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Lumley

(54) **DRAGLINE BUCKETS**

(76) Inventor: **Graham Lumley**, Queensland (AU)

Correspondence Address:
ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017 (US)

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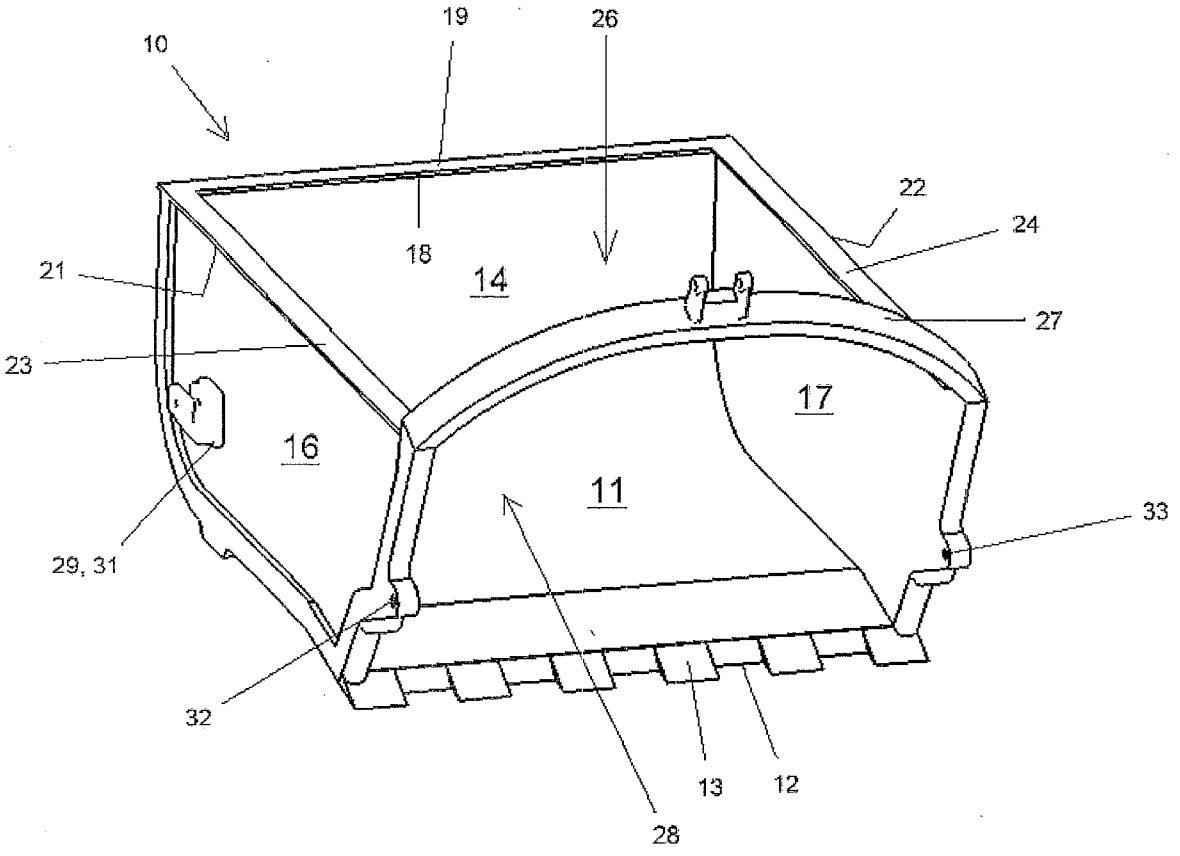
(57) **ABSTRACT**

A dragline bucket comprising: a floor having a ground engaging leading edge, a rear wall extending upward from said floor and spaced rearward from said leading edge, and two spaced apart side walls extending upward from said floor and forward from said rear wall, the upper edges of said rear wall and said side walls defining an open top and the height from said floor of at least a portion of said side walls forward of said rear wall being substantially less than the height of said side walls adjacent said rear wall.



