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㉒ Applicant: **GÖTEBORGS BETONGPALAR AB,**
Verkstadsгатan 3, S-434 00 Kungsbacka 1 (SE)

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㉔ Inventor: **Johansson, John Ragnar, Pl. 1810 Hjuvik,**
S-423 00 Torslanda (SE)

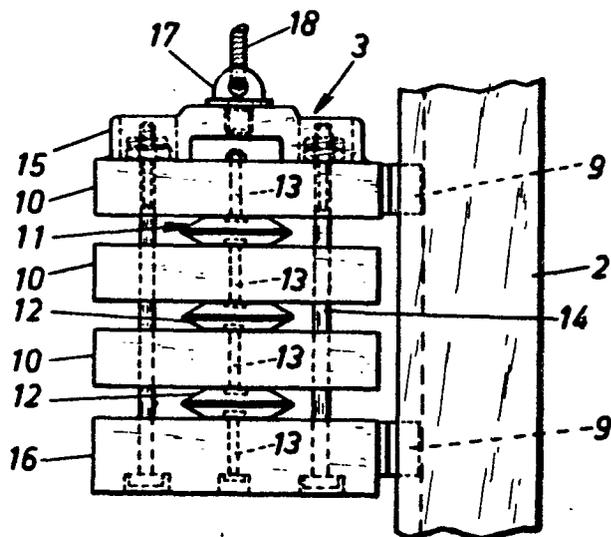
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㉖ Representative: **Ryrlén, Evert et al, ALFONS HEDBERGS**
PATENTBYRÅ AB Aschebergsgatan 35,
S-411 33 Göteborg (SE)

㉗ **Improvements in pile driving machines.**

㉘ A device in pile driving machines including a drop hammer (3) which drives down piles into the ground.

The problem of preventing crushing and breaking damages to the piles is solved in accordance with the invention in that the drop hammer (3) consists of two or several superposed weight segments (10) arranged, against the action of spring members (11), to be drawn together as a result of their velocity energy when hitting the pile. The velocity energy is adjustable by control of the bias of the spring members (11) with the aid of connecting rods (14) passing through the weight segments (10).



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Improvements in Pile Driving Machines

The present invention relates to pile driving machines of the kind which by means of a drop hammer ram down piles into the ground.

5 A problem connected with pile-driving operations is the crushing and breaking damages to which the piles are sometimes exposed when they are being subjected to the impacts from the drop hammer. One cause of damages of this kind is that the kinetic energy of the drop hammer, which may be
10 considerable, is momentarily released when the hammer hits the pile. For economical reasons it is also advantageous to use small and comparatively light drop hammers which are allowed to hit the pile at high speeds of impact. Another reason is that the tip of the pile penetrates a high-density section
15 of the ground.

One method of limiting damages to the piles is to protect the heads thereof with an impact-absorbing pad made from e.g. hard wood. However, the pad is capable of protection only against direct crushing damages from impact on the upper part
20 of the pile. So far, it has not been possible to solve as easily the problems of breaking damages. By measuring the pressure wave propagated from the drop hammer down to the pile one has found that it is favourable to reduce the force of impact on the pile and instead prolong the space of time
25 during which the force acts on the pile. On the basis of these findings the pads have been further developed and provided with spring means which are compressed at the moment of impact and thus prolong the time factor of each operative stroke.

30 Resilient pads of this type usually comprise a large number of cup springs (often about 40) which must be covered

with some lubricating medium in order to provide the desired resilient compression.

The resilient pads thus comprise a large number of parts which must cooperate in order to give the desired effect and which must also be provided with means allowing the spring units to be biased. For these reasons the length of the pad usually considerably exceeds 1 meter. The great length is a disadvantage, since it limits the length of the drop-hammer stroke, at least in the initial stage of the driving-down of each pile section.

The device in accordance with the subject invention is intended to utilize more efficiently the kinetic energy of the drop hammer and to reduce to a minimum the vertical dimensions of the pad. This is achieved in that the drop hammer comprises two or several superposed weight segments which are arranged against the action of spring means, such as resilient portions of the segments, to be drawn together as a result of their velocity energy when hitting the pile, and in that this velocity energy is adjustable by control of the bias of the spring means with the aid of connecting rods passing through the weight segments.

