United States Patent

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[54] **ROTARY APPLIANCE FOR FACILITATING THE DRIVING OR WITHDRAWAL OF PILES, PIT-PROPS AND THE LIKE**
12 Claims, 7 Drawing Figs.

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[51] Int. Cl. B25d 15/00
[50] Field of Search 173/93, 94; 61/53.5

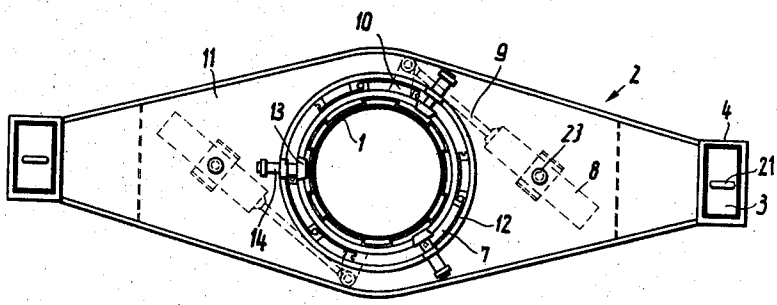
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ABSTRACT: Rotary appliances for driving and withdrawing piles, pit-props and the like, wherein the weights responsible for producing the inertia forces, and the pile or the like which is being driven or withdrawn by it, can all be separated from one another for ease of handling by conventional lifting tackle. The inertial energy developed by the rotary appliance is transformed into torsional hammer blows through coupling arrangements which incorporate elements which are easily exchanged and replaced when wear has taken place.



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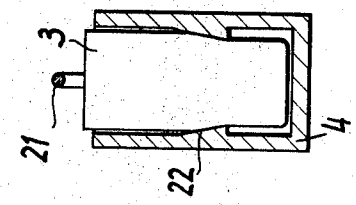