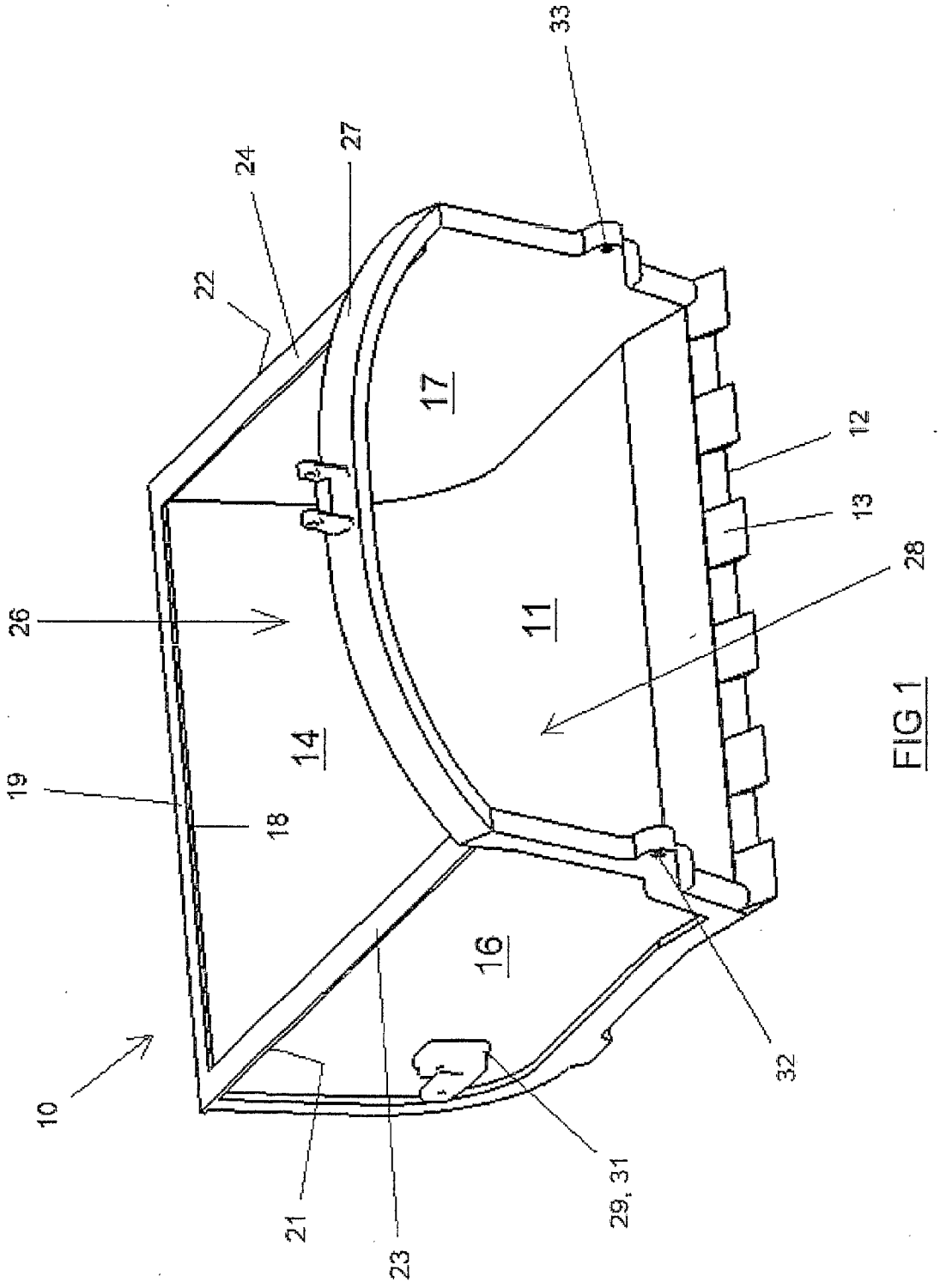


FIG 1

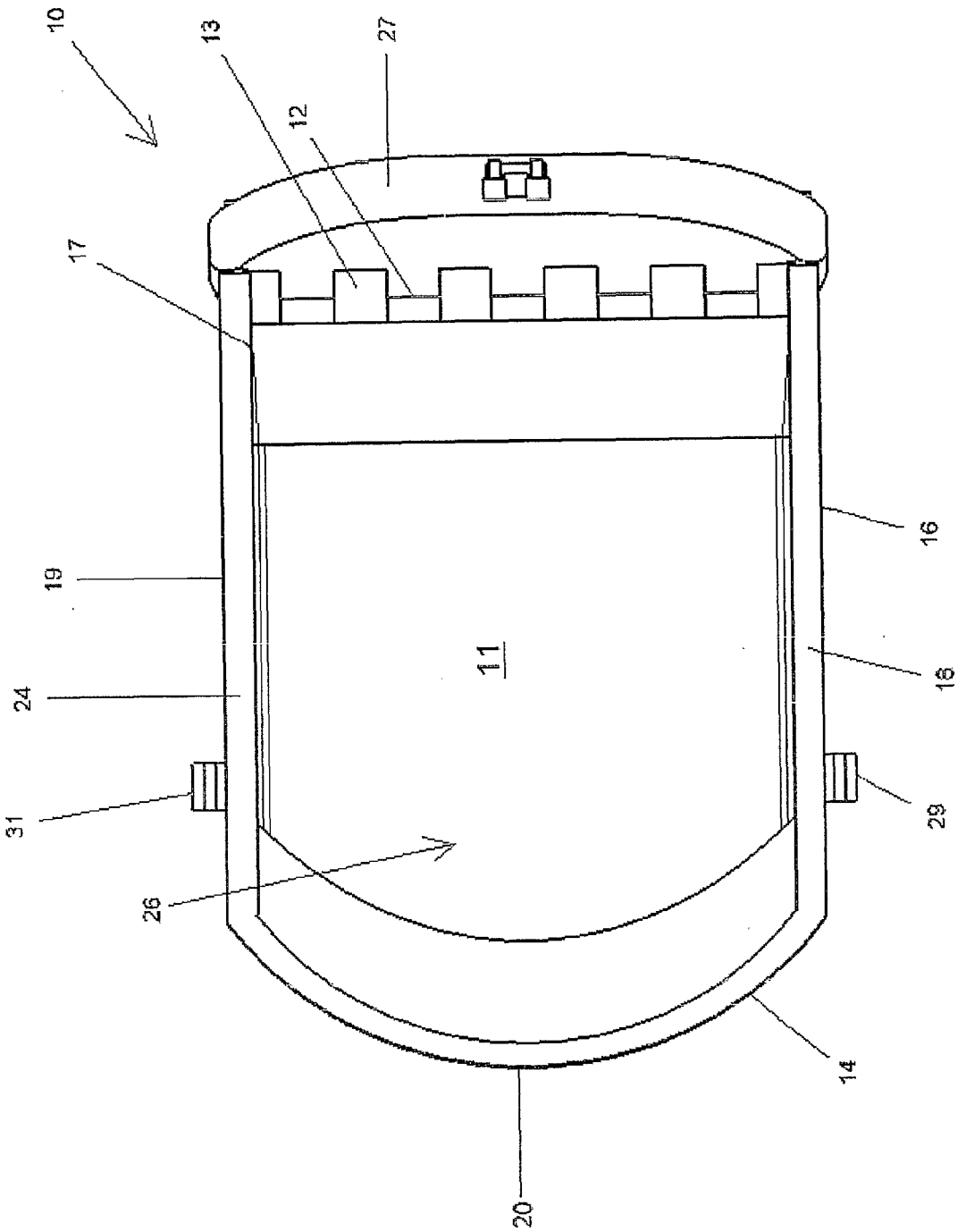


FIG 2

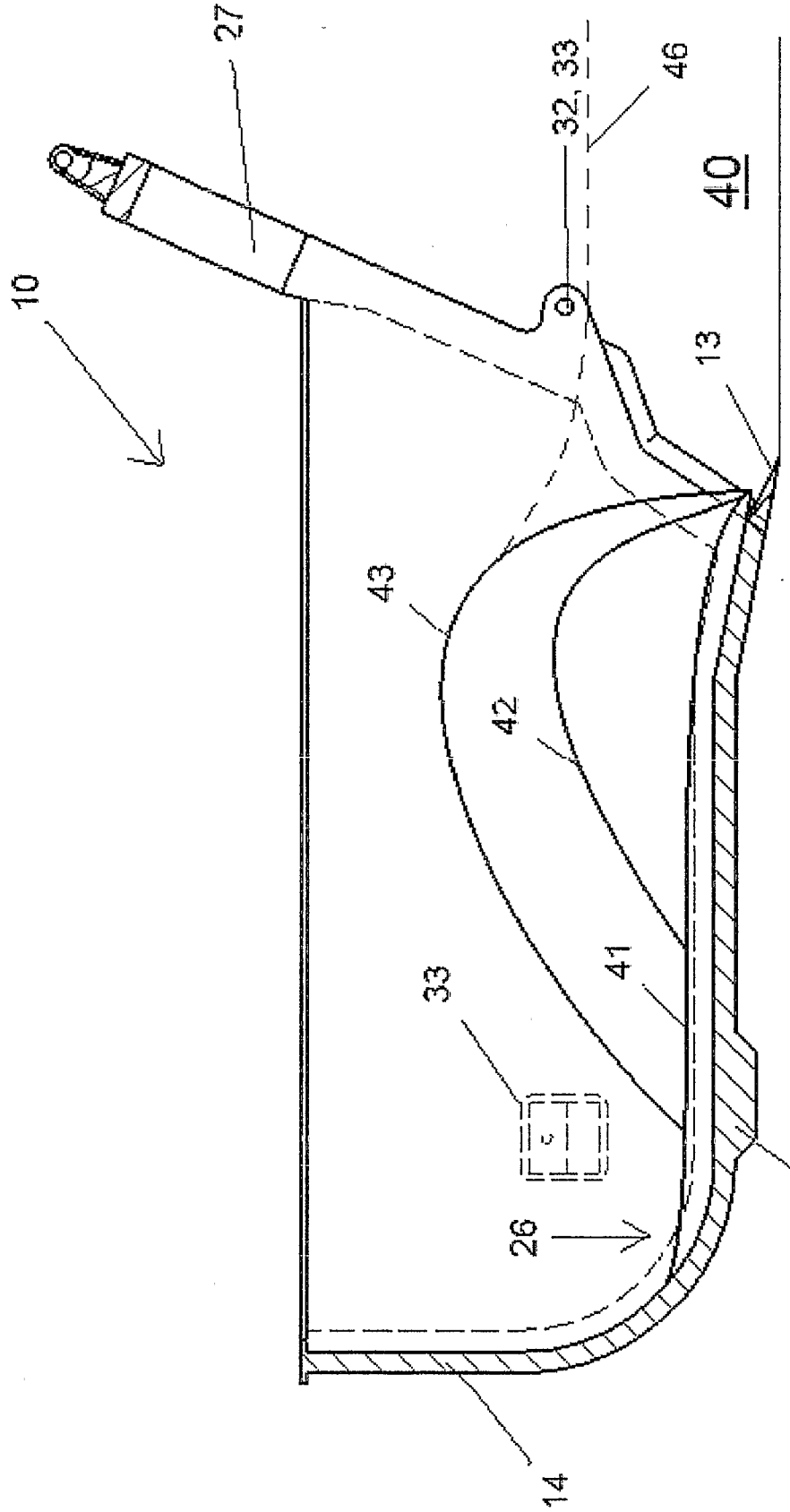


FIG 3 A

