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(71) Applicant: **JC Bamford Excavators Ltd**
Rocester
Uttoxeter
Staffordshire ST14 5JP (GB)

(72) Inventor: **Harper, Lee**
Uttoxeter, Staffordshire ST14 5JP (GB)

(74) Representative: **Unsworth, Jennifer Mary**
Withers & Rogers LLP
4 More London Riverside
London SE1 2AU (GB)

(54) A MATERIAL HANDLING MACHINE

(57) A method of operating a material handling machine (10) having a material handling implement (18) moveable relative to a chassis (14, 16) of the machine (10), the method including the steps of
a) positioning the material handling implement (18) in a first position (101) of a first region (59),
b) moving the material handling implement (18) to a second region,
c) providing a control system to automatically return the material handling implement (18) to the first region (59) by positioning it at a second position (102) of the first region (59) different to the first position (101) of the first region (59),
d) returning the material handling implement (18) to the second region.

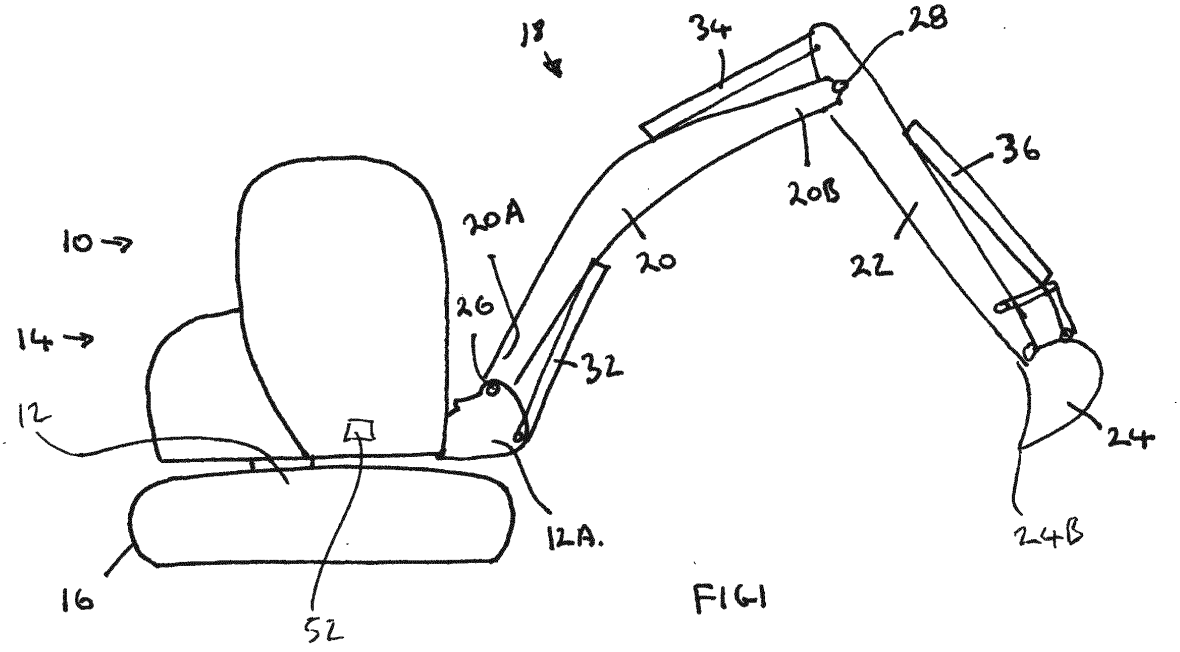

FIG1

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Description

[0001] The present invention relates to a material handling machine.

[0002] Known material handling machines such as excavators have a material handling arm assembly. The arm assembly may have an arm, known as a boom, pivotally mounted about a generally horizontal axis relative to a chassis of the machine. A further arm, known as a dipper, may be attached to an end of the boom remote from the chassis and may be pivotable about a generally horizontal axis. A material handling implement such as a bucket may be pivotably mounted on an end of the dipper. The boom may be raised and lowered by operation of a first hydraulic ram. The dipper may be moveable relative to the boom by operation of a second hydraulic ram, the bucket may be moveable relative to the dipper by operation of a third hydraulic ram.

