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(54) Crushing apparatus

(57) The container crushing apparatus is primarily for plastics and/or metal or co-mingled containers and comprises a rotatable drum 12 and crusher plate 20 mounted adjacent to the drum so as to define a throat 22 therebetween. The crusher plate 20 , has a concave portion 23 of greater radius R than the radius r of the drum 12, the concave portion 23 having an axis of curvature which is spaced from the axis of rotation of the drum 12 so that the throat 22 narrows progressively. The drum 12 preferably has shark tooth shaped teeth 14 thereon. A switch may be provided for interrupting the rotation of the drum 12 passage of an item through the throat 22 is impeded. Alternatively or additionally, a fluid operable arrangement 25 may be for maintaining the crusher plate 20 in a desired position in relation to the drum 12 to so as to define a throat 22 of desired size between the crusher plate 20 and the drum 12. The fluid operable arrangement 25 is also operable to move the crusher plate 20 away from the drum 12 to increase the size of the throat 22 where required.

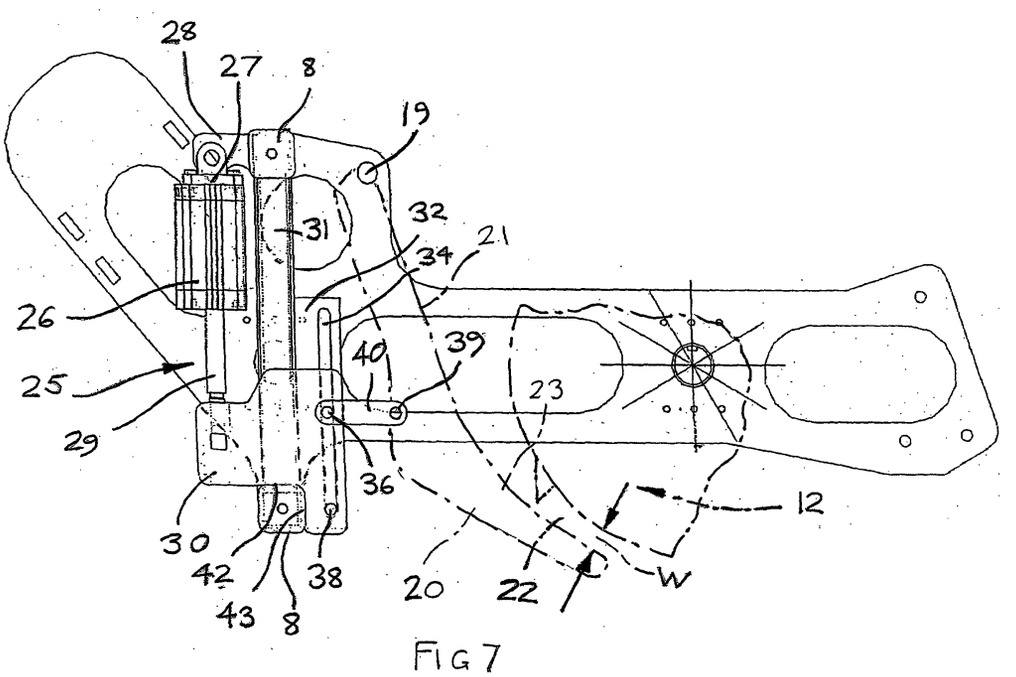

FIG 7

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Description

[0001] The invention relates to a container crushing apparatus. Such a crusher is primarily intended for the crushing of containers such as plastics bottles or aluminium or steel cans when combined, known in the art as "co-mingled", or when independent. In each case, the containers will be segregated from typical domestic refuse.

[0002] Numerous forms of crushers have been devised over the years and generally comprise a rotatable drum having radial projections on its periphery and a crusher plate positioned relative to the drum to form a throat into which the crushable items are drawn as the drum rotates.

[0003] The present invention is concerned with a crusher of that general type.

[0004] According to a first aspect of the invention, there is provided a container crushing apparatus comprising a rotatable drum and a crusher plate mounted adjacent the drum so as to define a throat therebetween, the plate having a concave portion of greater radius than the radius of the drum, the concave portion having an axis of curvature which is spaced from an axis of rotation of the drum so that the throat narrows progressively.

[0005] The drum preferably has a plurality of teeth of shark-tooth shape.

[0006] According to a second aspect of the invention there is provided apparatus for crushing bottles and/or cans, the apparatus comprising a rotatable drum and a crusher plate mounted adjacent the drum so as to define a throat therebetween, the drum having a plurality of teeth of a shark-tooth shape.

[0007] The shark-tooth shape is defined by leading and trailing edge surfaces of the tooth which intersect so as to define a cutting edge for the tooth. Preferably, the leading edge of the tooth is inclined at a first angle relative to a radial line extending between the axis of rotation of the drum and the cutting edge of the tooth and the trailing edge of the tooth is inclined at a greater angle to the said radial line.

[0008] In one embodiment the throat narrows progressively to define a minimum space between the pressure plate and the drum from 20 mm to 30 mm and preferably in the range 23 mm to 27 mm and most preferably in the range 24-25 mm.

[0009] Interrupter means may be provided for interrupting the rotation of the drum if sensor means senses that passage of an item through the throat is impeded.

[0010] According to a third aspect of the invention there is provided a container crushing apparatus, the apparatus comprising a rotatable drum, a crusher plate mounted adjacent the drum so as to define a throat therebetween and interrupter means for interrupting the rotation of the drum if sensor means senses that passage of an item through the throat is impeded.

[0011] Said interrupter means may comprise a limit switch which operates to switch off a drive to a drum as a result of movement of the crusher plate caused by the item which is impeded in its movement through the throat.

[0012] The drum may be driven by a fluid operable motor. Drive may be provided by means of one or more belt and pulley drives, or by a chain drive arrangement, driven by the motor. Alternatively, a flywheel arrangement, driven by the motor may be used. The latter embodiment has been found to be particularly efficient.

[0013] Where the drum is driven by a fluid operable motor, the interrupter means may comprise a pressure operated device arranged to stop the motor when fluid pressure builds up in a fluid supply to the motor when the item is impeded in its movement through the throat.

[0014] According to a fourth aspect of the invention there is provided a container crushing apparatus, the apparatus comprising a rotatable drum, a crusher plate mounted adjacent the drum so as to define a throat therebetween and positioning means for maintaining the crusher plate in a desired position in relation to the drum so as to define a throat between the crusher plate and the drum, the positioning means being operable to move the crusher plate away from the drum to increase the size of the throat where required.

