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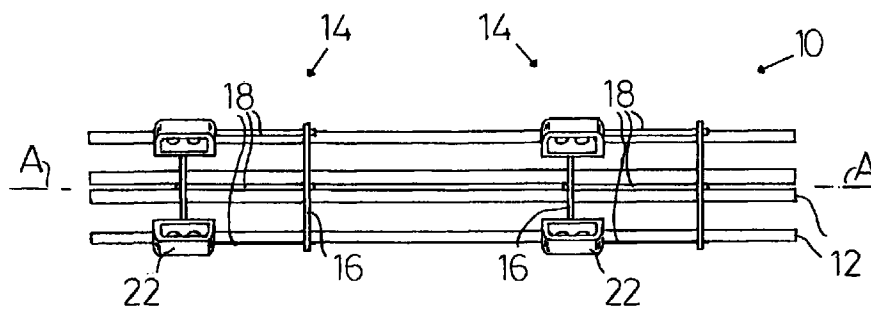
(54) **Cage former**

(57) This invention relates to a cage former (14), and in particular to a cage former for use in assembling and maintaining a pile cage (10) for a reinforced concrete pile.

According to one feature of the invention there is provided a cage former (14) having two frames (16) interconnected by a plurality of rods (18), the cage former having integral spacer means (22), characterised in that the spacer means is separate from each rod. Separating the spacer from the rod enables the number

of spacers to be chosen separately from the number of rods which may be required.

According to another feature of the invention, the spacer means (22) has an extended surface (30); this increases the surface area in engagement with the earth surrounding the pile in use, and reduces the likelihood that the spacer will dig into that earth and so misalign the pile cage.



**FIG 5**

**EP 0 955 423 A2**

**Description**

## FIELD OF THE INVENTION

[0001] This invention relates to a cage former, and in particular to a cage former for use in assembling and maintaining a pile cage for a reinforced concrete pile.

## BACKGROUND TO THE INVENTION

[0002] Reinforced concrete piles are known for use in the foundations of roadway bridges and the like. The piles are sunk deep into the ground and can for example provide a link between the bridge supports and the underlying rocks. The cage comprises a number of bars which in use are arranged to lie substantially along the longitudinal axis of the pile. The bars are interconnected so as to maintain their separation and alignment. The bars can be interconnected by a helical wire and/or by one or more frames arranged at intervals along the length of the bars.

[0003] In one known method of providing a reinforced concrete pile, a hole is drilled into the ground and a hollow metal tube known as a pile casing is inserted into the hole. The cage is lowered into the casing and then concrete is poured into the casing and around the cage. The casing is withdrawn so that it can subsequently be re-used.

[0004] In another method of providing piles, particularly smaller dimension piles, a hole is drilled into the ground by a hollow auger. When the hole has been drilled to the required depth the auger is removed. In this method, however, concrete is pumped down the central hollow shaft of the auger as it is removed. The introduction of concrete in this way avoids the requirement for a casing, and so provides a considerable saving in terms of cost. However, in the second-described method it is necessary to lower or push the cage into the concrete before it has set. This is not too onerous for smaller piles, but with larger dimension piles the risk of some of the concrete losing its workability before the cage has been inserted is too great, so that the first-described method is still used in such piles.

[0005] The cage former of the invention, and the prior art cage farmers described below, are primarily intended for use with the latter method.

[0006] The cage acts both as a reinforcement for the concrete and also as a means to tie the bridge support or the like to the pile.

[0007] In order to maintain the integrity of the pile it is necessary to ensure that the metal cage bars (and also the metal of the frames and/or interconnecting wire) does not encroach too near the surface of the concrete, and it is recognised that a "cover zone" is required within which either no metal, or only metal which is protected against corrosion, should be present. The cover zone will typically comprise a layer several centimeters thick adjacent the surface of the concrete.

[0008] Should unprotected metal encroach into the cover zone there is a risk that over time water and other agents will contact the metal and cause it to corrode, eventually breaking down parts of the pile. It is usually uneconomic to manufacture the whole pile cage from protected metal such as stainless steel or otherwise corrosion resistant metal, and so the manufacturers of piles and pile cages therefore seek to ensure that non-protected metal does not enter the cover zone.

