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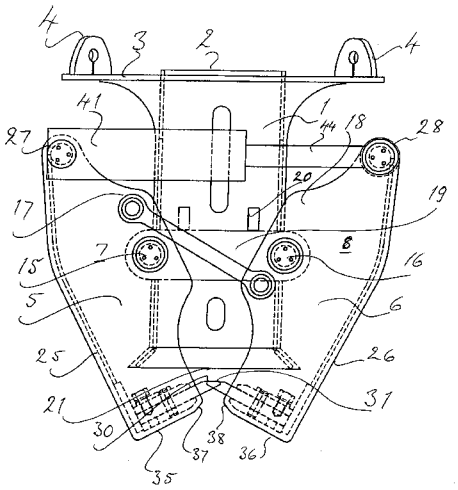
(54) Title: PILE CROPPING APPARATUS

Figure 1




(57) Abstract: A pile-cropping apparatus comprises a lifting body (1) of generally rectangular form with an internal longitudinal through passage (2) open at the top and bottom of the lifting body for receiving the top of a pile, and a top plate adapted for lifting (3) the body with lifting eyes (4) arranged around the periphery of the top plate. Opposed bucket shells (5, 6) are positioned about the lifting body and have lobes (17, 18) attached to respective pivot pins (15, 16) which are fixed to the lifting body such that the upper edges (27, 28) and lower edges (37, 38) of the respective shells are movable towards and away from a cutting zone below the lower end of the lifting body. Overhead transverse paired linear actuators (40, 41) act reversibly upon the upper edges of the shells. Opposed cutter or breaker elements providing bevelled hardened edges (30, 31) upon the lower edges of the respective shells enable concrete breaking and rebar cutting.

## Pile Cropping Apparatus

Field of the Invention

This invention relates to apparatus for cropping concrete piled foundations.

Background to the Invention

Modern buildings are often erected on reclaimed land, or sites which previously would have been considered not suitable for building works. Construction on such sites is possible due to extensive use of foundations established using reinforced concrete piles. Piles can have a single reinforcing bar or a multiple bar cage configuration. Such piles are either precast or cast *in situ*. In the case of pre-cast piles, these are driven vertically into the ground using a pile hammer. The height of pile remaining above ground level after driving the toe to a design set is variable, and further height construction superimposed upon the driven piles requires a levelling of the piles to a common height i.e. "cropping of the piles". Even in the case of cast *in situ* piles it is often desirable to cast to a level above ground and crop the cast pile back to a desired level. Such practice accounts for natural quality weaknesses at the top of the cast pile.

It will be understood that cropping of piles requires removal of both concrete and reinforcing bar ("rebar") materials in a manner which does not cause deterioration of the remaining pile. Thus repeated sudden or cyclic deformation loadings are desirably avoided. Furthermore, bending deformations also make it harder to remove fragmented concrete mass from the reinforcement embedded therein. A sound top surface of good quality concrete is desirably left on each pile to facilitate subsequent construction works upon the cropped piles.

Various methods are known in the field to achieve the cropping effect. These include use of jackhammers for breaking the set concrete, saws adapted to the purpose, a combination of drilling and wedge-driving to part set concrete, each of which methods to a varying extent calls for manual labour hand-tool activities

coupled with use of dumpers, bucket excavators or suitably adapted lifting gear to remove the debris.

Summary of the Invention

According to an aspect of the present invention there is provided apparatus for cropping piles comprising a lifting body equipped with means for attachment of lifting gear at an upper end,
first and second cooperating bucket shells each having a corresponding cutting edge, a rear wall and side walls defining a cavity for receiving material, the respective side walls being positioned on either side of the lifting body and connected one to the other upon a pivot rod such that the pivot axis is positioned at an intermediate location within the length of the side walls,
means for applying force to the bucket shells transversely across and above the pivot rod to cause the bucket shells to selectively close or open and thereby cause the cutting edges of the bucket shells to be driven to close together below the lifting body and subsequently opened,
wherein said cutting edges are adapted to cut reinforced concrete.

According to another aspect of the present invention there is provided apparatus for cropping piles comprising a lifting body adapted to be placed over and receive the top of a pile,
first and second opposed cutters each pivotally mounted upon the lifting body by a mechanism configured to allow the pivotally mounted cutters to be driven to close together below the lifting body,
wherein the mechanism comprises a linear actuator positioned transversely above the pivotally mounted cutters and having an axis of displacement configured to cause the cutters to selectively close or open.

According to a further aspect of the present invention, there is provided apparatus for cropping piles comprising opposed bucket shells pivotally mounted upon a body provided with an internal recess for receiving an end of a pile, the bucket shells having first and second ends and being pivotally mounted through side walls thereof at a position intermediate with respect to said first

and second ends, and having driving means attached to said first ends and cutter means provided at said second ends, whereby said cutter means are brought together or moved apart by operation of the driving means acting upon said first ends to drive said ends apart or bring them together.

In each of the aforesaid aspects of the invention, the lifting body may have a recess which is an open through passage permitting the lifting body to be lowered over the pile head to be cut and the pile head to emerge from the top of the through passage. This has the advantage of permitting a wide range of selected lengths of pile to be cropped, so that even if prefabricated uniform size piles are driven in to unequal depths, a common design set is readily achievable by cropping using the apparatus of this invention.