[0015] The positioning means may comprise a fluid operable arrangement. The fluid operable arrangement may also be arranged to move the crusher plate away from the drum where required. The positioning means may include an over-centre device. The over-centre device may comprise an arm connected at one end by a first pivot to the crusher plate and connected by a second pivot at the other end to a movable member forming part of the positioning means. The movable member is preferably arranged to move the second pivot over-centre in relation to the first pivot as the crusher plate almost arrives at its desired position in relation to the drum. The moveable member may be arranged to co-operate with a fixed part of the apparatus whereby crushing load applied to the crusher plate during operation of the apparatus will be transmitted through the arm to the fixed part. The moveable member preferably contacts a stop, for example the fixed member, to limit further movement after the over centre movement has taken place.

[0016] Where the positioning means is operable to move the crusher plate away from the drum, it may be operable in response to an indication that passage of an item through the throat is impeded.

[0017] A stripper plate may be provided for stripping crushed articles from the teeth, the stripper plate being arranged to provide a gradual lift-off effect for the crushed items, thus reducing the tendency to tear the items. Items must be punctured to facilitate crushing but it is important that there is minimal tearing to reduce danger to any person handling the material after crushing.

[0018] According to a fifth aspect of the invention, there is provided a container crushing apparatus comprising a rotatable drum and a crusher plate arranged adjacent the drums to define a throat therebetween, the

drum having a plurality of teeth and a stripper plate being provided which is arranged to provide a gradual lift-off of crushed items from the teeth.

[0019] The gradual lift-off minimises tearing which might otherwise occur by using a stripper comb which extends radially towards the drum and combs through spaces between the teeth.

[0020] The stripper plate may be curved so as to define a convex outer surface which provides the lift-off effect. The convex surface preferably extends from a position closely adjacent the periphery of the drum and gradually curves away from the drum. The stripper plate may be formed with a plurality of slots through which the teeth pass to enable removal of the crushed items to be effected, with minimal tearing.

[0021] It is envisaged that the crusher can be fitted to a refuse vehicle for receiving segregated or co-mingled items to be crushed so that the crushed items then enter the refuse container on the vehicle thereby taking up less space and increasing the transportable quantity of material.

[0022] Where refuse is co-mingled, but separate items enter the crusher, they will leave the crusher in a similar manner. That is particularly advantageous as the individual items will leave the crusher substantially non-interlocked thereby facilitating further individual processing at a recycling facility.

[0023] It is important that the crushed items are not fully flattened. If they are crushed beyond the point of residual resilience, baling under tension is not practical.

[0024] In order to minimise noise from the crusher, it is envisaged that at least some surfaces of the housing will carry sound deadening material.

[0025] A crushing apparatus according to the invention will now be described with reference to the drawings in which :-

Figure 1 is a perspective plan view of a preferred form of an elevation of the crushing apparatus;

Figure 2 is a side elevation of the crushing apparatus as shown in Figure 1;

Figure 3 is a figure similar to Figure 2 but showing areas A, B, and C surrounded by broken line circles;

Figure 4 is an under plan view of the cutting apparatus shown in Figure 6.

Figures 5A, 5B and 5C show the circled areas in Figure 6 drawn to a larger scale.

Figure 6 is a perspective view of part of the crushing apparatus shown in Figure 1 to illustrate a hydraulic or pneumatic arrangement for positioning a crusher plate,

Figures 7 and 8 are side elevations of the crushing apparatus as shown in Figure 2 with a hopper side removed and showing the crusher plate in positions close to and away from a drum respectively and

Figure 9 is a diagrammatic view of a refuse vehicle on which the crushing apparatus in accordance with the invention has been mounted.

[0026] Referring to Figs 1 to 3, the crushing apparatus comprising a housing 1 having side walls 2 to which are fastened respective mounting plates 4. The mounting plates 4 are fastened to a rigid frame 6 having two cross tubes 8 (see Figs 6, 7 and 8) which space the mounting plates 4 apart. The housing 1 also has end walls 10 extending between the side walls 2. The mounting plates 4 support a rotatable cylindrical drum 12 provided with a plurality of shark-tooth shape teeth 14 on its periphery. As shown in Fig 5A The shark-tooth shape of each tooth 14 is defined by leading and trailing edge surfaces 14a, 14b respectively which intersect so as to define a cutting edge 15 for the tooth. The cutting edge 15 preferably lies approximately 25 mm away from the periphery of the drum 12.

[0027] The leading edge 14a of the tooth is inclined at a first angle x relative to a radial line T extending between the axis of rotation of the drum and the cutting edge of the tooth and the trailing edge 14b of the tooth is inclined at a greater angle y to the said radial line. The teeth 14 are axially and circumferentially spaced, preferably whereby items will make contact with at least two teeth 14. The teeth 14 may be arranged in helical rows. The side walls 2 carry respective curved metal strips 13 which bridge gaps between ends of the drum 12 and the adjacent surfaces of the side walls. The metal strips 13 inhibit the entry of parts such as metal lids into the gaps.

[0028] The drum is 12 driven by means of two toothed belt and pulley drive arrangements 16a, 16b to provide a reduction drive from a hydraulic motor 17 inside the housing 1. If desired a chain drive arrangement may be used instead or a combination of belt and chain drives. Alternatively (not shown) a flywheel arrangement may be used instead of the belt or chain drivers. The flywheel may be driven by the hydraulic motor 17. The housing 1 supports a first hopper plate 18 which slopes downwardly from an open top of the housing 1 and which terminates at a crusher plate 20 mounted on a pivot 19 adjacent the lower end of the first hopper plate 18. The pivot 19 is supported by the mounting plates 4 on the housing 1. It will be noted that the crusher plate 20 extends downwardly and has straight section 21 followed by a concave section 23. The concave section 23 and drum 12 are arranged so as to define a throat 22 therebetween.

[0029] As shown in Figure 5B, the radius of curvature R of the concave section 23 of the crusher plate 20 is greater than the radius of curvature of the drum 12. The axis of curvature of the concave section 23 and axis of rotation of the drum 12 are spaced apart by a distance

D so that the throat 22 gradually reduces in size towards the lower end of the concave section 23 as viewed in Figs 2 and 3. It will also be noted that the axis of curvature of the concave section 23 is positioned away from a vertical plane V passing through the axis of rotation of the drum 12 as viewed in Fig 5 by a small distance d.

