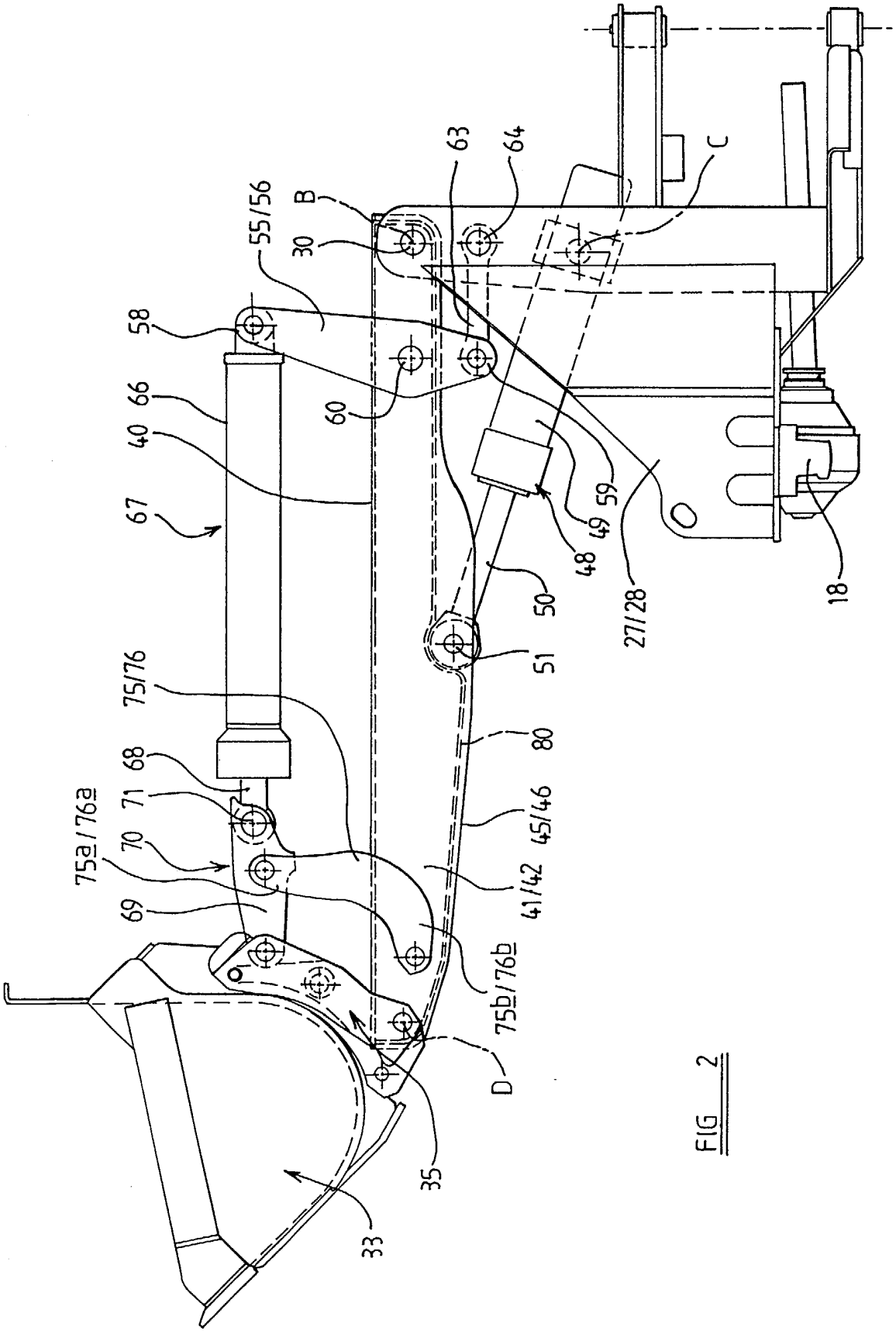
63
64
C
B
55/56
30
58
66
40
67
60
59
49
48
50
51
27/28
18
75/76
68
71
70
69
75a/76a
80
45/46
41/42
75b/76b
D
35
33