[0003] In order to handle material, for example dig a trench, a machine operator must simultaneously operate all three hydraulic actuators and this is a skilful process. A skilful operator, when digging a trench, will quickly be able to fill the bucket with material, lift bucket out of the trench and empty the bucket to one or other side of the vehicle. This excavation cycle time or loading cycle time is markedly affected by the initial penetration of the bucket into the ground. If the bucket penetrates too far into the ground then the bucket cannot be drawn through the ground to be filled. Conversely if the bucket does not penetrate far enough into the ground, then the bucket only half fills. Less well trained operators tend to operate at lower excavation/ loading cycle times.

[0004] Accordingly, there is a need for an improved material handling machine.

[0005] Thus, according to the present invention there is provided A method of operating a material handling machine having a material handling implement moveable relative to a chassis of the machine, the method including the steps of

a) positioning the material handling implement in a first position of a first region,
b) moving the material handling implement to a second region,
c) providing a control system to automatically return the material handling implement to the first region by positioning it at a second position of the first region different to the first position of the first region,
d) returning the material handling implement to the second region.

[0006] The first region may be a region where it is desired to dig a trench. The second region may be a region where it desired to deposit spoil from the trench. Advantageously step a) positions the implement in the first region, for example in the region where it is desired to dig a trench but step c) positions the material handling implement at a different position in the first region than step a). Advantageously the control system automatically positions the material handing implement at an incrementally different position in the trench, thereby assisting digging of the trench as it is incrementally extended. The material handling implement is automatically placed directly at the next sequential position in the trench as the length of the trench is progressively extended. The different positions in the trench to which the material handling implement is directly positioned as the trench is incrementally extended may successively progress towards the machine or away from the machine. The direct positioning of the material handling implement to the required position within the trench (i.e. the material handling implement is not moved via a previous digging position) saves time and facilitates more efficient digging.

[0007] The invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a schematic side view of a material handling machine according to the present invention,
Figure 2 is a schematic plan view of part of the material handling machine of figure 1, and
Figure 3 is a schematic side cross-section view of a trench dug by the machine of figure 1 according to the method of the present invention.

[0008] With reference to figures 1 and 2 there is shown a material handling machine 10 including a chassis 12 and an operator cab 14. The operator cab is mounted on the chassis 12. Ground engaging transport means in the form of a pair of tracks 16 are provided on the chassis to move the machine over the ground.

[0009] Attached to a frame of the cab 14 is an arm assembly 18, the arm assembly includes a first arm in the form of a boom 20, a second arm in the form of a dipper 22 and a ground engaging implement in the form of a bucket 24. The boom 20 is pivotally mounted by pivot 26 to link 12A at a first end 20A of the boom. Link 12A is pivotally mounted at a generally vertical axis relative to the frame. Pivot 26 is orientated horizontally. The dipper is pivotally mounted via pivot 28 to a second end 20B of the boom 20. Pivot 28 is orientated horizontally. The bucket is pivotally mounted via pivot 30 to an end 22B of dipper 22 remote from end 22A of dipper 22. Pivot 30 is orientated horizontally.

[0010] A first hydraulic actuator in the form of a first hydraulic ram 32 has a first end 32A pivotally attached to the frame and a second end 32B pivotally attached to the boom part way between the first and second ends of the boom. A second hydraulic actuator in the form of a second hydraulic ram 34 has a first end 34A pivotally attached to the boom part way between the first and second ends of the boom and a second end 34B pivotally attached to the dipper proximate the first end 22A of the dipper. A third hydraulic actuator in the form of a third hydraulic ram 36 has a first end 36A pivotally attached to the dipper proximate the first end 22A of the dipper

and a second end 36B pivotally attached to a linkage mechanism 38 proximate the second end of the dipper. The linkage mechanism 38 per se is known and simply converts extension and retraction movement of the third hydraulic ram 36 into rotary movement of the bucket 24 about pivot 30.

