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(54) **A method for pile-driving and a ram head for fixation of a hammer assembly in relation to a pile.**

(57) In a method for driving of a pile (2), where the pile has a top side and side faces extending substantially perpendicularly to the top side, a hammer assembly is held firmly in position in relation to the longitudinal axis of the pile and drives the pile into the ground by hammering on the top of the pile. According to the invention the hammering action is exerted within a defined area of the pile top, not extending to the edges of the pile, while the edge zones are held free of the hammering action. This may be carried out by means of a ram head (110) for fixation of the hammer assembly in relation to the pile, said ram head having a bottom part provided for transmitting the impact impulse to an intermediate plate or impact piece (100) which, in turn, transmits the impulse to the pile top, said bottom part of the ram head being provided with a projecting collar (126) embracing the impact piece to hold it within a defined area not extending to the edges of the pile top.

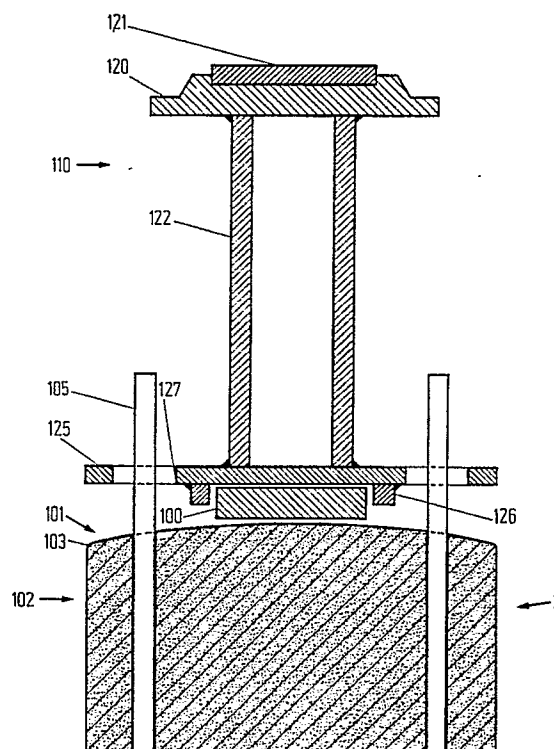


Fig. 3

A method for pile-driving and a ram head for fixation of a hammer assembly in relation to a pile.

The present invention relates to a method for pile-driving and a ram head for fixation of a hammer assembly in relation to a pile to be driven by means of the hammer assembly.

Pile-driving is a well-known technique for placing many different forms of foundations in the ground. Piles are today often made of concrete, and the production may take place under industrial conditions in a factory, and very effective machinery for pile-driving is available nowadays, so that the work can be carried out quickly and effectively on site. Modern pile-drivers are provided with a hammer assembly, or ram, and a slide guide, called the leader, which is arranged along the pile driving direction, for example vertically or almost vertically thereto. A modern and very effective hammer assembly comprises an elongate unit being placed on top of the pile in extension of the axis thereof, which unit by means of hydraulically supplied power throws an internal weight upwards and drops it to perform the ramming. The hammer assembly follows the pile downwards during the ramming, so that the drop height and frequency of the weight need not be dependent on the actual driving depth of the pile. The pile top must, of course, be guided in relation to the hammer assembly, so that the pile is hit squarely on the top, and this is suitably achieved by means of a sort of holding mechanism arranged in the form of a so-called ram head. Normally, an intermediate plate or impact piece is placed between the hammer mechanism and the pile top, said intermediate plate or impact piece being of a material such as for example wood or plastic which may, to some degree, cushion the blows.

It should be mentioned that there are limits to the accuracy with which piles may be placed so that certain disadvantages have to be accepted, such as slight displacements and angular deviations of the piles. Also, in the case of piles with longitudinal edges, f. ex. piles of rectangular shape, there is a risk of turning the pile during driving. Finally, in the case of piles made of a material of some friability, such as concrete, there is a risk of impact damages on the top which will disfigure the appearance of the pile, although it is normally possible to hit the piles so gently that the damages will be of no importance for the bearing capacity or strength of the pile. For this reason, driving of concrete piles is at present not very often used at places where the pile top will remain visible, and if, nevertheless, this technique is used, it is calculated that there will be a need for a refinishing of the pile top.