[0030] The crusher plate 20 is maintained in the position shown in the drawings by a hydraulic or pneumatic arrangement 25 (see Figs 6 to 8). The hydraulic or pneumatic arrangement 25 has two spaced apart rams 26 each of which has a cylinder 27 pivotally connected at its upper end to a rigid bracket 28 mounted on the upper cross tube 8 of the rigid frame 6 as viewed in Figs 6 to 8. Each ram 26 has a pushrod 29 pivotally connected to a pair of rigid plates 30. The plates 30 of each pair are arranged one each side of a vertical post 31, each post 31 carrying a vertically extending guide block 32 formed with an elongate slot 34. The rigid plates 30 extend alongside the guide block 32 and are interconnected by spaced apart upper and lower bolts 36, 38 which project slidably through the slot 34. The upper bolt 36 pivotally supports ends of two arms 40 arranged one each side of the guide block 32. The opposite ends of the arms 40 are pivotally connected by a bolt 39 to the underside of the crusher plate 20. Both pairs of rigid plates 30 are connected to the crusher plate 20 in the same way. The pairs of rigid plates 30 are slidable upwardly and downwardly relative to their respective posts and guide blocks 31, 32 as the both rams 26 operate in unison to extend and retract their pushrods 29. The rams 26 are powered by a suitable pump (not shown) from a control panel (also not shown). Each of the rigid plates 30 has a lower edge 42 which can contacts the lower cross tube 8 to form a stop for limiting extension of the rams 26. Each rigid plate also has a vertical edge 43 which can also contact the lower cross tube 8 as described below.

[0031] In another embodiment (not shown), the hydraulic or pneumatic arrangement 25 has one ram 26 which acts on the centre of the crusher plate 20.

[0032] With reference to Figs 7 and 8, the hydraulic arrangement 25 operates as follows:-

[0033] Beginning at the Fig 8 position with the lower end of the crusher plate 20 arranged at a maximum distance from the drum 12, the control panel is operated so as to cause the rams 26 to extend their pushrods 29 in unison and move the rigid plates 30 downwardly towards the lower cross tube 8. As such movement progresses, the arms 40 begin to pivot the crusher plate towards the drum 12. Just before the lower edges 42 of the rigid plates 30 make contact with the lower cross bar 8, each of the bolts 39 reaches a "top dead centre" position relative to the bolts 36 and further movement of the rigid plates 30 into contact with the lower cross tube 8 moves the bolts 36 over centre with respect to their associated bolts 39. In that position, the crusher plate 20 is positioned correctly to provide a the required throat width W. The over centre positioning of the arms 40 enables the crusher plate to withstand significant forces during crushing operations, forces being transmitted advantageously through the arms 40 to the lower cross tube 8 via the vertical edges 43 of the plates 32 and not to the rams 26.

[0034] In order to move the crusher plate 20 back to the Fig 8 position, the rams 26 are retracted and the arms 40 move over centre again in the opposite direction and the crusher plate 20 begins to pivot away from the drum 12. Finally, the arms 40 take up the Fig 8 position with the bolt 36 arranged directly above bolt 38.

[0035] During extension and retraction of the rams 26, the upper and lower bolts 36, 38 ensure that the rigid plates 30 do not undergo any rotary movement relative to the frame 6.

[0036] The minimum throat width W (see Fig 7) is in the range of 20 to 30 mm and preferably around 25 mm. The throat width W is quite critical and it has been found that it can take twice as long to crush plastics bottles and cans through a 20 mm gap than through a 25 mm gap.

[0037] The width W of the throat 22 is selected so as to avoid total crushing of cans and bottles so that the crushed cans and bottles have some residual resilience. The residual resilience enables a recycling facility to bale the crushed articles. If they are crushed beyond the point of residual resilience, baling is not practical.

[0038] With the throat width in the above range, the cutting edges 15 of the teeth 14 will lie approximately 2 mm from the lower end of the crusher plate 20. The throat width is the minimum distance between the concave section 23 and the drum 12 for any given position of the crusher plate 20. Smaller teeth 14 can be used and the throat 22 reduced appropriately to leave an approximate gap of 2 mm between the cutting edge 15 of the teeth 14 and the surface of the crusher plate 20.

[0039] In the instance that a crush resistant item such as a log or brick is introduced accidentally into the crushing apparatus, the crusher plate 20 can be moved away from the drum 12 by the rams 26 to allow the item to pass through without damaging the apparatus. If desired, a pressure sensitive device (not shown) such as a switch can be arranged in fluid circuit (also not shown) which includes the pump for driving the motor 17. Where excessive resistance to drum rotation is detected resulting from the presence of the crush resistant item, a resulting increase in fluid pressure in the supply to the motor 17 will be sensed by the device. The device is arranged to turn off the pump for driving the motor 17 after pressure rises beyond a given level so as to stop rotation of the drum 12 and prevent damage to the crushing apparatus. The pressure sensitive device could, alternatively or additionally, cause the rams 26 to retract and move the crusher plate 20 towards the Fig 8 position to allow the crush resistant item to pass through the apparatus.

[0040] In another embodiment (not shown) one or more springs acts upon the underside of the crusher plate 20 urging the plate towards the drum 12. The

crusher plate 20 can deflect the springs if a crush resistant item is introduced to the apparatus, thereby widening the throat 22 and allowing the items to pass through. The presence of such an item may cause the crusher plate 20 to move away from the drum 12 against the springs. A proximity device such as a limit switch can be provided which will operate to interrupt drive to the drum 12 if the crusher plate deflects beyond a given position. Although springs can be used, the use of the hydraulic or pneumatic arrangement 25 is preferred as it is advantageous over the springs. For example, the hydraulic or pneumatic arrangement 25 shown in Figs 6 to 8 having the arms 40 which move over centre provides a more positive holding force for the crusher plate 20 to maintain a given throat size. Also, a positive opening movement can be effected on the crusher plate 20 if desired to release the crusher plate in the case where a crush resistant item enters the throat 22. In all, the hydraulic or pneumatic arrangement 25 offers better control than springs.

[0041] Typically, a rotational speed of the drum 12 is around 10 to 20 rpm. If the drum 12 rotates much faster than that, there is a risk that the material to be crushed will not be drawn into the throat 22.

[0042] As shown in Figs 2, 3, 4 and 5C, a stripper plate 44 is provided adjacent the side of the drum 12 opposite to the crusher plate 20. The stripper plate 44 is formed with an edge having a plurality of slots 45 through which the teeth 14 can pass and it will be noted that the stripper plate 44 has a curved outer surface 46 and extends from a position adjacent the periphery of the drum 12 at a distance j from a vertical plane P passing through the axis of rotation of the drum as viewed in Fig 5C to a position spaced from the drum 12. The curved outer surface 46 has a radius of curvature RS preferably smaller than the radius of the drum 12 and an axis of curvature AX spaced from the aforesaid plane P by a distance k. In that way any articles which remain attached to the teeth 14 after leaving the lower end of the crusher plate 20 encounter the curved outer surface 46 of the stripper plate 44 and the outer surface tends to apply a gradual lift-off force to the items as the teeth 14 pass through the slots 45. Such a lift-off action minimises tearing of items attached to the teeth 14. Finally, the teeth 14 clear the stripper plate 44 totally and the stripped items fall from the lower end of the housing 10.

