

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) ROTARY OSCILLATING APPLIANCE FOR FACILITATING THE DRIVING OR WITHDRAWAL OF A TUBE AS USED IN PILING AND LIKE OPERATIONS

(71) We, ELISABETH HOCHSTRASSER and JURGEN HOCHSTRASSER, of Kobenhüttenweg 22, Saarbrücken 3, Germany, both German Citizens, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a rotary oscillating appliance for the purpose of facilitating the driving or withdrawal of a tube as used in piling and like operations.

It has already been proposed to use a rotary oscillating appliance for facilitating the driving or withdrawal of such a tube and that appliance has an inertial mass mounted to rotate about the tube, the rotary oscillating movement of the mass being produced by a device linking the inertial mass with the tube and by stops provided on the periphery of the tube, the kinetic energy of the inertial mass being converted into hammer blows acting tangentially in relation to the periphery of the tube. In this known appliance, the inertial mass consists of a weighted disc rotatably mounted upon an attachment ring integral with the tube, the cylinder of a pneumatic ram being pivotally connected to the periphery of the disc whilst its piston rod engages the periphery of the attachment ring.

In this known appliance, the piston rods of the pneumatic cylinders directly engage the attachment ring, and the stops for transmitting the tangential blows are likewise arranged directly on the attachment ring. Therefore the tube and the complete rotary oscillating appliance, i.e. the inertial mass, form a single entity so that the casing, complete with rotary oscillating appliance, has to be lifted by a crane. This known design is suitable where rather small diameters and short lengths of tube are concerned. When larger diameter tubes are used, which, because of the higher friction which has to be overcome during driving and because of their

higher inertia, require a substantially higher energy amounting to several hundred tonnes-metres per impact, this known design is no longer suitable since to use the requisite cranes, able to cope with the higher weight of both the tube and rotary oscillatory appliance, is no longer economically feasible. In producing foundation works in this way, there is at the present time a general requirement for increasingly larger piles with diameters upwards of 1.2 m. Piles of this sort, with large diameters of for example 4 m. are required for the foundations of bridge piers, in harbour installations and for artificial islands. Nowadays too, single piles are required to support very high vertical forces at junction points in all kinds of structures. These large-diameter piles can withstand substantial bending moments, something which has to be avoided in the case of smaller piles.

It is an object of the present invention to improve the known type of appliance to the extent that it can be used in an economical fashion to drive and withdraw the large diameter tubes nowadays required.

In accordance with the present invention a rotary oscillatory appliance for the purpose referred to comprises an annulus which is detachably mountable concentrically on the tube so as to be fixed therewith, an oscillatory inertia mass in the form of a lever mounted concentrically on the annulus for limited angular movement relative thereto and having a plurality of arms with weights detachably mounted at the ends of the arms, at least one drive ram coupled between the annulus and the lever and operable to cause said relative angular movement and, around the outside of the annulus, a plurality of stops which, when each or said drive ram is operated are engaged by stops fixed with the lever whereby the inertia energy of the lever is transmitted to the annulus for transfer to the tube. The invention is based upon recognition of the fact that a rotary appliance

suitable for handling maximum diameter
 piles can be handled by cranes normally
 available on site, if there is a facility for
 separating the tube from the rotary appliance
 and for distributing the inertia mass needed
 to produce a high impact energy, of the order
 of several hundreds of tonnes-metres, into
 a plurality of individual weights which are
 arranged in the appliance in such a way as to
 be individually detachable. In an appliance
 proposed in accordance with the present
 invention, first of all a tube can be separately
 set up in a bore-hole, then the appliance can
 be assembled on the tube without the weights,
 and finally the individual weights can be
 assembled in the appliance. Using an
 appliance in accordance with the invention, it
 is possible to produce practically any desired
 impact energy by arranging for the lever to
 have not simply two arms, but three
 arms arranged at 120° intervals or four
 arms arranged at 90° intervals. Likewise,
 when extracting the tube the appliance in
 accordance with the invention can be handled
 by conventional lifting tackle, because, prior
 to extraction, the individual weights can
 be removed from the lever; with the weights
 removed, the appliance remains in position
 on the tube during extraction, and the impact
 energy produced by the weightless lever
 is sufficient, with the tube under tension, to
 rotate the tube a small amount with each
 blow with the result that there may develop
 around the pipe a lubricating film which
 facilitates the extracting operation, overcom-
 ing the adhesion so that the tube and lever
 can be withdrawn. When driving in the tube,
 the assembled weights are used to produce
 the necessary high impact energy for this
 operation. A further feature of the invention
 is that the projections on the inside of
 the annulus are symmetrically disposed
 projecting coupling dogs whose lateral faces
 taper inwardly in a downward direction, and
 on the tube there is fixed a coupling ring
 equipped with corresponding recesses. The
 annulus, together, with the rotary lever and
 drive elements, preferably in the form of
 pneumatic or hydraulic rams form a single
 unit which, through the medium of the
 coupling dogs on the annulus, can be inser-
 ted onto the coupling ring fixed to the tube
 and thus provides proper transfer of the
 developed impact energy. The coupling
 between the annulus and the coupling ring
 must be so contrived that on the one hand it
 locates the rotary appliance in the axial
 sense, on the tube, and on the other hand can
 properly transfer the impact forces developed
 tangentially in relation to the tube, without it
 being possible for the appliance, under the
 action of the impact forces, to rise off
 the coupling ring. In this context, it is
 also possible for example, for the internal
 peripheral surface of the annulus and the
 external peripheral surface of the coupling
 ring to taper conically outwards in the
 downward direction. By this measure, axial
 location of the appliance in relation to the
 tube is ensured, so that the force transmitting
 faces of the coupling dogs on the annulus
 and on the corresponding recesses in the
 coupling ring, need only have a slight
 inclination from the vertical in order to
 effect proper transfer of the tangential impact
 forces.