[0011] Extension of the first hydraulic ram causes the boom to raise, and contraction of the first hydraulic ram causes lowering of the boom. Extension of the second ram causes the dipper to pivot in a clockwise direction (when viewing figure 1) about pivot 28, i.e. causes the boom to move in a "dipper in" direction, and retraction of the second hydraulic ram 34 causes the dipper to move in an anticlockwise direction when viewing figure 1 about pivot 28, i.e. in a "dipper out" direction. Extension of the third hydraulic ram 36 causes the bucket 24 to move in a clockwise direction about pivot 30, i.e. in a "crowd" direction, and retraction of the third hydraulic ram 36 causes the bucket to move in an anticlockwise direction about pivot 30, i.e. in a "dump" direction.

[0012] The first, second and third hydraulic rams are all double acting hydraulic rams. Double acting hydraulic rams are known per se. They include a piston within a cylinder. The piston is attached to a rod which extends beyond the end of the cylinder. The end of the rod remote from the piston defines one end of the hydraulic ram. The end of the cylinder remote from the rod defines an opposite end of hydraulic ram. A "head side chamber" is defined between the piston and the end of the cylinder remote from the rod. A "rod side chamber" is defined between the piston and the end of the cylinder proximate the end of the rod. Pressurisation of the head side pressure chamber extends the ram and pressurisation of the rod side chamber causes the ram to retract.

[0013] The machine includes a system for operating the first, second and third hydraulic rams, as described below.

[0014] A hydraulic pump (not shown) is driven by a prime mover. Prime mover may be an internal combustion engine, though other prime movers are suitable. A boom spool valve (not shown) can be operated by an operator manipulating boom control (not shown) to extend or retract hydraulic ram 32. A dipper spool valve (not shown) can be controlled via a dipper control (not shown) to extend or retract hydraulic ram 34. A bucket spool valve (not shown) can be controlled by a bucket control (not shown) to extend or retract hydraulic ram 36. Thus, the operator can manually manipulate the boom control, dipper control and bucket control in order to manoeuvre and handle material.

[0015] The material handling machine also includes a control system 52.

[0016] The control system 52 can be selectively enabled or disabled at the option of the operator. In order to enable the control system 52 the operator actuates a switch, button or other operator input device (not shown). In order to disable the control system 52 the operator actuates the button, switch or other operator input device.

[0017] When the control system is disabled, the operator can manually manipulate the boom control, dipper control and bucket control, as described above, in order to manoeuvre and handle material.

[0018] With the control system enabled, operation is as follows:-

[0019] The control system 52 allows a pre-programmed sequence of manoeuvres to be carried out automatically.

[0020] Thus, by way of example when it is required to dig a trench or the like the operator enables the control system 52. The control system 52 then controls movement of the boom, dipper and bucket in a pre-programmed sequence of manoeuvres. In a typical sequence of movements of the arm assembly is as follows:-

[0021] Firstly, the control system 52 lowers the boom and the dipper is moved in a "dipper out" direction thereby moving the bucket teeth 25 of the bucket 24 away from the chassis 12. The boom is then further lowered such that the bucket teeth 25 engage the ground. The bucket is then crowded slightly so as to start to move the bucket teeth through the ground. The dipper, boom and bucket are then simultaneously operated by the control system 52 to progressively move the dipper in a "dipper in" direction and to move the boom in a "boom raised" direction and to move the bucket in a "crowd" direction such that the bucket teeth move generally towards the chassis to fill the bucket with ground material. Once the bucket is full, the boom is raised, the arm assembly is swung laterally relative to the machine and the ground material is then dumped by moving the bucket to a dumped position. The sequence is then generally repeated. However, as the bucket is returned to the trench it is not positioned in the same position as when the first bucket load of ground material was removed, rather it is positioned at an incrementally different position ready to take the second bucket load of ground material.