Hydraulic actuators may be used as the means for operating the cutter means in any of the aforesaid aspects of the invention. The actuators may be used paired in parallel, and positioned on either side of the body to which the cutters are mounted. Each cutter of the cutter means may be driven by a dedicated actuator, and the operation of the cutter means is controlled normally by use of a pair of matched independent actuators at the same time.

The hydraulic actuators may be attached directly to upper edges of confronting bucket shells such that an end of the cylinder is pivotally attached to an edge of a first bucket shell, and the rod is pivotally attached to a corresponding edge of the other bucket shell, whereby linear displacement of the rod with respect to the cylinder causes corresponding movement of the edges of the bucket shells.

In an embodiment of the invention, the pivot axis for connection between the actuator and the upper edge of the bucket shell, the pivot axis about which the bucket shell pivots to open or close, and the leading edge of the cutter means are aligned in a common plane.

Generally, the overhead actuators, arranged transversely, preferably in paired configuration, drive the cutter means through a dual pivotal mounting to perform a “pincer” action. Preferably the cutter means are mounted on discrete mutually

spaced pivot pins, so that in the case where the cutter means are mounted on bucket shells, then each bucket shell has its own pivot axis. The pivot pins are spaced apart on a generally horizontal mounting plate attached to the lifting body such that the pivot axes lie outside the width of the recess in the lifting body. In this way optimum opening of the cutter means to permit the pile to easily pass beyond the cutter means into the body of the apparatus, and significantly improved mechanical advantage is achievable.

The cutter means are preferably detachable tool elements mountable upon an edge surface of a bucket shell, e.g. bevelled cutter blades, breaker blades or toothed elements. In this way the cutter means can be changed readily.

The mounting of the cutter means, e.g. on bucket shells, and use of independently operable actuators, e.g. a pair of matched hydraulic cylinders enables the apparatus operation to be synchronised not only by the control system for the hydraulics, but by inclusion of optional mechanical features, such as limit stops to determine the extremity of travel for the bucket shells for example, or use of tie bars between the buckets.

According to a still further aspect of the invention, there is provided apparatus as defined according to any of the preceding aspects of the invention, and further comprising additional independently controllable actuators and cutters which are mounted upon the lifting body. These additional cutters may be chisels configured to be driven through an aperture in the lifting body to perform fine cutting work to remove concrete around the rebar where the rebar is not to be cut. A suitable configuration of the apparatus is one wherein the additional actuators and cutters are positioned on opposite sides of the lifting body and configured to work towards each other. At least two such confronting actuator and cutter assemblies are usefully provided for the purpose of further breaking of the concrete around the rebar and to prevent distortion to the rebar when removing the debris.

According to a still further aspect of the invention, there is provided a method of cropping concrete piles comprising lifting cropping apparatus including pivot

mounted cutting elements upon a lifting body having a central throughbore over a pile, lowering the lifting body sufficiently to allow the pile to pass into the throughbore, and operating the cutting elements to break the concrete.

Preferably the method uses cropping apparatus incorporating concrete breaking or cutter elements upon pivotal bucket shells mounted upon the lifting body, whereby the method includes the additional step of closing the bucket shells during the cutting step to enclose concrete debris and lifting the lifting body with closed bucket shells away from the cropped pile.

Optionally, where reinforcing bars within the concrete pile are to be preserved, the method is modified to limit closure of the bucket shells to avoid shearing of the reinforcing bars, and includes a concrete breaking step realised by provision of additional actuators and additional cutting elements e.g. chisels upon the lifting body, and working the additional cutting elements through apertures in the lifting body to further break the concrete and allow removal of debris whilst reducing the risk of distortion to the reinforcing bar during removal of concrete debris between and around the reinforcing bars.

Description of the Drawings

Figure 1 shows a view from one side of an embodiment of the pile cropping apparatus of the invention in a closed configuration; and

Figure 2 shows a view from another side of the embodiment of the pile cropping apparatus of the invention shown in Figure 1;

Figure 3 shows the embodiment shown in Figure 1 in an open configuration;

Figure 4 shows a view from one side of another embodiment of the pile cropping apparatus of the invention in a closed configuration which is equipped with additional cutters;

Figure 5 shows a view from another side of the embodiment shown in Fig. 4; and

Figure 6 shows the embodiment shown in Figure 4 in an open configuration.

Description of Embodiments of the Invention

Referring to Figure 1, a pile cropping apparatus comprises a lifting body **1** of generally rectangular form with an internal longitudinal recess **2** for receiving the top of a driven pile (not shown), and a top plate **3** with lifting eyes **4** arranged around the periphery of the top plate so that the body can be lifted using chains for example. The recess 2 in this embodiment is a through passage open at the top and bottom of the lifting body 1. The lower end of the through passage in this embodiment has a flared opening **21**. Opposed bucket shells **5**, **6** are positioned about the lifting body. The shells have a back wall **25**, **26,** a base plate **35, 36** and side walls **7**, **8** which have lobes **17**, **18** attached to respective pivot pins **15**, **16** which are fixed to the lifting body such that the upper edges **27**, **28** and lower edges **37**, **38** of the respective shells are movable towards and away from a cutting zone below the lower end of the lifting body 1.

The base plate 35, 36 of each shell in this embodiment is adapted for breaking and cutting reinforced concrete by provision of a bevelled hardened edge **30**, **31**. The edges 30, 31 are provided by way of detachable blade elements.

