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## (54) Noise shield for use in combination with a hydraulic hammer mounted on a hammer or pile driving rig

(57) Subject of the present invention is a noise shield for use in combination with a hydraulic hammen mounted on a hammer rig, the shield comprising a housing with front wall opposite side walls and a rear wall, all of them being of a sandwich structure.

Further, the shield comprises a set of inwardly protruding damping flanges provided at the upper end of said housing and a pair of bottom end closure walls connected through hinge connections to said housing at the lower end thereof. A set of suspension spring elements is provided to suspend said noise shield.

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## Description

**[0001]** The present invention relates to a noise shield for use in combination with a hydraulic hammer mounted on a hammer or pile driving rig.

**[0002]** A number of technical solutions for the improvement of pile driving rigs have been proposed throughout the last decades among which the applicant's European patents EP 0 392 309, EP 0 392 310, EP 0 392 311, and EP 0 984 105 are to be referred to. The pile driving rig technique is an expedite and highly cost efficient technique of improving the foundation for the building of a house and has also gained success with the field of raising electric over head masts for railroads etc.

**[0003]** The trend towards environmental improvements relating to less pollution and reduced noise has, however, called for improvements within the pile driving technique and the use of hydraulic hammers which are themselves insulated for reducing the noise generated have to some extent improved the pile driving technique. A serious drawback, however, still exists as the impact location, i.e. the location at the lower end of the hydraulic hammer and the top surface of the pile is not insulated and therefore still gives origin to an extreme noise generation. Attempts have been made to provide noise shields for at least partly encasing the impact location, however these attempts have been little successful or insufficient.

**[0004]** A serious problem in obtaining a sealed enclosure in which the impact location is contained exists for the reason that the high impact system exposes not only the pile but also the mast and the hammer to extreme mechanical loads which cause vibration and make it difficult to obtain the necessary sealing of the impact location enclosing chamber. Furthermore concerns as to the weight of the noise shield are pronounced.

**[0005]** A further problem relating to the use of the noise shield at different levels above ground level exists and these problems together with numerous other problems which will be evident from the below detailed description of the presently preferred embodiment of the noise shield according to the present invention are solved by a noise shield to be used in combination with a hydraulic hammer mounted on a hammer rig and comprising according to the teachings of the present invention, comprising:

a housing including a front wall, opposite side walls and a rear wall, together defining a substantially rectangular cross-sectional configuration, each of the walls being of a sandwich structure including an outer solid steel plate, an inner perforated sound diffusing steel plate and a sound absorbing layer sandwiched between the outer steel plate and the inner steel plate, the rear wall being adapted to be positioned juxtaposed the hammer rig and the housing having dimensions allowing the housing to be positioned enclosing the lower pile engaging end of the hydraulic hammer,

a set of inwardly protruding damping flanges being provided at the upper end of the housing for closing off the gap between the housing and the hydraulic hammer,

a pair of bottom end closure walls connected through hinge connections to the housing at the lower end thereof for allowing the bottom end closure walls to be shifted from a first operational position to a second open position, the bottom end closure walls each having inwardly protruding damping flanges for tightly engaging with a pile when in the first position and the bottom end closure walls allowing the housing to be positioned on a supporting surface such as the ground when in the second position, and

a set of suspension spring elements for suspending the noise shield in the hammer rig and co-operating with the housing for maintaining the housing in a fixed position during the penetration of the pile by means of the hydraulic hammer without substantially shifting the housing vertically relative to the hydraulic hammer.

**[0006]** According to the basic teachings of the present invention, the noise shield provides a housing which is composed of outer walls and further including top and bottom closure walls for sealing off an inner chamber in which the impact location, i.e the top surface of the pile, which is hit by the pile driving hammer, is enclosed.

**[0007]** According to a particular feature of the noise shield according to the present invention, the noise shield is suspended in spring elements for maintaining the housing in a fixed position during the penetration of the pile thereby preventing that the noise shield be moved relative to the hydraulic hammer and also to an substantial extent the pile which would else cause mechanical wearing off of the material of the flanges providing the top and bottom sealing of the encasing.