The risk of displacement, angular deviation or

turning furthermore has the effect that driven piles cannot readily be used for masts which must be positioned very accurately. If they were to be used for this purpose there would be a need for the possibility of adjusting or levelling by fastening of the mast which entails a further complication. The simplest way of mounting a mast in an adjustable manner is to provide the pile with upwardly projecting fixation elements, such as bolts, whereby the mast may be adjustably fastened. It is very difficult, however, to drive a pile if it is provided with bolts projecting from its top. There is an immediate risk of deforming or otherwise damaging the bolts. Experiments as to providing the ram head and impact piece with openings for projecting elements such as bolts, have for various reasons not been successful. One important reason is that the impact piece during ramming is severely deformed or crushed to such an extent that the impact piece must be renewed after each pile driving. It is, therefore, useless to provide openings in the impact piece as the latter is normally completely mashed, and thereby in practice forged onto the bolts, so that the ram head after ramming is stuck in the pile. It should be remarked that normally the ram head is of a relatively simple configuration, f. ex. having a plane impact surface and sides fitting around the pile top, as by more sophisticated configurations there will be a substantial risk that the ram head will crack or be broken during ramming.

According to the invention a method as stated in Claim 1 is provided. It is hereby achieved that piles of a relatively friable material, such as concrete, can be driven without any damages to the top edges of the pile.

According to the invention a method is provided for driving a pile having plane side faces at intervals and longitudinal side edges as stated in Claim 3. It is hereby achieved that such a pile can be driven without damage to the side edges, even if the pile material is relatively friable.

According to the invention a ram head is provided for fixation of a hammer assembly in relation to a pile as stated in Claim 4. It is hereby achieved that a pile may be driven without damages, by using a very simple and cheap impact piece.

According to the invention a ram head is provided for driving a pile having plane side faces at intervals and longitudinal edges as stated in Claim 6. It is hereby achieved that such a pile may be driven without any risk of damaging the side edges.

According to the invention a ram head is provided for use in connection with a pile having elements projecting from its top as stated in Claim

7. It is hereby achieved that such a pile may be driven without any risk of damaging the projecting elements and without any problems in connection with releasing the ram head from the pile top after driving.

According to the invention a ram head is furthermore provided as stated in Claim 8. It is hereby achieved that a pile of f. ex. quadrangular cross section may be placed in different angular orientations about its vertical axis and be driven under control of the orientation. This is suitable where there is a strong exigency of a very accurate pile orientation, such as for example by foundations for masts which must have a specific orientation and where the site for placing the pile driver cannot be freely chosen. This ram head is particularly suitable for pile drivers moving along and working from their position on rails.

According to an advantageous embodiment the ram head is made of steel of low hardness and low strength. Practical experiments have surprisingly shown that ram heads of such material in practice are more durable than ram heads of high strength steel having a tendency to crack during hammering. The reason herefor is not quite clear but is assumed that it may be due to the fact that low strength steel is relatively vibration-absorbent.

The invention is more fully explained in the following with reference to preferred embodiments shown in the drawings, wherein

FIG. 1 shows a vertical section through a pile top with a ram head according to the prior art,

FIG. 2 shows a horizontal section through a pile top and the bottom part of a ram head according to the prior art,

FIG. 3 shows a vertical section through a ram head according to the invention placed in position above a pile top,

FIG. 4 shows a horizontal section through a pile top with elements of a ram head according to the invention,

FIG. 5 shows a side view of a ram head according to another embodiment of the invention,

FIG. 6 shows a side view corresponding to Fig. 5, but in direction perpendicular thereto,

FIG. 7 shows a horizontal section through the top part of a ram head according to the invention, and

FIG. 8 shows a horizontal section corresponding to Fig. 7, but at a lower position.

Initially, the principle used in the prior art ram heads will be explained, reference being made to Figures 1 and 2. The ram head 106 is shown embracing a rectangular pile top, and it appears that the ram head has the form of a box with a bottom or hammer surface 107 lying above the pile and with side faces 108 extending downwardly along the pile sides for fixation of the pile. A usual

impact piece or intermediate plate 100 is interposed between the hammer surface 107 and the pile top 101. Although it does not appear from Fig. 1, the intermediate plate is practically so dimensioned that it may be hammered in position in the ram head 106 and may stick thereto without falling out, while the pile and the ram head are hoisted in position and are brought together. With a ram head of this type the pile can be driven quickly and effectively, but in practice it has been found that in piles of a material of some brittleness or friability, such as concrete, there will be damages on the top edge 103 of the pile and on the longitudinal edges 104. From a cosmetic point of view these damages are very adverse, and upwardly open cracks may be formed which outdoors may give rise to problems, as water may seep down and cause frost bursting of the foundation.

In the following, various embodiments of the invention will be discussed with reference to Fig. 3 and the following Figures.