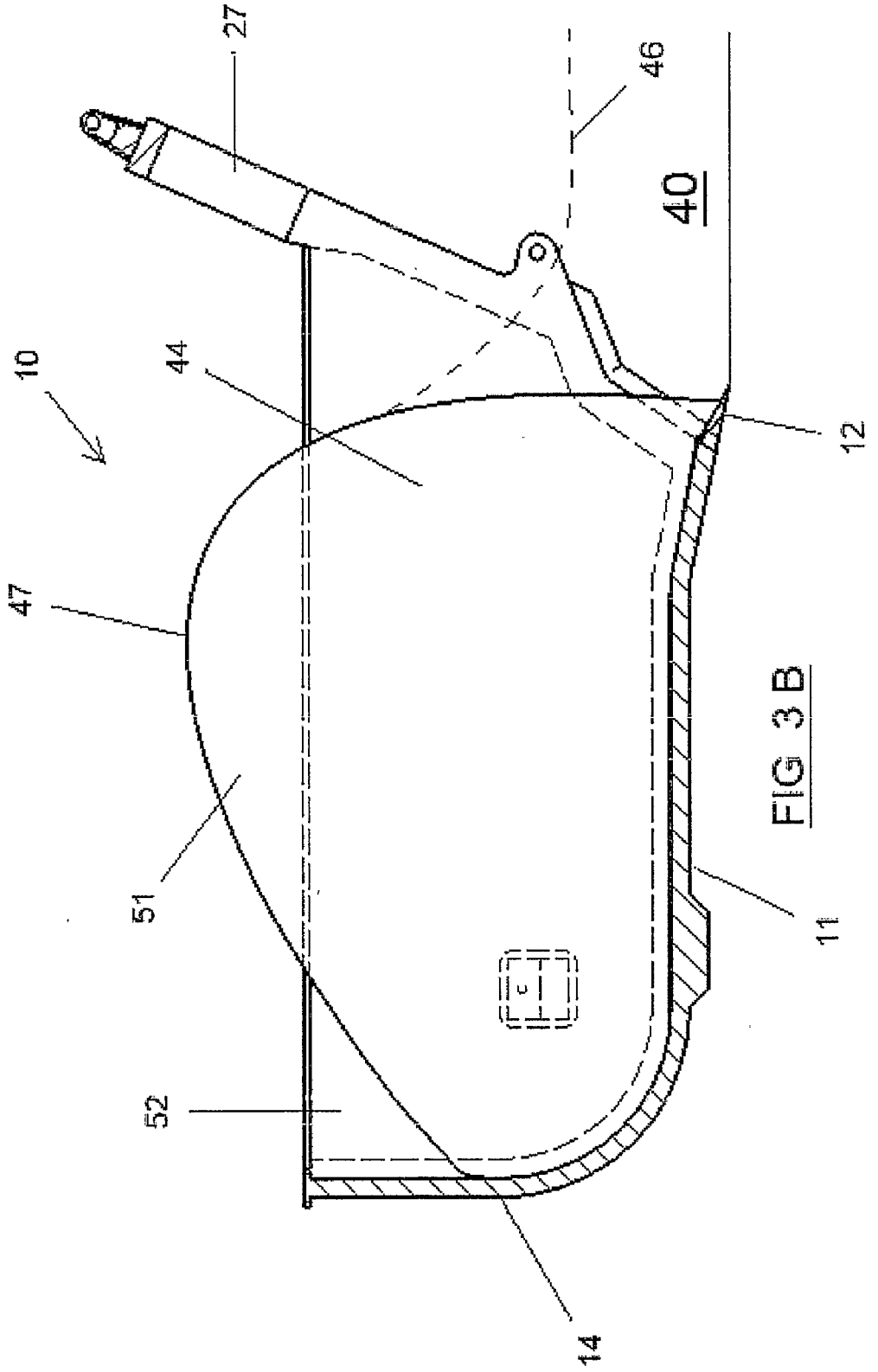


FIG 3B

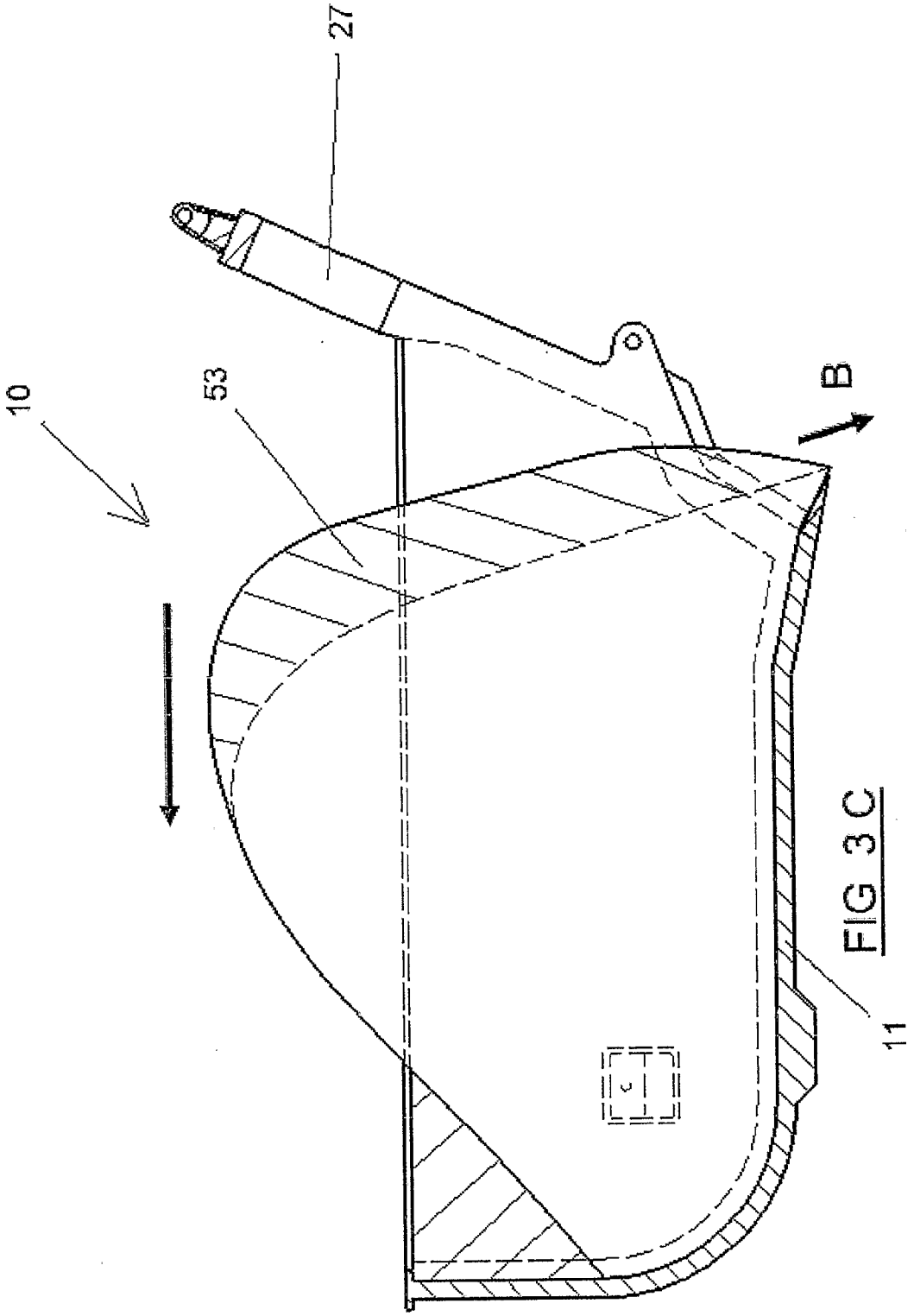


FIG 3C

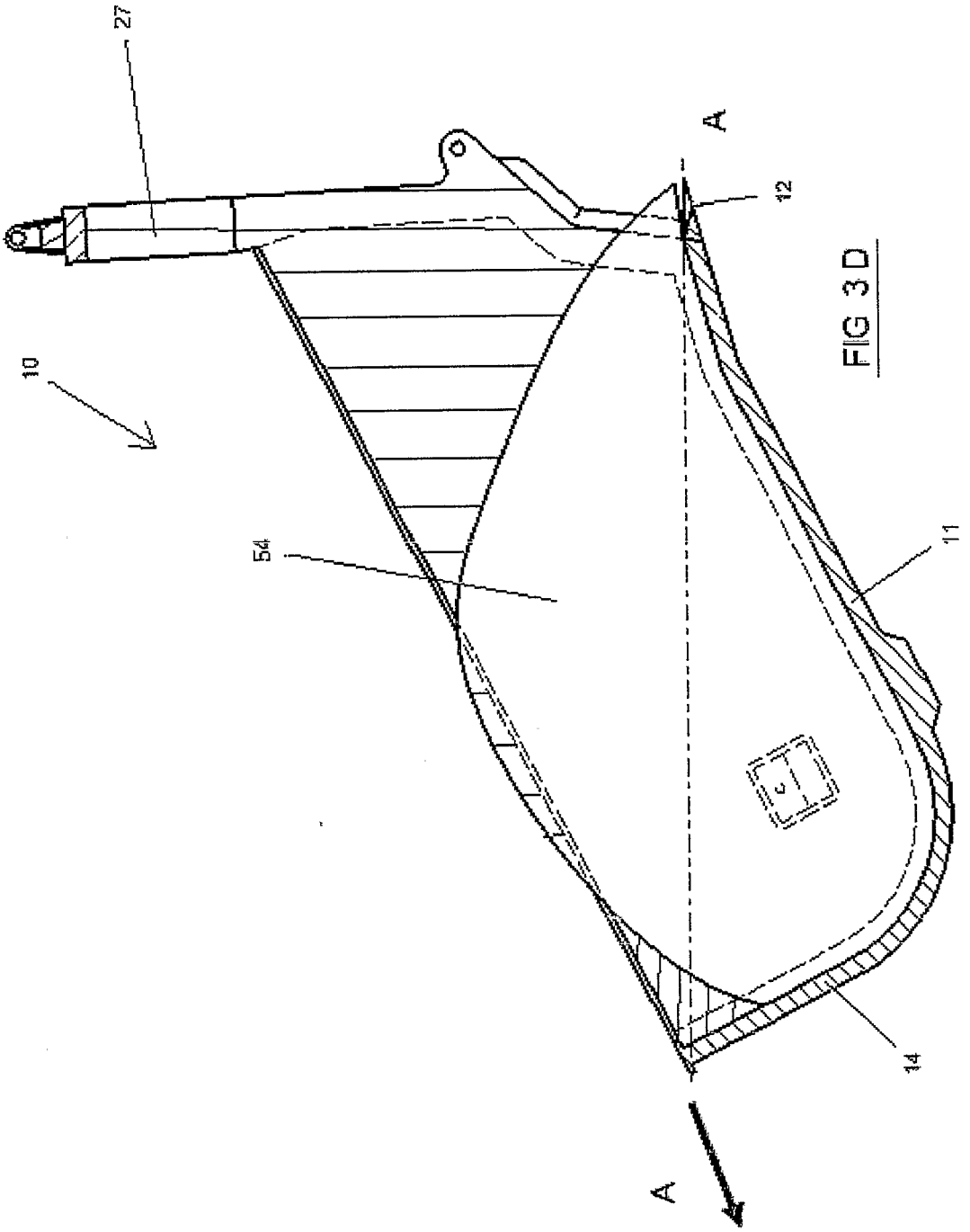
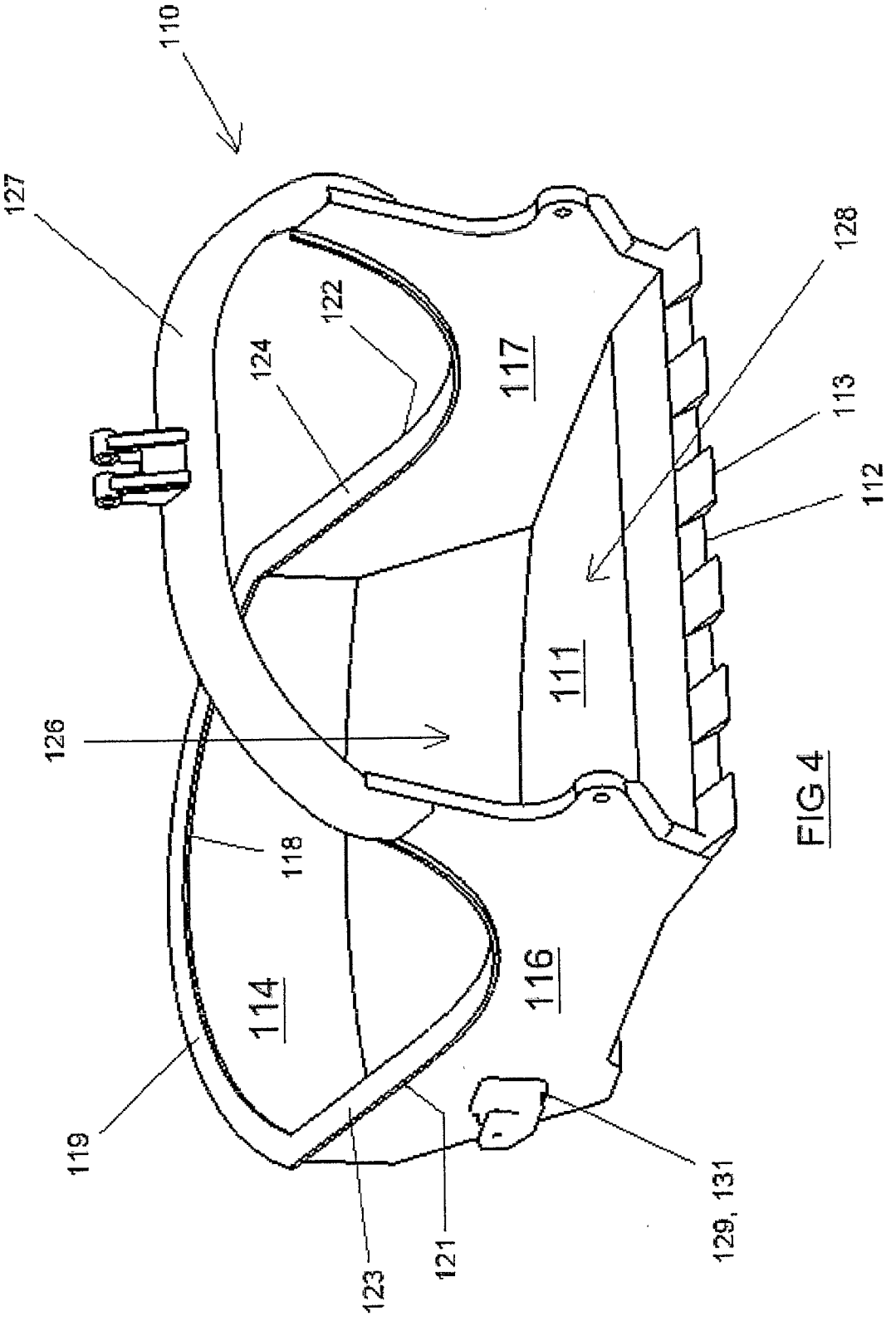