[0043] The stripper plate 44 is carried by a second hopper plate 48, the lower end of which as viewed in the drawings is formed with clearance slots 49 for the teeth 14 on the drum 12. The lower end of the second hopper plate 48 is arranged at a position relative to the drum 12 such that the teeth 14 will carry cans and bottles over the roller and into the throat 22. If the teeth 14 are made smaller, the lower end of the second hopper plate 48 plate needs to be raised. If the teeth 14 are made bigger, then the floor of the second hopper plate 48 can be lowered. Together, the first hopper plate 18 and the second hopper plate 48 effectively form a two part floor for guiding cans and bottles to the throat 22.

[0044] As shown diagrammatically in Fig 9 it is envisaged that the crusher (shown in broken lines and the housing being indicated at 1) can be fitted to a refuse vehicle 50 for receiving segregated or co-mingled items to be crushed so that the crushed items then enter a refuse container 52 on the vehicle 50 thereby taking up less space and increasing the transportable quantity of material. Controls for operating the crusher can, if desired, be combined with controls for operating the refuse vehicle.

[0045] Surfaces of the housing, for example, surfaces of the hopper plates 18, 48 may carry suitable sound deadening material to minimise noise from the apparatus during use.

Claims

1. A container crushing apparatus comprising a rotatable drum (12) and crusher plate (20) mounted adjacent to the drum so as to define a throat (22) therebetween, the plate having a concave portion (23) of greater radius than the radius of the drum, the concave portion having an axis of curvature which is spaced from an axis of rotation of the drum so that the throat narrows progressively.

2. A container crushing apparatus according to claim 1 in which teeth (14) of shark tooth shape are arranged on the drum.

3. A container crushing apparatus according to any preceding claim in which the crusher plate (20) and drum (12) are mounted so as to define a throat (22) of width substantially in the range 20 -30 mm.

4. A container crushing apparatus according to any preceding claim in which interrupter means is provided for interrupting the rotation of the drum (12) if a sensor means senses that passage of an item through the throat (22) is impeded.

5. A container crushing apparatus according to claim 4 in which said interruputer means comprises a limit switch which operates to switch off a drive to a drum (12) as a result of movement of the crusher plate (20) caused by the item which is impeded in its movement through the throat (22).

6. A container crushing apparatus according to any preceding claim in which the drum (12) is driven by a fluid operable motor (17).

7. A container crushing apparatus according to any preceding claim in which positioning means is provided for maintaining the crusher plate (20) in a desired position in relation to the drum (12) so as to

define a throat (22) between the crusher plate (20) and the drum (12), the said positioning means being operable to move the crusher plate (20) away from the drum (12) to increase the size of the throat (22) where required.

8. A container crushing apparatus according to claim 7 in which the means for maintaining the crusher plate (20) in the desired position may comprise a fluid operable arrangement.

9. A container crushing apparatus according to any preceding claim in which is provided a stripper plate for stripping crushed materials away from the drum.

10. A container crushing apparatus according to any preceding claim in which the speed of rotation of the drum is, in use, in the range of 12 - 20 rpm.