The attachment of the shells to mutually spaced pivot pins 15, 16 on the lifting body 1 allows the edges 30, 31 to be brought together directly within the cutting zone below the recess 2 within the lifting body 1.

The side walls of the respective confronting shells are optionally connected by tie bars **42**, **43** (Fig. 2) which synchronise operation of the shells during operation.

The pivot pins 15, 16 are spaced apart upon a central mounting plate **19**, so that the respective pivot axes lie outside the width of the recess 2 in the lifting body to avoid interference with the admission of the top of the pile.

Limit stops **20** (upper two shown) are provided on the body 1 to contact and limit movement of the bucket shells 5, 6 at the extremities of travel.

The upper edges 27, 28 of each shell 5, 6 in this embodiment are pivotally attached to a linear actuator (here a pair of matched hydraulic cylinders **40**, **41**) whose axis of displacement lies generally orthogonal to the longitudinal axis of the recess 2 within the lifting body. In this embodiment, the cylinder 41 is pivotally attached to an edge 27 of a first bucket shell 5, and the rod **44** is pivotally attached to a corresponding edge 28 of the other bucket shell 6, whereby linear displacement of the rod 44 with respect to the cylinder 41 causes corresponding movement of the edges 27, 28 of the bucket shells 5, 6.

Thus, the linear actuator acts reversibly to drive apart (or draw together) the upper edges 27, 28 of the shells, and through the intermediate pivot position of the lobes 17, 18, causes the edges 30, 31 to be brought together directly below lifting body such that in use great cutting force can be brought into play upon a pile. The use of such an overhead transverse drive offers significant advantages over other possible arrangements for positioning of the actuator.

In use of the apparatus, lifting gear such as a crane, fork-lift, elevated boom vehicle, or excavator etc. is utilised to lift the apparatus over a protruding top of a driven or *in situ*-formed pile to be cropped. The lifting body 1 is properly aligned so that the recess 2 is located over the top of the pile, and lowered until the shells are positioned correctly for the depth of cut to leave the desired residual height of pile. The actuator is enabled and the shells driven to close upon the pile. As the loading from the actuator is continued the pile is crushed and the reinforcing bars sheared through. Up to about 2.5 m of pile may be removed at a time.

Since the cutting edges are brought together by the bucket shells, it follows that these too are closed around the pile and lifting body so that debris is containable within the closed shells. Elevation of the lifting body allows the cropped pile to be revealed and the debris to be carried off site in the bucket shells by the lifting vehicle. The whole cutting and loading operation typically takes less than 1 minute for each pile.

In a further embodiment as illustrated in Figs. 4 to 6 a modification to permit fine control of removal of concrete around the reinforcing bars, provides additional actuators **80**, **81** for control of further cutter tool elements such as chisels **60**, **61** positioned at the lower region of the lifting body to reach through apertures in the lifting body to cut around the rebar after the initial concrete breakage. Apart from this modification, the apparatus uses corresponding parts to those of the first embodiment shown in Figs. 1 to 3 so that like or equivalent parts are correspondingly numbered.

In use of the modified embodiment the work is conducted in a similar fashion by positioning of the apparatus using lifting gear such as a crane, fork-lift, elevated boom vehicle, excavator etc. over a protruding top of a driven or *in situ*-formed pile to be cropped. The lifting body 1 is properly aligned so that the recess 2 is located over the top of the pile, and lowered until the shells 5, 6 are positioned correctly for the depth of cut to leave the desired residual height of pile. The actuator 40, 41 is enabled and the shells driven to close upon the pile. As the loading from the actuator is continued the pile is crushed but in this case the cutting is stopped short of the reinforcing bars which are not sheared through in the initial cutting step. The lifting body 1 may be re-positioned if necessary to facilitate further breaking of the concrete pile between and around the rebars by operating actuators 80, 81 for the chisel tool elements 60, 61.

As in the first embodiment the bucket shells 5, 6 can be used to remove most of the concrete debris in the lifting away of the lifting body.

In use, the pile cropping apparatus of either embodiment can be operated to break piles of various sizes, enabling a clean cut through the rebars if required or optionally used to break and strip concrete away from the rebars which are left intact. Typically, the pile cropping apparatus is connected to an excavator or power pack and placed over the pile to be broken. The unique use of overhead paired transverse floating rams which exert force on two breaking shells enables improved cutting of the pile and also enables the shells to be used to retain debris for lifting away to a container, dumper etc.

## Claims

**1.** An apparatus for cropping piles comprising a lifting body (1) equipped with means (3, 4) for attachment of lifting gear at an upper end,
first and second cooperating bucket shells (5, 6) each having a corresponding cutting edge (30, 31) , a rear wall (25, 26) and side walls (7, 8) defining a cavity for receiving material, the respective side walls being positioned on either side of the lifting body and connected one to the other upon a pivot rod (15, 16) such that the pivot axis is positioned at an intermediate location within the length of the side walls,
means (40, 41) for applying force to the bucket shells transversely across and above the pivot rod to cause the bucket shells to selectively close or open and thereby cause the cutting edges of the bucket shells to be driven to close together below the lifting body and subsequently opened,
wherein said cutting edges are adapted to cut reinforced concrete.

**2.** An apparatus for cropping piles comprising a lifting body (1) adapted to be placed over and receive the top of a pile,
first and second opposed cutters (30, 31) each pivotally mounted upon the lifting body by a mechanism configured to allow the pivotally mounted cutters to be driven to close together below the lifting body,
wherein the mechanism comprises a linear actuator (40, 41) positioned transversely above the pivotally mounted cutters and having an axis of displacement configured to cause the cutters to selectively close or open.