FIG 3D


110
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129, 131

FIG 4

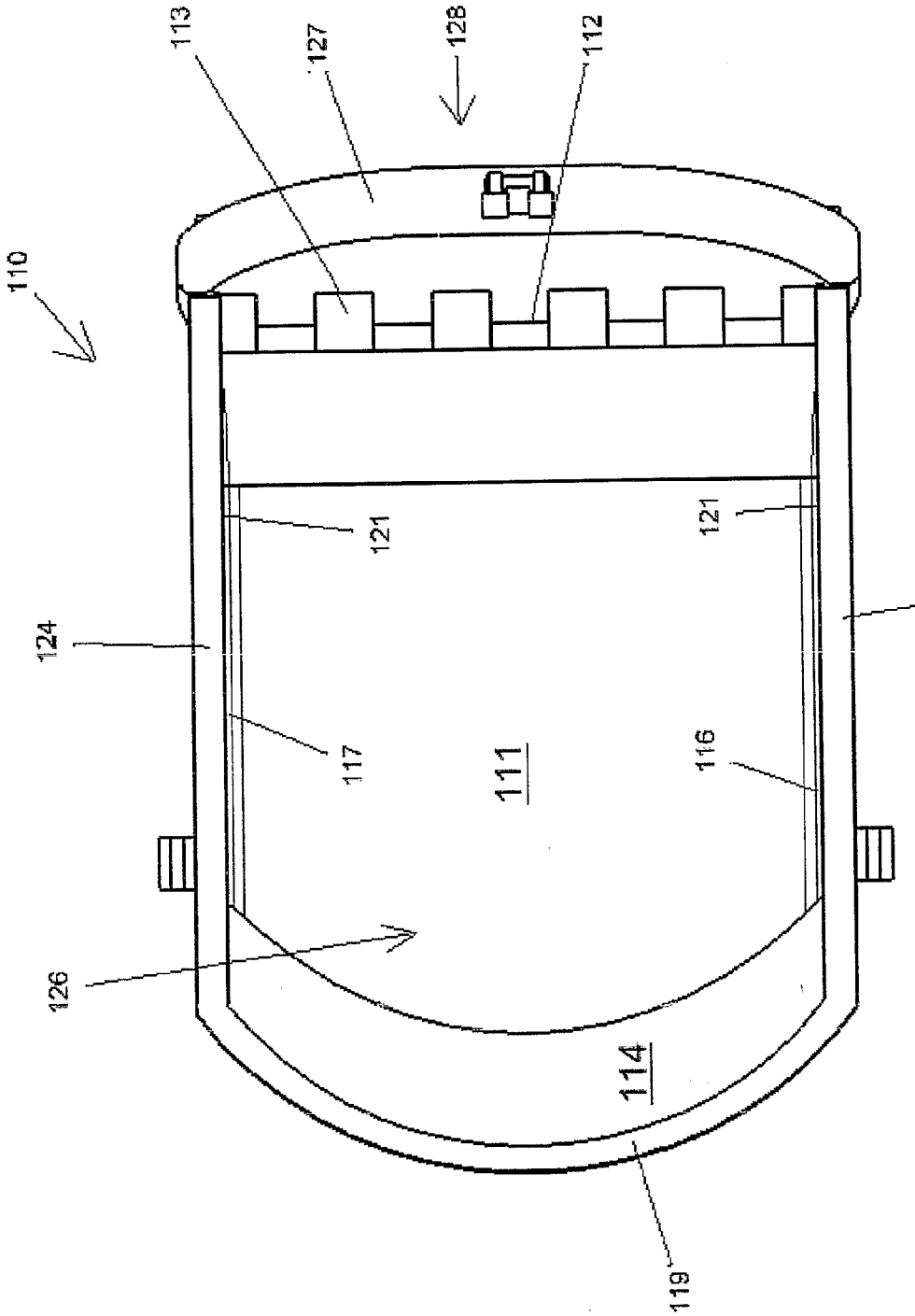

FIG 5 A

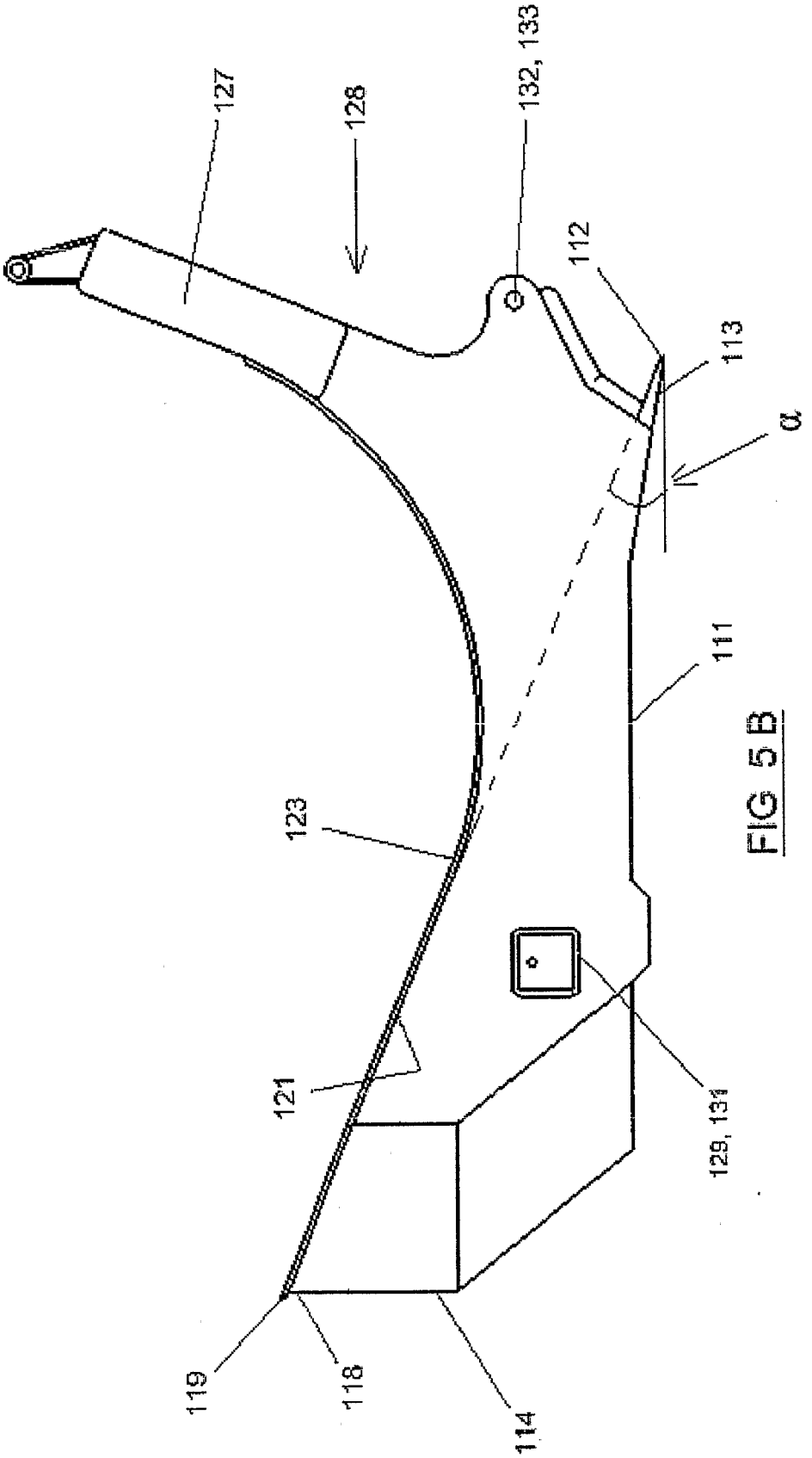

FIG 5B

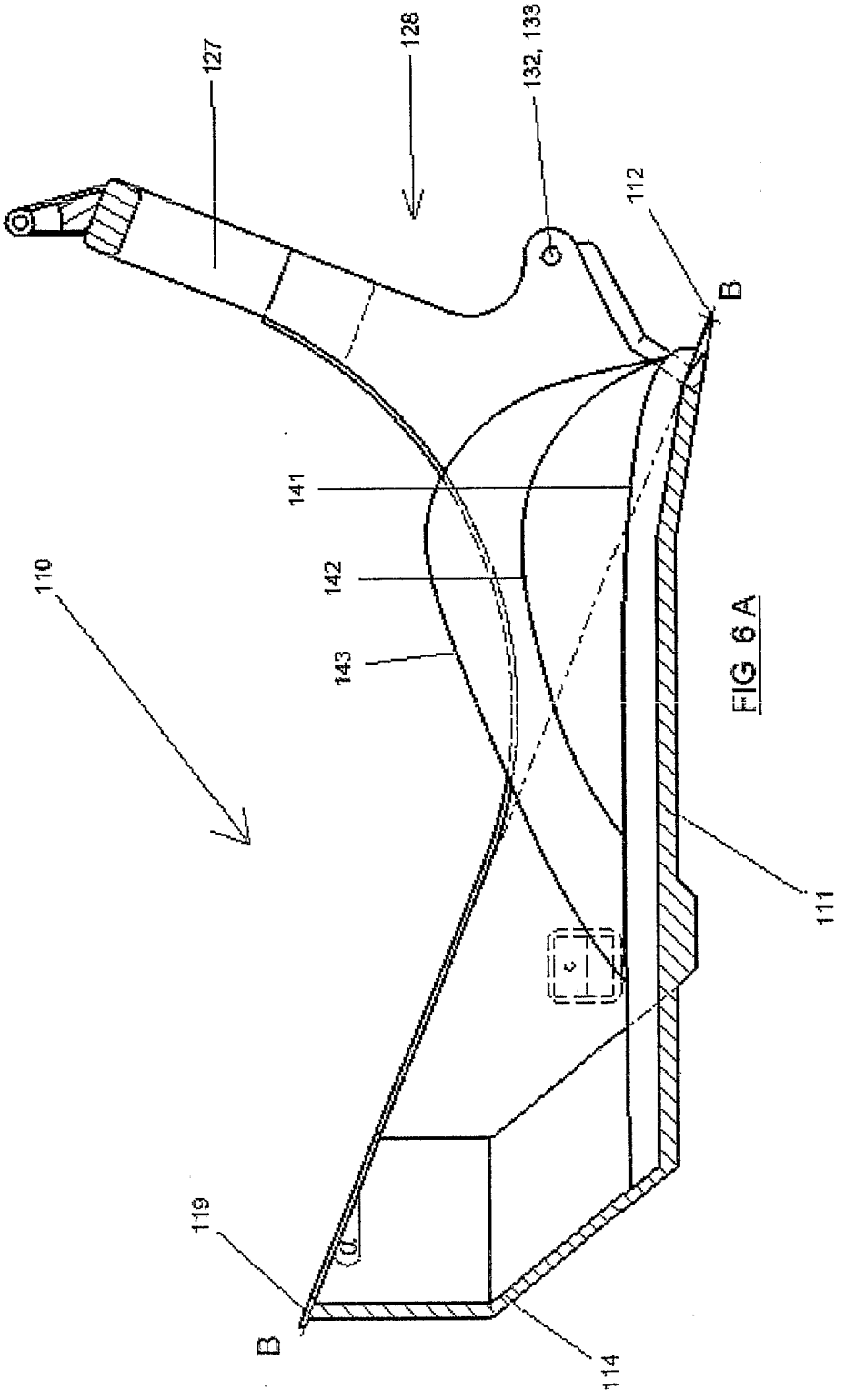

FIG 6 A

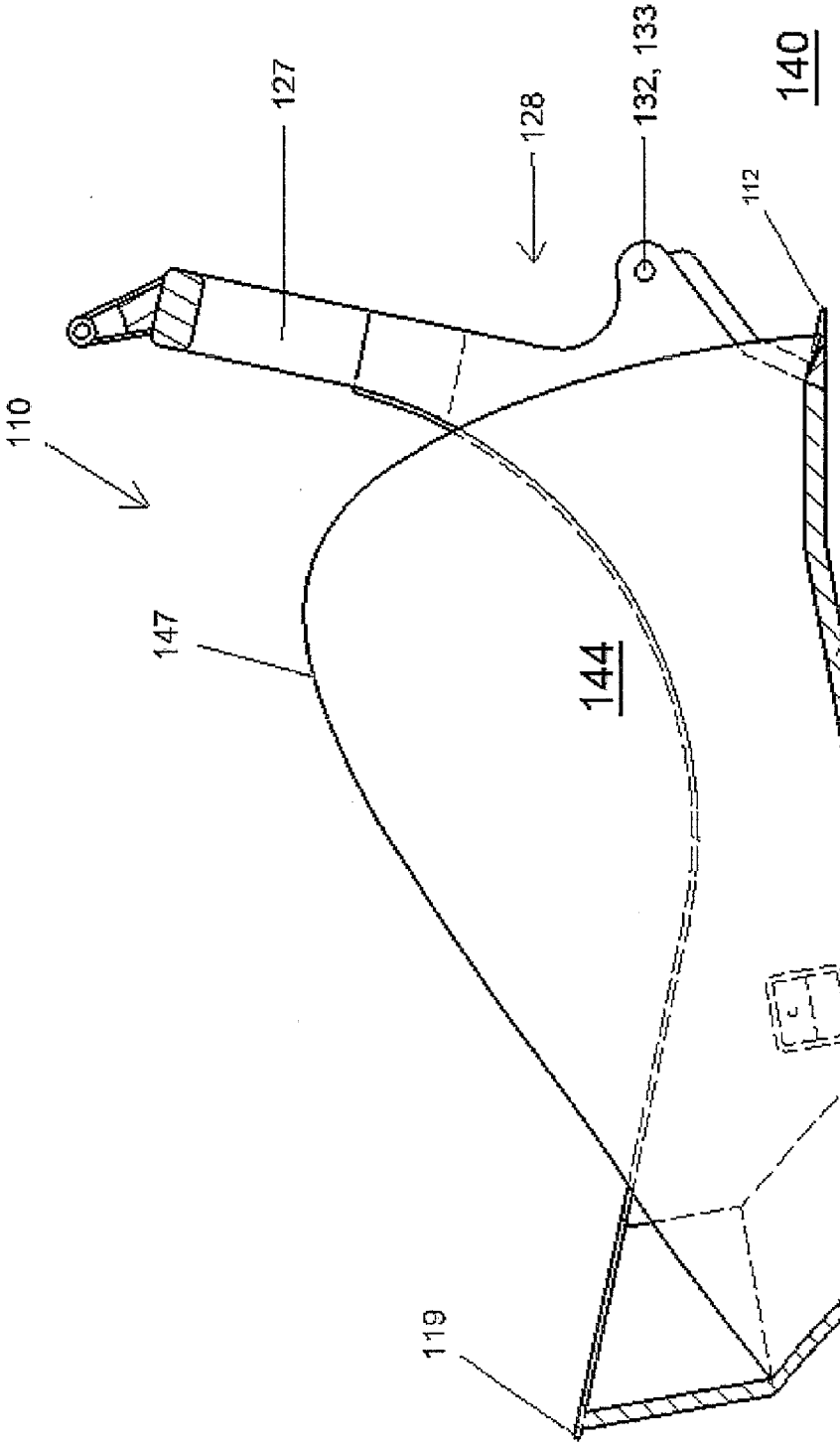

FIG 6B

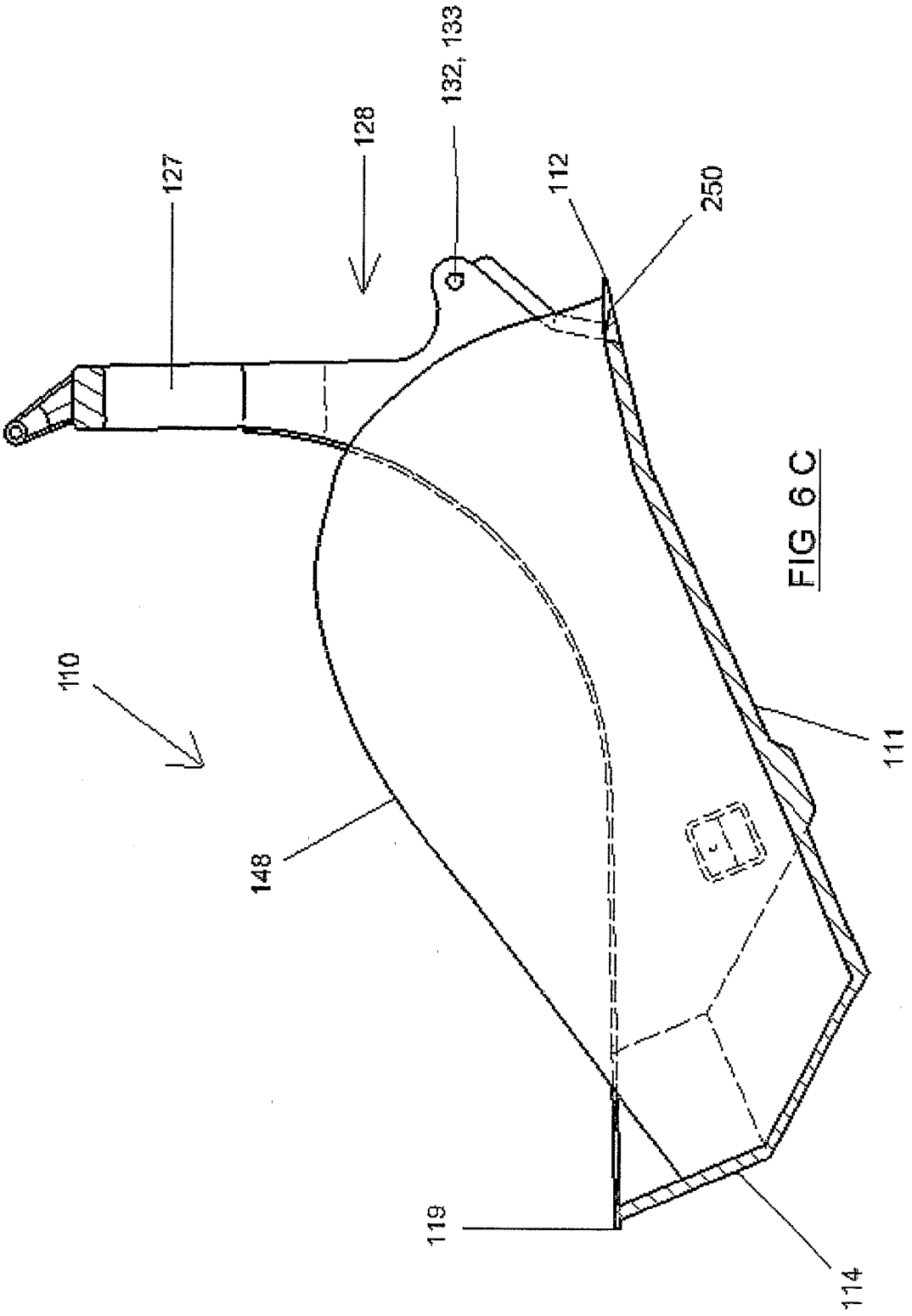

FIG 6 C

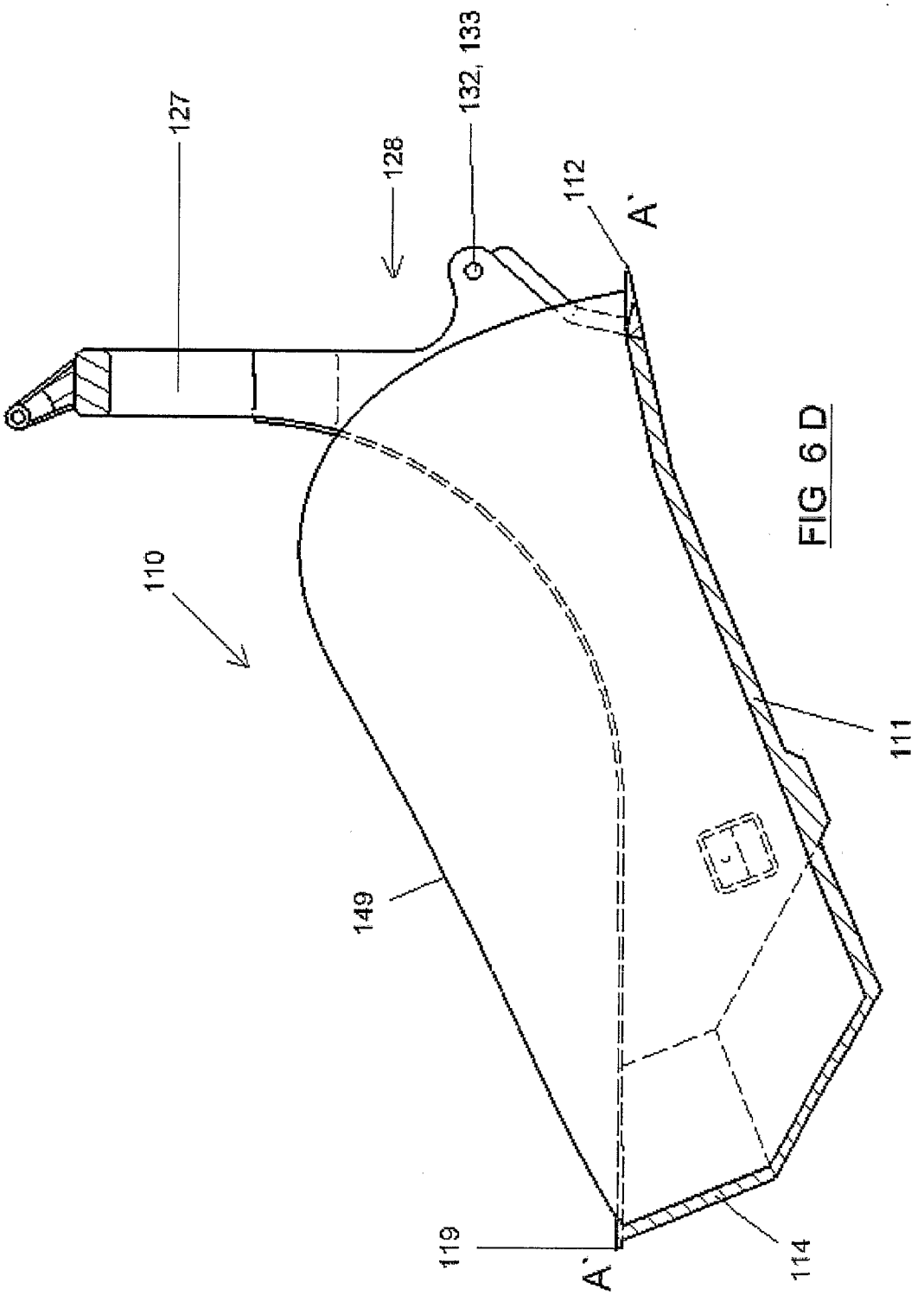

FIG 6 D

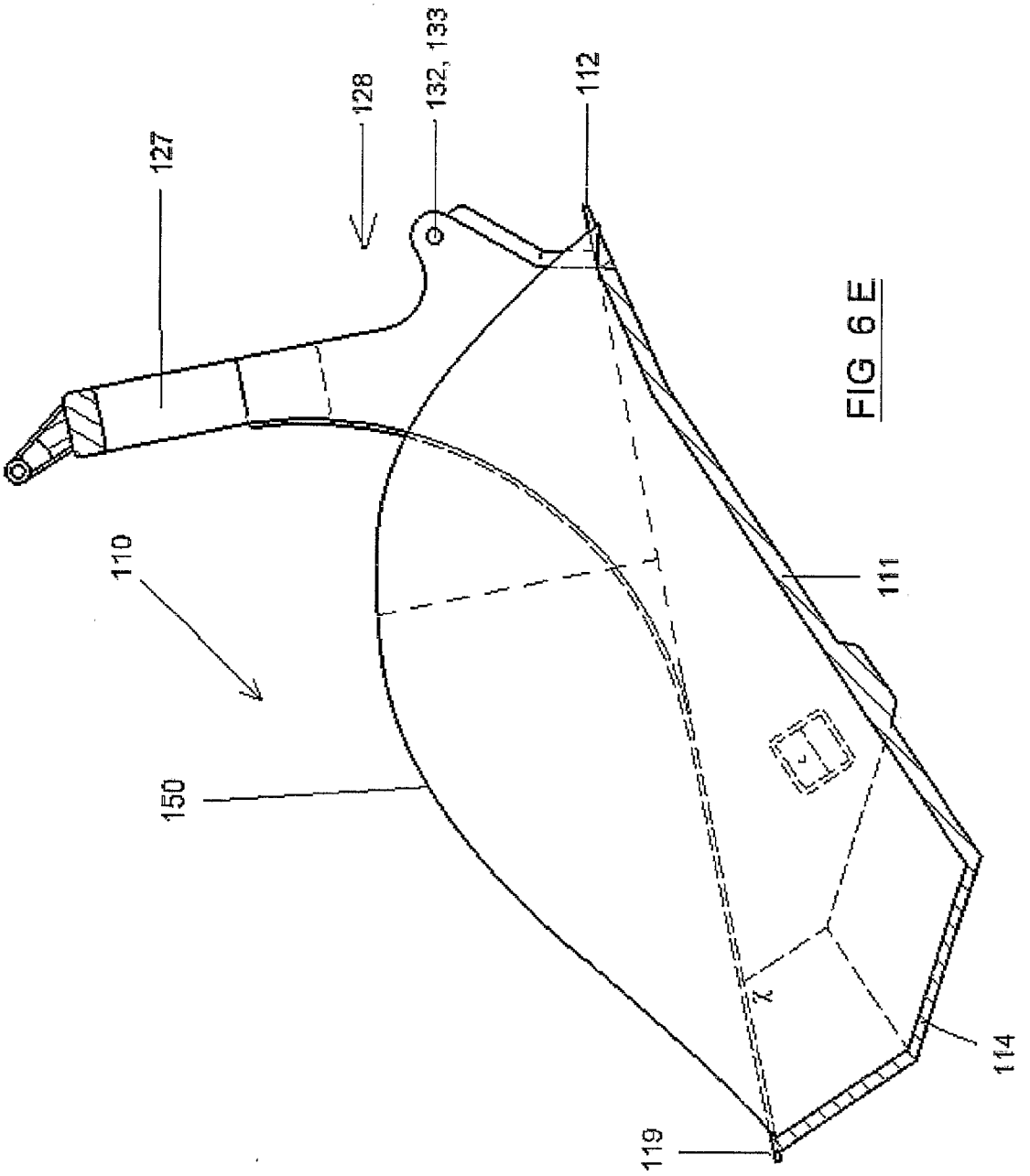

FIG 6 E

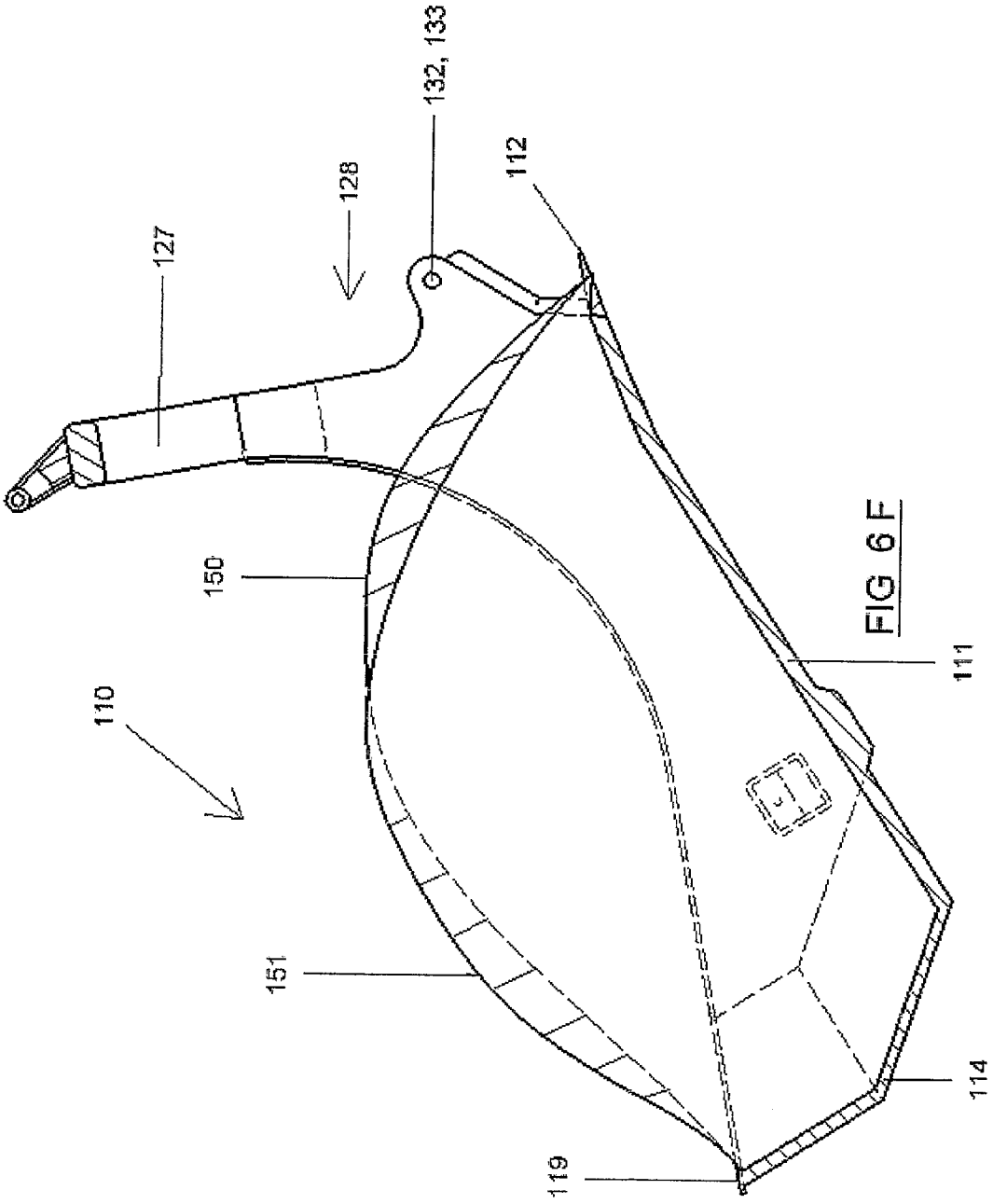

FIG 6 F

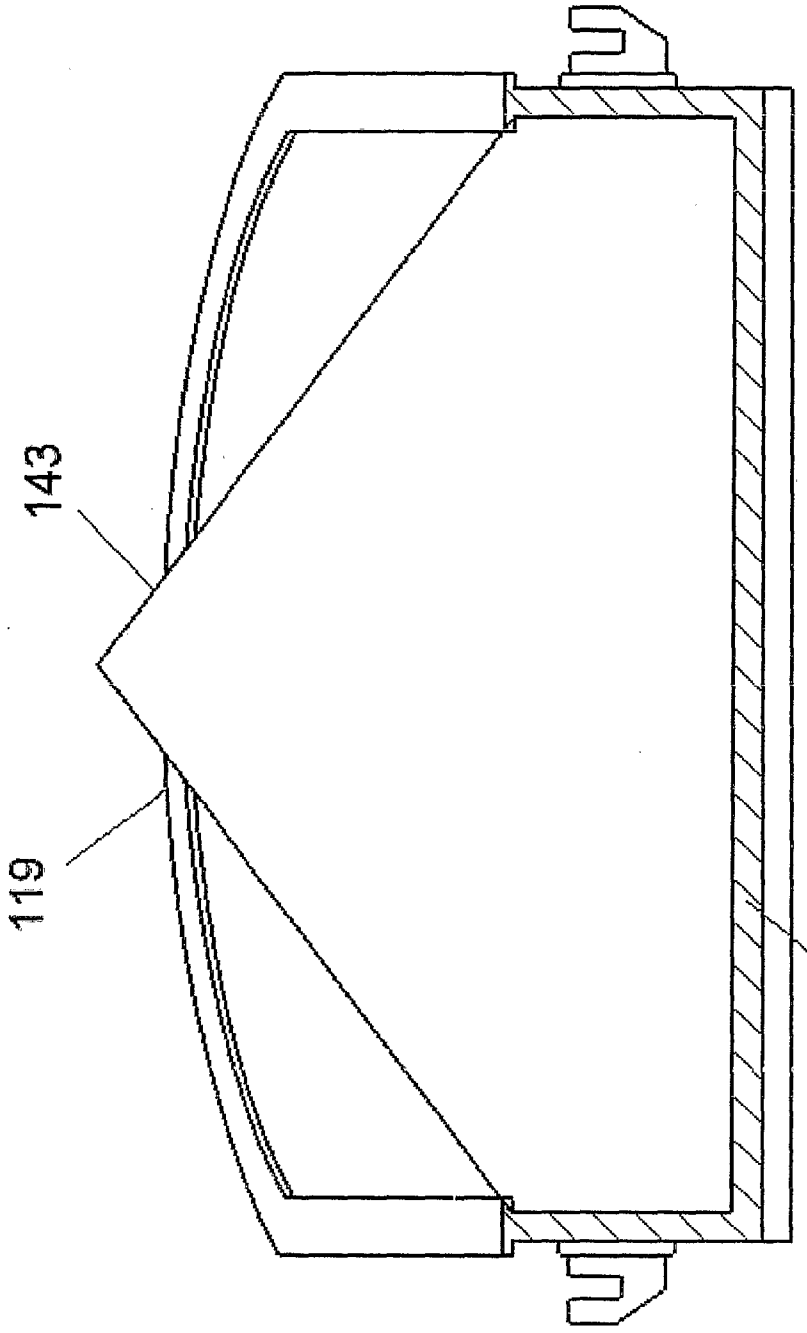

FIG 6 G

DRAGLINE BUCKETS

FIELD OF THE INVENTION

[0001] This invention relates to dragline buckets.

BACKGROUND OF THE INVENTION

[0002] Although there are many factors affecting the productivity of a dragline, the efficiency and effectiveness of the bucket during the dig cycle (that is, fill carry and dump) has a big influence on the overall productivity of the dragline. Previous inventions have been aimed at increasing the efficiency and effectiveness of the bucket during the fill component of the dig cycle. However, there is room for further improvement in that area and there is also room for improvements in other areas.

[0003] A large amount of energy is required to pull a dragline bucket through spoil during the fill phase and to carry the bucket and the spoil to the dump site. Some of the energy is used in moving the bucket itself and some to moving the spoil contained in the bucket. Thus it is desirable to maximise the ratio of mass of spoil, that is, the payload, to the mass of the bucket. It is also desirable to retain as much of the spoil as possible which has entered the bucket during the fill phase through the carry phase to the dump site. The present invention is aimed at providing a dragline bucket which is more efficient than previously known buckets at least in some circumstances.

DISCLOSURE OF THE INVENTION

[0004] With the foregoing in view, the invention in one aspect resides broadly in a dragline bucket comprising:

[0005] a floor having a ground engaging leading edge, a rear wall extending upward from said floor and spaced rearward from said leading edge, and two spaced apart side walls extending upward from said floor and forward from said rear wall, the upper edges of said rear wall and said side walls defining an open top and the height from said floor of at least a portion of said side walls forward of said rear wall being substantially less than the height of said side walls adjacent said rear wall.

[0006] In another aspect, the invention resides broadly in a dragline bucket comprising:

[0007] a floor having a ground engaging leading edge;

[0008] a rear wall extending upward from said floor and spaced rearward from said leading edge;

[0009] two spaced apart side walls extending upward from said floor and forward from said rear wall, the upper edges of said rear wall and said side walls defining an open top; and

