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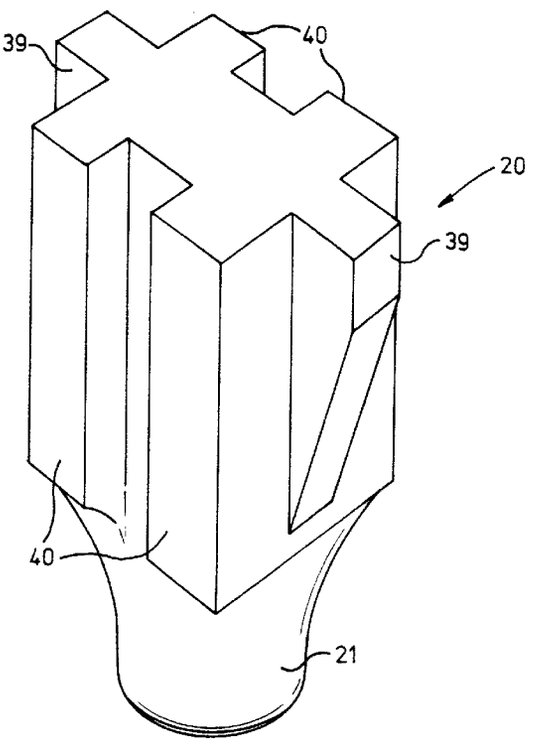
(54) Pile-driving installation with improved ram

(57) An installation for driving a slender object (11), such as a pile, tube or sheet pile section, into the ground or for extracting such a driven-in object from the ground comprises a hammer device with a ram (20), drive means (16) for moving the ram and striking means which can be brought into interaction with the slender object (11) and which have a striking face for receiving blows originating from the ram (20) brought into movement by the drive means (16). Viewed in the direction perpendicular to that side thereof which comes into contact with the striking face of the striking means, the ram (20) has a cross-sectional pattern which essentially changes continuously without discontinuities, such that the force waves which are generated in the ram when the ram strikes the striking means do not give rise or only slightly give rise to the generation of parasitic shock waves.

Fig-4



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Description

The invention relates to an installation for driving a slender object, such as a pile, tube or sheet pile section, into the ground or for extracting such a driven-in object from the ground, which installation comprises a hammer device with a ram, drive means for moving the ram and striking means which can be brought into interaction with the slender object and which have a striking face for receiving blows originating from the ram brought into movement by the drive means.

Installations of this type are generally known. The ram contained therein, which is also termed falling weight, has a mass sufficiently high to enable the desired impulsive forces to be developed in the slender object. The ram itself is likewise exposed to said impulsive forces and during the life of the ram this dynamic shock loading can, in view of the numerous fluctuations in load, give rise to fatigue problems.

In this context it is also important that many rams have on the underside a narrowed section or nose which interacts with a striking plate or driving cap which has been placed on the slender object. Said nose usually has an appreciably smaller cross-section than that part of the ram located above it.

The reasons for this shaping are, inter alia, that a part of the ram must have a specific minimum size of cross-sectional area in order to obtain a maximum impulsive force when the ram strikes the striking plate at a certain impact velocity. Furthermore, the impulsive force must be transmitted centrally onto the slender object as well as possible. This can be assured if the nose of the ram has a cross-section which is as small as possible.

With the known falling weights, there is an abrupt transition from the fairly narrow nose to the remainder of the falling weight. Often the necessary care is given to rounding off the transition regions, but nevertheless inadmissibly high stress concentrations, generated by the passage of the force wave originated at the striking face of the ram, are still found to occur.

On passing abrupt transitions or discontinuities, the force waves give rise to parasitic tensile waves and bending waves, which give rise to shearing in the material. These phenomena lead to increased stresses, in particular in the vicinity of the discontinuities. As a consequence of this, cracks can occur at these locations, as a result of which parts of the ram can ultimately become detached.

The aim of the invention is to offer a solution to this problem. Said aim is achieved in that the ram, viewed in the direction perpendicular to that side thereof which comes into contact with the striking face of the striking means, has a cross-sectional pattern which essentially changes continuously without discontinuities, such that the force waves which are generated in the ram when the ram strikes the striking means do not give rise or only slightly give rise to the generation of parasitic shock waves.