**3.** An apparatus for cropping piles comprising opposed bucket shells (5, 6) pivotally mounted upon a body (1) provided with an internal recess (2) for receiving an end of a pile, the bucket shells having first and second ends and being pivotally mounted through side walls (7, 8) thereof at a position intermediate with respect to said first (27, 28) and second ends (37, 38), and having driving means (40, 41) attached to said first ends and cutter means with cutters (30, 31) provided at said second ends, whereby said cutter means are

brought together or moved apart by operation of the driving means acting upon said first ends to drive said ends apart or bring them together.

**4.** An apparatus according to any one of claims 1 to 3, wherein the lifting body has a recess which is an open through passage (2) permitting the lifting body to be lowered over the pile head to be cut and the pile head to emerge from the top of the through passage.

**5.** An apparatus according to any one of claims 1 to 4 wherein the means for operating the cutters or cutter means are hydraulic actuators (40, 41).

**6.** An apparatus according to any one of claims 1 to 5 wherein each cutter of the cutter means is driven by a dedicated actuator.

**7.** An apparatus according to any one of claims 1 to 6, wherein the operation of the cutters or cutter means is controlled by use of a pair of matched independent actuators (40, 41) at the same time.

**8.** An apparatus according to claim 7, wherein the actuators are paired in parallel, and positioned on either side of the lifting body (1) to which the cutters are mounted.

**9.** An apparatus according to any one of the preceding claims wherein the hydraulic actuators (40, 41) are configured to provide overhead actuators by attachment directly to upper edges of confronting bucket shells (5, 6), such that an end of an actuator cylinder (40, 41) is pivotally attached to an edge of a first bucket shell, and the actuator rod (44) is pivotally attached to a corresponding edge of the other bucket shell, whereby linear displacement of the actuator rod with respect to the actuator cylinder causes corresponding movement of the edges of the bucket shells.

**10.** An apparatus according to any one of the preceding claims, wherein a pivot axis of the pivotal attachment for connection between the actuator and the upper edge of the bucket shell, and a pivot axis about which the bucket shell pivots to open or close, and a leading edge of the cutter means are aligned in a common plane.

**11.** An apparatus according to claim 9 or 10 wherein the overhead actuators are provided in paired configuration and drive the cutters or cutter means through a dual pivotal mounting to perform a "pincer" action.

**12.** An apparatus according to claim 11 wherein the cutters or cutter means are mounted on discrete mutually spaced pivot pins such that when the cutters or cutter means are mounted on bucket shells, then each bucket shell has its own pivot axis.

**13.** An apparatus according to claim 12 wherein the pivot pins are spaced apart on a horizontal mounting plate (19) attached to the lifting body such that the pivot axes (15, 16) lie outside the width of the recess in the lifting body.

**14.** An apparatus according to any of the preceding claims wherein the cutters or cutter means are detachable tool elements (30, 31) mountable upon an edge surface of a bucket shell (5, 6).

**15.** An apparatus according to claim 14 wherein the detachable tool elements can include bevelled cutter blades, breaker blades, and/or toothed elements.

**16.** An apparatus according to any one of the preceding claims wherein limit stops (20) are positioned upon the lifting body (1) to determine the extremity of travel for the bucket shells.

**17.** An apparatus according to any one of the preceding claims wherein the bucket shells are synchronised by provision of tie bars (42, 43) between the bucket shells.

**18.** An apparatus according to any one of the preceding claims wherein additional independently controllable actuators (80, 81) and cutters (60, 61) are mounted upon the lifting body (1).

**19.** An apparatus according to claim 18, wherein the additional cutters are chisels configured to be driven through an aperture in the lifting body.

**20.** An apparatus according to claim 18 or 19 wherein the additional actuators and cutters are positioned on opposite sides of the lifting body and configured to work towards each other.