[0022] Thus, with regard to figures 2 and 3, in order to dig the trench the cutting edge 24B of the bucket must first be positioned on the ground surface G at point 101. The control system then moves the boom, dipper and bucket so as to draw the leading edge 24B to point 102. The control system then crowds the bucket to draw the cutting edge 24B to point 103 following which the boom is raised to move the bucket out of the ground. This results in the removal of portion A of the ground shown cross-hatched in figure 3. The frame is then swung clockwise relative to the chassis (when viewing figure 2) so as to move the bucket towards a second region 60, where it is intended to dump the spoil from the trench. Once the bucket 24 is above second region 60 the bucket is then "dumped" thereby depositing spoil A on the ground at region 60. The frame is then swung anticlockwise and the cutting edge 24B is returned to the trench. However, since ground material A has been moved, the leading edge 24B of the bucket 24 needs to be positioned at position 102 by the control system rather than at position 101. In order to fill the bucket for the second time the

cutting edge is positioned at position 102, moved to position 104 and then moved to position 105 in order to collect ground material B shown cross-hatched in figure 3. The boom is then raised to lift the bucket out of the ground, the frame is swung clockwise and the spoil B is deposited at the second region 60 thereby forming a spoil pile. For the third bucket load the cutting edge is initially positioned at position 104 by the control system and then moved to position 106 and 107. For the fourth bucket load the cutting edge is positioned at position 106 by the control system and then moved to position 108 and 109. The fifth bucket load is positioned at position 108 by the control system and then moved to position 110 and then 111. The sixth bucket load is positioned at position 110 by the control system and then moved to position 112 and 113. Thus, each time the bucket is returned to the trench, the cutting edge is positioned by the control system incrementally differently from the previous occasion.

[0023] The desired position of the trench represents a first region 59 (see figure 2). The spoil pile of the trench represents second region 60 (see figure 2). The invention provides for moving the material handling implement (in this example the bucket 24) repeatedly between the first and second regions. However, the implement is not moved to the same position when at the first region, rather it is moved automatically to an incrementally different position of the first region. In this way a trench or the like can progressively be dug.

[0024] Where short trenches are required to be dug, then the movement of the boom, dipper and bucket alone may be sufficient to dig the short trench, in other words it may not be necessary to move the vehicle via tracks 16. However, in other circumstances where a longer trench is required then the first part of the trench may be dug (for example by removing ground material A, B and C whilst the chassis is positioned at position 1 of figure 1. In order to remove ground material D, E and F it may be necessary to move the chassis to position 2 as shown in figure 2. In spite of movement of the chassis the bucket nevertheless returns to the first region, i.e. returns to the trench in order to remove ground material D, E and F.

[0025] In one embodiment the system allows automatic digging of a trench or the like, and as such there is no need for an operator to be physically present in the machine, rather the operator can be remote from the machine. This is particularly advantageous in dangerous environments where the operator can be remote from the machine in a safe location.

[0026] When in a remote location, the operator need not control all aspects of the machine. In one example all that the operator needs to define is the first position of the first region and the second region. Once this has been done the control system can automatically cause a sequence of predefined movements to occur thereby handling material in a desired manner, for example digging a trench or a hole at the first region and depositing the spoil at the second region.

[0027] Alternatively, in another embodiment only certain steps may be controlled by the controller. For example, it is only necessary for the step of returning the material handling implement to the first region by positioning it at a second position of the first region different to the first position of the first region be carried out automatically. This enables the implement to be quickly returned to an appropriate position (for example in a trench) different from the previous position of implement (for example in the trench). The control system therefore can quickly return the implement to an incrementally different position. This then enables the operator to control movement of the implement, for example to handle material, until such time as it is required to return the implement to another incrementally different position. This is advantageous when the material being handled is not uniform, for example where the ground includes occasional large rocks or other such material. For example, when digging a trench the first three bucket loads may contain loose material such as soil. Pickling up of this soil requires a particular implement manoeuvre. However, a fourth load may require the digging up of a rock or the like which will require a slightly different implement manoeuvre. The operator will be able to determine the required implement manoeuvre required to pick-up the soil or rock, as appropriate, but nevertheless once the earth/rock has been deposited on the spoil heap, the machine can nevertheless return the implement to an appropriate incrementally different position ready for a further material handling implement manoeuvre to pick-up further soil or a further rock as appropriate and as will be seen by the operator.

[0028] As described above, and as shown in figure 3, the leading edge 24B of the bucket starts at position 101. For each successive bucket load it is positioned at positions 102, 104, 106, 108 and 110. These incrementally different starting positions generally progress towards the machine. However, in further embodiments the incrementally different positions need not progress towards the machine, rather they can progress in any direction. In particular, when digging a deep hole, or a deep trench, certain of the incrementally different position may be directly below a previous position.