By virtue of the gradual transitions and changes in shape in the ram, no or hardly any stress concentrations are produced in the material of the ram as a consequence of the force wave, generated by a blow, as a result of which fatigue phenomena are substantially eliminated. The ram is as it were streamlined with respect to such a force wave, such that no parasitic shock waves are generated.

The shape of the ram can be varied in many ways, provided that the condition described above is met. In particular, good results can be obtained if the ram, which has at least one region having a relatively small cross-sectional area, such as a nose, and a region having a relatively large cross-sectional area, is constructed in such a way that the outer surface of the ram located between said regions is shaped such that each intersecting line is defined by the intersection of a plane running through the centre line or mid line of the ram and said outer surface consists of one or more curved sections and/or one or more straight sections, the curvature of said curved sections being between 1 and 20 degrees per metre length, and each tangent at a curved section, and each straight section, makes an acute angle with the centre line or mid line, which angle is between 0 and 20 degrees.

With a shaping of this type, with which, incidentally, slight deviations may be present between the various sections of the intersecting line which define the outer surface, as defined above, of the ram, it is found that stress concentrations hardly occur.

With regard to the slight deviations, the preference is for an angular displacement between the tangents of the adjoining ends of successive curved sections, or between the tangent of the end of a curved section and the successive straight section, or between successive straight sections, which angular displacement is between 0.1 and 5 degrees.

According to a first possible embodiment of the installation according to the invention, comprising a ram having a nose which can be brought into contact with a driving cap placed on the slender object, the nose is so constructed that there is a gradual transition between said nose and the remainder of the ram.

According to a second possible embodiment of the installation according to the invention, comprising striking means having a striking face oriented towards the slender object, as well as a pulling construction by means of which the striking means can be connected to the slender object, the ram has a striking portion which faces towards the striking face and which has a gradual transition to the remainder of the ram.

In the case of said latter embodiment, the installation comprises a frame in which the hammer device with drive means is mounted, which frame is provided at the bottom with a driving cap and can be guided along a leader of a mobile piling rig, in such a way that the frame with its driving cap can be positioned on a slender ob-

ject, the pulling construction comprising two cable loops (grommets) which extend along the frame and which each have a striking shoe at their upper end, which ram has two opposing projections which reach into the cable loops such that the striking shoes are located in the path of the projections.

The best results can be obtained if the ram is made of a material which is suitable for prolonged exposure to fluctuating shock loads. In this context the ram is preferably made of a forged high-grade steel which has a tensile strength of between 700 and 1000 N/mm^2. The yield point (sigma 0.2) of said material is preferably between 550 and 900 N/mm^2, whilst the Sharpey notched bar impact value is preferably between 40 and 100 Joule/cm^2 at a temperature of 20 degrees Celsius.

The invention will be explained in more detail below with reference to an illustrative embodiment shown in the figures.

Figure 1 shows an installation according to the invention, constructed as a mobile pile-driving installation.

Figure 2 shows an enlarged detail of the installation according to Figure 1.

Figure 3 shows a front view of the detail according to Figure 2.

Figure 4 shows a ram or falling weight as used in the installation according to Figures 1-3.

Figure 5 shows a detail with striking shoe.

The installation shown in Figure 1 comprises a mobile piling rig, which is indicated in its entirety by 1, provided with a mobile chassis 2 fitted with caterpillar tracks, as well as a cab 3 rotatably mounted thereon. A column 6 is fixed to said cab 3 in an adjustable manner by means of hydraulic cylinder-piston device 4 and 5. Both column 6 and the chassis 2 are supported on a substrate which, for example, consists of planks 7.

A leader 8 is mounted on the column 6, along which leader the frame 9, which is to be described in more detail, is slidable by means of claws 10.

By means of the piling rig 1 the tube 11 can either be driven in or extracted from the ground 12. Said tube 11 is provided at its top with a head 13 with fill opening 14 for pouring a concrete pile into the work. The frame 9 is positioned on the top end of the tube 11, as can also be seen in Figures 2 and 3. In Figures 2 and 3 the periphery of the frame 9 is indicated diagrammatically by dash-and-dot lines. One of the two main uprights 15 of said frame is also shown. A hydraulic cylinder-piston device 16, together with the associated accumulator installation 17 and hydraulic lines 18, is fixed close to the top of said uprights 15. The ram or falling weight 20 is fixed to the piston rod 19 of the hydraulic cylinder-piston device 16.