Fig. 3 shows a vertical sectional view of a ram head 110 according to an embodiment of the invention and in position above a pile 2 having upwardly projecting elements 105, f. ex. in the form of embedded bolts. This ram head has a bottom plate 125, and an impact piece 100 is placed between said bottom plate 125 and the pile top 101, said impact piece 100 being of f. ex. wood, preferably oak, or synthetic material, preferably nylon. According to the invention the bottom plate is provided with a downwardly extending collar 126 enclosing the impact piece 100. This collar serves the purpose not only of holding the intermediate plate in its undeformed shape, but also of holding the impact piece 100 within its limits, even in the case of a severe deformation thereof. It is hereby achieved that the impact impulses are only acting on the central area of the pile top, and not near the top edges 103. Experiments have shown that hereby the pile may be driven without any damage of the top edges, if only the impact piece is of a suitable thickness and the length of the collar is adapted thereto, for example half the thickness of the impact piece. The collar may have the form of any closed, or substantially closed, outline, but preferably it is rectangular or circular.

Furthermore, the bottom plate 125 is provided with openings 127 leaving free space around the bolts 105. The hammer assembly acts on the impact plate 121 being firmly mounted on top of the horizontal top section 120 which transmits the impact impulse to the bottom plate 125 through the body 122 being in the form of a cylindrical tube.

In the following, another practical embodiment of the ram head according to the invention is explained with reference to Figures 4, 5, 6, 7, and 8 of the drawings. Those parts of the ram head of

Figure 3 which are also found in the present embodiment are provided with the same reference numerals.

As clearly apparent from Figures 5 and 6, this ram head is provided with guiding beams 128 mounted on the body 122 of said ram head and strengthened by welding to the bottom plate 125, extending downwardly around the pile which is secured by the contact pieces 129, as clearly apparent from Figure 4. These lateral guides secure the pile so that it can neither be displaced laterally nor rotate about its longitudinal axis, said lateral guides acting on contact faces on the pile sides 102 in distance from the side edges of the pile and in distance from the top edges of the pile. Practical experiments have shown extremely good results with this construction, as damaging of the pile edges and the pile as a whole can be avoided during driving. The contact pieces 129 are secured to the guide beams 128 by means of simple bolts 130, so that the contact pieces may be removed and for example be replaced by contact pieces of other dimensions, so that the guide may be adjusted to different pile dimensions.

The ram head of this embodiment is made in two parts, i.e. a stationary part 111 (see Figure 6) and a part 112 being rotatable about the vertical, central axis. The stationary part 111 is firmly secured in relation to the hammer assembly (not shown) by appropriate securing of a projecting collar 113. The stationary part continues from the collar 113 downwards into a cylindrical body 116 having a supporting plate 114 mounted below. The entire stationary part is constructed in such a manner that it is dividable in a plane containing the longitudinal axis for ease of mounting and dismantling, and the two parts are held together by means of fish-plates 115. The rotatable part 112 is guided by sliding rings 119 and is supported by the supporting plate 114. As mentioned in connection with the embodiment of Figure 3, the rotatable part also here comprises a top section 120 with an impact plate 121 on which the hammer acts. The top section is welded to the cylindrical body part 122.

Just below the top section 120 a number of radially projecting fins 124 are provided (see Figure 7) and below these fins a horizontal supporting flange 123 is mounted by means of which the rotatable part is supported on the supporting plate 114. The fins which are welded to the top section 120 and to the supporting flange 123 serve the purpose of partly supporting these parts and partly fixing the rotary orientation of the rotatable part in relation to the stationary part 111. As shown in Figure 7, eight fins define between themselves seven grooves having equal intervals, shown here with a pitch of 15° between them. In the stationary part two bushings 117 are provided at a mutual

positional distance of $22,5^\circ$. In these bushings a guide pin 118 with conical point may optionally be inserted and secured, said pin fitting into the interval between the fins. As appears from Figure 7, the rotatable part may thus by means of the two bushings 117 alternately be turned and fixed in a total of fourteen positions at intervals of each $7,5^\circ$, over an angular region of totally 105° . Of course, a further possibility of rotation can be achieved by raising the ram head from the pile and turn the rotatable part 90° in relation to the pile top and lower it again. The arrangement has in practice been found to be able to perfectly endure the impact actions, which is supposed to be due to the possibility of longitudinal displacement of the rotatable part in relation to the stationary part, so that the impact impulse is not transferred to the guide pin 118 or to the fins.

The ram head is suitably made of steel of low hardness and preferably of steel type 37-2 according to DIN 17100 or ISO 630.

Claims

1. A method for the driving of a pile into the ground or a similar substance, said pile having a top surface disposed substantially at right angles to its longitudinal axis, and side faces extending substantially parallel to its longitudinal axis, wherein a hammer assembly is constricted to move in the direction of the longitudinal axis of the pile and drives the pile downwards by hammering on the top surface of the pile, CHARACTERIZED in that the action of the hammer onto the top surface is restricted to an area of the pile surface not extending to the edges, while the edge zones are kept free of the action of the hammer.