The invention will be described in closer detail in the following with reference to the accompanying drawings, wherein

Fig. 1 is a front view of a pile-driving machine in accordance with the invention,

Fig. 2 illustrates schematically the stress at the moment of drop hammer impact, and

Figs. 3, 4, and 5 illustrate in lateral views three different embodiments of a pile-driving machine incorporating a drop hammer in accordance with the subject invention.

The pile-driving machine illustrated in Fig. 1 is mounted on a track-laying vehicle 1 which is provided with means to operate a pile-driving mast 2 and a drop hammer 3. The latter is displaceable in guides in the mast 2. Driving-down of a pile 4 into the ground is generally effected in the following manner: a hoisting mechanism lifts the drop

hammer 3 over some distance, inside the mast ,whereafter the drop hammer is allowed to fall onto the head of the pile.

The diagram in Fig. 2 shows the variations of the force of impact immediately after the drop hamme has hit the pile. The line of dashes 5 represents the force of impact effected by conventional drop hammers provided with pads of hard wood. As apparent from the diagram, the force of impact increases to a maximum value 6, whereupon it falls to a minimum value which corresponds to the dead load of the drop hammer. The continuous line 7 represents the force of impact effected by a drop hammer in accordance with the subject invention.

The drop hammer in accordance with the invention is provided with resilient means. The force of impact of a drop hammer of this kind increases to a plateau value 8 which lasts for a while and then drops again to the minimum value. The force of impact is not of the same magnitude as when drop hammers of conventional design are used; instead, it lasts over a longer period of time. This means that the driving-down movement of the pile is accelerated at a slower pace at the moment of impact but that the acceleration continues for a longer period of time. The strain on the pile therefore will be smaller, when a drop hammer according to curve 7 is used, despite the higher driving efficiency developed by such hammers.

The drop hammer illustrated in Fig. 3 which is displaceable along the mast along guide means 9, consists of a number of weight segments 10 which are held together in spaced relationship by spring members 11. In accordance with the embodiment illustrated in this drawing figure these spring members consist of cup springs 12 which are positioned rim-to-rim in pairs between each weight segment and which are retained in position at the centre of the weight segments 10 by bolt joining members 13. The weight segments 10 are interconnected by connecting rods 14 which allow adjustment of the bias of the cup springs 12. Owing to this possibility of adjustment it becomes possible to adapt the curve 7 to the

prevailing circumstances and the materials used. The drop hammer is provided with end pieces 15 and 16. The upper end piece is provided centrally with a lifting loop 17 to which a hoisting wire 18 may be secured.

5 The drop hammer illustrated in Fig. 4, like the hammer in accordance with the previous embodiment, is provided with weight segments 10, connecting rods 14 and end pieces 15 and 16. The spring members, are not however, cup springs; instead the springiness is obtained through indentations 19 and 20
10 which are formed in the weight segments proper in diametrically overlapping positions and impart to each weight segment a certain resilient deformability.

 The lower end piece 16 of the drop hammer 3 is illustrated in Fig. 4 in abutting position against an impact pad
15 21 which is arranged for sliding movement relative to the mast 2 with the aid of guide means 22. The impact pad 21 forms the impact area on which the hammer drops and is provided with a protective plate 23 which is made e.g. from laminated
20 wood fibre board and which is designed to protect the upper end of the pile 4. The pad 21 is also provided with a conically inwards inclining edge wall 24 which serves to guide the pile, ensuring that the latter remains in line with the direction of impact of the drop hammer.

 Like the drop hammers in accordance with the two previous
25 embodiments, the drop hammer shown in Fig. 5 is provided with weight segments 10 and spring members 11. The drop hammer in accordance with this embodiment is formed in one integral piece, having no separate end pieces. At least two
portions 25 and 26 of the drop hammer are formed with notches
30 27 which extend from diametrically opposite sides of the hammer at right angles to the longitudinal axis thereof, being distributed vertically along the drop hammer and spaced equal distances apart vertically but displaced in pitch, so that the notches on one side will be located between the notches
35 formed on the opposite side. The notches on both sides extend beyond the centre line of the drop hammer such that they will overlap as illustrated. Upon impacts on a pile 4 the thus

notched portions 25 and 26 of the hammer therefore are capable of bending somewhat resiliently, thus distributing the force of impact over some period of time.