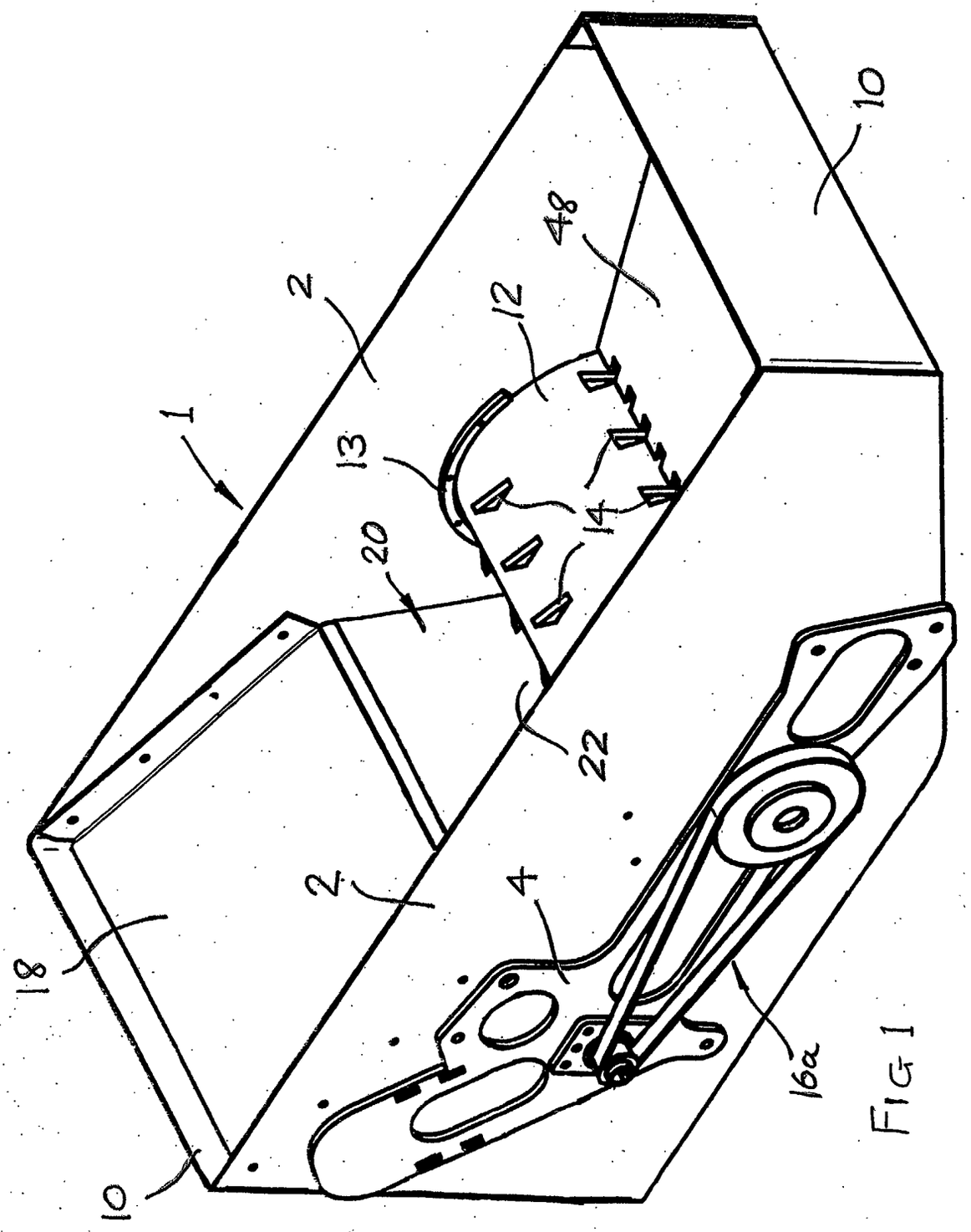


FIG 1

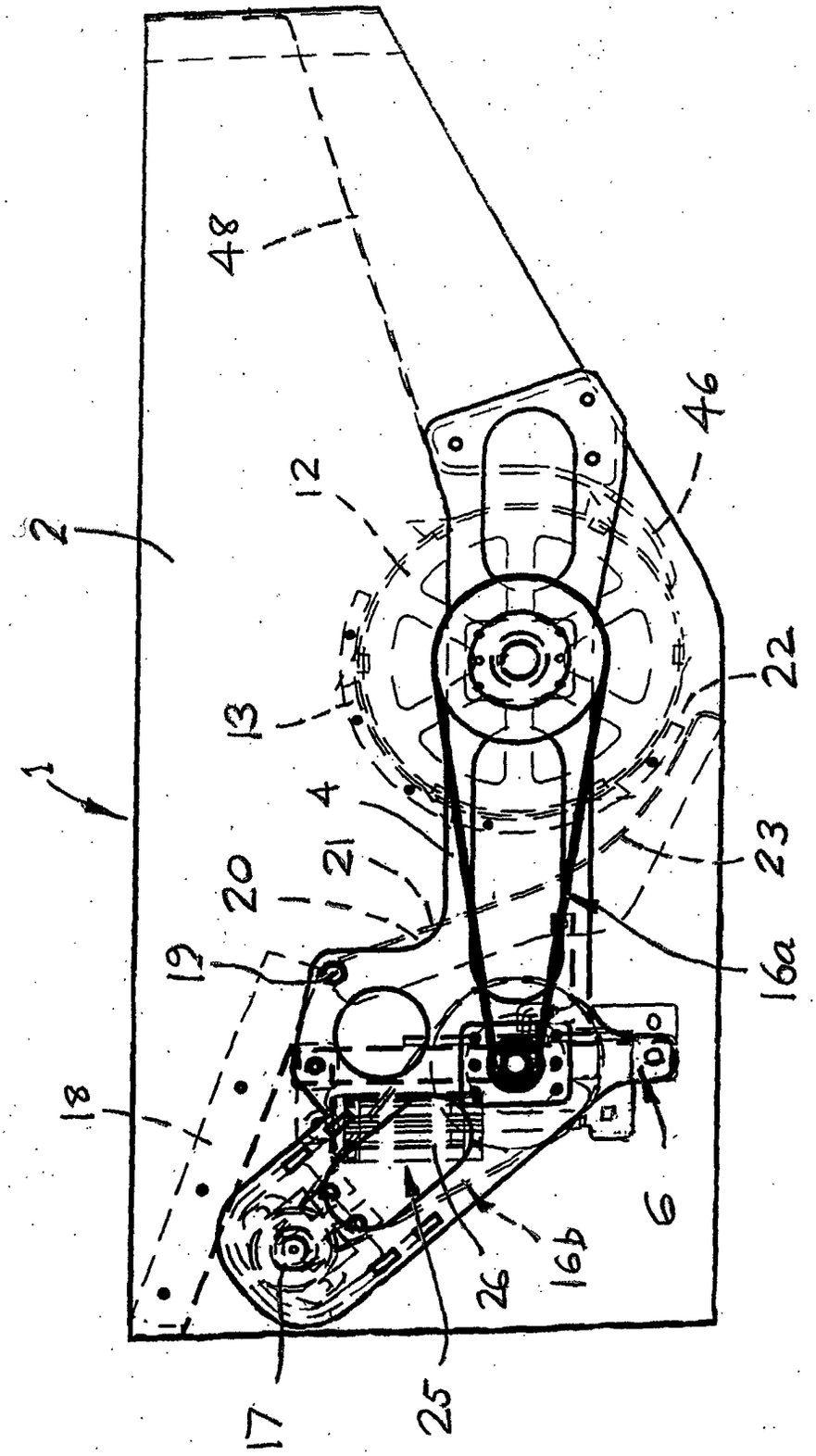


FIG 2

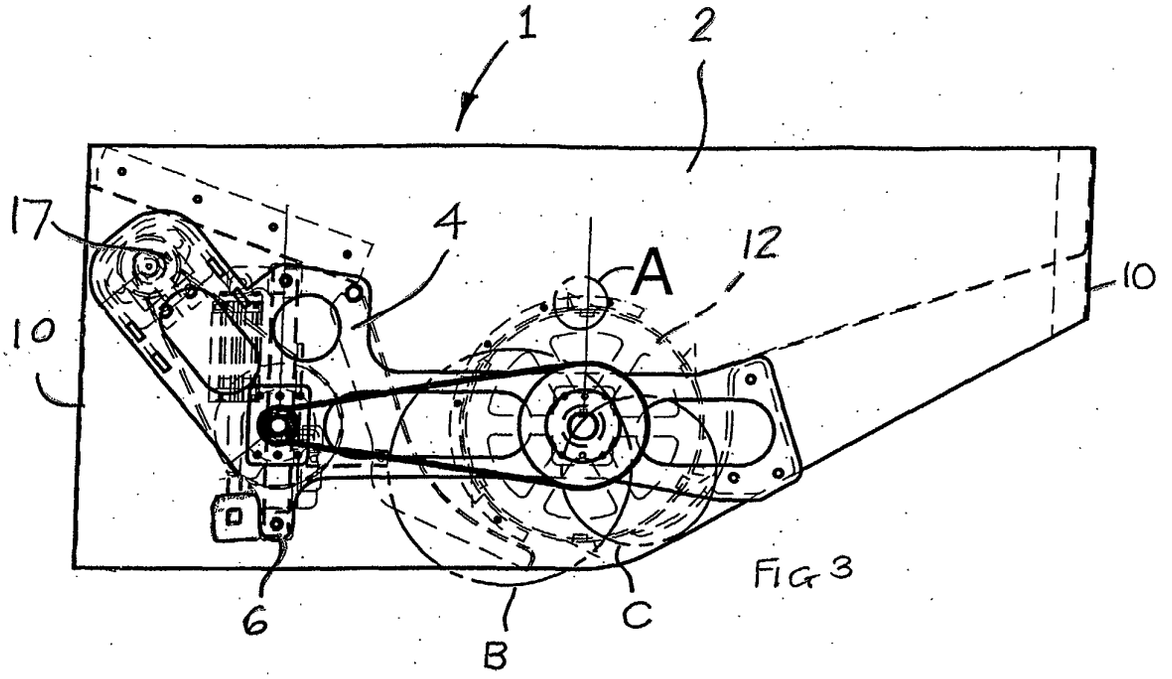

1
2
17
4
A
12
10
10
6
B
C

FIG 3

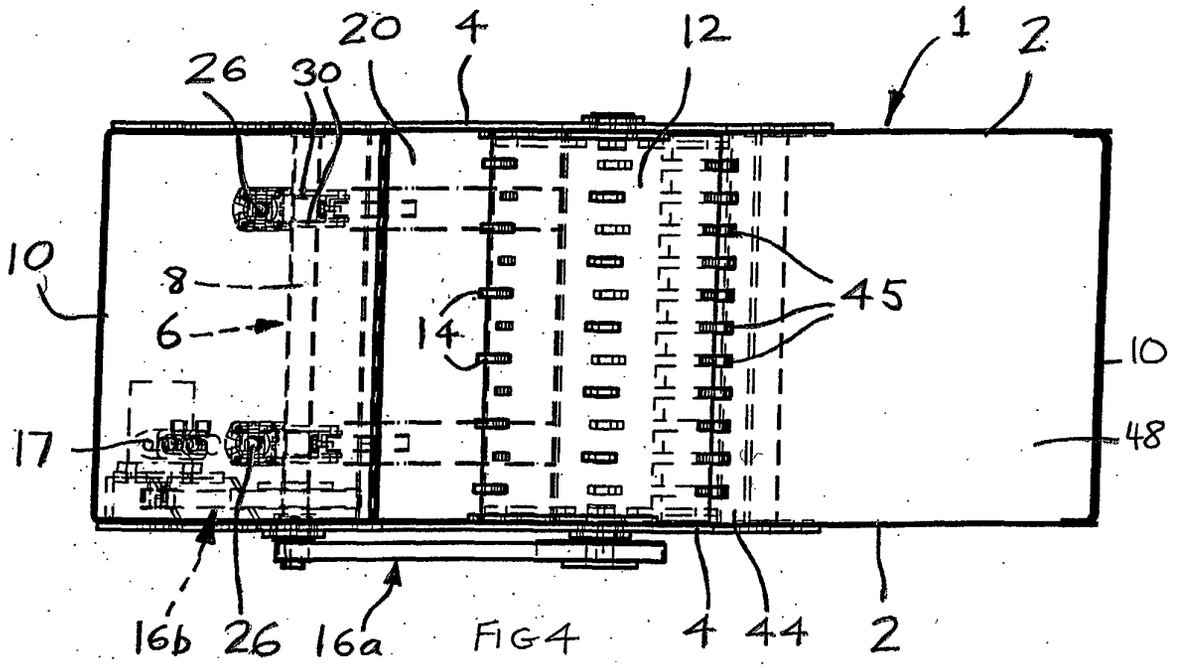