**[0008]** According to a further feature of the noise shield according to the present invention, the bottom enclosure walls may be shifted from a first or normal operation position in which the bottom enclosure walls serve the purpose of closing off the bottom end of the housing to a second open position allowing the noise shield to be positioned on the ground for maintaining the noise shield in position as the pile is driven into the ground at ground level or even below ground level.

**[0009]** According to the teachings of the present invention of preventing the noise shield from vibrating or moving relative to the hammer rig, the suspension spring elements provide a critical damping of the housing or an overdamped suspension of the housing relative to the hydraulic hammer.

**[0010]** The inner steel plate of the sandwich structure of the front wall, the opposite side walls and the rear wall of the housing of the noise shield according to the

present invention serves on the one hand to provide a stiff element in the sandwich structure, and on the other hand, due to the aperture configuration serves the purpose of allowing the sound or noise to be radiated into the sound absorbing layer sandwiched between the inner perforated steel plate and the outer solid steel plate. According to the teachings of the present invention, the inner perforated sound diffusing steel plate of the front, side and rear walls have a perforation area of no less than 20%, such as 30%, preferably 40% or 50% such as 20%-60%, e.g. 30%-50% or 20%-30%, 30%-40%, 40%-50% or 50%-60%.

**[0011]** For further improving the noise reduction ability or characteristic of the noise shield according to the present invention, a bitumen layer is preferably interposed between the sound absorbing layer and the outer solid steel plate of the front, side and rear walls of the housing for on the one hand providing a vibration reducing effect and on the other hand due to the difference in the density of the bitumen area and the steel plate provide a sound damping effect.

**[0012]** The flanges sealing off the top end and the bottom end of the housing may be made from any substantially wear resistant material providing a fairly good sound damping characteristic such as bitumen rubber, etc.

**[0013]** The bottom end closure walls of the noise shield may be configurated as a one side hinged structure, e.g. a structure hinged to the front wall of the housing, however, and according to a presently preferred embodiment of the noise shield according to the present invention, the bottom enclosure walls are of symmetrical structure and are hinges to the side walls of the housing.

**[0014]** The present invention is now to be further described with reference to the drawings in which

Figs. 1a and 1b are front and side elevational views of a pile driving rig including a hydraulic hammer and a first and presently preferred embodiment of a noise shield enclosing the lower pile engaging end of the hydraulic hammer and the upper end of the pile,

Fig. 2 is an overall perspective and partly exploded view of the first and presently preferred embodiment of the noise shield according to the present invention to be used in connection with a hydraulic hammer,

Figs. 3a and 3b are perspective and schematic views illustrating the lower end of the noise shield in two alternative operational modes, and

Fig. 4 is a perspective and schematic view of the structure of the walls of the noise shield according to the present invention.

**[0015]** In Figs. 1a and 1b, a pile driving rig is shown in a front and a side elevational view, respectively. The pile driving rig is carried by a vehicle designated the reference numeral 10 in its entirety and comprises a rig 12 supporting a pile 18 by means of upper and lower guides 14 and 16, respectively. The pile 18 is to be forced into the ground or the earth by the impact from a hydraulic hammer 20 suspended in the pile driving rig from the mast 12. The lower pile engaging end of the hydraulic hammer 20 and the upper impact receiving end of the pile 18 are encased within a noise shield 30 constituting a first and presently preferred embodiment of the noise shield according to the present invention. No detailed description of the pile driving rig is presented in this context as reference is made to among others the applicant's European patents listed above and describing in greater details the structure of the pile driving rig.

**[0016]** The noise shield 30 shown in greater details in Fig. 2 comprises two opposite side walls 32 and 34 of basically identical structure, a front wall 36 land a rear wall 38. The walls 32, 34, 36 and 38 are made from a sandwich structure which is illustrated in greater details in Fig. 4 and which comprises an outer solid steel plate 40, such as a 6 mm steel plate, a high density bitumen or asphalt based vibration damping layer 42, e.g. of a thickness of 5mm, serving the purpose of providing a vibration damping effect and a sound absorbing effect, a sound absorbing layer 44 such as a 50mm mineral fibre or foamed sound absorbing layer, and finally an inner perforated steel plate 46 such as a 4mm perforated steel plate having a number of apertures. In Fig. 4 the apertures are shown as circular apertures and in Fig. 2 shown as elongated apertures.