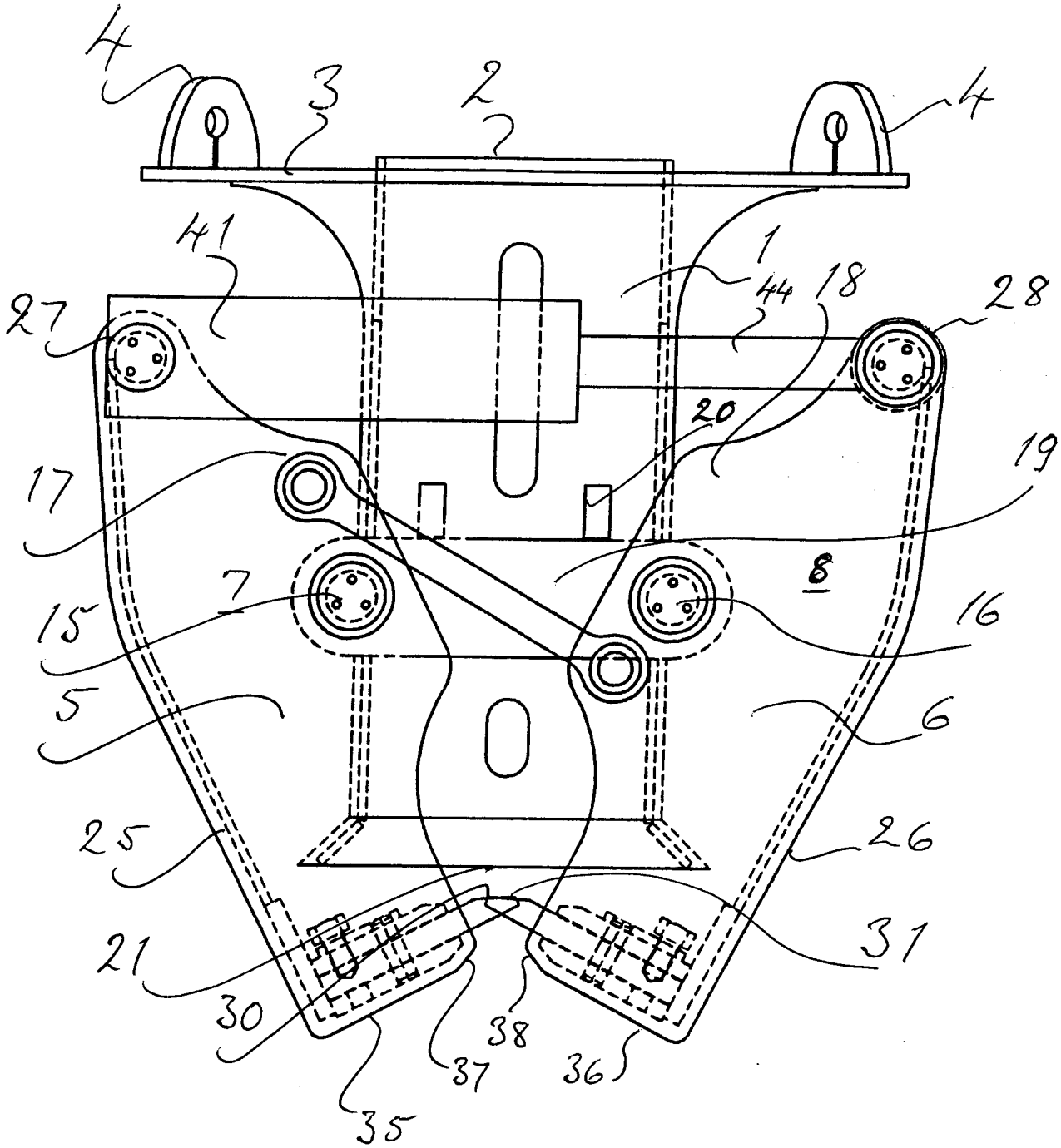



Figure 1

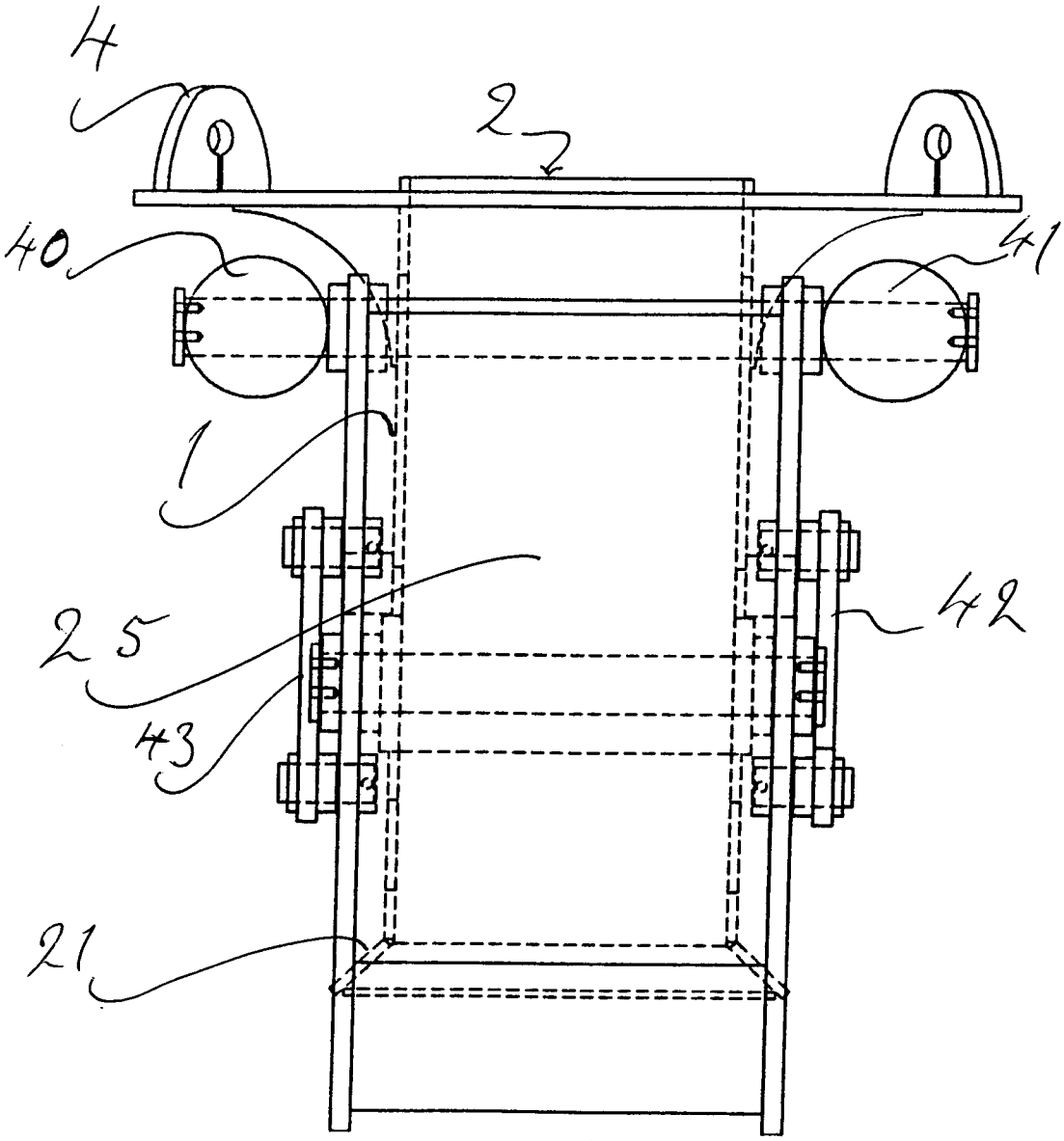