20
4
12
1
2
26
30
10
8
6
14
45
10
17
48
16b
26
16a
4
44
2

FIG4

FIG 5A

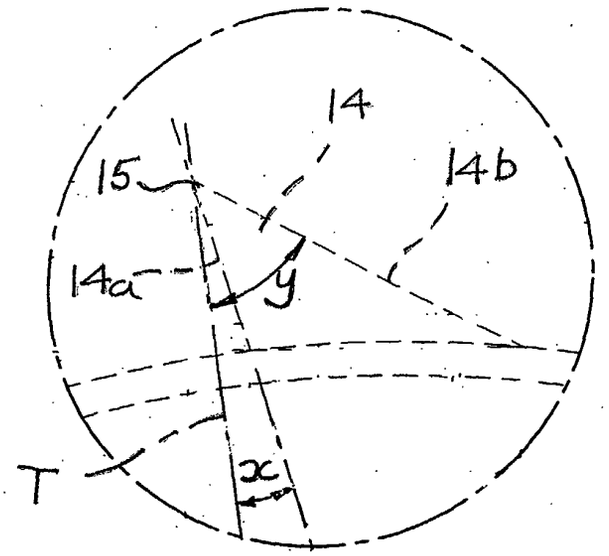


FIG 5B

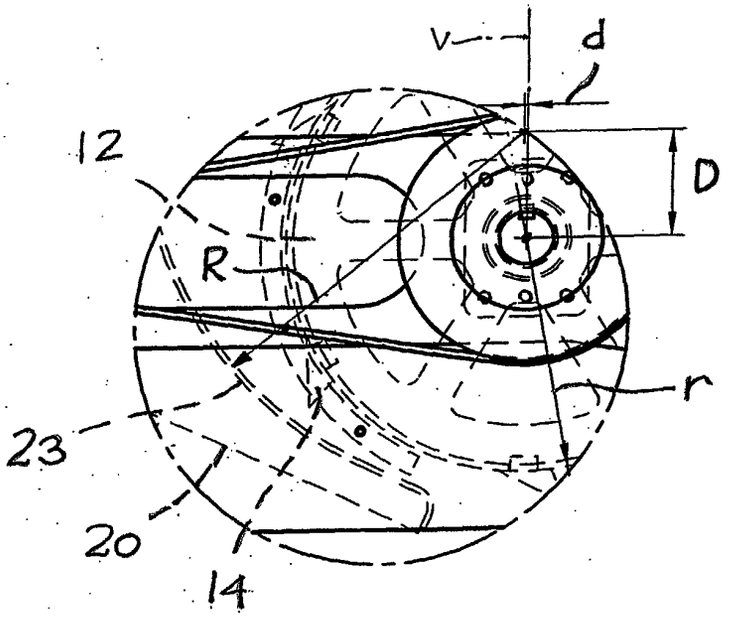
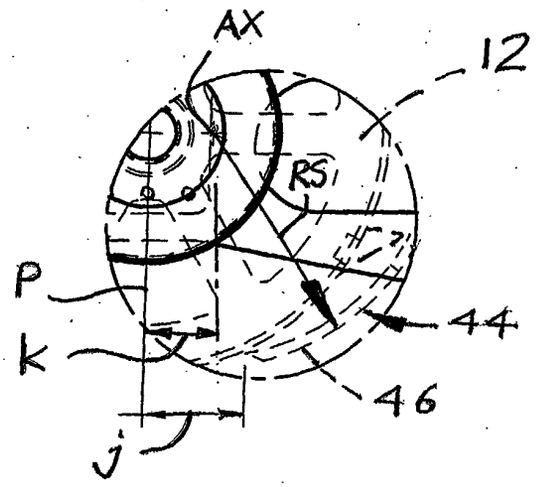