[0010] a lifting arch operatively connected to said floor and/or said side walls forward of said rear wall, said leading edge and said lifting arch defining a mouth through which spoil may enter, the height from said floor of at least a portion of said side walls between said rear wall and said lifting arch being substantially less than the height of said rear wall from said floor.

[0011] In yet another aspect, the invention resides broadly in a dragline bucket comprising:

[0012] a floor having a ground engaging leading edge;

[0013] a rear wall spaced from said leading edge and extending upwards from said floor and curving forward at opposite sides of its centre to meet two spaced apart side walls also extending upward from said floor and forward from said rear wall, the upper edges of said rear wall and said side walls defining an open top.

[0014] In yet another aspect, the invention resides broadly in a dragline bucket comprising:

[0015] a floor having a ground engaging leading edge;

[0016] a rear wall spaced from said leading edge and extending upwards from said floor and curving forward meet two spaced apart side walls also extending upward from said floor and forward from said rear wall, the upper edges of said rear wall and said side walls defining an open top; and

[0017] a lifting arch operatively connected to said floor and/or said side walls forward of said rear wall, said leading edge and said lifting arch defining a mouth through which spoil may enter.

[0018] Preferably, said side walls and said rear wall terminate in a top rail running therealong from the lifting arch on one side of the mouth to the lifting arch on the other side of the mouth. However, if desired the top rail could be spaced above the side walls along said portion of lower height. In such case, stiffening ribs, gussets or the like may be added to the side walls if desired to increase its strength.

[0019] Preferably, the upper edges of said side walls slope downward at a predetermined angle from the upper edge of said rear wall towards the leading edge of said floor to respective predetermined points. It is preferred that the predetermined angle is the angle enclosed by a straight line joining the upper edge of the rear wall (at the points where the respective side walls meet the rear wall) to the leading edge or a point just in front of or just behind the leading edge. Although theoretically the height of the side walls could fall to zero at the leading edge, preferably, the predetermined points are selected to achieve desired energy efficiency while at the same time maintaining sufficient strength. In one presently preferred form, the respective predetermined points are where the height of the side walls is about half