FIG 2

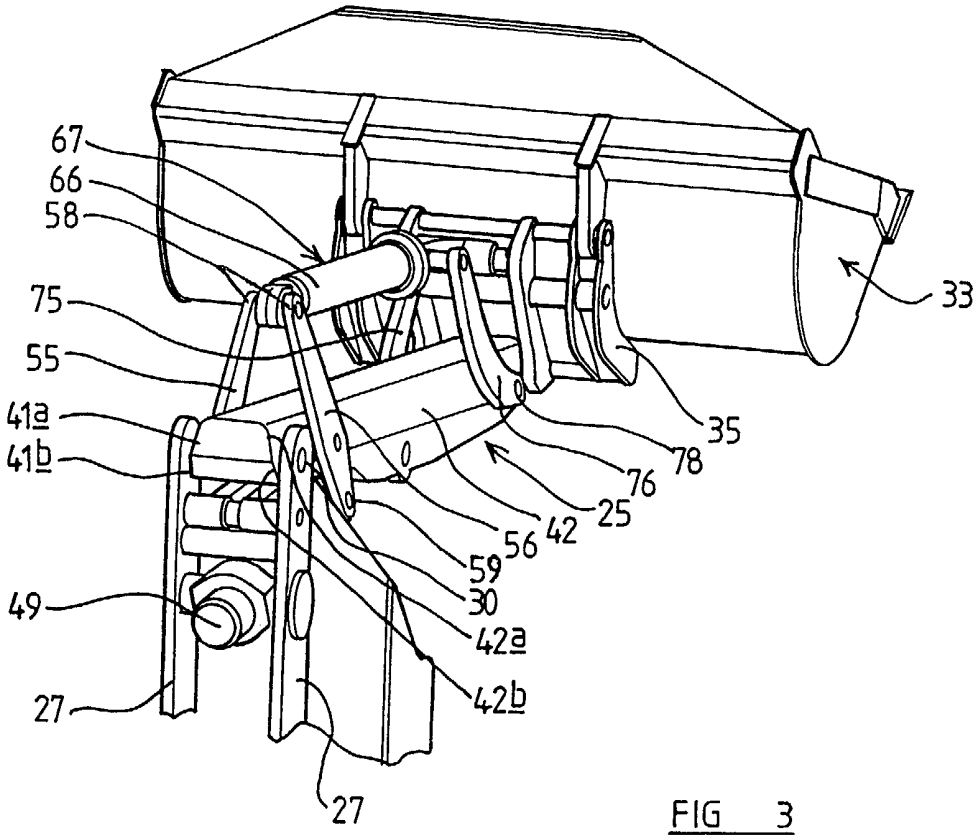

FIG 3

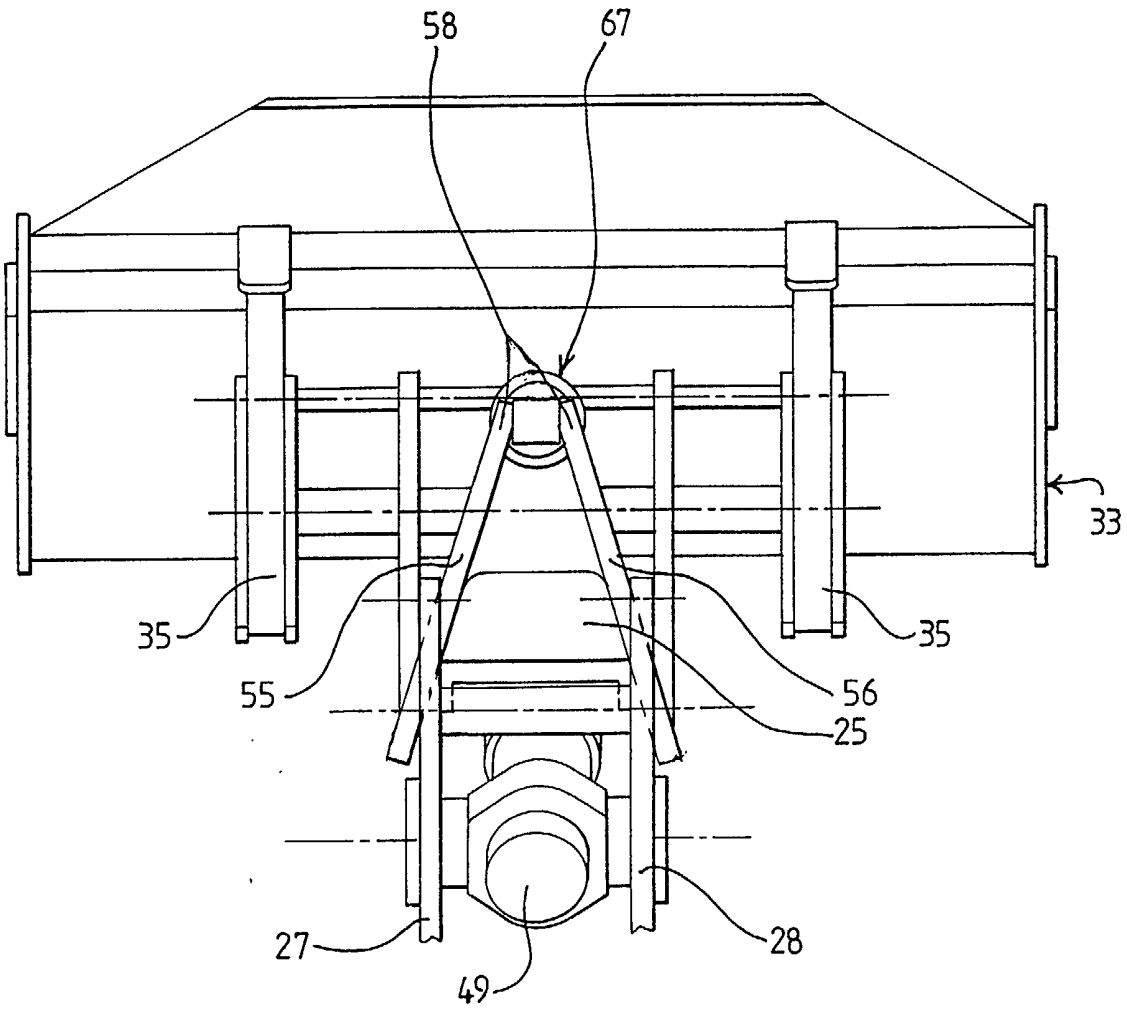

FIG 4

PATENTS ACT 1977

Title: A Machine Having a Working Arm

Description of Invention

This invention relates to a machine having a working arm and more particularly but not exclusively to a machine known as an articulated shovel which has a first body part connected to a second body part of the machine by an articulated connection which permits of relative movement between the first and second body parts of the machine about a generally upright axis. Usually an engine or other power means for the machine, together with an operator's cab are provided on the second body part, and the first body part mounts the working arm which carries at an end thereof remote from the first body part, a bucket or other working implement.

Conventionally articulated loading shovels have had a pair of spaced apart working arms, which are both mounted at first ends thereof on the first body part, and carry between them at their second ends, the bucket or other working implement. A pair of working arms have been provided primarily in order to provide the necessary strength as the arm lifts heavy loads. Thus each arm has usually been provided with its own lifting actuator.

Articulated loading shovels with single working arms of general box configurations have been proposed, for example in GB patent application 2333759. Such box configuration single working arms have advantages over providing a pair of working arms in that the single working arm can be made lighter than comparable twin arm arrangements, thereby improving the lifting performance of the working arm.

In patent application 2333759, tilting of the working implement is achieved by a tilt cylinder which is mounted above the working arm. A first end of the tilt cylinder is pivotally connected to one end of a rear tilt link lever

which in turn is pivotally connected to the working arm. A rear tilt link is pivotally connected to a second end of the rear tilt link lever and to a body of the machine. A second end of the tilt cylinder is pivotally connected to a front tilt lever, which is in turn pivotally connected to the working implement. The front tilt link lever is also pivotally connected to the working arm by means of a front tilt link.

Such a geometry enables an orientation of the working implement to be maintained automatically as the working arm is raised or lowered.

In GB2333759, to accommodate the rear tilt link lever, which passes from above the working arm to below the working arm, and the front tilt link, the working arm is provided with forked ends.

The provision of forked ends compromises the strength of the working arm, and increases the complexity of the working arm configuration, and hence increases the cost of constructing the working arm.