**[0017]** The apertures provide an open transmission area of no less than 30%, such as preferably 40% of the overall area of the steel plate 46. The combination of the perforated sound diffusing inner steel plate 46, the sound absorbing layer 44 and the high density vibration damping layer 42 and the sandwich structure provides a major sound damping effect damping the noise generated by the impact of the lower end of the hydraulic hammer on the pile of the order of 6-10 db dependent on the impact frequency generated.

**[0018]** The noise shield 30 is provided with a plurality of brackets, one of which is designated the reference numeral 48 allowing the noise shield to be fixated relative to the mast 12, however fixated so as to allow the noise shield 30 to move downwardly together with the hydraulic hammer 20 as the noise shield 30 is suspended in the hydraulic hammer 20 by means of a total of four spring elements 50 which are fixated in respective eyelets 52 at the outer corners of the upper end of the housing of the noise shield 30 which housing is composed of the walls 32, 34, 36 and 38. Apart from the eyelets 52, the suspension of the noise shield 30 is accomplished by means of chains 54 fixated at their upper ends, not shown, to hooks or similar fixation elements of the hydraulic hammer 20.

**[0019]** The springs 50 are adjusted to the weight of the noise shield 30 so as to provide a critical or overdamping of the mechanical system in order to prevent that the noise shield 30 is moving relative to the hydrau-

lic hammer as the hydraulic hammer forces the pile 18 into the ground or the earth. It is contemplated that the damping of the noise shied 30 in its suspension relative to the hydraulic hammer 20 is a critical factor in obtaining a high noise reduction in the first place for eliminating the risk of having any sound gaps being generated by deteriorating the flaps 56 due to any motion of the noise shield 30 relative to the hydraulic hammer and also for providing a mechanical decoupling between the two elements, viz. the noise generating noise shield 30 and the rig including the hammer 20 and also the pile 18.

**[0020]** At the upper open end of the housing defined by the opposite side walls 32 and 34 and the front wall 36, sound damping flaps 56 are provided for closing off the gap between the inner surfaces constituted by the inner perforated steel plates of the walls 32, 34, 36 and the outer wall of the hydraulic hammer. These flaps are preferably made from high density bitumen containing rubber.

**[0021]** Along the upper side and along the inner sides of the opposite side walls 32 and 34, additional noise damping bitumen containing rubber flaps 58 and 60 are provided.

**[0022]** At the lower end of the housing composed of the walls 32, 34, 36 and 38, bottom closure plates are provided which are designated the reference numeral 60. The two plates are of identical and symmetrical structure and are provided with a bottom opening for allowing the pile 18 to be encircled by the two bottom plates 60. For sealing off the gap between the bottom plates 60 and the outer side of the pile 18, high density rubber flaps 62 similar to the flaps 56 and 58 described above are provided. A particular feature of the noise shield relates to the ability of the noise shield to be used in two alternative positions which are illustrated in Figs. 3a and 3b.

**[0023]** In Fig. 3a, the noise shield 30 is shown in its normal or first operational position in which the bottom plates are closed around the pile 18 for sealing off the inner chamber in which the lower end of the hydraulic hammer impacts the top surface of the pile 18.

**[0024]** As the pile 18 is forced into the earth or into the ground, the top surface of the head of the pile 18 approaches the ground surface and at the time the top surface or the head of the pile 18 is to be forced into the ground surface, the noise shield 30 cannot maintain its position as illustrated in Fig. 3a for enclosing the top surface of the pile 18 which top surface is impacted by the hammer 20. For allowing the noise shield to be used even at ground level, i.e. as the pile 18 is forced into the ground, the plates 18 may be shifted from their closed or normal position shown in Fig. 3a to the positions shown in Fig. 3b in which the interior of the noise shield 30 is opened by the swinging away of the bottom plates 30 allowing the lower circumferential rim of the noise shield housing defined by the walls 32, 34, 36 and 38 to rest on the ground or the earth, still providing a substantial noise reduction as compared to a situation in which no noise shield is being used.