FIG 5C



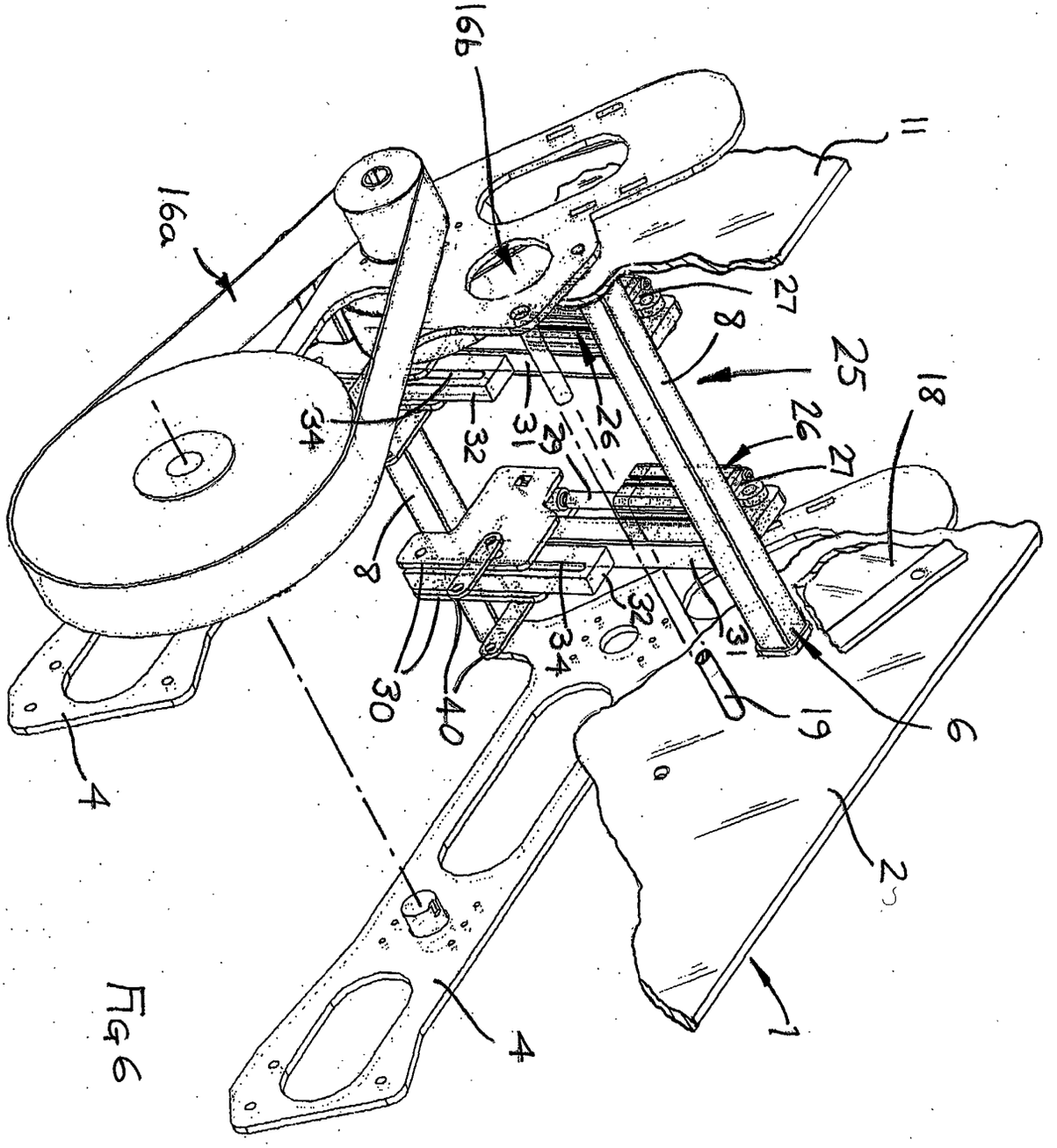


Fig 6

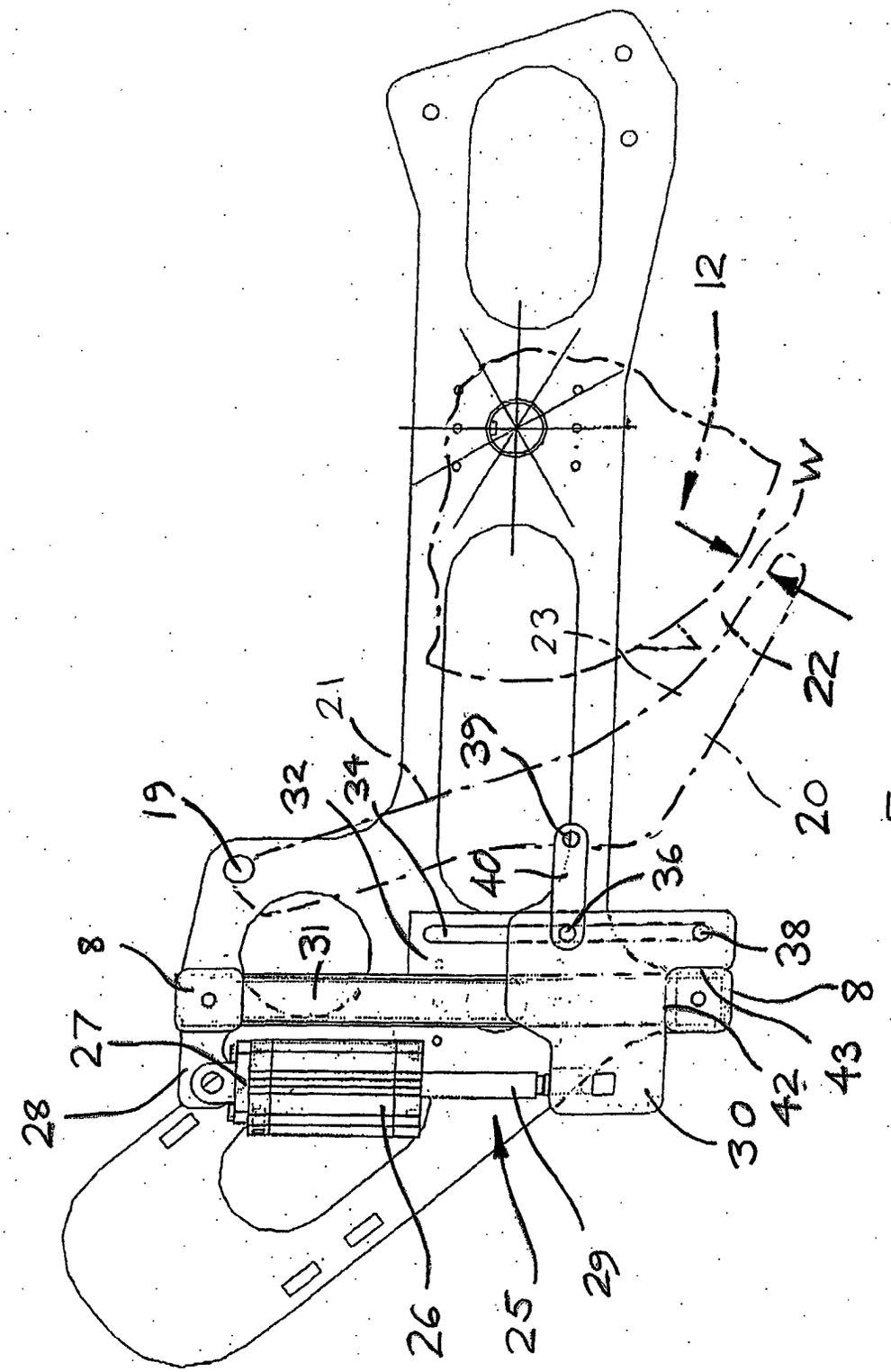


FIG 7

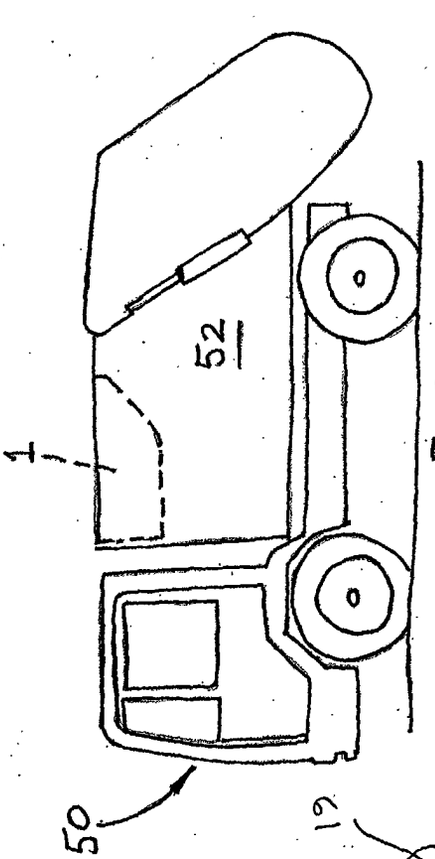


FIG 9

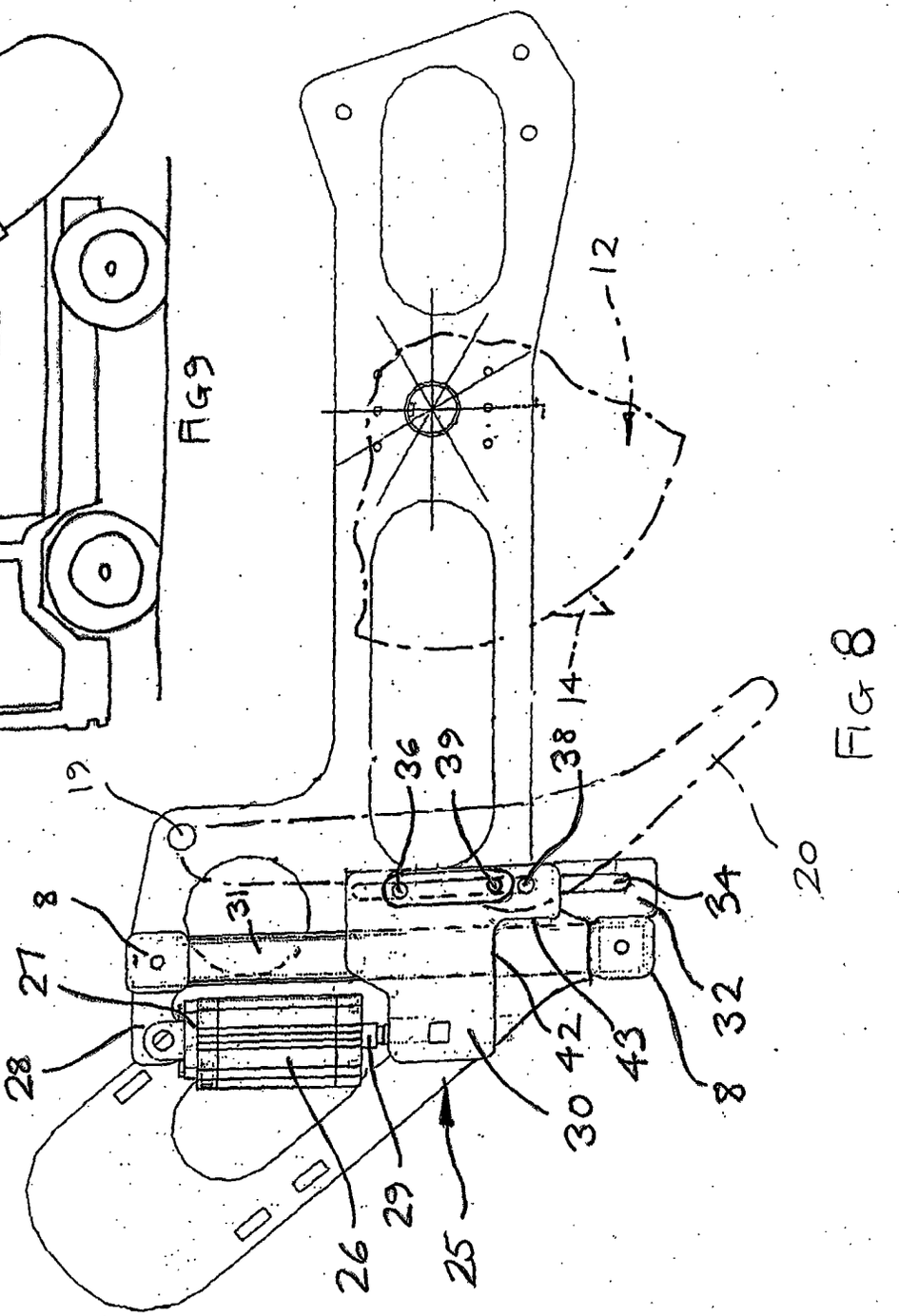


FIG 8

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 30 9154

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 5 558 284 A (BAUMUNG RALPH F ET AL) 24 September 1996 (1996-09-24) * column 1, line 6 - line 8 * * column 3, line 33 - column 4, line 10 * * column 5, line 66 - column 6, line 8 *	1,6,7,9	B02C19/12 B02C19/14
Y	* column 8, line 35 - line 44; figures 1,7 * ---	2,4,5,8	
A		3,10	
X	EP 0 611 601 A (HALTON SYSTEM OY) 24 August 1994 (1994-08-24) * column 5, line 30 - line 37; figure 1E * ---	1	
X	GB 416 287 A (BATCHELOR ROBINSON & COMPANY L;JOHN RUSSELL GREEN) 13 September 1934 (1934-09-13) * page 3, line 71 - line 100; figure 1 * ---	1	
Y	US 4 703 899 A (LODOVICO FRANK J) 3 November 1987 (1987-11-03) * column 6, line 49 - line 56 * * column 7, line 39 - line 44 * ---	2,4,5	TECHNICAL FIELDS SEARCHED (Int.Cl.7) B02C
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	29 January 2002	Bunn, D

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
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D : document cited in the application
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 30 9154

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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29-01-2002

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