It has been suggested in UK patent application no. 001138.5 to provide a pair of rear tilt link levers and a pair of front tilt links, and to position one of each pair on either side of the working arm. The working arm has top part and a pair of generally parallel side walls, and the rear tilt levers, and front tilt links are pivotally connected to each side wall.

The rear tilt link levers and front tilt links are generally parallel, so, if it is required to increase the separation of the side walls of the working arm, for example to increase the strength and stiffness of the working arm, the separation of the rear tilt link levers and the front tilt links must also increase. Thus the rear tilt link levers and front tilt links may compromise visibility for an operator from the cab, down to the working implement.

According to one aspect of the present invention we provide a machine having a working arm, the working arm having two side walls, and the machine including a body part to which a first end of the arm is attached for relative pivotal movement about a first generally horizontal axis and the working arm

having a second end adapted to mount a working implement for movement relative to the working arm about a second generally horizontal axis, such movement of the working implement being effected by tilting means including first and second tilting members and a pair of rear tilt levers, the tilting means be arranged such that an orientation of the working implement may be maintained as the working arm is lowered or raised, an intermediate portion of one rear tilt lever of the pair being pivotally attached at each side of the working arm to a respective side wall of the working arm, the rear tilt levers further each having a first end positioned above the top part of the working arm, and a second end positioned below the working arm, the first ends of the rear tilt levers being pivotally connected to the first tilting member which extends generally along the top part of the working arm, and the second ends of the rear tilt levers being pivotally connected to the second tilting member which is pivotally connected to the body part of the machine, characterised in that the first ends of the rear tilt levers are spaced closer together than the intermediate portions of the rear tilt levers.

By virtue of eliminating the need to provide the working arm with a forked end to receive the rear tilt levers, the working arm may be made very economically.

Moreover, the tilting actuator and rear tilt levers may present an obstacle to an operator's view along the top of the working arm to the working implement, but by virtue of the invention, the separations of the second ends of the rear tilt levers may be minimised in order to minimise the extent to which the operator's view is blocked. In addition, if, in order for the working arm to have the required strength and stiffness for useful operation, it is required to provide a working arm with a large separation between the side walls, by virtue of the invention, it is possible to increase the separations of the intermediate portions of the rear tilt levers, without increasing the separations of the second ends of the rear tilt levers.

Preferably, the tilting means includes a linearly extending actuator, extension and retraction of which causes movement of the working implement relative to the working arm. The first tilting member may be the linearly extending actuator, and the second tilting member may be a rear tilt link, or vice versa.

Preferably, the first tilting member is connected at a second end to the working arm by means including a pair of front tilt links, and to the working implement by means of a pair of front tilt levers, first ends of the front tilt links being mechanically connected to the second end of the first tilting member, and second ends of the front tilt links being pivotally connected to the working arm e.g. to a respective side wall of the working arm. Thus the first ends of the front tilt links may be spaced closer together than the second ends of the front tilt links.

By virtue of eliminating the need to provide the working arm with a forked end to receive the front tilt links, the cost of constructing the working arm may be reduced further.

In addition, the front tilt links means may also present an obstacle to an operator's line of sight along the working arm to the working implement, but by virtue of the invention, the separations of the second portions of the front tilt links may be minimised in order to further minimise the extent to which the operator's view is blocked.

The rear tilt levers may be generally planar, such that, in use, an angle between the two levers is generally constant from the first ends to the second ends of levers. Alternatively, the rear tilt levers may be bent between the first and second ends, such that the levers include a first and a second part mutually inclined at an angle of between 90 and 180°. In this case the rear tilt levers may be located, in use, such that the second parts are mutually inclined at an angle of greater than 0° and less than 90°, the second parts including the second ends and intermediate portions, and the first parts of the two rear tilt levers are

generally mutually parallel, the first parts including the first ends of the rear tilt levers.

Similarly, the front tilt links may be generally planar, such that the angle between the two front tilt links is generally constant from the first ends to the second ends of the tilt links. Alternatively, the front tilt links may be bent between the first and second end such that each link includes a first part and a second part mutually inclined at an angle of between 180 and 90°. The front tilt links may then be located, in use, such that the second parts of the two tilt links are generally mutually parallel, the second parts including the second ends and intermediate portions, and the first parts are mutually inclined at an angle of greater than 0° and less than 90°, the first parts including the first ends.