## DESCRIPTION OF THE PRIOR ART

[0009] It is known to provide a rigid structure comprising a number of frames to which the cage bars can be secured, the rigid structure being referred to herein as a cage former.

[0010] One cage former is shown in GB patent application 2,235,223. In that cage former, two frames are interconnected by four rods. The frames are of dissimilar size, one frame being adapted to lie inside the cage bars in use, the other being adapted to lie outside the cage bars in use.

[0011] In an effort to ensure that no part of the cage bars or cage former encroaches into the cover zone it is known to fit spacers to the cage former, and in particular to the frames. A widely used spacer for this purpose is a plastic wheel which has an opening so that it can be clipped onto the frame after the cage has been assembled. Such spacers suffer a number of disadvantages. Firstly, because the spacers are designed to be clipped into place on site they are relatively insecure; when the cage is being lowered or pushed down into the concrete the spacers can readily become detached from the cage former so that part of one or more of the cage bars and/or the cage former(s) can encroach into the cover zone; because the spacer has become detached within the concrete there is no way of knowing that this has occurred until the pile subsequently is either site-inspected or shows signs of corrosion damage. Secondly, the spacers can migrate around the frame so that two spacers may lie close to each other. The ability of the spacers to keep the cage bars out of the cover zone relies upon the spacers being substantially equally spaced, so that the grouping of two or more spacers severely impairs their effectiveness. Once again, there is no way to detect this until after the pile has been completed and the concrete has set.

[0012] European patent application 0 608 068 discloses a cage former having integral spacers, which cannot easily become detached therefrom. The spacers are provided by plastic-sleeved outwardly flared sections of the rods interconnecting the two frames. This cage former therefore avoids the problems associated with the use of the above-mentioned clip-on wheel spacers.

[0013] However, the cage former of EP 0 608 068 has its own disadvantages. Firstly, the outwardly flared rods introduce ferrous metal into the cover zone; notwith-

standing that the metal is protected by the plastic sleeve (assuming this remains intact) the presence of metal so close to the surface of the concrete is not welcomed by some pile constructors and specifiers. Secondly, the plastic sleeves provide relatively small area contact between the cage and the surrounding earth as the cage is being lowered or pushed into the concrete. In soft earth and/or with a heavy cage it is known that the sleeve can cut into the earth, so that the cage is no longer maintained centrally within the hole and metal of the cage bars and/or of the cage former which is not protected by a plastic sleeve can encroach into the cover zone. Thirdly, the rods serve the three functions of interconnecting the frames, carrying the spacers, and providing a location for securement to a cage bar. Accordingly, the number of rods is determined by the number of cage bars, and in larger cages some of the rods may be redundant in performing their interconnecting and/or spacing function. Fourthly, the plastic which in practice is used for the sleeves is PVC, and it is becoming increasingly recognised that the chlorides in the PVC can migrate and subsequently react with any water which is present so as to break down the concrete.

#### DISCLOSURE OF THE INVENTION

**[0014]** The object of the invention is to seek to avoid the problems associated with the known cage formers described above.

**[0015]** According to the invention therefore, there is provided a cage former having two frames interconnected by a plurality of rods, the cage former having integral spacer means, characterised in that the spacer means is separate from each rod.

**[0016]** By "integral" is meant that the spacers are substantially permanently secured to the cage former, and in particular are secured to the cage former "off-site" by the cage former manufacturer. The spacers are therefore distinguished from the prior art wheel-type spacers which are sufficiently loose to be fitted on site. However, since the frames and bars of the cage former are typically of non-corrosion resistant metal the spacer means will necessarily be of a different material to the remainder of the cage former.

**[0017]** Because the spacer means is separate from the rods, there is no requirement for metal to enter the cover zone. Alternatively stated, the present invention avoids the three functions of the rods of the cage former of EPA 0 608 068 which results in the presence of metal in the cover zone.

**[0018]** In addition, because the spacer means is separate from the rods, there is no requirement for there to be a spacer means associated with each rod. If the spacer means comprises discrete spacers, there may be fewer spacers than rods, as desired by the user.