[0029] The control system may be pre-programmed at the manufacturing factory with a sequence of manoeuvres to be carried out. Alternatively, the control system may be pre-programmed in the field. In particular the control system may be pre-programmed in the field by recording a sequence of material handling manoeuvres and then arranging for those manoeuvres to be repeated with an offset. For example, an alternative way of digging the trench of figure 3 is with the control system disabled, the operator removes soil A and B.

[0030] With the control system still disabled, the operator enables a recording system which then records the sequence of manual manipulations of the boom control, dipper control and bucket control used to remove soil C and D. That sequence of recorded manoeuvres becomes the pre-programmed sequence of manoeuvres in order to remove soil E and F except with an offset. In other

words sequence of manoeuvres used to remove soil D and E are repeated to remove soil E and F except they are repeated with an offset according to the distance between position 104 and 108.

[0031] In an embodiment additional sensors can be provided to provide a feedback loop for the positional control of the implement. However, in an embodiment no sensors or the like are required and accordingly no positional feedback loop. Such an arrangement is therefore relatively inexpensive (since no feedback sensors are required) and is relatively easy to maintain (since there are no sensors which require maintenance.

[0032] As described above, the material handling machine is an excavator. However, the present invention is not limited to excavators and other material handling machines could be used, for example a back hoe loader, a telescopic handler, a fork lift truck etc. As described above, the implement used is a bucket. However, in further embodiments it is not necessary to use a bucket and other implements should be used, for example fork lift truck or telescopic handler forks could be used etc.

[0033] As described above, the step of positioning the material handling implement in a first position of a first region and the step of returning the material handling implement to the first region by positioning it at a second position of the first region different to the first position of the first region are carried out with the machine stationary, either with the machine stationary in the same position, or with the machine stationary in different positions. In further embodiments it is impossible to carry out one or both of these steps whilst the machine is in motion, i. e. whilst the machine is travelling over the ground.

Claims

1. A method of operating a material handling machine having a material handling implement moveable relative to a chassis of the machine, the method including the steps of

   a) positioning the material handling implement in a first position of a first region,
   b) moving the material handling implement to a second region,
   c) providing a control system to automatically return the material handling implement to the first region by positioning it at a second position of the first region different to the first position of the first region,
   d) returning the material handling implement to the second region.

2. A method as defined in claim 1 wherein step a) is carried out automatically by the control system, preferably step a) includes carrying out a material handling manoeuvre with the implement, preferably the manoeuvre picks up material.

3. A method as defined in claim 1 or 2 wherein step b) is carried out automatically by the control system, preferably step b) includes moving material carried by the implement to the second region.

4. A method as defined in any preceding claim wherein step b) is carried out automatically by the control system, wherein step b) includes carrying out a material handling manoeuvre with the implement at the second region, preferably the manoeuvre deposits material.

5. A method as defined in any preceding claim wherein step c) is carried out automatically by the control system, wherein step c) includes returning the material handling implement to the first region absent any material.

6. A method as defined in any preceding claim wherein step c) is carried out automatically by the control system, wherein step c) includes carrying out a material handling manoeuvre with the implement, preferably carrying out a material handling manoeuvre of claim 2.

7. A method as defined in any preceding claim wherein step d) is carried out automatically by the control system, preferably step d) includes moving material carried by the implement to the second region.

8. A method as defined in any preceding claim wherein step d) is carried out automatically by the control system, wherein step d) includes carrying out a material handling manoeuvre with the implement at the second region, preferably carrying out the material handling manoeuvre of claim 4.

9. A method as defined in any preceding claim wherein step b) is carried out automatically by the control system, wherein step b) includes moving the material handling implement to a first position of the second region and is carried out automatically by the control system, wherein step d) includes returning the material handling implement to a second position of the second region different from the first position of the second region.

10. A method as defined in any preceding claim wherein the method is used to dig a hole, and/or wherein the material is frangible material and/or loose material, for example wherein the method is used to transfer the frangible and/or loose material from the first region to the second region.