Figure 2

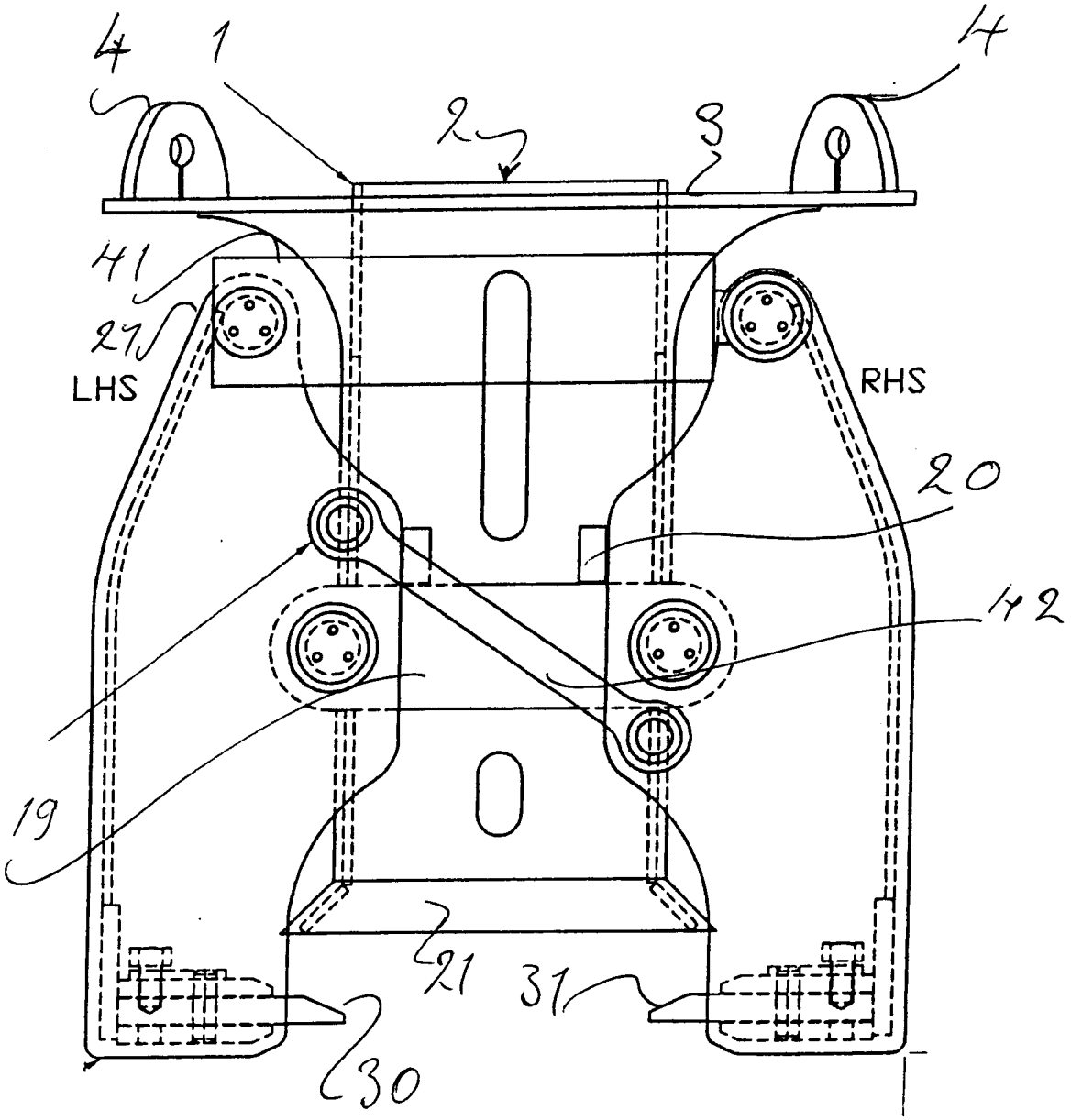