**[0019]** According to another aspect of the invention there is provided a cage former having two frames inter-

connected by a plurality of rods, the cage former in use locating a number of cage bars, each of the cage bars having a longitudinal axis with the longitudinal axes of the respective bars being substantially aligned, the frames being substantially perpendicular to the longitudinal axes, the cage former having integral spacer means, the spacer means having a peripheral surface which in use lies adjacent or engages the surface of a hole formed for a pile, characterised in that the peripheral surface is extended in the longitudinal direction.

**[0020]** According to this aspect, the extended surface of the spacer means provides a larger area in contact with the earth as the cage is lowered or pushed into the concrete so that the spacer means is less likely to dig into the earth surrounding the hole. Thus, it will be easier to guarantee that the cage will be maintained centrally within the hole and that no metal will encroach into the cover zone.

**[0021]** Preferably, the spacer means is of plastics material, usefully polyethylene. The use of polyethylene is preferred since it does not contain chlorides which can react with the cage.

**[0022]** Desirably, the spacer means comprises at least three separate spacers arranged around one of the frames. Desirably also the spacers are mounted upon respective brackets which are each welded or otherwise affixed to a frame. Usefully, each bracket lies approximately mid-way between the connection of adjacent rods with said one of the frames.

**[0023]** Usefully, each spacer can be clipped onto a respective bracket. In such embodiments, the clipping of the spacers to the brackets will preferably be effected off site, usefully by machine, i.e. as above indicated the affixing of the spacers to the brackets will be sufficiently secure to ensure that a spacer will not inadvertently be removed during handling on site or whilst the cage is lowered into the concrete.

**[0024]** Preferably the frames are of similar size and are arranged to lie outside the cage bars in use. Preferably also the frames are substantially circular and coaxial.

**[0025]** Desirably, at least one intermediate locator bar is provided, intermediate two adjacent rods. The locator bar is connected to only one of the frames, and can serve to locate a cage bar and so avoid the requirement to provide a rod connected to both frames for every cage bar. Such a locator bar can be cheaper and lighter than a rod, and since it will only require securement to one of the frames there can result a saving of manufacturing cost, complexity and weight of the cage former (and so the assembled cage). There may also be a reduction in the time taken to assemble the cage on site.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0026]** The invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

- Fig.1 is an end view of a cage having four cage bars and fitted with a cage former according to the invention;
- Fig.2 is a side view of a spacer and its fixing bracket;
- Fig.3 is a view of the underside of the bracket and spacer;
- Fig.4 is a sectional view along the lines IV-IV of Fig.2;
- Fig.5 is a side view of the cage of Fig.1; and
- Fig.6 is a partial view of a cage former fitted with a locator bar.

#### DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0027] The cage 10 comprises four cage bars 12 which are held in relative position by two substantially identical cage formers 14.

[0028] In common with the prior art, each cage former 14 comprises a pair of frames 16 interconnected by a plurality of (in this embodiment four) rods 18, the frames and rods suitably being welded together. In the assembled cage as best seen in Fig.5, the longitudinal axes of the cage bars 12 are substantially parallel, the longitudinal axis A-A of the cage 10 being substantially parallel with those longitudinal axes.

[0029] Also in common with the prior art, the cage bars 12 are fixed to the frames 16 adjacent the connection of the frame to the respective rods 18, the fixings being effected on site by way of wire ties or the like. In this way, provided that the rods 18 are substantially equally spaced by the cage former manufacturer, the corresponding equal spacing of the bars 12 can readily be arranged.

[0030] Secured to one of the frames 16 of each cage former 14, as by welding, is a set of brackets 20. In this embodiment there are four brackets 20, each one being located approximately mid-way between the connections of adjacent rods 18. In other embodiments there may be more or fewer brackets (and also perhaps more or fewer rods), and the number of brackets can differ from the number of rods. However, it is necessary that there are at least three brackets suitably located around a frame to ensure that the metalwork of the cage former and thus the cage can be kept away from the surface of the concrete, i.e. out of the cover zone.

[0031] Secured to each bracket 20 is a spacer 22. In this embodiment each spacer is of moulded polyethylene, although other suitable materials can be used. The spacer has two lugs 24 which can be pressed into corresponding apertures 26 in the bracket 20. The shaping of the lugs 24 and apertures 26, and the resilience of

the material from which the spacer is produced, provide for secure clip fitting of the spacer 22 to the bracket 20, but resist the separation thereof except under considerable force; thus, the spacer is effectively permanently secured to the bracket and so is not likely to become separated therefrom either during handling on site or during insertion of the cage into the concrete. It is expected that the spacers will be secured to the brackets by machine as part of the manufacturing process of the cage former.