The ram 20 according to the invention can be used in two ways. According to a first possibility, in which it is used as an impact pile-driving ram, the ram 20 is moved upward by means of the hydraulic cylinder-piston device and is then released such that the nose 21 of the ram 20 is able to inflict blows on the driving cap 22 which has been placed on the top of the tube 11. In this case the installation according to the invention is functioning as an impact device driver inserting piles.

According to a second possibility, the ram can be used to extract a driven-in tube 11 from the ground. For this purpose the installation is equipped with two cable loops or grommets 23. Said grommets 23, which are made up from a single piece of cable, the ends of which have been fixed to one another by means of crimp connectors 24, comprise two essentially straight parts 25 as well as a lower part 26, which is curved through about 180°, and an upper curved part 27.

Pile shoes 28 are fixed at the lower curved portion and striking shoes 29 are fixed at the upper curved portion.

The pile shoes 28 and the striking shoes 29 possess an outward-facing essentially U-shaped slot which extends over an 180° bend. A striking shoe 29, the bottom of which is indicated by 30, is shown in Figure 5. The curved parts 27 of each grommet 23 are fitted closely in said U-shaped slot, such that they cannot be pulled flat under the influence of the tensile forces.

The curved cable sections 27, 28, which, because of the thickness of the cables used, try to assume a less curved shape, are held tightly in the U-shaped slot by means of bolts or pins 36 which extend between the two walls of said U-shaped slot.

A fixing cable 32 is fastened to the striking shoes 29, which fixing cable is connected by means of block 33 to a cable 34 which is suspended from the hoisting line 35 of the piling rig.

The pile shoes 28 located at the bottom of the grommets 23 are hooked under the lugs 38 which are welded to the pile 11.

The ram 20 has two opposing projections 39, which are positioned such that the striking shoes 29, in particular the striking face 37 thereof, are located in the path of said projections 39. The ram 20 can be accelerated upward by means of the hydraulic cylinder-piston device 16, the projections 39 ultimately each coming into contact with the striking face 37 of a striking shoe 29. The jolt generated as a result is transmitted via the cable loops 23 onto the pile 11, as a result of which said pile moves upwards.

While the blows are being struck, the cable loops 23 are continuously pulled upwards by means of the hoisting line 35 of the piling rig.

The striking face 37 of the striking shoes is preferably located some distance away from the imaginary mid point 41 of the circle which defines the bottom 30 of the U-shaped slot. This position of the striking face 37 prevents a situation where the striking shoes 29 would be able to start to tilt under the influence of the blows struck thereon by the projections 39.

The ram 20, which is shown in detail in Figure 4, is provided with guides 40 which engage, in pairs, on either side of, in each case, one main upright 15 of the frame 9.

As is shown in Figure 4, the nose 21 of the ram is narrower than the remainder thereof. The transition between said nose 21 and said remainder proceeds fluently via a curved line, such that the force wave generated in the ram 20 generates virtually no parasitic shock waves. There is also a gradual transition from the projections 39 to those parts of the ram 20 located lower down, so that here too the generation of parasitic shock waves is prevented.

By virtue of said shaping, virtually no stress concentrations occur in the ram 20, which has a favourable effect on the life thereof.

Claims

1. Installation for driving a slender object, such as a pile, tube or sheet pile section, into the ground or for extracting such a driven-in object from the ground, which installation comprises a hammer device with a ram, drive means for moving the ram and striking means which can be brought into interaction with the slender object and which have a striking face for receiving blows originating from the ram brought into movement by the drive means, characterised in that the ram, viewed in the direction perpendicular to that side thereof which comes into contact with the striking face of the striking means, has a cross-sectional pattern which essentially changes continuously without discontinuities, such that the force waves which are generated in the ram when the ram strikes the striking means do not give rise or only slightly give rise to the generation of parasitic shock waves.

2. Installation according to Claim 1, wherein the ram has at least one region which has a relatively small cross-sectional area and a region which has a relatively large cross-sectional area and the outer surface of the ram located between said regions is shaped such that each intersecting line is defined by the intersection of a plane running through the centre line or mid line of the ram and said outer surface consists of one or more curved sections and/or one or more straight sections, the curvature of said curved sections being between 0.1 and 20 degrees per metre length, and each tangent at a curved section, and each straight section, makes an acute angle with the centre line or mid line, which angle is between 0 and 20 degrees.