The invention will now be described with reference to the accompanying drawings in which:-

FIGURE 1 is an illustrative perspective view of a machine having a working arm, in accordance with the invention;

FIGURE 2 is a side detailed view of part of the machine of figure 1; and

FIGURE 3 is an illustrative perspective view of the working arm of the machine of figures 1 and 2.

Referring to figures 1 and 2 of the drawings, a machine 10 of the kind known as an articulated loading shovel, includes a first, front, body part 11 and a second, rear, body part 12, the first and second body parts 11, 12 being articulated for relative movement about a generally upright axis A, in this example, by linear acting hydraulic actuators, the position of one of which being indicated in the drawings at 14. Each body part 11, 12 has a pair of ground engaging wheels 16, 17 respectively, carried on respective axles 18, 19, and the wheels 16, 17 being driven via a mechanical and/or hydrostatic transmission from an engine the position of which is indicated at 20, provided on the second body part 12.

Thus the machine 10 may be driven over the ground, and steered by relatively articulating the body parts 11, 12. The machine 10 is controlled from an operator's cab 21 positioned on the second body part 12 between the engine 20 and the first body part 11.

The machine 10 includes a working arm 25 which is pivotally connected at a first end 26 thereof, to the first body part 11. To achieve this, the first body part 11 includes a pair of mounting members 27, 28 which provide a space between them in which the first end 26 of the arm 25 is received. A pivot pin 30 extends through the mounting members 27, 28 and through the arm 25 as hereinafter described.

At a second end 32 of the working arm 25, there is mounted a working implement 33 which in this example includes a bucket, and a so called "quick hitch" device 35 on the arm 25 to facilitate mounting buckets of different configuration and capacity at the second end 32 of the arm 25.

In accordance with the present invention, the working arm 25 is of substantially inverted channel configuration having a top part 40 and a pair of depending integrally formed side walls 41, 42. The side walls 41, 42 have a first portion 41a, 42a which extends along the length of the working arm 25 adjacent to the top part 40, wherein the first portions 41a, 42a of the side walls 41, 42 are mutually inclined at an angle of greater than 0°, such that in transverse cross-section, the first portions 41a, 42a of the side walls 41, 42 taper towards the top part 40. The side walls 41, 42 also include a second portion 41b, 42b which extends along the length of the arm 25, wherein the second portions 41b, 42b of the side walls 41, 42 are substantially parallel.

The arm 25 is substantially straight between the first 26 and second 32 ends thereof and of generally constant width. The top part 40 and side walls 41, 42 are formed by pressing from a blank as described in UK patent application 0011138.5. The depths of the side walls 41, 42 from the top part 42 to free edges 45, 46 thereof, may vary along the length of the working arm 25.

This configuration is achieved with no or minimal machining, i.e. during the pressing operation.

The pivot pin 30 which connects the first end 26 of the working arm 25 to the mounting members 27, 28 passes through openings in the side walls 41, 42 of the arm 25, which openings may have journalled therein, bearings. Alternatively, or in addition, the pivot pin 30 may be fixed relative to the arm 25, and be received by bearings journalled in openings in the mounting members 27, 28 which receive the pivot pin 30. In each case, the openings in the side walls 41, 42 of the arm 25 and/or in the mounting members 27, 28 may be strengthened, e.g. by attaching keyhole castings, as is well known in the art.

The working arm 25 may be moved about a first generally horizontal axis B co-incident with the axis of the pivot pin 30, relative to the first body part 11 of the machine 10, to lift and low the arm 25, by a single linearly acting hydraulic actuator 48. In this example a cylinder part 49 of the actuator 48 is pivotally connected to the first body part 11 intermediate the ends of the cylinder part 49, for pivoting relative to the first body part abut an axis C, whilst a piston part 50 of the actuator 48 is pivotally connected to the working arm 25. In another arrangement the actuator 48 may be reversed so that the piston part 50 is pivotally connected to the first body part 11 and the cylinder part 49 to the arm 25. However the arrangement described is preferred, particularly with the cylinder part 49 being pivoted intermediate its ends for pivoting about axis C, as the actuator 48 can then occupy less space forwardly of the axis C than the required stroke of the actuator 48. This connection may be a so-called trunnion mounting.