[0032] The separation between a lug 24 and the respective aperture 26 is exaggerated in Figs. 2 and 3, for clarity; in practice there would be little or no separation, i.e. the lugs 24 would be a tight mating fit within the apertures 26. Also, in practice the angle of undercut of the apertures 26, which angle is matched by the lugs, may be reduced to permit easier assembly of the spacer to the bracket, provided always that the subsequent inadvertent removal of the spacer from the bracket is substantially prevented.

[0033] The spacer 22 has a peripheral surface 30 which as the cage is lowered into the concrete will ordinarily engage the earth surrounding the hole which has been drilled for the pile. The increased area of this surface compared to that of the prior art, and in particular its extended dimension in the direction parallel to the axis A, reduces the likelihood that the spacer will cut into the earth, so that the cage will be maintained centrally within the hole and no metal will encroach into the cover zone.

[0034] In this embodiment the spacer 22 has a reduced thickness central portion 32 in which two openings 34 are formed. The central portion 32 is of reduced thickness, and the openings 34 are provided, primarily to reduce the weight and cost of the spacer whilst maintaining its integrity and minimising disruption to the concrete-mix components adjacent the spacer.

[0035] The spacer 22 also has curved edges 36, one of which edges will in use be the leading edge as the spacer is lowered into the concrete; the curvature on this edge is to reduce the resistance provided by the spacer as it enters and moves through the concrete, and thus to reduce the likelihood that the spacer 22 will become separated from its bracket 20. The edges 38 are also curved, for the purpose of limiting the effective projected cross-sectional area of the spacer, so as to seek to minimise the hydraulic resistance applied during cage installation.

[0036] In the embodiment shown the brackets 20 are secured to the outer periphery of the frame 16 and the spacers 22 project outwardly therefrom; in other embodiments the brackets may be secured to the inner periphery of the frame, the spacers then perhaps having a cut-out to bridge the frame.

[0037] Fig.6 shows a locator bar 40 suitable for use to locate a cage bar 12 in place of a rod 18. The locator bar 40 has recesses 42 adjacent its ends, and these can serve to locate wire ties 44, which in known fashion can

surround a cage bar 12 are secure it to the locator bar 40. Thus, each cage bar 12 can be secured to a locator bar 40 at two spaced positions.

[0038] Alternatively, the wire tie can be secured around the (welded) junction of the locator bar 40 with the frame 16, so that only a single securement position is provided. In such cases, the locator bar would not require recesses.

[0039] In the prior art arrangement of EPA 0 608 068, for example, the rods serve the three functions of {i} interconnecting the frames, {ii} carrying the spacers and {iii} providing location points for the cage bars relative to the frame.

[0040] For use in a cage having eight cage bars, with such a cage former it would be necessary to employ eight rods, each connected to both frames and with an integral spacer. The inventor has, however, realised that in such cages some of the rods are redundant in performing their interconnecting and spacing functions, i.e. the cage may be adequately spaced from the surrounding earth by three (though preferably four) spacers, and the provision of the additional rods and integral spacers merely to interconnect the frames and/or to locate the additional cage bars is expensive and an unnecessary waste of material.

[0041] The provision of separate locator bars avoids such waste of material. In a cage former for a cage having eight cage bars there could therefore be four rods 18 interconnecting the frames and four locator bars 40, each locator bar being located between two adjacent rods (and vice versa). Accordingly, four of the cage bars 12 would be located by rods 18 and four by the (shorter, lighter and cheaper) locator bars 40. The spacing function would be carried out by (at least three) separate spacers 22. The locator bars could be mounted upon the same frame as the spacers, or to the other frame, as desired.

[0042] Clearly, with larger cages having a greater number of cage bars the potential savings are increased. For example a cage having twelve cage bars might employ four rods, eight locator bars and four spacers. Even if the user specified six rods, six locator bars and six spacers for such a cage, the saving in material, weight and cost of the cage formers, and so the resulting cage, over the prior art arrangements, would be considerable.