3. Installation according to Claim 2, wherein the angular displacement between the tangents of the adjoining ends of successive curved sections, or between the tangent of the end of a curved section and the successive straight section, or between successive straight sections, is between 0.1 and 5 degrees.

4. Installation according to Claim 1, 2 or 3, comprising a ram having a nose which can be brought into contact with a driving cap placed on the slender object, there being a gradual transition, in respect of shock waves, from the nose to the remainder of the ram.

5. Installation according to one of the preceding claims, comprising striking means having a striking face oriented towards the slender object, as well as a pulling construction by means of which the striking means can be connected to the slender object, the ram having a striking portion which faces towards the striking face and, in respect of shock waves, has a gradual transition to the remainder of the ram.

6. Installation according to Claim 5, comprising a frame in which the hammer device with drive means is mounted, which frame is provided at the bottom with a driving cap and can be guided along a leader of a mobile piling rig, in such a way that the frame with its driving cap can be positioned on a slender object, the pulling construction comprising two cable loops (grommets) which extend along the frame and which each have a striking shoe at their upper end, which ram has two opposing projections which reach into the cable loops such that the striking shoes are located in the path of the projections.

7. Ram for an installation according to one of the preceding claims, for driving a slender object, such as a pile, tube or sheet pile section, into the ground or for extracting such a driven-in object from the ground, which installation comprises a hammer device in which said ram is incorporated, drive means for moving the ram and striking means which can be brought into interaction with the slender object and which have a striking face for receiving blows originating from the ram brought into movement by the drive means, characterised in that the ram, viewed in the direction perpendicular to that side thereof which comes into contact with the striking face of the striking means, has a cross-sectional pattern which essentially changes continuously without discontinuities, such that the force waves which are generated in the ram when the ram strikes the striking means do not give rise or only slightly give rise to the generation of parasitic shock waves.

8. Ram according to Claim 7, wherein the ram is made of a forged high-grade steel having a tensile strength of between 700 and 1000 N/mm^2.

9. Ram according to Claim 8, wherein the yield point (sigma 0.2) is between 550 and 900 N/mm^2.

10. Ram according to Claim 8 or 9, wherein the Sharpey notched bar impact value is between 40 and 100

Joule/cm^2 at a temperature of 20 degrees Celsius.