that of the rear wall (at the points where the respective side walls meet the rear wall). In one particularly preferred form, at that point the side walls then curve upwards towards the lifting arch. Typically a plurality of spaced apart teeth will be fitted to the floor along the leading edge in known manner to improve ground cutting performance and in such cases the preferred points to which the straight line referred to above is drawn may vary according to the particular bucket or the particular teeth being used.

[0020] In another form, the invention resides broadly in a method of operating a dragline, including:

[0021] providing a dragline having a dragline bucket as previously described;

[0022] dragging the bucket through spoil in a forward direction to substantially fill a front portion of the bucket and then lifting the ground engaging leading edge while continuing dragging in the forward direction to tilt the front of the bucket upwards whereby spoil accumulated adjacent the mouth of the bucket moves towards the rear wall of the bucket;

[0023] tilting the bucket to a predetermined carry angle;

[0024] lifting the bucket to a desired height;

[0025] carrying the bucket to a dump site; and

[0026] dumping the spoil at the dump site.

[0027] Advantageously, the method according to the invention reduces the amount of load on the drag rope which will be connected to the side walls for pulling the bucket forward.

[0028] Terms such as horizontal, vertical, upper, lower, front, rear, side and the like are used herein for the purpose of describing the invention from the perspective of its normal at rest position and are not intended to limit the invention to use in any particular orientation. The term spoil is intended to encompass virgin ground and ground which has been dug or stockpiled.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] In order that the invention may be more easily understood and put into practical effect, reference will now be made to the accompanying drawings wherein:

[0030] FIG. **1** is a pictorial representation of a conventional dragline bucket;

[0031] FIG. **2** is a plan of the dragline bucket of FIG. **1**;

[0032] FIG. **3***a* is a schematic sectional side elevation of a conventional dragline bucket showing various spoil shear plane lines during the fill phase of a dig cycle;

[0033] FIG. **3***b* is a schematic sectional side elevation of the dragline bucket of FIG. **3***a* showing the initial fill line at the end of the fill phase of the dig cycle;

[0034] FIG. **3***c* is a schematic sectional side elevation of the dragline bucket of FIG. **3***a* showing the initial fill line and the retained fill line after spilling or settling while being lifted at the end of the fill phase;