The pivotal connection of the lifting actuator 48 with the arm 25 is provided by the piston part 50 of the actuator 48 having a so-called hammer head construction, with there being a pivot pin 51 ends of which are received in openings in the side walls 41, 42 of the working arm 25 with the piston part 50 of the actuator 48 providing a bearing connection with the pin 51. Thus as the

lifting actuator 48 is extended and retracted, the actuator 48 my pivot relative to the first body part 11 and relative to the working arm 25, as the working arm 25 is raised and lowered.

It can be seen that the depths of the side walls 41, 42 of the working arm 25 are at a maximum in the region of the pivotal connection (pins 51) of the lifting actuator 48 to the arm 25, where maximum strength is required.

The working implement 33 is pivotally mounted at the second end 32 of the working arm 25, for pivotal movement relative to the arm 25 about a generally horizontal axis D. To achieve such pivotal movement, a tilting means is provided which includes a pair of rear tilt link levers 55, 56, an intermediate portion of each being pivotally mounted to the first portions 41a, 42a of respective side walls 41, 42 of the arm 25 at a position adjacent the first end 26 of the arm 25. The tilt levers 55, 56 each have a first upper end 58 located above the top part 40 of the arm 25, and a lower second end 59 located below the arm 25. A pivot pin 60 extends through the first portion 41a, 42a of the side walls 41, 42 of the arm 25 and has an intermediate portion of the tilt levers 55, 56 mounted on the ends thereof, again with bearings being provided in openings in the side walls 41a, 42a of the arm 25, in which the ends of the pivot pin 60 are journalled.

The second lower ends 59 of the tilt levers 55, 56 are each pivotally connected to one or one of a pair of rear tilt links 63, which are the second tilting means and are pivotally connected to the first body part 11 of the machine 10 at the position indicated at 64, e.g. by a pivot pin received in the mounting members 27, 28. The first upper ends 58 of the rear tilt levers 55, 56 are pivotally connected to one end, in this example a cylinder end 66, of a linearly acting tilting actuator 67 which is the first tilting member.

The rear tilt levers 55, 56 are mutually inclined at an angle of approximately 30°, such that the second ends 58 are spaced further apart than the middle portions, and the middle portions are spaced further apart than the

first ends 59. The rear tilt levers 55, 56 are generally planar, such that the angle between the two rear tilt levers 55, 56 is generally constant from the first end 58 to the second end 59. By virtue of this arrangement, the extent to which the first ends 58 of the rear tilt levers 55, 56 block an operator's field of view is minimised, even if the separation between the side walls 41, 42 of the working arm 25 is large.

A piston end 68 of the tilting actuator 67 is connected to a first pivot connection 71 of a front tilt lever 69 which couples the tilting actuator 67 to the working implement 33. A second pivot connection 72 of the front tilt lever 69 is pivotally connected to the quick hitch 35 of the working implement 33.

Intermediate the first and second pivot connections 71, 72 of the front tilt lever 69, the coupling member 69 is pivotally connected to a pair of front tilt links 75, 76. Each front tilt link 75, 76 is pivotally connected at a first end 75a, 76a to the front tilt lever 69 between the first 71 and second pivot connections 72. A second end 75b, 75b of one of the pair of front tilt links 75, 76 is pivotally attached to each side of the working arm 25 to the first portion 41a, 42a of a respective side wall 41, 42 of the working arm 25.

The front tilt links 75, 76 are mutually inclined at an angle of approximately 30° such that the first ends 75a, 76a are spaced closer together than the second ends 75b, 76b. The front tilt links 75, 76 are generally planar such that the angle between the two front tilt links 75, 76 is generally constant from the first end 75a, 76a to the second end 75b, 76b.

The geometry of the tilt mechanism is such that when the working implement 33 is set in an orientation relative to the ground by extending or retracting the tilt actuator 67, when the lifting actuator 48 is operated to raise or lower the arm 25, the working implement 33 will retain its orientation relative to the ground. Thus the tilt mechanism is so-called self levelling, without it being necessary to extend and/or retract the tilt actuator 67 during lifting and

lowering of the arm 25, at least over a large range of lifting/lowering movement of the arm 25.

When it is desired to change the orientation of the working implement 33 relative to the ground, for example to load or unload the bucket thereof, the tilt actuator 67 will of course need to be extended and/or retracted.