Figure 3

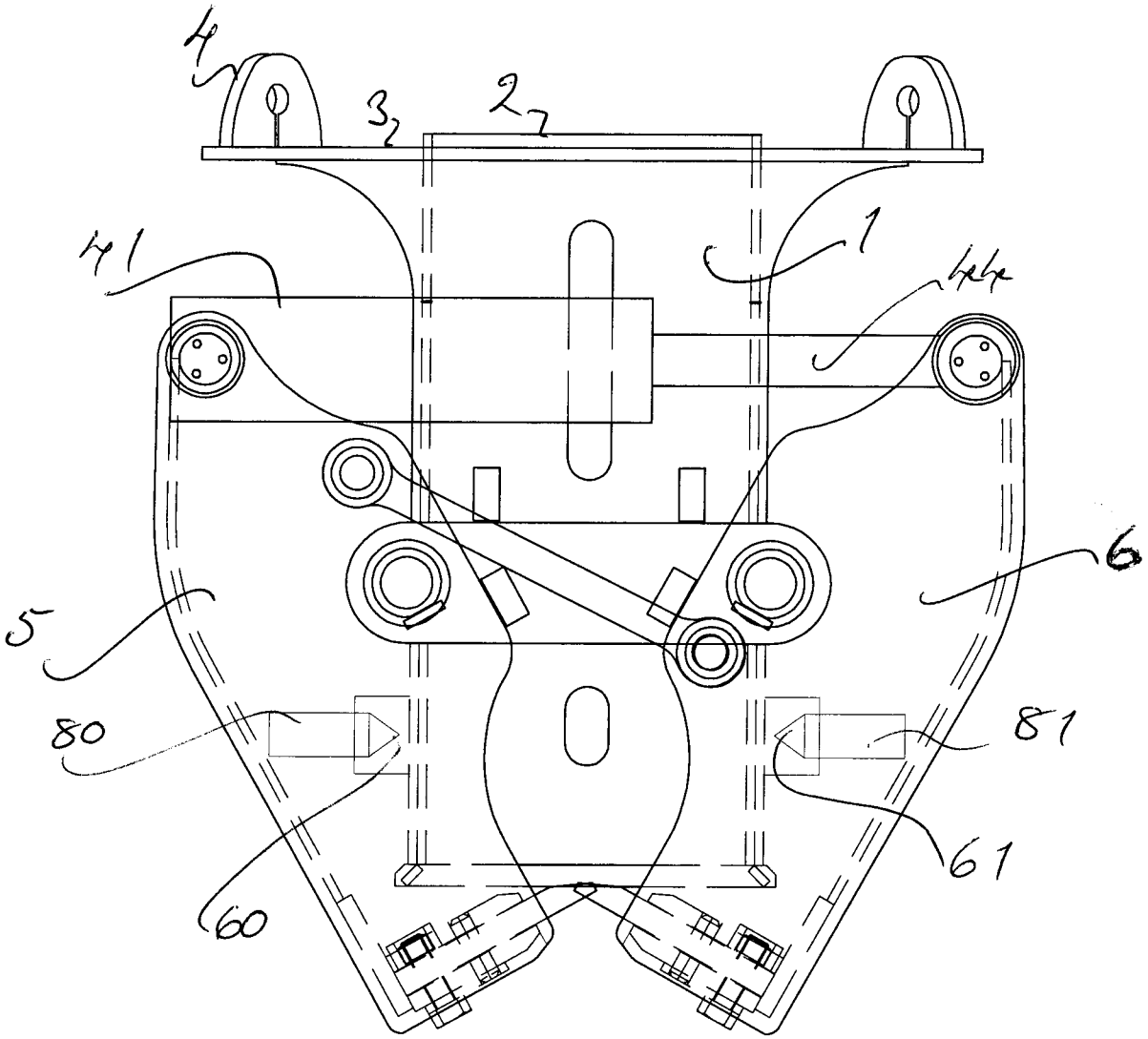



FIG 4

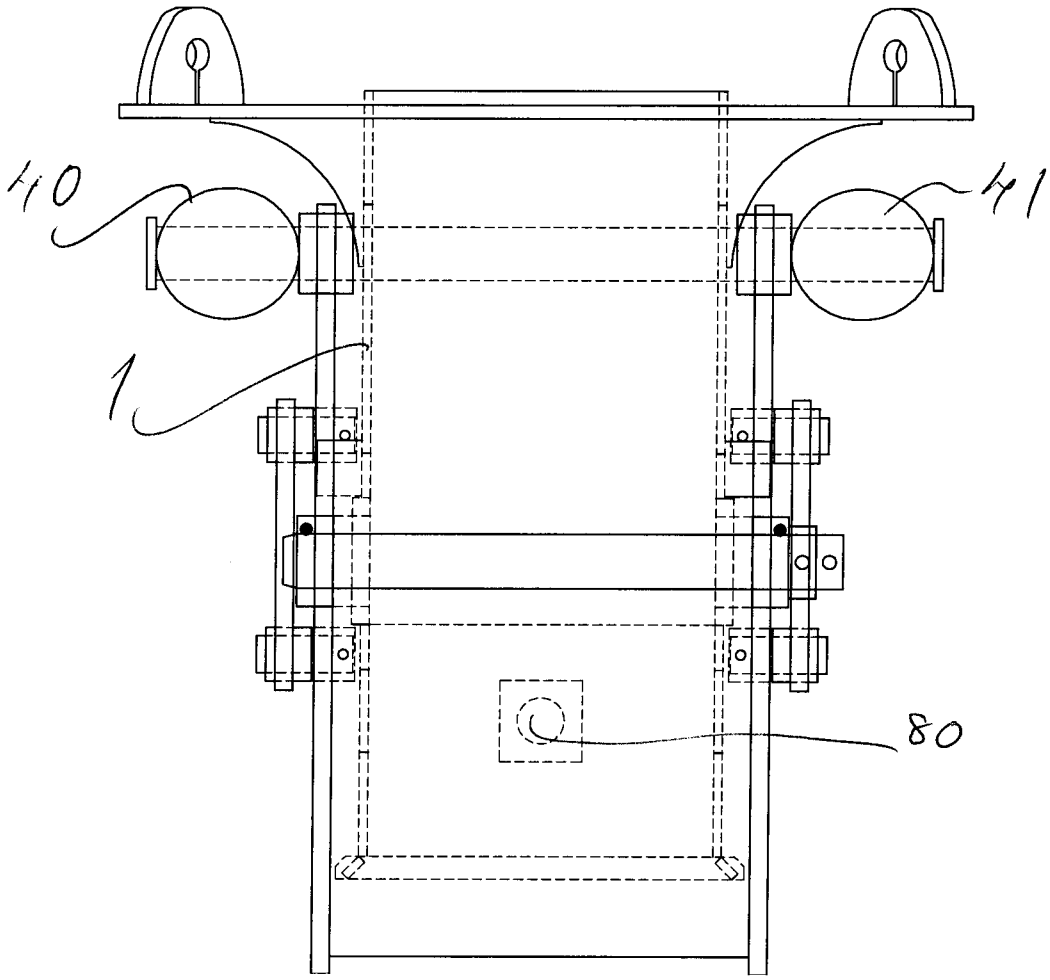