To accommodate the weights, open topped
 box-like attachments may be fixed in place at
 the ends of the arms of the rotary lever, into
 which the individual weights are lowered by
 the lifting tackle, or from which they can be
 removed. The box-like attachments may have
 downwardly convergent inside seating sur-
 faces and the external walls of the weights
 may have corresponding surfaces engageable
 therewith.

A further feature of the invention may be
 that the pairs of stops on the annulus and the
 rotary lever have vertically extending part
 circular section recesses and that in the recess
 formed in one stop of each pair, there is
 releasably attached a cylindrical pin for
 transmitting the impact energy to the
 particular opposite stop. The rotary lever
 normally has on the inside a series of
 symmetrically distributed stops or dogs
 which, with operation of the lever, engage
 with corresponding stops arranged on the
 external periphery of the annulus and thus
 transfer the impact energy from the beam
 through the coupling ring to the tube being
 driven. The impact energy is not transmitted
 directly by the pairs of stops; it is transferred
 through an exchangeable pin which is
 releasably attached in the groove-like recess
 in one stop and engages in the similar recess
 in the other to transfer the energy. It is clear
 that these pins are subjected to heavy wear
 and it is for this reason, that they are readily
 exchangeable. The pins can for example be
 made of copper or synthetic material. The
 pairs of stops distributed symmetrically
 above the periphery of the annulus and
 the rotary lever, ensure that the developed
 impact energy is symmetrically transferred.

Yet another feature of the invention is that
 there may be two mutually opposite drive
 rams, which are preferably attached to the
 underside of the rotary lever, in pivoted
 fashion, and whose piston rod ends engage in
 diametrically opposite eyes underneath the
 annulus. A further important feature is
 that at the top of the rotary lever, there
 are attached several support and guide rollers
 distributed symmetrically about the rotation
 axis of the lever and bearing against a top
 conical edge of the annulus, which serves as a
 race, the said rollers having a tapered form to
 correspond with the cone angle of the race.
 Outside the annulus there may be another

ring which is designed as a ball race and which is attached to the annulus through several brackets.

The invention will now be described with reference to the accompanying drawings, which illustrate the invention but in no restrictive sense.

Figure 1 illustrates a side elevation of the rotary appliance in accordance with the invention, partially in section;

Figure 2 is a plan view of Figure 1;

Figure 3 is a section through one of the boxes containing the weights;

Figure 4 is an enlarged fragmentary sectional view of an annulus with the rollers and the base of a rotary lever, in section;

Figure 5 shows part of of Figure 2 on a larger scale;

The rotary appliance for use with a tube 1 consists of three main easily separable parts, namely a rotary lever 2 and a pair of weights 3. The rotary lever 2 has two diametrically opposite arms with boxes 4 at the ends in which the weights 3 are detachably housed.

On the external peripheral surface of the tube 1, six coupling dogs 5 are attached whilst the lever 2 comprises an annulus 7 whose internal peripheral surface carries six mating dogs 6. The coupling dogs 5 on the tube 1 and the mating dogs 6 on the ring element 7 have downwardly tapered convergent end surfaces 6'. As the drawings clearly show, the dogs 5 and 6 engage one another and form a releasable connection between the tube 1 and the annulus 7. The dogs 5, 6 locate the lever on the casing in the axial sense, due to their tapered faces 6' which serve at the same time to transfer the torsional impacts exerted by the lever 2 through the annulus 7 upon the casing 1. The internal peripheral surface of the annulus 7 may be conically divergent in the downward direction as also may be the top outside surface of the tube or a coupling ring fixed thereto. The annulus 7 has two diametrically opposite eyes 10, in which there engage the piston rods 9 of the two rams 8, the latter being pivotally attached by means of pins 23 at the underside of a base plate 11 forming part of the lever 2. The plate 11 carries an annular collar 12 disposed concentrically in relation to the annulus 7. On the upper surface of the plate 11 rollers 13 are mounted in bearings 14; the rollers 13 have tapered surfaces 15 which run upon a corresponding conical race 16 formed at the upper surface of the annulus 7. The annulus 7 is in this way attached to the lever 2 in such a way as to be angularly movable by means of the rams 8 and their piston rods 9.