[0035] FIG. **3***d* is a schematic sectional side elevation of the dragline bucket of FIG. **3***a* at commencement of the carry phase showing the settled fill line;

[0036] FIG. **4** is a pictorial representation of a dragline bucket according to the invention;

[0037] FIG. **5***a* is a plan of the bucket of FIG. **4**;

[0038] FIG. **5***b* is a side elevation of the bucket of FIG. **4**;

[0039] FIG. **6***a* is a schematic sectional side elevation of the bucket of FIG. **4** showing various spoil shear planes during the fill phase of a dig cycle;

[0040] FIG. **6***b* is a schematic sectional side elevation of the dragline bucket of FIG. **4** towards the end of the fill phase;

[0041] FIG. **6***c* is a schematic sectional side elevation of the dragline bucket of FIG. **4** showing the initial fill line and the retained fill line after spilling or settling while being lifted at the end of the fill phase;

[0042] FIG. **6***d* is a schematic sectional side elevation of the dragline bucket of FIG. **4** during the carry phase showing the settled fill line;

[0043] FIG. **6***e* is a schematic sectional side elevation of the dragline bucket of FIG. **4** being carried at a greater carry angle than that in FIG. **6***d*; and

[0044] FIG. **6***f* is a schematic sectional side elevation of the dragline bucket of FIG. **4** showing the settled fill line for the carry angle of FIG. **6***e* with the settled line from FIG. **6***d* superimposed.

DETAILED DESCRIPTION OF THE DRAWINGS

[0045] The dragline bucket **10** illustrated in FIG. **1** has a floor **11** with a ground engaging leading edge **12** to which a plurality of spaced apart teeth **13** are fitted in known manner, a rear wall **14** extending upward from the floor and spaced rearward of the leading edge which is contiguous with two spaced apart side walls **16** and **17** which also extend upward from the floor and forward from the rear wall, the rear wall terminating at its upper edge **18** in a rear top rail **19** and the side walls terminating at their upper edges **21** and **22** in side top rails **23** and **24** respectively, the top rails defining an open top **26**.

[0046] A lifting arch **27** is connected to the forward end portions of the side walls and to the floor (via the side walls) for connecting the bucket to the lift cable of the dragline in known manner. It will be appreciated that the leading edge **12** together with the side walls and the lifting arch define a mouth **28** through which spoil may enter the bucket. Lifting lugs **29** and **31** are welded to the outer face of the side walls towards the rear wall for attaching lifting chains also for connection to the dragline cable. Similarly, drag lugs **32** and **33** are connected to the forward ends of the side walls below the lifting arch for connection to the drag chain of the dragline in known manner.