2. A method according to Claim 1, CHARACTERIZED in that the hammering is exerted on an intermediate plate or impact piece overlying the pile surface, said impact piece being held within a defined partial area of the pile surface so that the impact piece cannot be squeezed out over the edge zones by the impacts of the hammering action.

3. A method according to Claim 1 or 2 for driving of a pile into the ground or a similar substance, said pile having side faces being at least partially plane and with longitudinal side edges, CHARACTERIZED in that the pile is secured in relation to the hammer assembly by being held over contact areas of the side faces, said areas terminating short of the side edges and short of the upper edges, while the zones adjacent these edges are kept free.

4. A ram head adapted for maintaining the alignment of a hammer assembly in relation to the

axis of a pile to be driven by means of said hammer assembly, said ram head having an underside adapted for transmitting the impact impulse to an intermediate plate or impact piece which transmits the impulse onto the pile top surface, CHARACTERIZED in that the underside of the ram head is provided with an axially projecting collar for embracing the impact piece and confining it within a defined area, said area terminating short of the edge of the pile top surface.

5. A ram head according to Claim 4, CHARACTERIZED in that means are provided for maintaining the alignment of the hammer assembly in relation to the axis of the pile, said means comprising holding or clamping surfaces facing the side face or the side faces of the pile, said holding or clamping surfaces covering pile contact areas terminating short of the top edge of the pile.

6. A ram head according to Claim 5 and for use in connection with a pile having at least partially plane side faces and longitudinal edges, CHARACTERIZED in that the holding or clamping surfaces are disposed to face the side faces of the pile over contact areas terminating short of the longitudinal edges.

7. A ram head according to any of the Claims 4-6, for use in connection with a pile comprising a top surface and elements projecting above said top surface, CHARACTERIZED in that the ram head is provided with openings in the underside to give free space around the upwardly projecting elements, and that the axially projecting collar is disposed to keep the impact piece clear of the upwardly projecting elements, also when the impact piece is affected by the impacts from the hammer assembly.

8. A ram head according to Claims 6 or 7 for the driving of a pile into the ground or into a similar substance, while maintaining a selected rotary orientation about the longitudinal axis of the pile, CHARACTERIZED in that the ram head is divided into a first and a second part, said first part being arranged above said second part in the operating position, said parts being mutually rotary about an axis extending parallel to the intended axis of driving the pile and through the middle of the second part and being adapted so that a mutually rotational orientation may be selected and fixed by the first part being provided with a removable and insertable guide pin, which may be fixed in the inserted position, an end portion of said guide pin fitting into anyone among a number of longitudinal grooves in the second part, so that the pin and groove together may establish a rotational fixation, while allowing mutual displacement of said parts in axial direction.

9. A ram head according to Claim 8, CHARACTERIZED in that said second part is provided

with seven grooves at angular spacings or intervals about the longitudinal axis of 15° , and in that said first part is adapted with two possibilities of inserting and fixing the guide pin at an angular spacing of $22,5^\circ$ about the longitudinal axis so as to achieve a total of fourteen possibilities of mutual orientation at angular intervals of $7,5^\circ$.

10. A ram head according to Claims 4-9, CHARACTERIZED in that it is made of steel of low hardness and low carbon content, such as steel type 37-2 according to DIN std. 17100 or ISO std. 630.