The annulus 7, as Figures 4 and 5 particularly clearly illustrate, has on its outside three symmetrically arranged projecting stops 17 (Figure 5). On the inside of the collar 12, likewise three projecting stops 18 are attached, which, with rotational

movement on the part of the rotary lever through the agency of the rams 8, 9, engage the stops 17 of the annulus 7 so that the impact energy produced by the rotation of the lever with its weights 3, is transmitted to the annulus 7 and through the coupling dogs 5, 6 to the casing 1. The stops 17 and 18, as Figure 5 indicates, have their lateral surfaces formed with semi-circular section, vertically extending recesses. In the semi-circular section recesses in the stops 17, impact pins 19, 20 are releasably attached. In the illustration of Figure 5, after rotation of the rotary lever 2 in the clockwise direction, the stops 17 and 18 engage one another through the impact pins 19.

The actuation of the rams 9 and 8 produces rotation of the rotary beam in the anti-clockwise direction, until the stops 18 on the collar 12 engage the other side of the stops 17 on the ring element 7, through the medium of the impact pins 20. In this fashion, by appropriately operating the rams 8, 9, the casing 1 is subjected to successive torsional impacts in alternate directions. The weights 3, as Figure 1 shows, are equipped with hooks 21 which enable them to be readily placed in, and removed from, the boxes 4. As Figure 3 indicates, the weights 3 and the boxes 4 have a tapered seating 22 which facilitates location of the weights 3 in the boxes 4, respectively.

The mode of operation of the appliance in accordance with the invention is as follows. First of all, the tube 1 equipped with the coupling dogs 5, is set up in a bore-hole. Then, the lever 2, with its annulus 7, is assembled on the tube, the mating dogs 6 being interengaged with the coupling dogs 5 on the tube 1. The lever 2 is now attached to the tube 1. Subsequently, the weights 3 are placed in the boxes 4. The appliance is now ready for operation. By actuating the ram arrangements 8, 9, the lever 2, with the weights 3, is operated in alternate directions, the resulting inertial energy being transferred to the tube 1 through the stops 17, 18 and the impact pins 19, 20, so that the tube experiences successive alternating rotational movements and in so doing, under the effect of the weight of the rotary lever, with its assembled inertial weights, is driven into the ground. If the tube is to be extracted, then first of all the weights 3 are removed from the boxes 4. Whilst a crane attached to the tube exerts an upward force on it, the ram parts 8, 9 are actuated to produce slight rotary movements in the tube, as a consequence of which the adhesion between the tube and earth is overcome and withdrawal of the tube is facilitated.

The advantage of the rotary appliance in accordance with the invention resides in the fact that the tube, the rotary lever and the

weights, can be handled separately so that even where tubes of larger diameter are concerned, the rotary appliance in accordance with the invention can be employed and the handling can be accomplished by normally available cranes.

WHAT WE CLAIM IS:—

1. A rotary oscillatory appliance for the purpose referred to comprising an annulus which is detachably mountable concentrically on a tube so as to be fixed therewith, an oscillatory inertia mass in the form of a lever mounted concentrically on the annulus for limited angular movement relative thereto and having a plurality of arms with weights detachably mounted at the ends of the arms, at least one drive ram coupled between the annulus and the lever and operable to cause said relative angular movement and, around the outside of the annulus a plurality of stops which, when each or said drive ram is operated are engaged by stops fixed with the lever whereby the inertia energy of the lever is transmitted to the annulus for transfer to the tube.

2. An appliance as claimed in Claim 1, wherein there are symmetrically disposed about the internal periphery of the annulus, projecting coupling dogs with downwardly convergent end faces, and the tube has at the top a coupling ring equipped with corresponding recesses.

3. An appliance as claimed in Claim 2, wherein the internal peripheral surface of the annulus and the external peripheral surface of the coupling ring are conically divergent in the downward direction.

4. An appliance as claimed in any of Claims 1 to 3, wherein at the ends of the arms of the lever, box-like attachments, open at the top, are provided for accommodating the weights.

5. An appliance as claimed in Claim 4,

wherein the box-like attachments, have downwardly convergent inside seating surfaces which are engageable by corresponding surfaces of the weights when occupying said box-like attachments.

6. An appliance as claimed in Claim 5, wherein pairs of stops on the annulus and the lever have in their mutually opposite lateral faces, vertically extending part circular section recesses, and wherein in the recess of one stop of each mutually opposite pair there is releasably attached a pin which serves to transfer the impact energy to the other stop.

7. An appliance as claimed in Claim 6, wherein the pin is made of copper or synthetic material.

8. An appliance as claimed in any of Claims 1 to 7, wherein two diametrically opposite drive rams are provided which are pivotally attached to the underside of a base part of the lever, and whose piston rod ends are located in diametrically opposite eyes provided on the underside of the annulus.

9. A rotary appliance as claimed in any of Claims 1 to 8, wherein on the top side of the lever, there are attached several support and guide rollers disposed symmetrically around the rotational axis of the lever and running on a frusto-conical edge of the annulus, which edge serves as a race, the said rollers having tapered peripheral surfaces corresponding to the cone angle.

10. An appliance as claimed in any of Claims 1 to 8, wherein outside the annulus there is a ring serving as a ball race, and is attached through brackets to the said annulus.

11. A rotary appliance for the purpose referred to substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

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