The arm 25 being substantially straight and of generally constant width along the entire length of the arm 25, will be strong and light. However to add further strength, in accordance with the invention, a strengthening member 80 is provided, the configuration of which is best seen in figure 2.

The strengthening member 80 is preferably formed from a plate-like structure, and is connected, typically by welding, to each of the side walls 41, 42, interiorially of the channel shape of the arm 25. Over a major part of the length of the arm 25, the strengthening member 80 is positioned close to the free edges 45, 46 of the side walls 41, 42, so as to provide a void within the arm 25 which may convey hydraulic and/electrical control lines if desired.

In the region of connection of the arm 25 to the lifting actuator 48, where the side walls 41, 42 are of maximum depth, the strengthening member 80 extends between the pivotal connection 51 and the top part 40 of the arm. Thus the strengthening member 48 does not inhibit lowering of the arm 25 by obstructing the lifting actuator 48.

The pivot pins 30 (to connect the arm to the mounting members 27, 28) and 60 (for the tilt links 55, 56) are however contained within the void of the arm 25 with the strengthening member 80 beneath the pivotal connections, adjacent the free edges 45, 46 of the side walls 41, 42. At the first end 26 of the arm 25, the strengthening member 80 is configured to close or at least substantially close the end of the arm 25, and in the example shown, the strengthening member 80 is connected, by welding to the underside of the top part 40.

In the particular example illustrated in the drawings, the arm 25 is about 3m in length, about 400mm wide, and the maximum depths of the side walls 41, 42, in the region of the pivotal connection 51 to the lifting ram 48, is about 300mm. The sheet from which the arm 25 is cut, typically may have a thickness of about 15mm only. These dimensions are given for illustrative purposes only, and may significantly be varied.

Various modifications in addition to those already identified may be made without departing from the scope of the invention. For example, the rear tilt levers 55, 56 may be bent between the first end and second end, such that each rear tilt lever 55, 56 includes a first part and a second part which are mutually inclined at an angle of between 90 and 180°. The rear tilt levers 55, 56 are located, in use, such that the second parts of the two tilt levers 55, 56, which include the second ends and intermediate portions, are generally mutually parallel, and the first parts, which include the first ends, are mutually inclined at an angle of greater than 0° and less than 90°.

Similarly, the front tilt links 75, 76 may be bent between the first and second end, such that each tilt link 75, 76 includes a first part and a second part. The front tilt links 75, 76 are located, in use, such that the second parts of the two tilt links 75, 76, which include the second ends, are generally mutually parallel, and the first parts, which include the first ends, are mutually inclined at an angle of greater than 0° and less than 90°.

In this case, the side walls 41, 42 of the working arm 25 need not have a first 41a, 42a and second 41b, 42b portion. The side walls 41, 42 may substantially parallel over their entire depth.

Alternatively, one of each pair of rear tilt levers 55, 56 or front tilt links 75, 76 may be generally planar, and the other of the pair may be bent.

The articulated connection between the first and second 11, 12 body parts may permit of some relative pivotal movement about a longitudinal axis of the machine in addition to the upright axis A. Preferably though the

articulated connection only permits movement about upright axis A with the axle 18 on which the wheels 17 of the rear second body part 12 are mounted, being mounted for oscillation about a longitudinal axis relative to the second body part 12.

If desired an alternative tilting mechanism geometry to that described may be provided. For example the tilting actuator 67 may be provided beneath the arm 25, and/or the positions of the tilt actuator 67 and the rear tilt links 63 which connect the rear tilt levers 55, 56 and the first body part 11 may be transposed.

The working arm may be moved about the first generally horizontal axis by more than one linearly acting actuator 48.

In each case preferably the integrity of the arm 25 is not compromised by the provision of any slot of the like to accommodate any component part of the tilt mechanism and/or to pivotally mount the arm 25 on the first body part 11 of the machine 10.

The invention may be applied to other kinds of machine to the articulated loading shovel described, for example to a non-articulated loading or excavating/loading machine, having a working arm and steerable wheels or even tracks. However the invention has particular application where the working arm is mounted generally centrally of a body part of the machine, so as to extend forwardly of an operator's cab 21, where a working arm 25 and associated working implement 33, and work implement 33 tilting means 63, 55, 56, 67, 75, 76, 69 constructed and configured as described, can provide for good visibility for an operator from the cab 21 during working operations.