[0043] As above indicated, the number of rods 18 interconnecting the frames 16 can be varied according to the requirements of the particular pile cage. The most critical factor will be the size of the cage - the larger the cage typically the greater should be the number of rods 18 to provide a substantially rigid interconnection between the frames. In addition, notwithstanding the possible use of locator bars as above described, typically greater number of rods will be required for cages having a greater the number of cage bars.

[0044] In addition, the number of brackets (and thus spacers) can be varied according to the requirements of

the particular pile cage and the ground conditions at the site, with once again larger cages likely utilising greater numbers of spacers.

[0045] Furthermore, whilst the cage 10 is shown with two cage formers 14, the number of cage formers used on a particular cage can be varied according to the requirements of the cage; longer cages (in the direction of axis A) typically requiring a greater number of cage formers.

## Claims

1. A cage former (14) having two frames (16) interconnected by a plurality of rods (18), the cage former having integral spacer means (22), characterised in that the spacer means is separate from each rod.
2. A cage former (14) having two frames (16) interconnected by a plurality of rods (18), the cage former in use locating a number of cage bars (12), each of the cage bars having a longitudinal axis with the longitudinal axes of the respective bars being substantially aligned, the frames being substantially perpendicular to the longitudinal axes, the cage former having integral spacer means (22), the spacer means having a peripheral surface (30) which in use lies adjacent or engages the surface of a hole formed for a pile, characterised in that the peripheral surface is extended in the longitudinal direction.
3. A cage former according to claim 1 or claim 2 in which the spacer means is of plastics material, preferably polyethylene.
4. A cage former according to any of claims 1-3 in which the spacer means comprises at least three separate spacers (22) arranged around one of the frames (16).
5. A cage former according to claim 4 in which there are fewer spacers (22) than rods (18).
6. A cage former according to claim 4 or claim 5 in which the spacers (22) are mounted upon respective brackets (20) which are each welded or otherwise affixed to only one of the frames (16).
7. A cage former according to claim 6 in which each bracket (20) lies approximately mid-way between the junction of adjacent rods (18) with said one of the frames (16).
8. A cage farmer according to claim 6 or claim 7 in which each spacer (22) can be clipped onto a respective bracket (20).
9. A cage former according to any of claims 1-8 in

which at least one locator bar (40) is secured to a frame (16), intermediate two adjacent rods (18).

10. A cage former according to any of claims 1-9 in which the frames (16) are of similar size, substantially circular and coaxial. 5