As should be apparent from the foregoing it is possible to design the spring members 12 in a variety of ways within the scope of the subject invention, depending on the resilience properties aimed at. A comparatively non-yielding resilient drop hammer may be suitable in pile-driving operations in porous earth strata, whereas a more resilient and springy drop hammer might be more useful in more compact and solid earth strata. By altering the bias on the connecting rods 14 in accordance with the first and second embodiments described above, it is possible to vary in a simple manner the resiliency properties of these drop hammers in situ, that is on the mast 2.

The subject invention makes it possible to utilize more efficiently the velocity energy of drop hammers while at the same time safe-guarding against bending and crushing damages to the pile.

The invention is not limited to the embodiments described above and illustrated in the drawings, but a variety of modifications are possible within the scope of the appended claims. The weight segments as well as the spring members may be designed differently. The drop hammer may be operated hydraulically instead of by a wire 18 fastened in a hook. The means guiding the drop hammer and the impact pad may be arranged in other ways than shown and described. For instance, the drop hammer may be arranged to operate in a cage which is mounted for sliding movement along the mast 2 and the bottom of which forms the member of pile impact.

C l a i m s

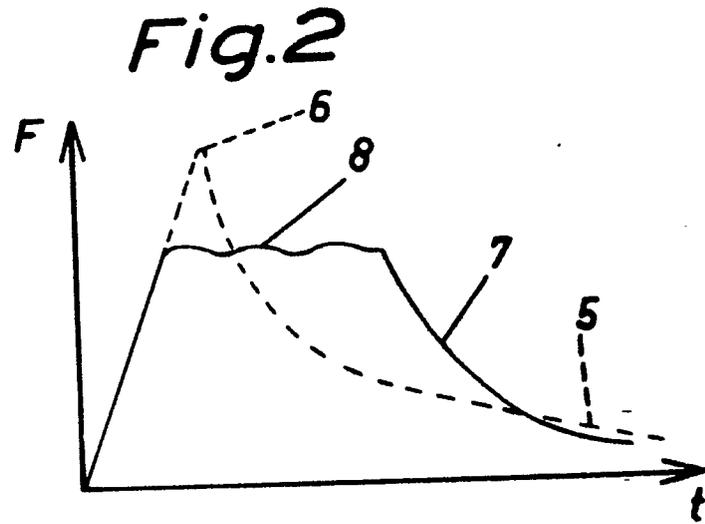
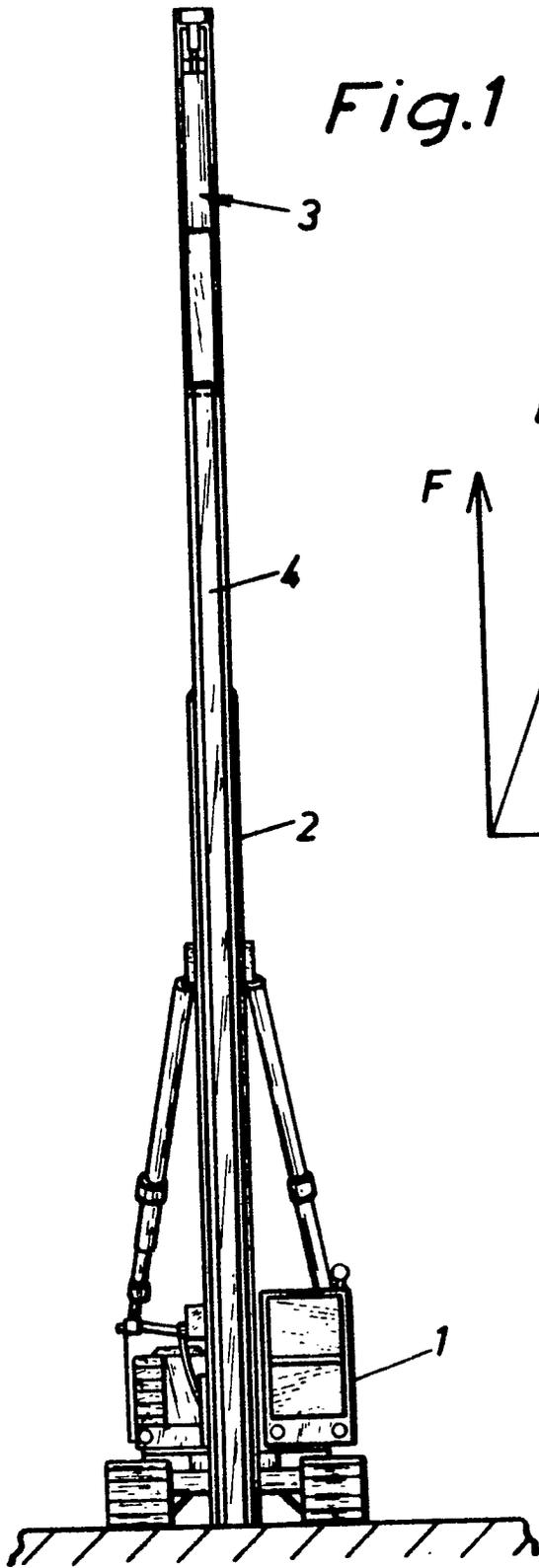
1. A device in pile driving machines of the kind which by means of a drop hammer ram down piles into the ground, characterised in that the drop hammer comprises two or several superposed weight segments arranged, 5 against the action of spring means, such as resilient portions of the segments, to be drawn together as a result of their velocity energy when hitting the pile, and in that this velocity energy is adjustable by control of the bias of the spring means with the aid of connecting rods passing 10 through the weight segments.