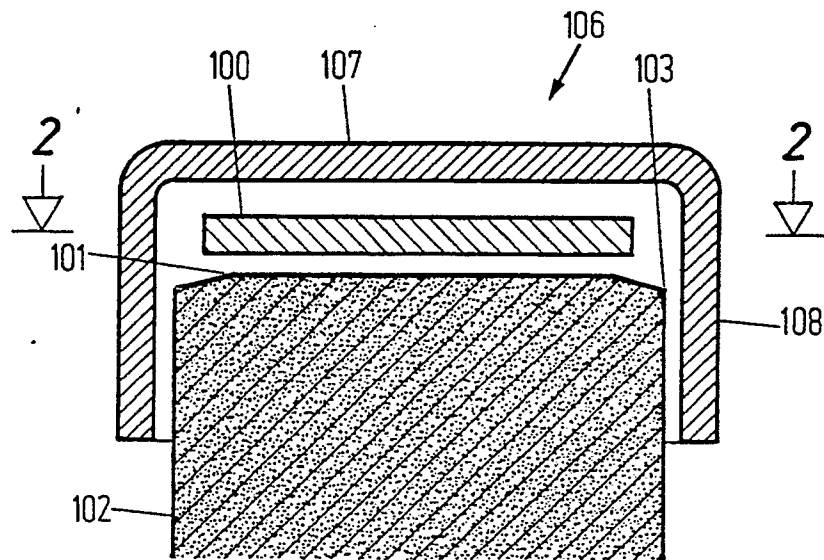


Fig. 1

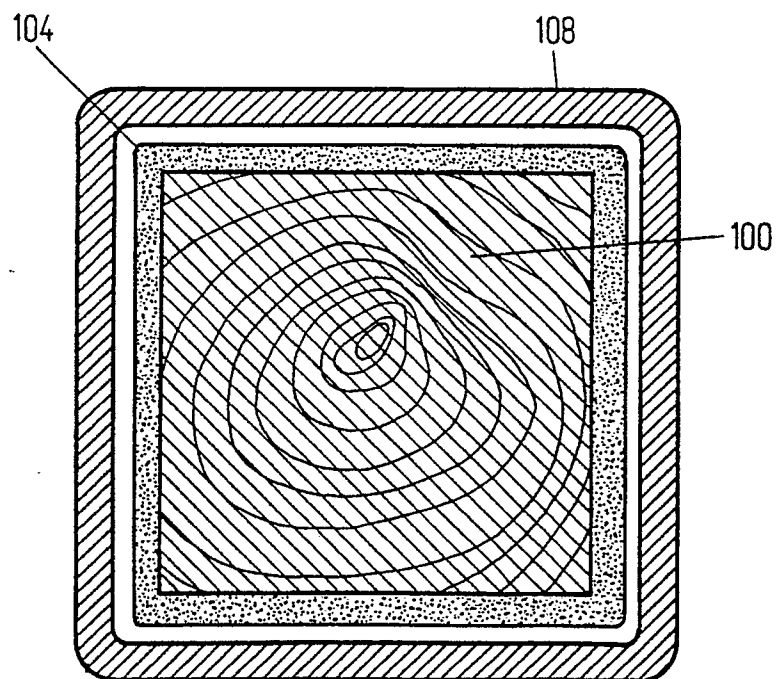