**[0025]** Although the present invention has been described above with reference to a presently preferred embodiment, numerous modifications are obvious to a person having skill in the art and such modifications and amendments are to be considered part of the present invention and consequently covered by the protective scope as defined in the pending patent claims.

## Claims

1. A noise shield for using in combination with a hydraulic hammer mounted on a hammer rig, the shield comprising:

   a housing including a front wall, opposite side walls and a rear wall, together defining a substantially rectangular cross-sectional configuration, each of said walls being of a sandwich structure including an outer solid steel plate, an inner perforated sound diffusing steel plate and a sound absorbing layer sandwiched between said outer steel plate and said inner steel plate, said rear wall being adapted to be positioned juxtaposed said hammer rig and said housing having dimensions allowing said housing to be positioned enclosing the lower pile engaging end of said hydraulic hammer,

   a set of inwardly protruding damping flanges being provided at the upper end of said housing for closing off the gap between said housing and said hydraulic hammer,

   a pair of bottom end closure walls connected through hinge connections to said housing at the lower end thereof for allowing said bottom end closure walls to be shifted from a first operational position to a second open position, said bottom end closure walls each having inwardly protruding damping flanges for tightly engaging with a pile when in said first position and said bottom end closure walls allowing said housing to be positioned on a supporting surface such as the ground when in said second position, and

   a set of suspension spring elements for suspending said noise shield in said hammer rig and co-operating with said housing for maintaining said housing in a fixed position during the penetration of said pile by means of said hydraulic hammer without substantially shifting the housing vertically relative to said hydraulic hammer.

2. The noise shield according to claim 1, said suspension spring elements providing a critical damping of said housing or a overdamped suspension of said housing relative to said hydraulic hammer rig.

3. The noise shield according to any of the claims 1 or 2, said inner perforated sound diffusing steel plates of said front, side and rear walls having a perforation area of no less than 20%, such as 30%, preferably 40% or 50% such as 20%-60%, e.g. 30%-50% or 20%-30%, 30%-40%, 40%-50% or 50%-60%.

4. The noise shield according to any of the claims 1-3, a bitumen layer being interposed between said sound absorbing layer and said outer solid steel plate of said front, side and rear walls.

5. The noise shield according to any of the claims 1-4, said flanges being made from bitumen rubber.

6. The noise shield according to any of the claims 1-5, said bottom end closure walls being of symmetrical structure and being hinged to said side walls of said housing.