11. A method as defined in any preceding claim wherein the material handling implement is a bucket or a shovel, and/or wherein steps a), b), c) and d) are carried out whilst the chassis of the machine is sta-

tionary.

12. A method as defined in any preceding claim including:-

e) arranging a control system to automatically return the material handling implement to the first region by positioning it at a third position of the first region different to the first and second positions of the first region, the second position of the first region being intermediate, the first position of the first region and the third position of the first region,
f) returning the material handling implement to the second region.

13. A method as defined in claim 12 wherein step f) is carried out automatically by the control system.

14. The method as defined in claim 12 wherein steps a), b), c), d), e) and f) are carried out whilst the chassis of the machine is stationary.

15. The method as defined in claim 12 wherein steps a), b), c) and d) are carried out whilst the chassis of the machine is stationary and prior to carrying out steps e) and f) the chassis of the machine is moved to a different and/or adjacent location.

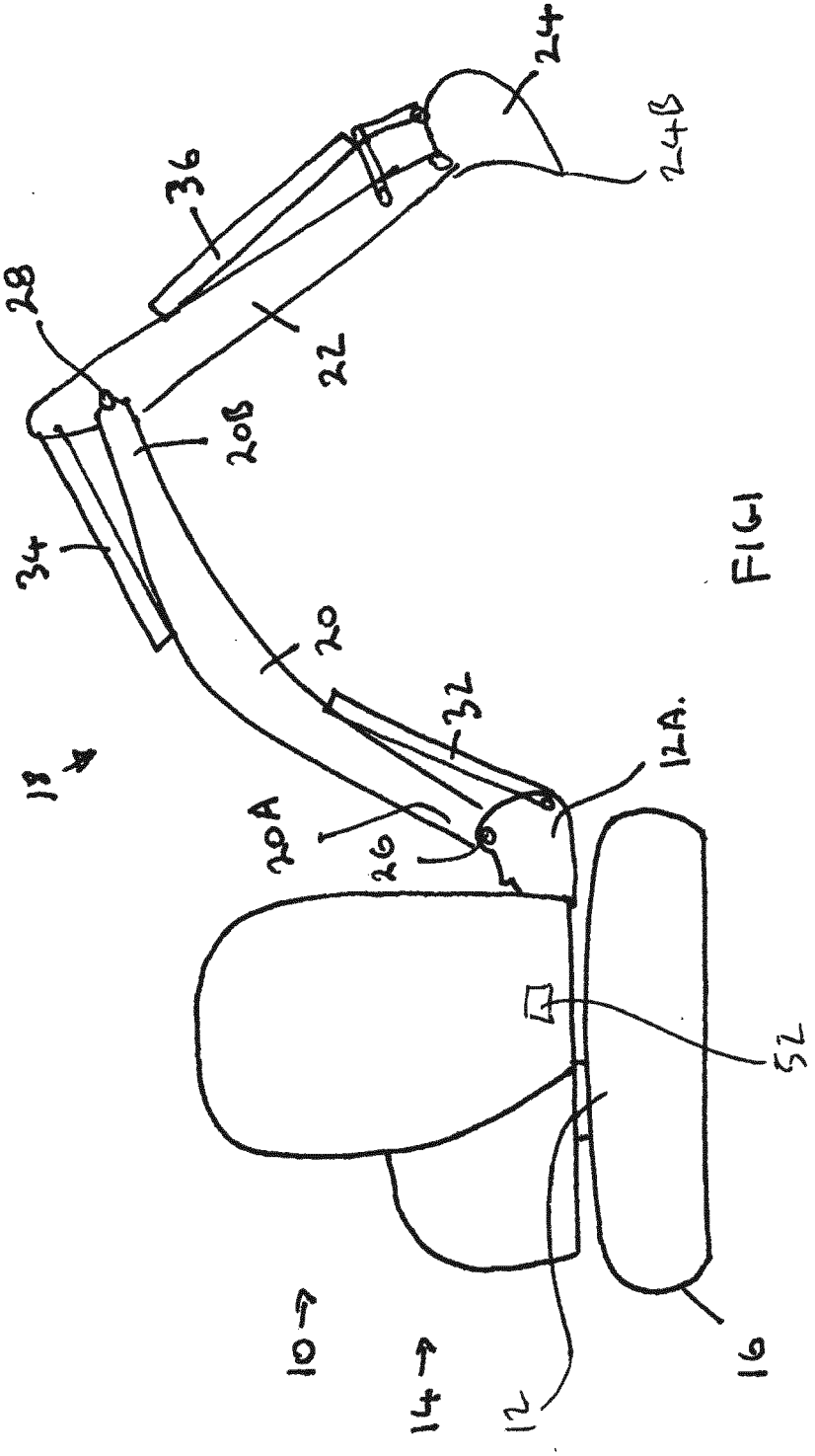

FIG 1

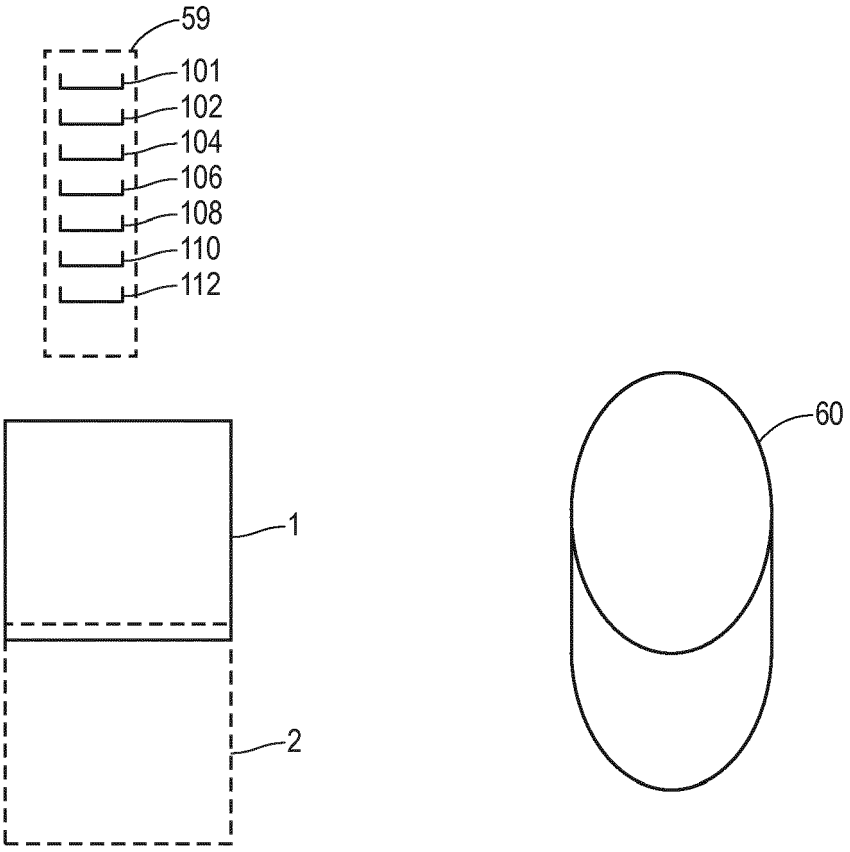
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FIG. 2

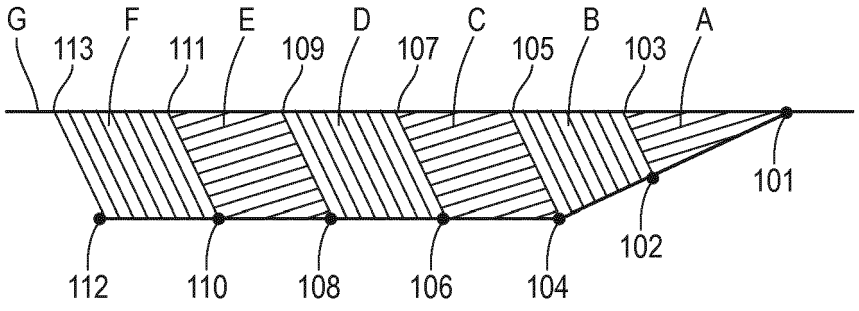
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FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 15 17 0945

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E02F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 February 2016	Laurer, Michael

CATEGORY OF CITED DOCUMENTS

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