Fig - 1

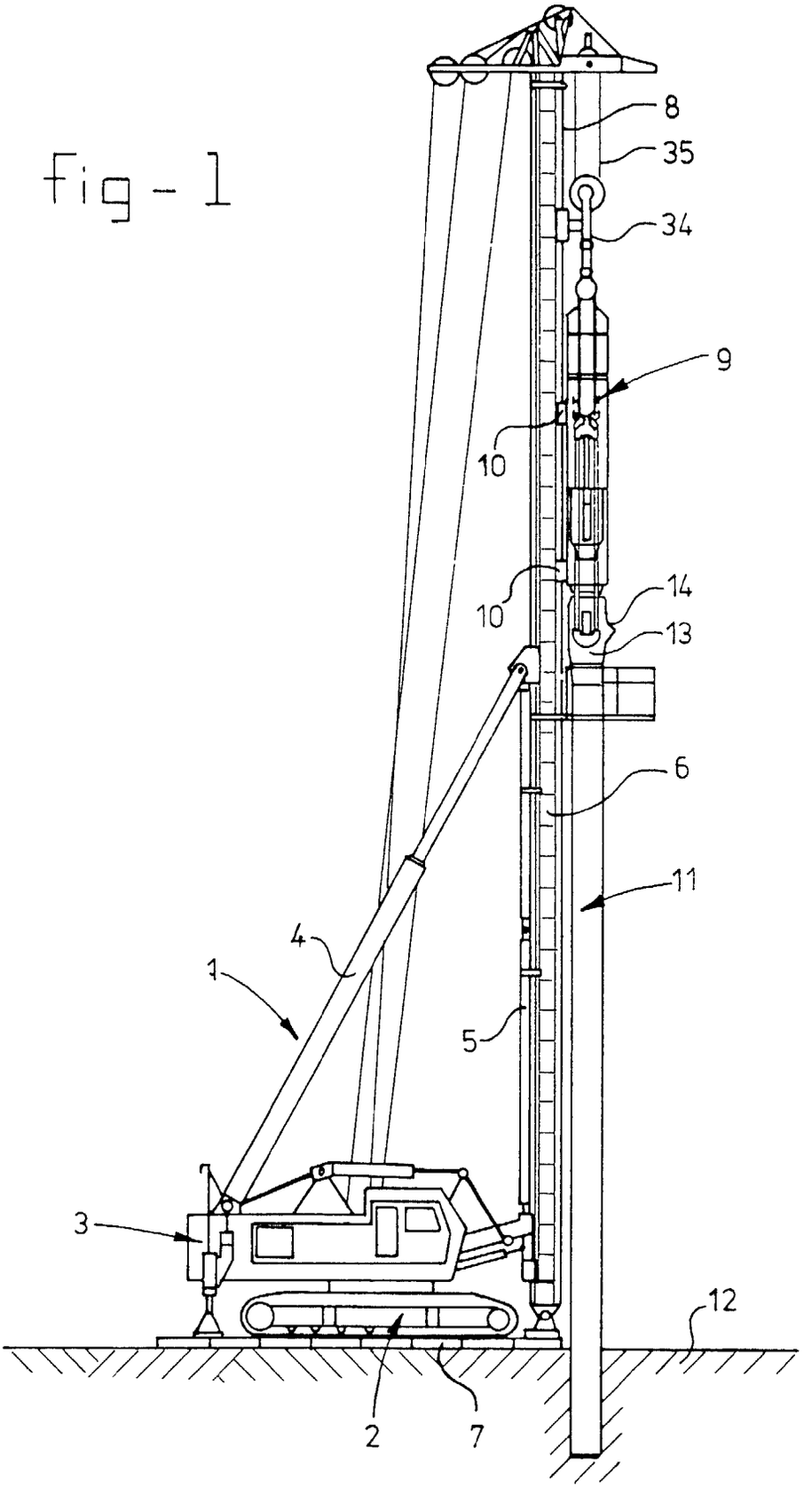

Fig - 2

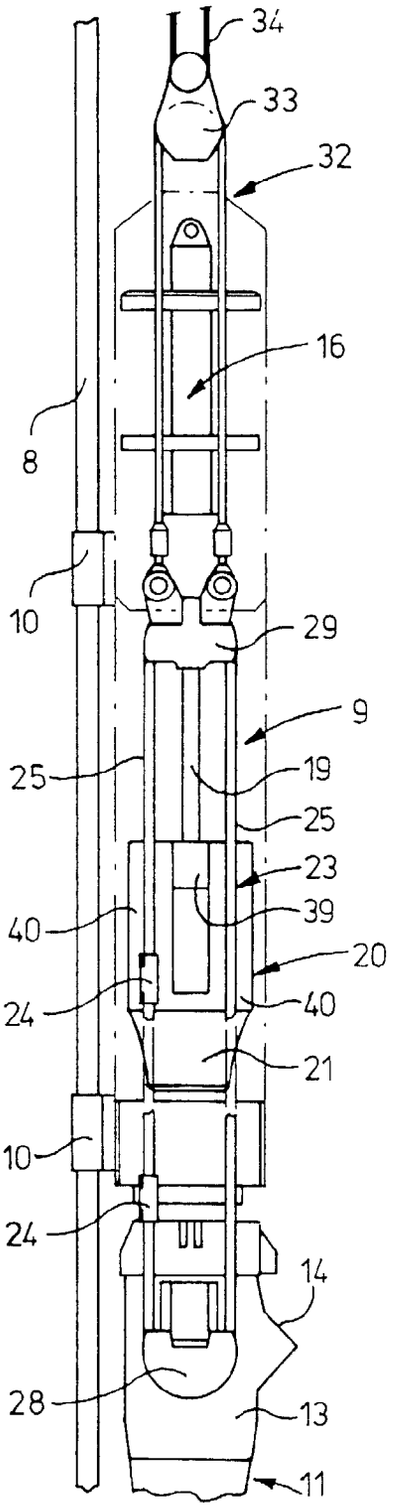
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Fig - 3