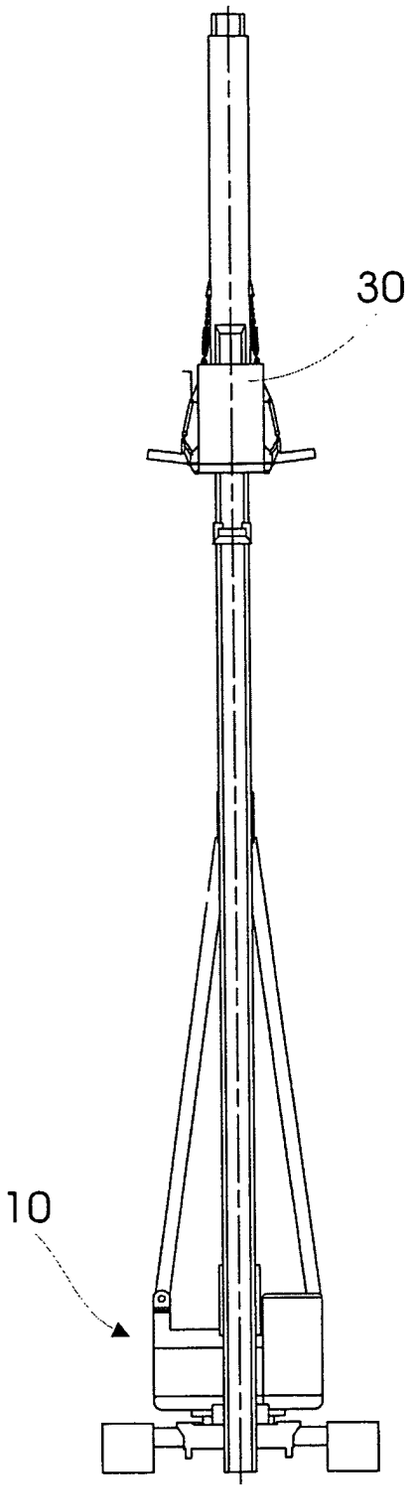


Fig 1a

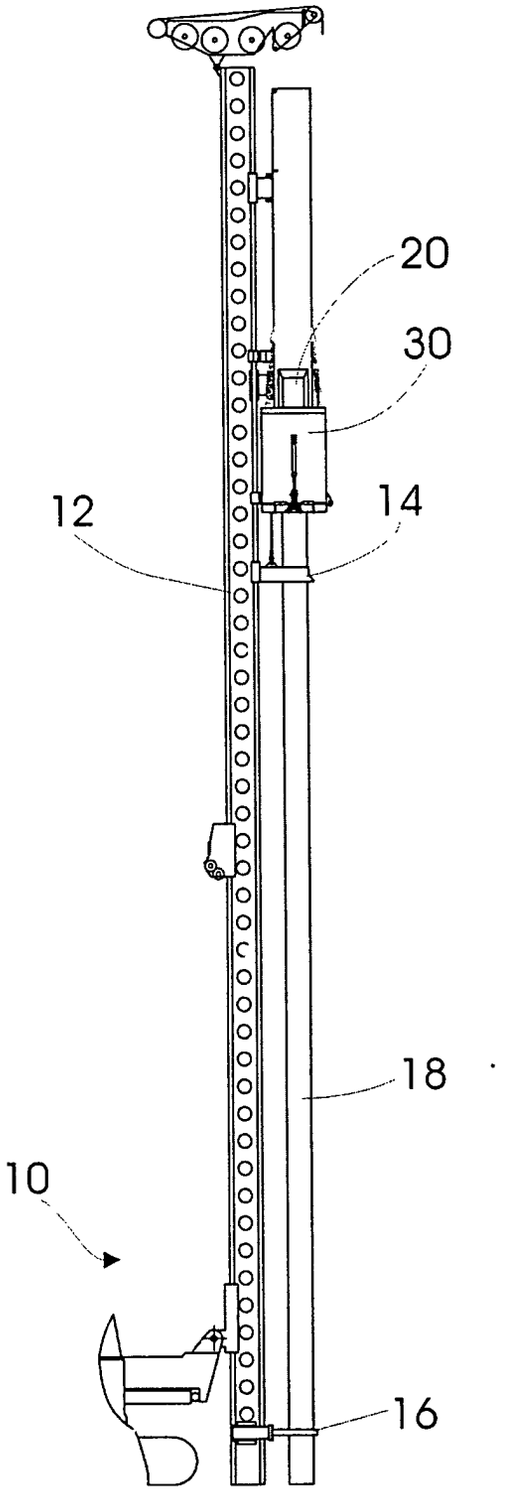


Fig 1b

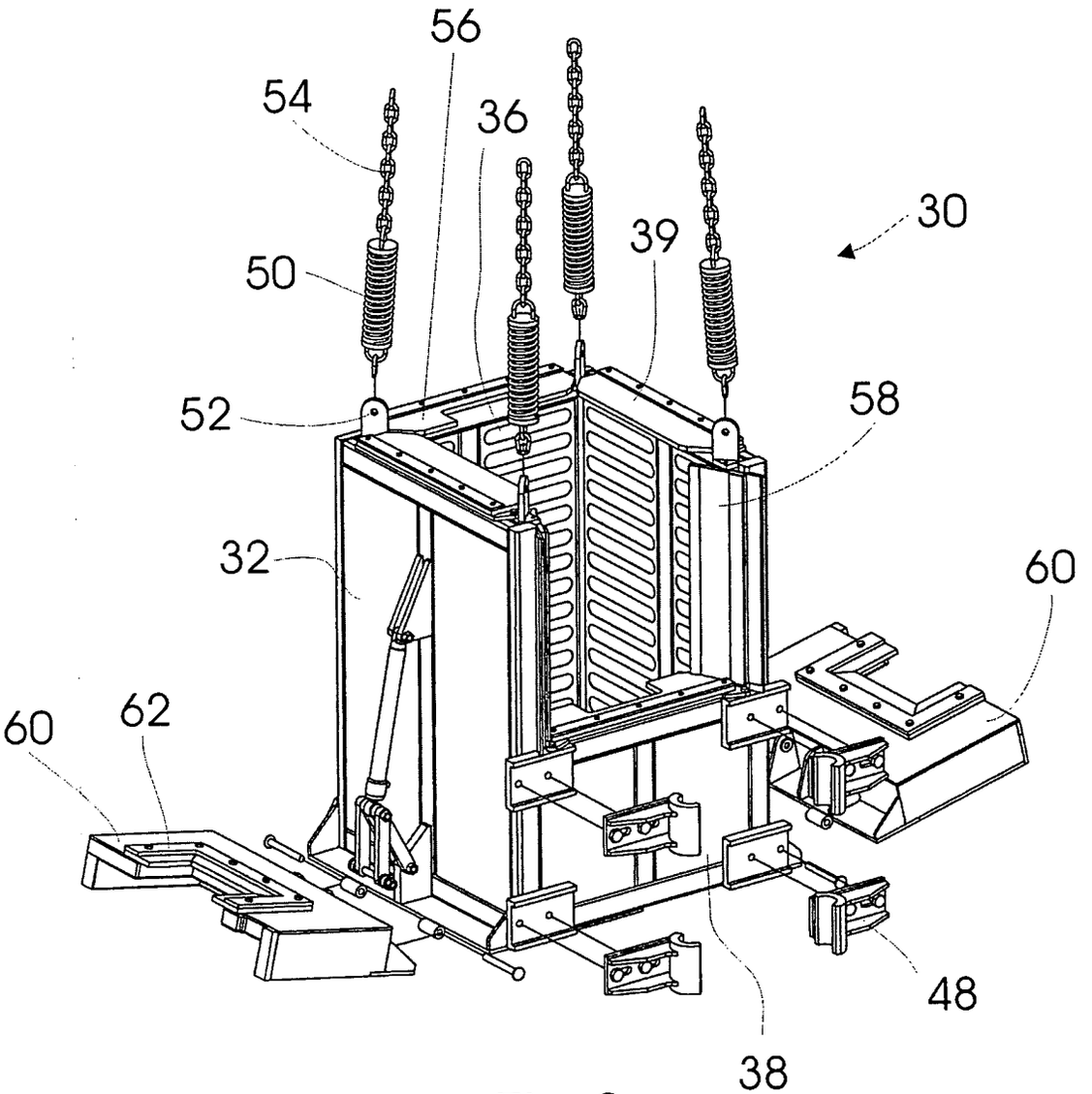


Fig 2

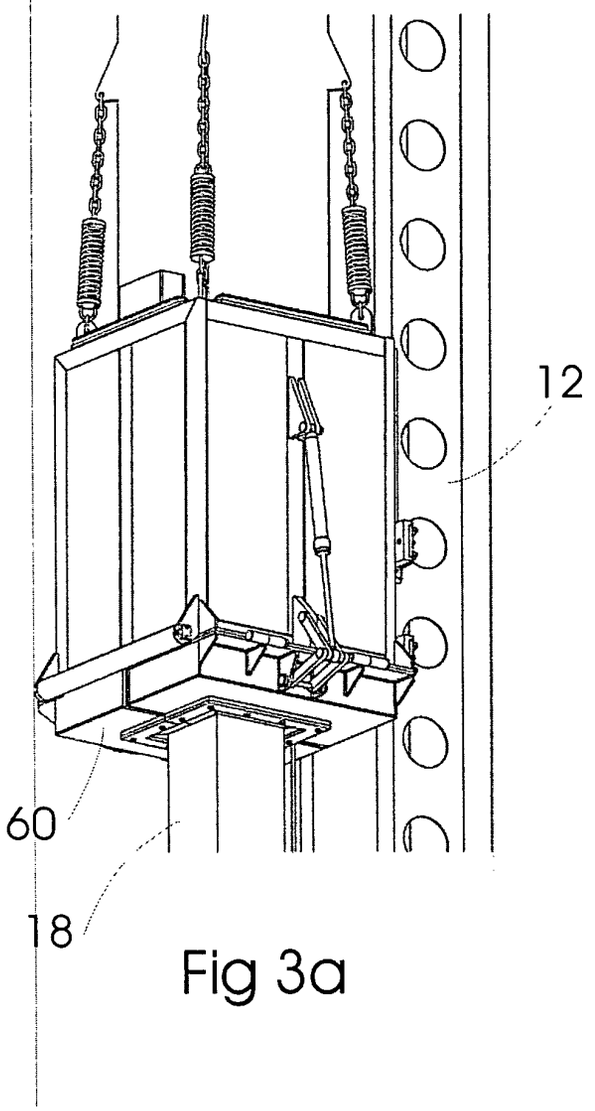


Fig 3a

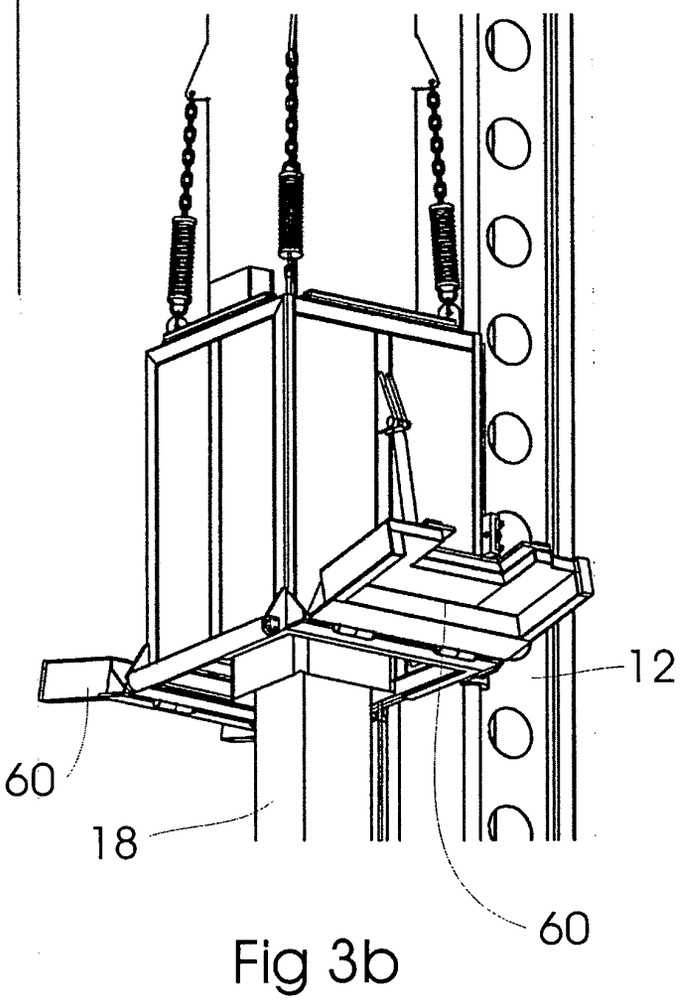


Fig 3b

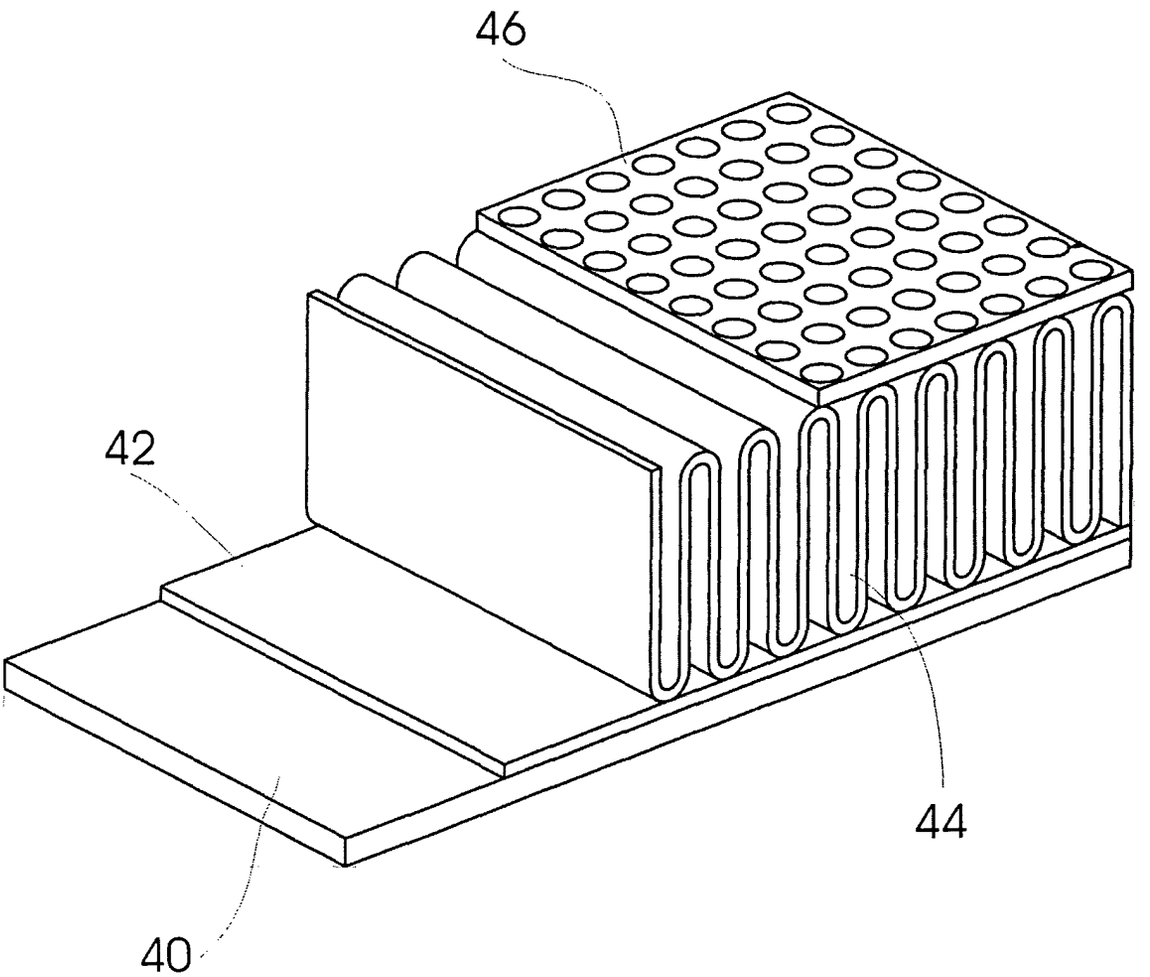


Fig 4

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# EUROPEAN SEARCH REPORT

Application Number
EP 04 38 8059

## 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) |
|---|---|---|---|
| A | PATENT ABSTRACTS OF JAPAN<br>vol. 018, no. 529 (M-1684),<br>6 October 1994 (1994-10-06)<br>& JP 06 185055 A (RAITO KOGYO CO LTD),<br>5 July 1994 (1994-07-05)<br>* abstract * | 1-6 | E02D13/00 |
| A | US 4 124 987 A (HALLMAN PHILIP J ET AL)<br>14 November 1978 (1978-11-14)<br>* column 2, line 4 - column 5, line 3; figure 1 * | 1-6 | |
| A | GB 1 577 334 A (WESTS PILING & CONSTRUCTION CO)<br>22 October 1980 (1980-10-22)<br>* page 1, line 36 - page 3, line 8; figure 1 * | 1-6 | |
| A | CH 574 018 A (LEHMANN RICHARD)<br>31 March 1976 (1976-03-31)<br>* column 1, line 1 - line 20; figures 1,3 * | 1-6 | |
| | | | TECHNICAL FIELDS SEARCHED (Int.Cl.7)<br>E02D |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 28 December 2004 | Geiger, H |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 38 8059

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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28-12-2004

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82