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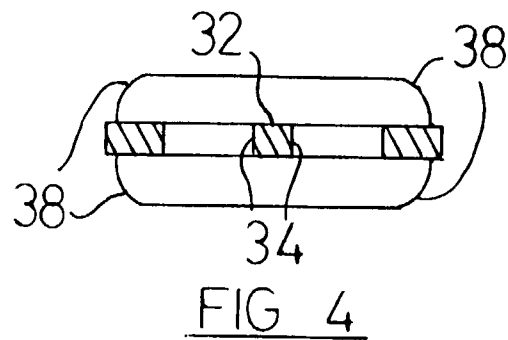
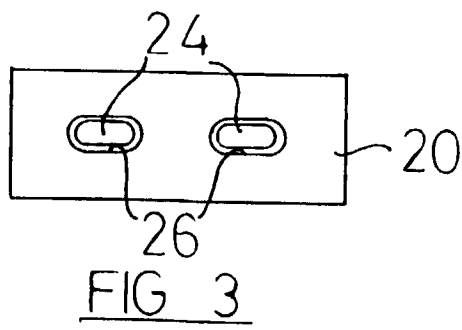
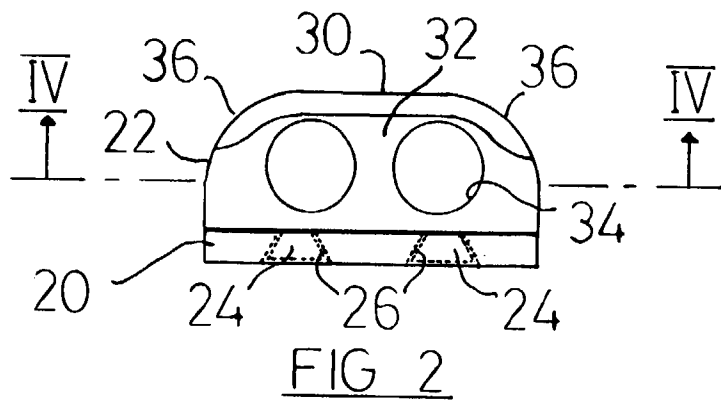
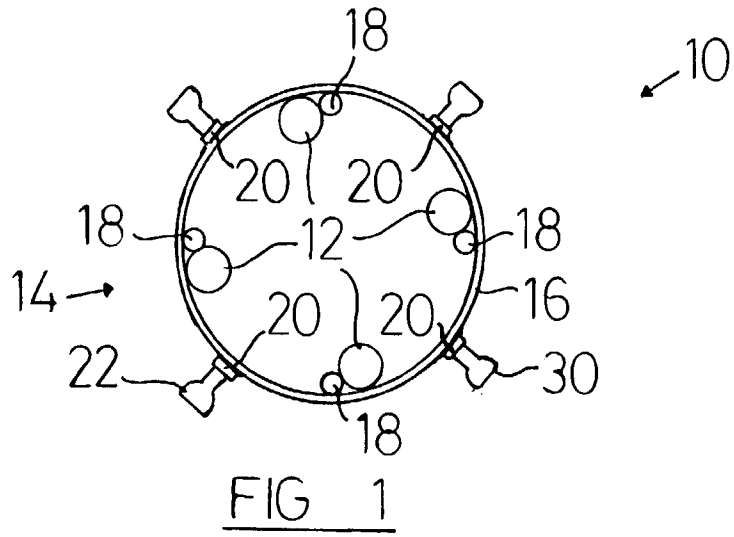
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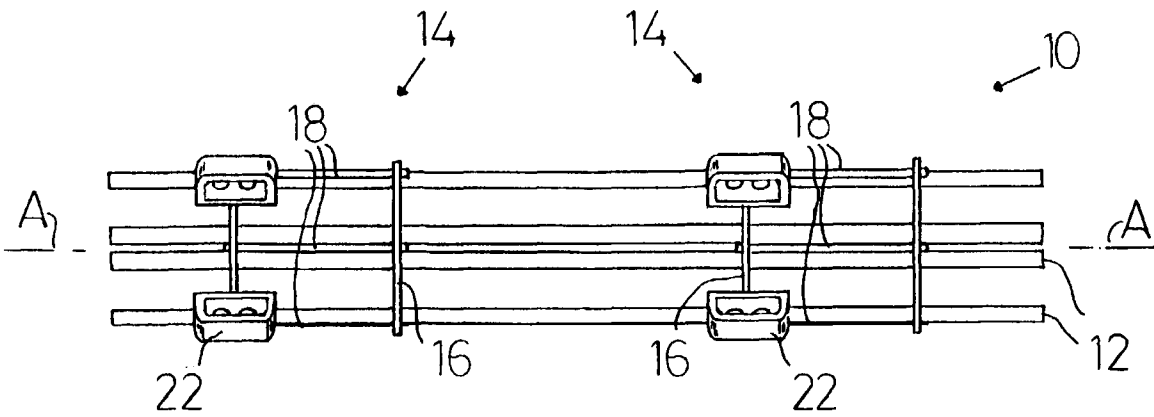


FIG 5

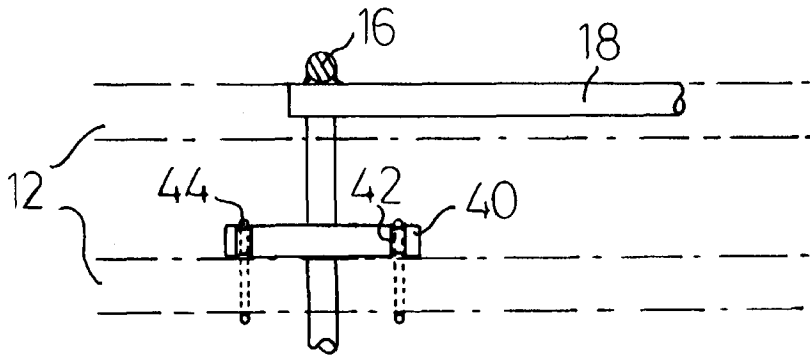


FIG 6