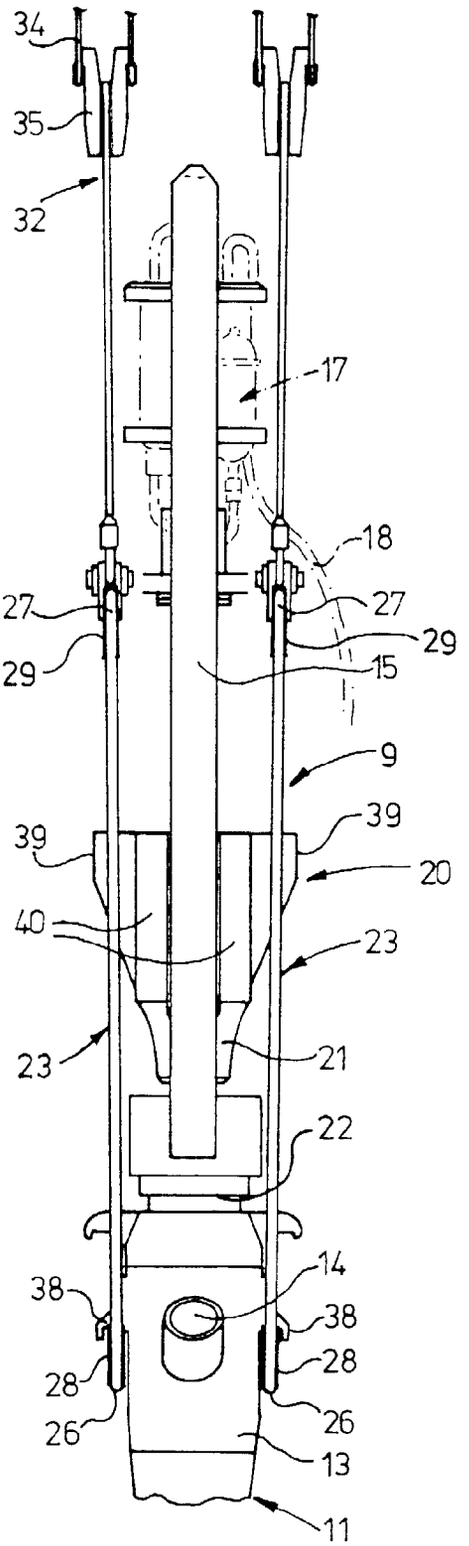
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fig - 4