[0047] It will be appreciated that the top rails **19**, **23** and **24** of the conventional bucket all lie in the same plane, that being a plane substantially parallel to the plane containing the surface of the body of the floor of the bucket (which is generally horizontal when at rest on level ground). Additionally, the rear wall meets the floor substantially at right angles with only a slightly rounded bottom corner and the rear wall meets the side walls substantially at right angles, the two side walls being substantially parallel and the floor being substantially rectangular.

[0048] It is understood in the mining industry that dragline buckets fill in accordance with what is known as the "shear zone theory". Under the shear zone theory as illustrated in FIGS. **3***a* to **3***d*, as the bucket starts to fill while it is pulled through the virgin spoil an initial laminar layer **41** of spoil forms over the floor of the bucket. Then, as filling continues, the virgin spoil immediately in front of the leading edge shears upwardly over the laminar layer **41** and progressively creates shear zones **42**, **43** and so on, until the end of the fill phase of the dig cycle to form the mound of spoil **44** as seen in FIG. **3***b*. As can also be seen in FIG. **3***b*, the mound **44** within the bucket is biased towards the leading edge **12**. The bias is due to the bucket "bulldozing" the virgin spoil **40** towards the end of the fill phase as evidenced by the upper surface **46** (shown in phantom) being moved upwards in front of the leading edge. It is believed that particles of clay in the spoil tend to bind together at the front of the bucket thereby increasing the density of the spoil in that area. The virgin spoil in front of the bucket helps hold the spoil **44** in the bucket.

[0049] As the shear zones **42**, **43**, etc, are formed, the shearing action causes the spoil towards the front of the bucket to be compacted and hence denser in front of the peak **47** of the heap **44** then the spoil behind the peak. Thus, a given volume of spoil forward of the peak will be heavier then the same volume reward of the peak.

[0050] As can be seen in FIG. **3***b*, at the end of the drag phase, a portion **47** of the heap is above the top rail and a space **52** remains behind the mound **44** although in other drag phases, the space may be filled. As the bucket is lifted while still in a horizontal attitude, a movement known as "nodding" occurs in which the bucket tilts forward and back and causes spoil from the peak (and forward of the peak) to shear and fall over the leading edge. That lost spoil is typically denser than most other spoil in the bucket for reasons mentioned previously. The bucket is then titled to a desired carry angle prior to being swung to a dump site. The carry angle typically places the floor at 32° to 38° to the horizontal as generally indicated in FIG. **3***d*.

[0051] The bucket **110** of the present invention as illustrated in FIG. **4** is similar to the conventional bucket **10** just described in many respects and accordingly corresponding numbers will be used to reference corresponding features except prefaced by a "1". Thus, it will be seen that bucket **110** has a floor **111** with a leading ground engaging edge **112** having spaced apart teeth **113** mounted thereto, a rear wall **114** extending upward from the floor and spaced rearward of the leading edge, two spaced apart side walls **116** and **117** also extending upward from the floor, the upper edge of the rear wall terminating in a rear top rail **119** and the upper edges of the side rails **116** and **117** terminating in side tops rails **123** and **124** respectively. A lifting arch **127** is mounted to the side walls and the floor in the same manner as in the conventional bucket shown in FIG. **1** and lifting lugs and drag lugs are provided in the same manner. However, in the bucket **110**, the rear wall curves outwards from the side walls such that the centre of the rear wall is further behind the leading edge than the ends of the rear wall. It will also be seen that the rear wall is higher in the centre and curves downwards to the points where it meets the respective sidewalls.

[0052] It will also be seen that the height of the side walls of the bucket **110** from the floor is not constant as in conventional bucket **10**, but rather the upper edges slope forward from the rear top rail at an angle α to a straight line drawn from the rear top rail to the ground engaging leading edge for a point approximately halfway along the length of the floor. At that point, the side walls are approximately half the height of the rear wall and from there, the side walls curve upwardly in an arc towards the top of the lifting arch in a manner selected to achieve sufficient structural integrity. Testing has demonstrated that the optimum carry angle of the dragline bucket, represented by the angle between the floor **111** and the horizontal to be equal to or greater than the angle α as will be discussed in more detail later.

[0053] As can be seen in FIG. **6***a*, the shear zone theory applies to the initial fill stages in the same manner as previously described in relation to conventional buckets in relation to shear zones **141**, **142**, **143** and so on. However, when the bucket is filled according to the method broadly described earlier, the peak **147** of the mound **144** is further forward than in the conventional bucket relative to the leading edge with more spoil in the zone of higher density. Moreover, as the bucket is titled further back as illustrated in FIG. **6***c*, spoil therein settles to the general shape of the mound **148** shown therein. One advantage of progressively angling the bucket **110** from the horizontal to the desired carry angle during the fill phase is that more of the filled spoil is retained during the fill phase and in the transition between the fill phase and the carry phase (that is the initial lift after filling) than with conventional buckets using conventional digging methods. Thus, buckets constructed according to the present invention and used according to the method described earlier are less likely to suffer the spoil losses due to "nodding" and will have a greater ratio of retained spoil payload to bucket weight than conventional buckets. It is also believed that buckets according to the present invention have higher drag efficiency due to less drag friction.

[0054] In use, bucket **110** commences digging in the horizontal attitude illustrated in FIG. **6***a* and after a mound forms to the level **147** shown in FIG. **6***b*, the bucket is tilted or rolled back slightly by lifting the lifting arch and thus the leading edge **112**. As the bucket moves, the arch is lifted higher thus tilting the bucket back further to the desired carry angle as it fills to the level **148** shown in FIG. **6***c* and then as the bucket is lifted further for the carry phase, the mound settles to the form **149** shown generally in FIG. **6***d*. Under this method, the face of the virgin spoil will tend to form an arc and the bucket will tend to follow the arc during each dig cycle. Depending on the type of spoil being dug, the bucket can be tilted further back and be carried at a steeper carry angle to prevent loss of filled spoil over the leading edge as shown by levels **150** and **151** in FIGS. **6***e* and **6***f*. it will be appreciated that the reduced height of the side walls of the bucket results in a decrease in energy consumption during the fill phase because spoil movement in the fill phase is not as constrained by the side walls as in previously known buckets.

[0055] The foregoing description has been given by way of illustrative example of the invention and all modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of the invention as defined by the appended claims.

1-14. (canceled)

15. A dragline bucket comprising:

a floor having a ground engaging leading edge, a rear wall extending upward from said floor and spaced from said leading edge, and two spaced apart side walls extending upward from said floor and forward from said rear wall towards said leading edge, the upper edges of said rear wall and said side walls defining an open top and the height of said rear wall and said side walls from said floor decreasing away from about the centre of said rear wall to at least respective predetermined points along said side walls.

16. A dragline bucket according to claim **15** wherein said predetermined points are located about midway between said rear wall and said leading edge.

17. A dragline bucket comprising:

a floor having a ground engaging leading edge, a rear wall extending upward from said floor and spaced from said leading edge, and two spaced apart side walls extending upward from said floor and forward from said rear wall towards said leading edge, the upper edges of said rear wall and said side walls defining an open top and at least a portion of the upper edge of each said side wall lying in a plane containing a line extending from about the centre of the upper edge of said rear wall to about said leading edge.

18. A dragline bucket according to claim **17** wherein the portion of the upper edge of each side wall lying in said plane extends from said rear wall to a predetermined point between said rear wall and said leading edge.

19. A dragline bucket according to claim **18** wherein said predetermined point is a point where the height of said side walls is about half the height of said rear wall.

20. A dragline bucket according to claim **15** wherein said side walls and said rear wall terminate in a top rail running along their respective upper edges or formed by their upper edges.

21. A dragline bucket according to claim **15** including a lifting arch operatively connected to said floor and/or said side walls forward of said rear wall, said leading edge and said lifting arch together defining at least in part a mouth through which spoil may enter.

22. A dragline bucket according to claim **21** wherein said side walls and said rear wall terminate in a top rail extending from the lifting arch on one side of the mouth to the lifting arch on the other side of the mouth.

23. A dragline bucket according- to claim **21** including generally horizontal top rails spaced above the upper edges of said side walls respectively along a substantial portion thereof.

24. A dragline bucket according to claim **21**, wherein the side walls curve upwards from said predetermined point towards said lifting arch.

25. A dragline bucket according to claim **17** wherein said side walls and said rear wall terminate in a top rail running along their respective upper edges or formed by their upper edges.

26. A drag line bucket according to claim **17** including a lifting arch operatively connected to said floor and/or said side walls forward of said rear wall, said leading edge and said lifting arch together defining at least in part a mouth through which spoil may enter.

27. A dragline bucket according to claim **26** wherein said side walls and said rear wall terminate in a top rail extending from the lifting arch on one side of the mouth to the lifting arch on the other side of the mouth.

28. A dragline bucket according to claim **26** including generally horizontal top rails spaced above the upper edges of said side walls respectively along a substantial portion thereof.

29. A dragline bucket according to claim **26**, wherein the side walls curve upwards from said predetermined point towards said lifting arch.

30. A dragline bucket comprising:

a floor having a ground engaging leading edge;

a rear wall spaced from said leading edge and extending upwards from said floor and curving forward from its centre on both sides thereof to meet two spaced apart side walls also extending upward from said floor and forward from said rear wall, the upper edges of said rear wall and said side walls defining an open top.

31. A dragline bucket according to claim **30** wherein said side walls and said rear wall terminate in a top rail running along their respective upper edges or formed by their upper edges.

32. A dragline bucket according to claim **30** including a lifting arch operatively connected to said floor and/or said side walls forward of said rear wall, said leading edge and said lifting arch together defining at least in part a mouth through which spoil may enter.

33. A dragline bucket according to claim **32** wherein said side walls and said rear wall terminate in a top rail extending from the lifting arch on one side of the mouth to the lifting arch on the other side of the mouth.

34. A dragline bucket according to claim **32** including generally horizontal top rails spaced above the upper edges of said side walls respectively along a substantial portion thereof.

35. A dragline bucket according to claim **32**, wherein the side walls curve upwards from said predetermined point towards said lifting arch.

36. A method of operating a dragline, including:

providing a dragline having a dragline bucket as claimed in claim **15**, including:

dragging the bucket through spoil in a forward direction to substantially fill a front portion of the bucket and then lifting the ground engaging leading edge while continuing dragging in the forward direction to tilt the front of the bucket upwards whereby spoil accumulated adjacent the mouth of the bucket moves towards the rear wall of the bucket;

tilting the bucket to a predetermined carry angle;

lifting the bucket to a desired height;

carrying the bucket to a dump site; and

dumping the spoil at the dump site.

* * * * *