FIG 5

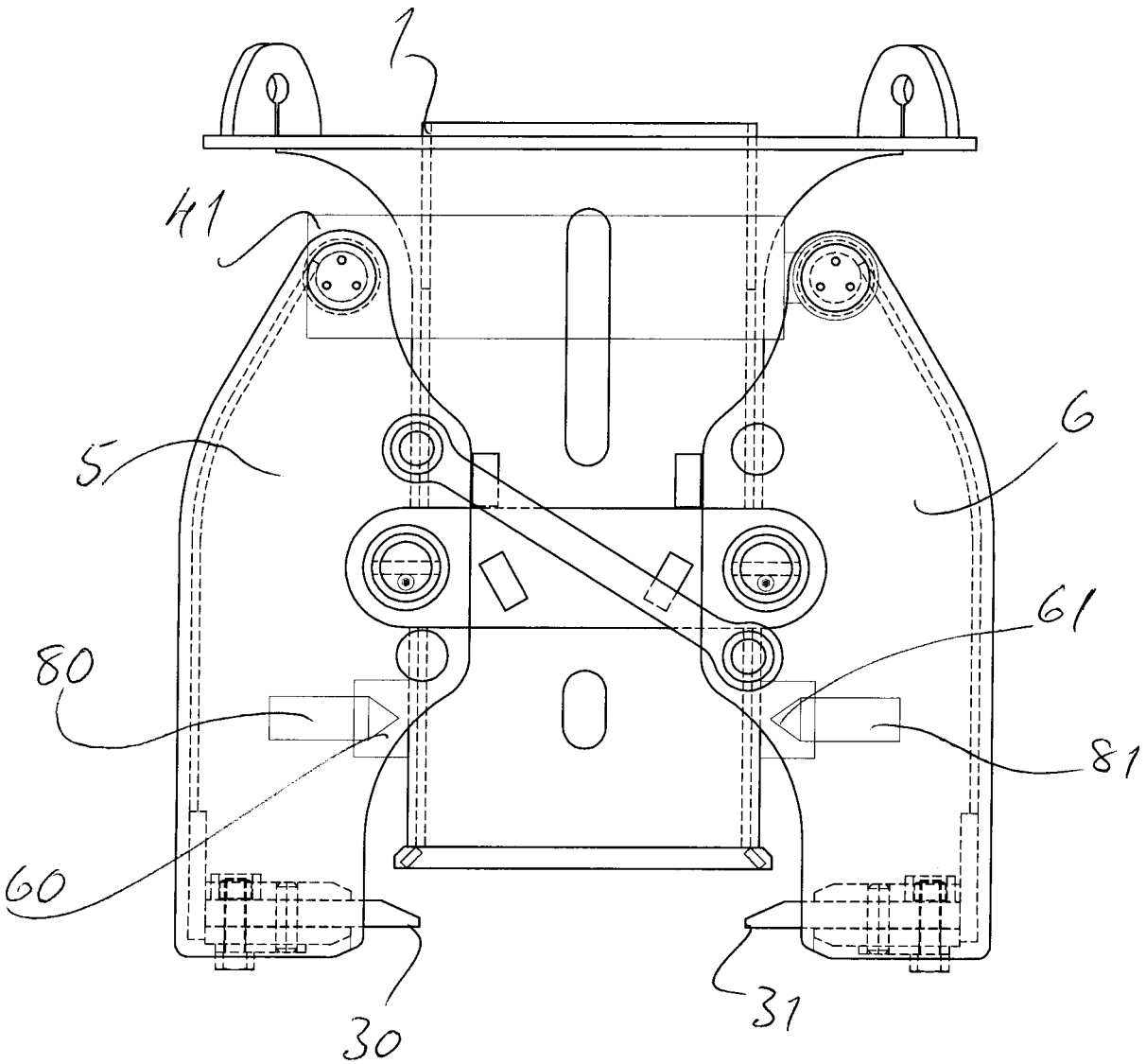



FIG 6