Fig. 2

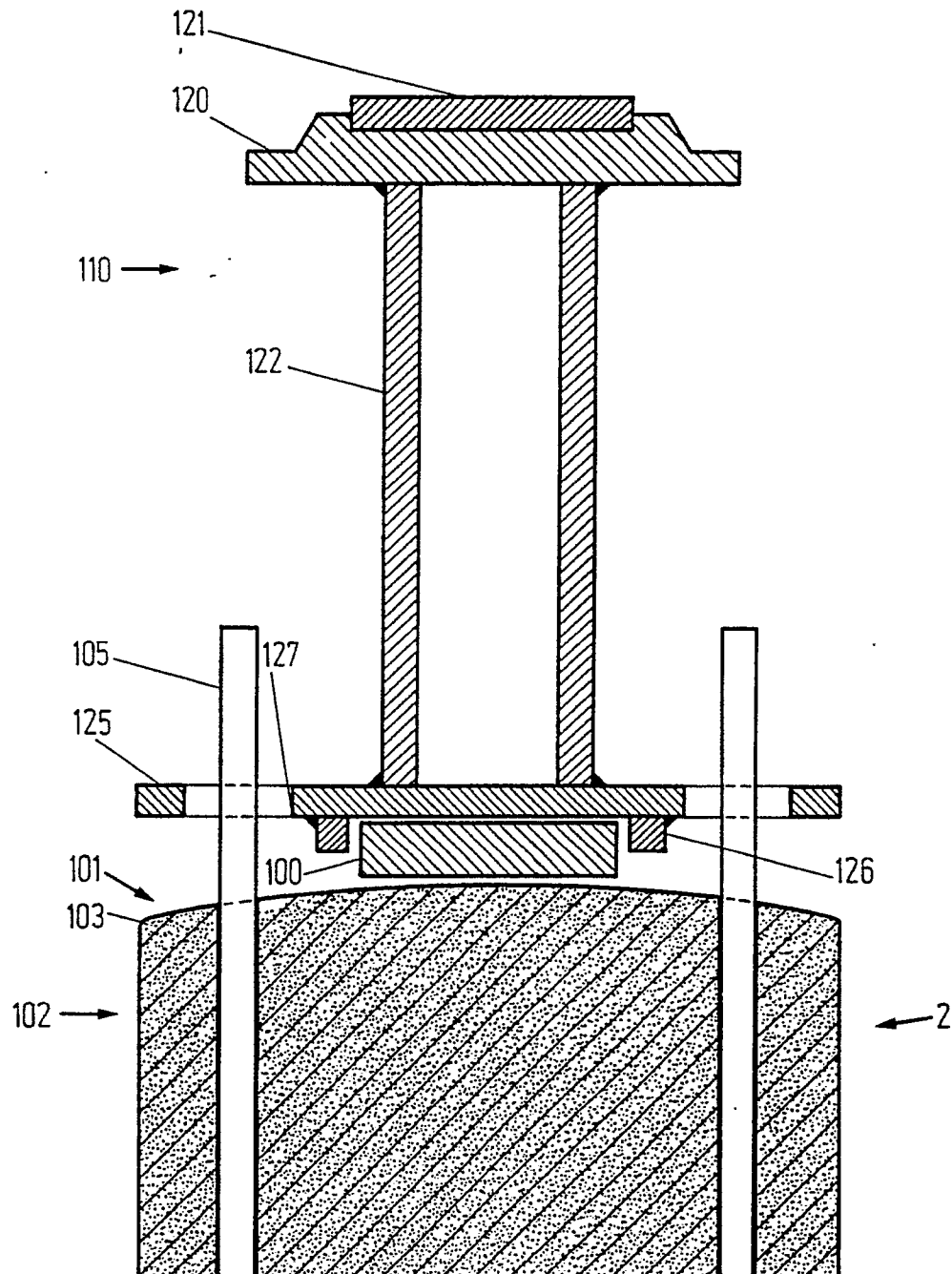


Fig. 3

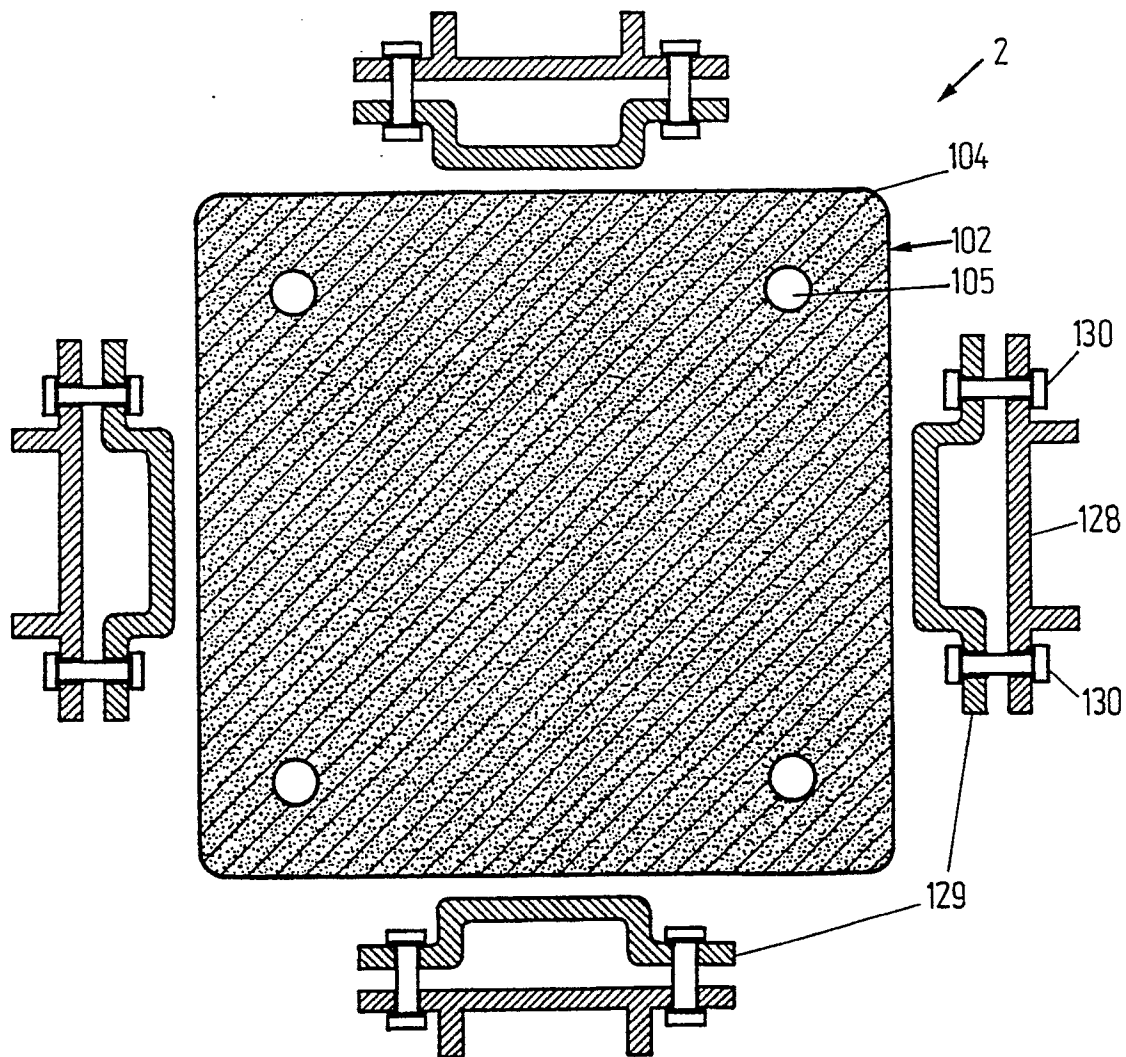