Whereas the strengthening member 80 preferably is a unitary member which extends substantially from one end of the arm 25 to the other, in another example, the strengthening member 80 may be made up from separate parts and need only be provided along the arm 25 where strengthening is required.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any machine of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A machine having a working arm, the working arm having two side walls, and the machine including a body part to which a first end of the arm is attached for relative pivotal movement about a first generally horizontal axis and the working arm having a second end adapted to mount a working implement for movement relative to the working arm about a second generally horizontal axis, such movement of the working implement being effected by tilting means including first and second tilting members and a pair of rear tilt levers, the tilting means be arranged such that an orientation of the working implement may be maintained as the working arm is lowered or raised, an intermediate portion of one rear tilt lever of the pair being pivotally attached at each side of the working arm to a respective side wall of the working arm, the rear tilt levers further each having a first end positioned above the top part of the working arm, and a second end positioned below the working arm, the first ends of the rear tilt levers being pivotally connected to the first tilting member which extends generally along the top part of the working arm, and the second ends of the rear tilt levers being pivotally connected to the second tilting member which is pivotally connected to the body part of the machine, characterised in that the first ends of the rear tilt levers are spaced closer together than the intermediate portions of the rear tilt levers.

2. A machine as claimed in claim 1 characterised in that the tilting means includes a linearly extending actuator, extension and retraction of which causes movement of the working implement relative to the working arm.

3. A machine as claimed in claim 2 characterised in that the first tilting member is the linearly extending actuator, and the second tilting member is a rear tilt link.

4. A machine as claimed in claim 2 characterised in that the first tilting member is a rear tilt link, and the second tilting member is the linearly extending actuator.

5. A machine as claimed in any preceding claim characterised in that the first tilting member is connected at a second end to the working arm by means including a pair of front tilt links, and to the working implement by means of a pair of front tilt levers, first ends of the front tilt links being mechanically connected to the second end of the first tilting member, and second ends of the front tilt links being pivotally connected to a respective side wall of the working arm.

6. A machine as claimed in claim 5 characterised in that the first ends of the front tilt links are spaced closer together than the second ends of the front tilt links.

7. A machine as claimed in any preceding claim characterised in that the rear tilt levers are generally planar, such that, in use, an angle between the two rear tilt levers is generally constant from the first ends to the second ends of the rear tilt levers.

8. A machine as claimed in any one of claims 1 to 7 characterised in that the rear tilt levers are bent between the first and second ends, such that the levers include a first and a second part mutually inclined at an angle of between 90 and 180°.

9. A machine as claimed in claim 8 characterised in that the rear tilt levers are located, in use, such that the second parts are mutually inclined at an angle

of greater than 0° and less than 90°, the second parts including the second ends and intermediate portions, and the first parts of the two rear tilt levers are generally mutually parallel, the first parts including the first ends of the rear tilt levers.

10. A machine as claimed in any preceding claim characterised in that the front tilt links are generally planar, such that the angle between the two front tilt links is generally constant from the first ends to the second ends of the tilt links.

11. A machine as claimed in any one of claims 1 to 9 characterised in that the front tilt links are bent between the first and second end such that each link includes a first part and a second part mutually inclined at an angle of between 180 and 90°.

12. A machine as claimed in claim 11 characterised in that the front tilt links are located, in use, such that the second parts of the two tilt links are generally mutually parallel, the second parts including the second ends and intermediate portions, and the first parts are mutually inclined at an angle of greater than 0° and less than 90°, the first parts including the first ends.

13. A machine having a working arm substantially as hereinbefore described and/or and shown in the accompanying drawings.

14. Any novel feature or novel machine of features described herein and/or shown in the accompanying drawings.

Application No: GB 0026533.0
Claims searched: 1 - 14

Examiner: Richard Baines
Date of search: 21 March 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): B8H (HAY, HCN, HEA, HFB)

Int Cl (Ed.7): E06F 3/22, 3/28, 3/36, 3/38

Other: Online: EPODOC, WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	US 5,964,301 A (GLASGOW) Note front tilt levers	
A	US 5,535,533 A (CATERPILLAR) Figure 5	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.