2. A device according to claim 1, characterised in that the spring means of said drop hammer are cup springs.

3. A device according to claim 1, characterised 15 in that the weight segments of the drop hammer are provided with indentations so located that they impart to each individual weight segment a certain resilient deformability relative to the vertically adjoining weight segments.

20 4. A device according to claim 3, characterised in that in alternate weight segments the indentation is positioned in the centre of one of the flat faces of the segments, that the indentation in the adjoining upper segment is positioned at the edge of the corresponding flat 25 face and that the indentations overlap diametrically.

5. A device according to claim 1, characterised 30 in that the drop hammer is provided with notches extending from diametrically opposite sides at right angles to and past the drop hammer longitudinal axis, said notches being distributed vertically along the drop hammer and spaced equal distances apart vertically but displaced in pitch so that every second notch will be positioned intermediate the notches formed on the opposite side.



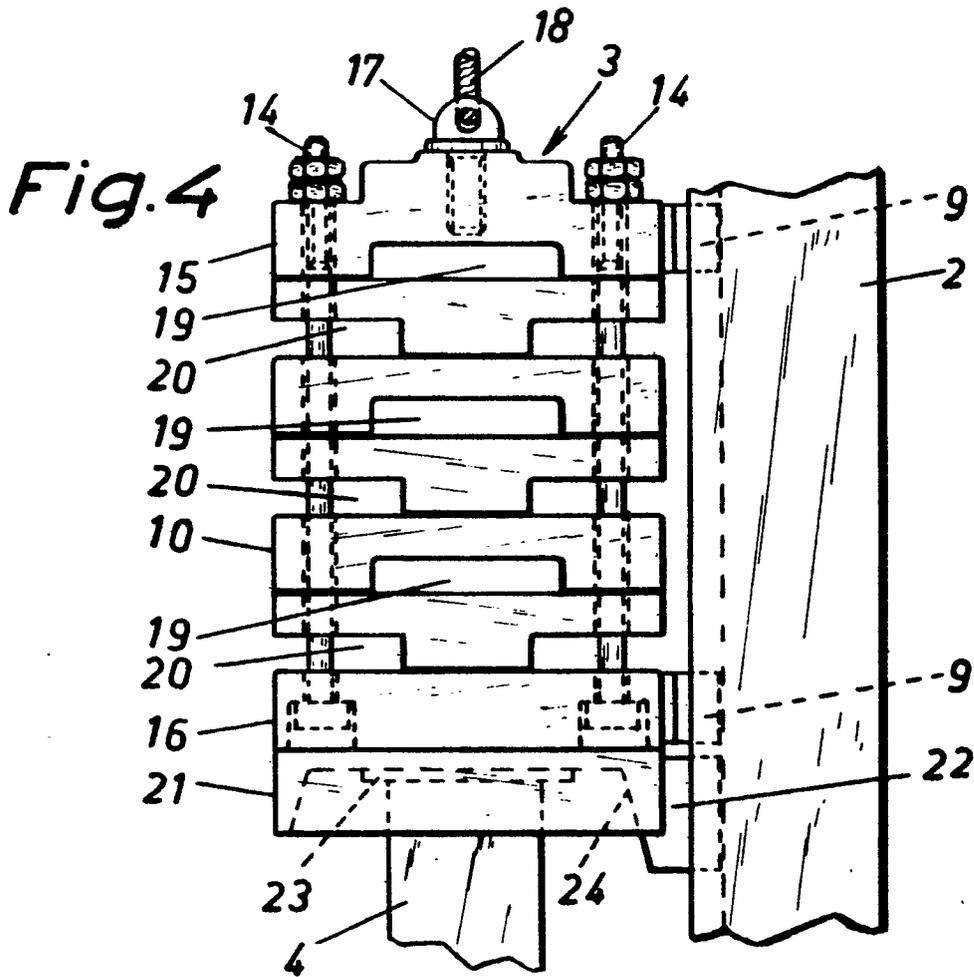
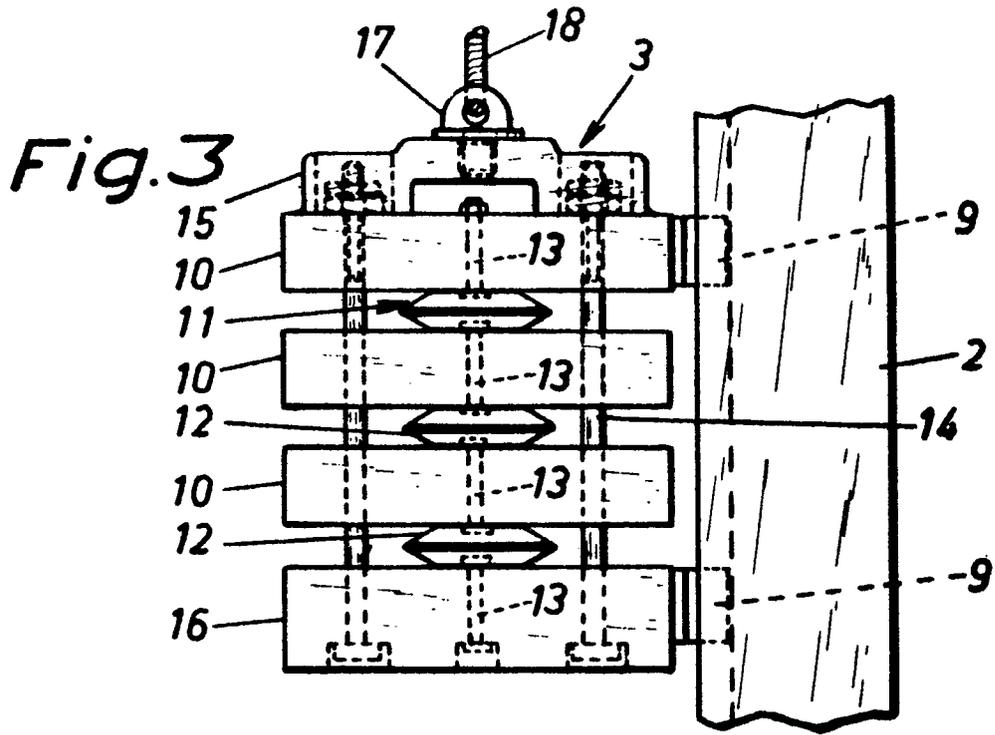


Fig.5