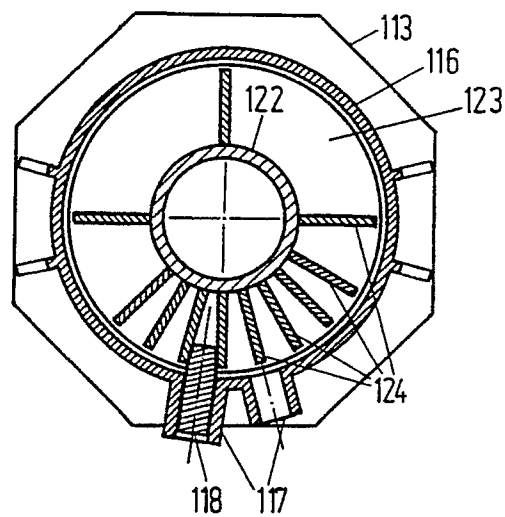
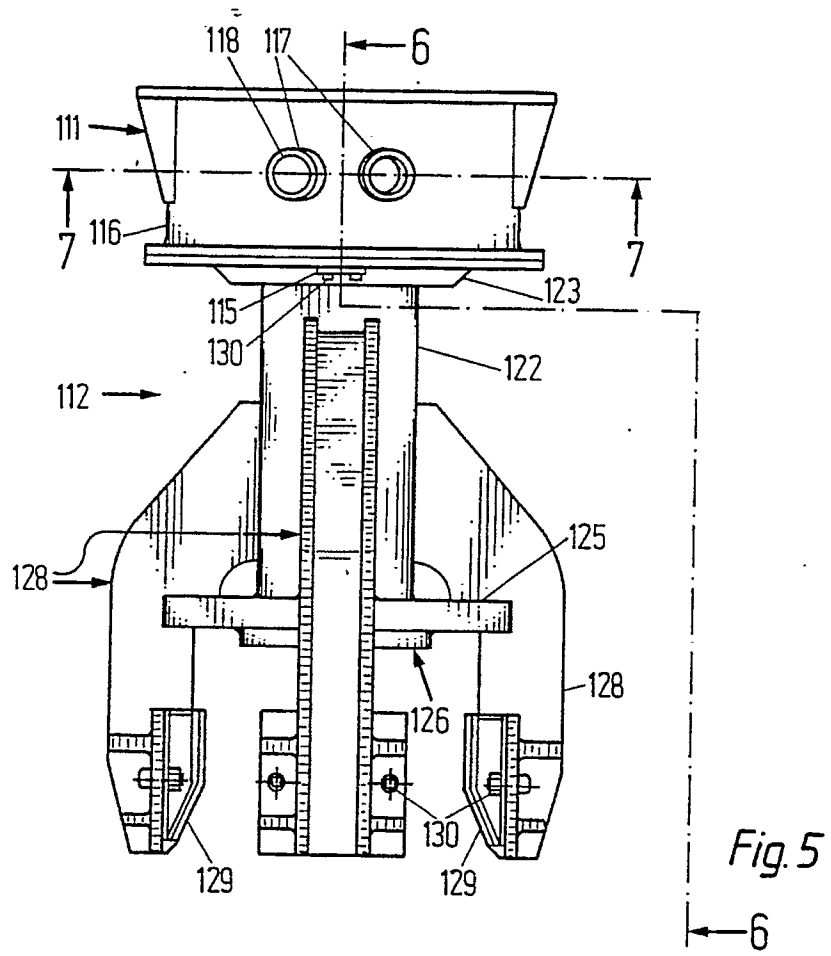