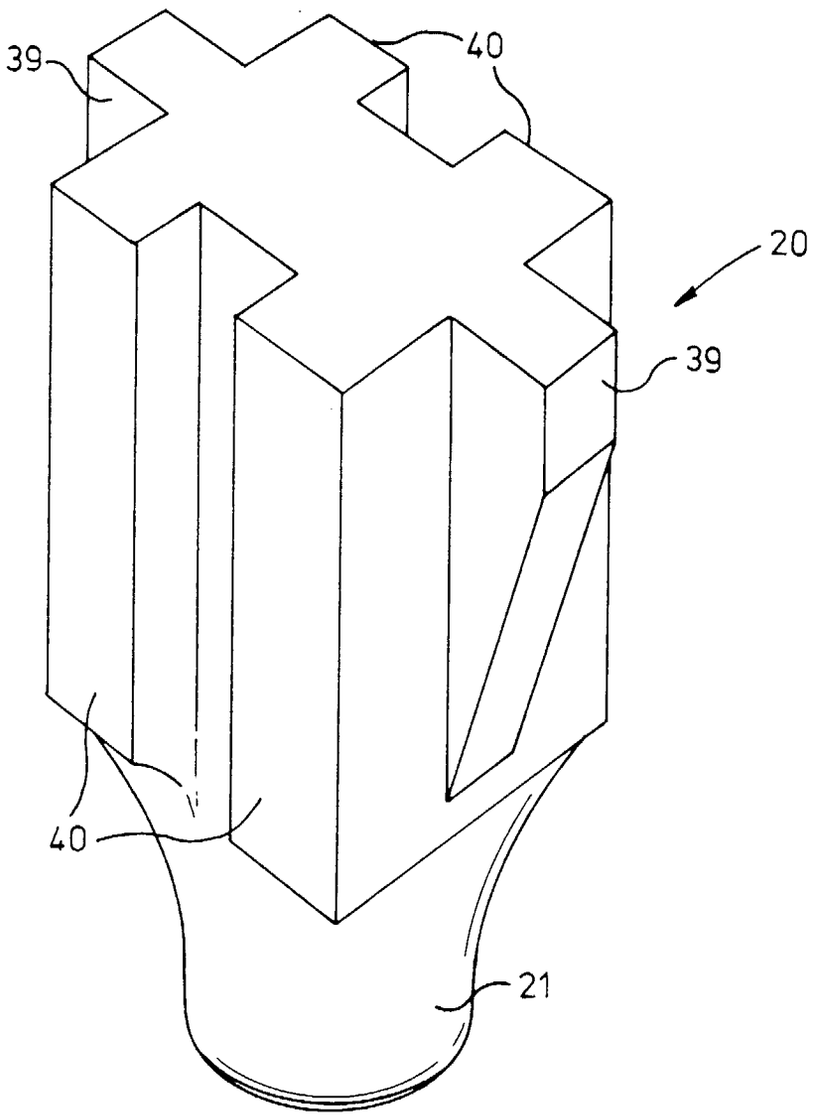
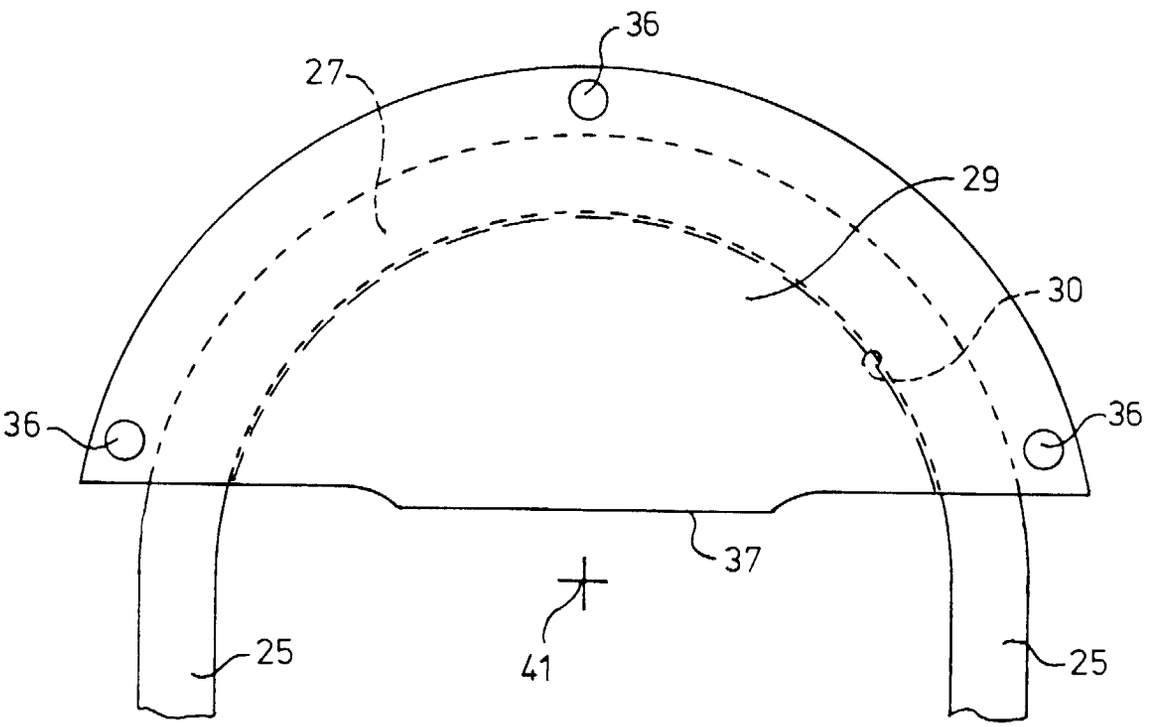


Fig - 5



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EUROPEAN SEARCH REPORT

Application Number
EP 98 20 0417

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.6)
X	GB 475 479 A (THE BRITISH STEEL PILING COMPANY LTD.) 16 December 1937	1,4,5,7	E02D11/00
A	* the whole document *	2,3,6	E02D7/14
X	FR 1 393 061 A (PAJOT) 8 February 1965	1,4,7	
	* the whole document *		
A	GB 1 178 962 A (THE BRITISH STEEL PILING COMPANY LTD.) 28 January 1970	6	
	* page 1, line 71 - page 2, line 15; figures *		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 April 1998	Blommaert, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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