Fig. 4



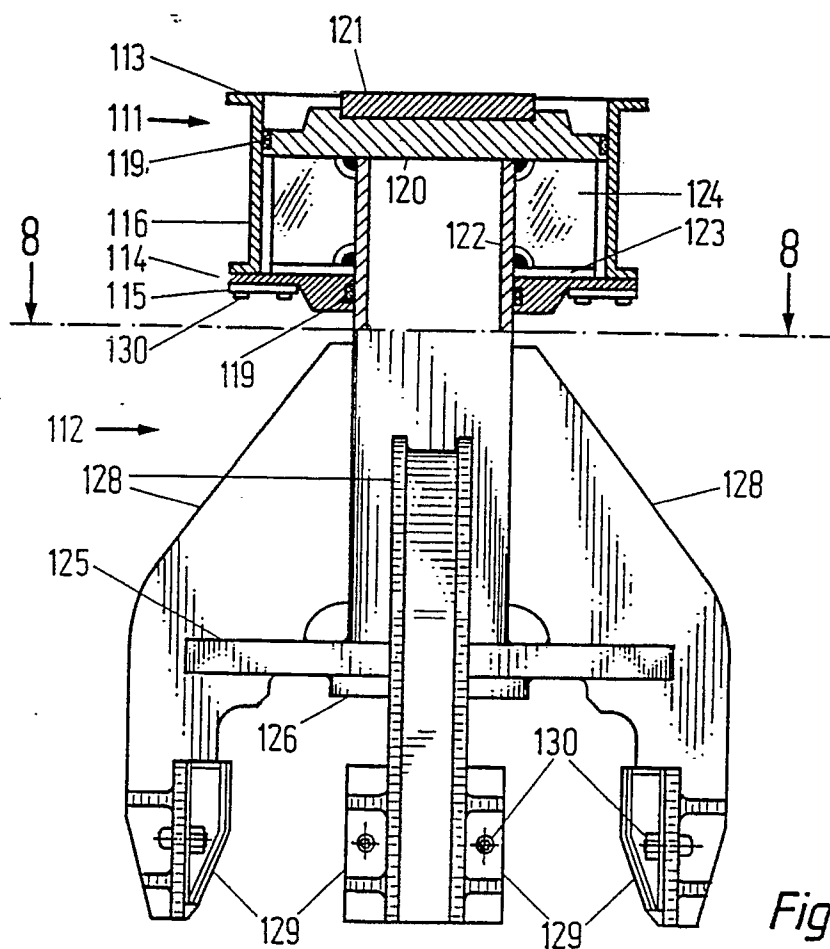


Fig. 6

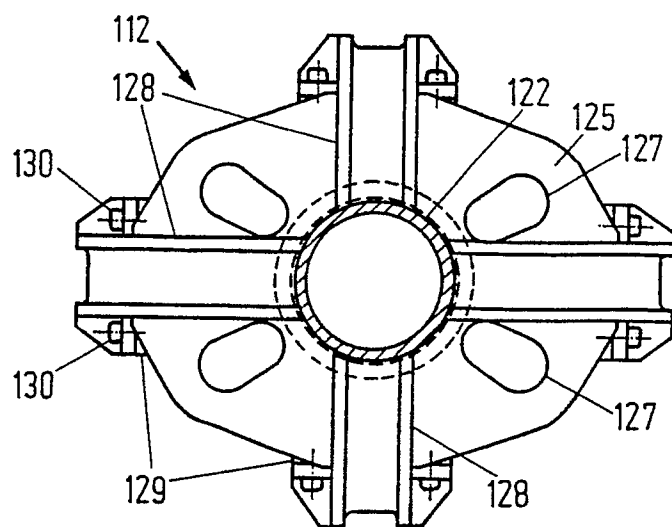


Fig. 8



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 10 6281

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.5)
X	WO-A-8 805 844 (DELMAG MASCHINENFABRIK REINHOLD DORNFELD) * Page 4, lines 9-35; page 5, lines 1-8; page 6, lines 12-16; page 7, lines 34-35; page 8, lines 1-2; figures 1,2 *	1	E 02 D 13/10
A	---	2,3	
X	DE-C- 659 274 (DEMAG) * Fig. *	1	
A	---	3	
A	US-A-2 931 186 (FREDERICK) * Column 2, lines 37-44,62-69; figure 12 *	1,2,3,5,6	
A	GB-A- 26 073 (THE YORKSHIRE HENNEBIQUE CONTRACTING CO.)(A.D. 1911) * Page 3, lines 37-55; page 4, lines 3-5,8-13,34-43; figures 1-6 *	1,2,3,6	
A	GB-A-1 409 188 (FOUNDATIONS PATENT AND INVESTMENT CO.) * Page 1, lines 70-74,90-100; page 2, lines 1-12; fig. *	7	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	US-A-4 653 595 (HEBERT)		E 02 D
A	US-A-4 479 552 (CHAPPELOW)		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17-06-1990	Examiner RUYMBEKE L.G.M.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	