Fig. 3

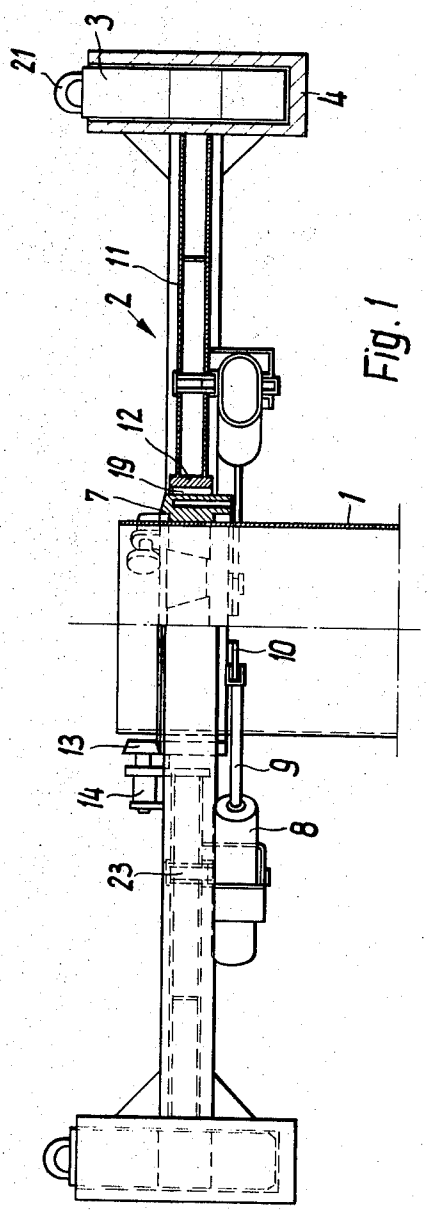


Fig. 1

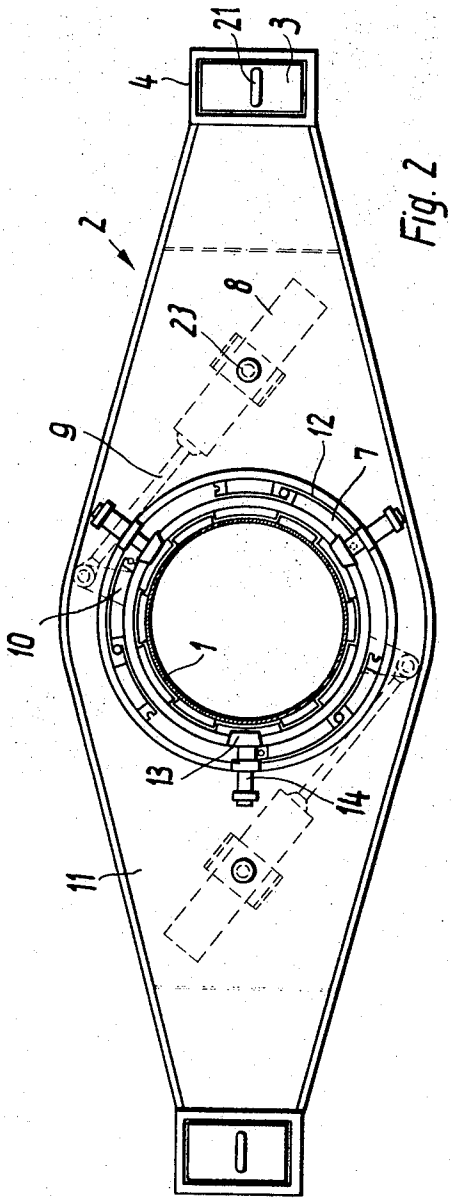


Fig. 2

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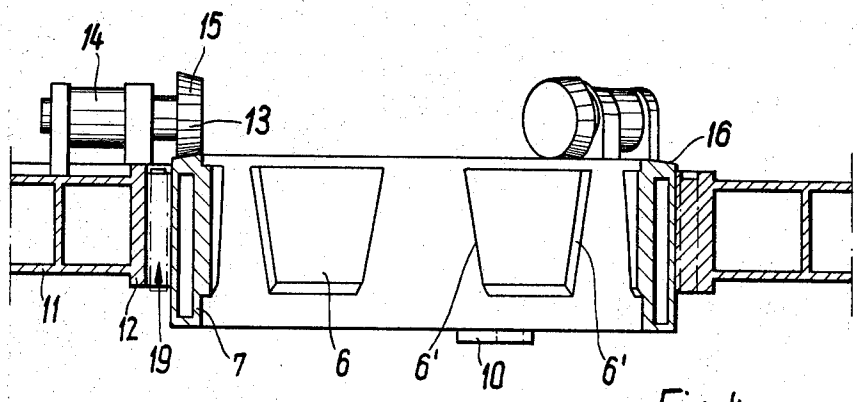


Fig. 4

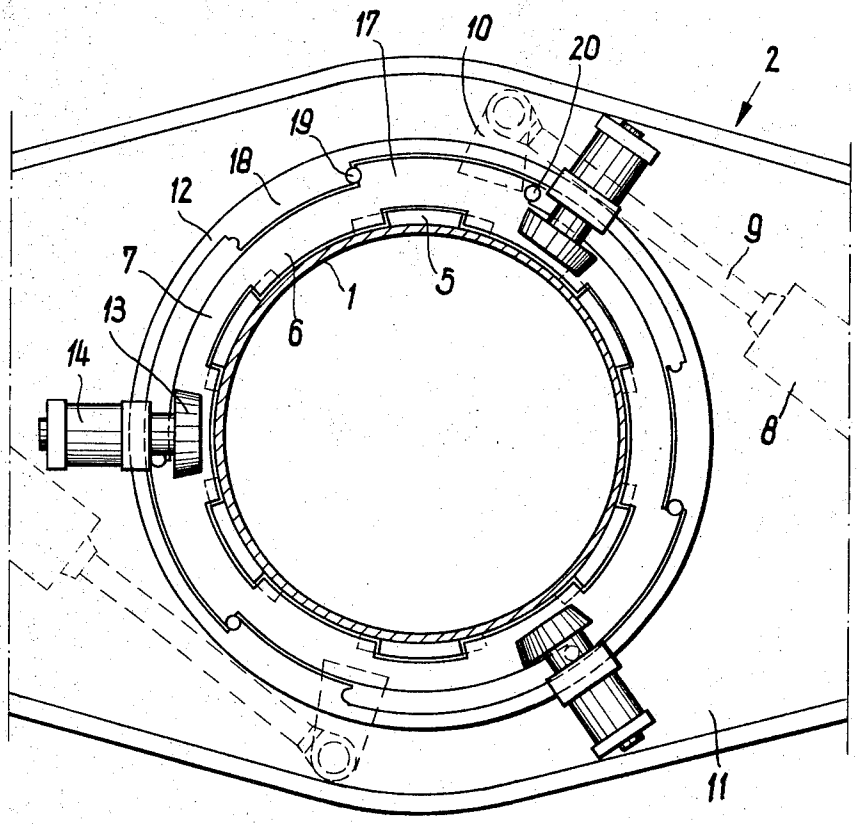


Fig. 5

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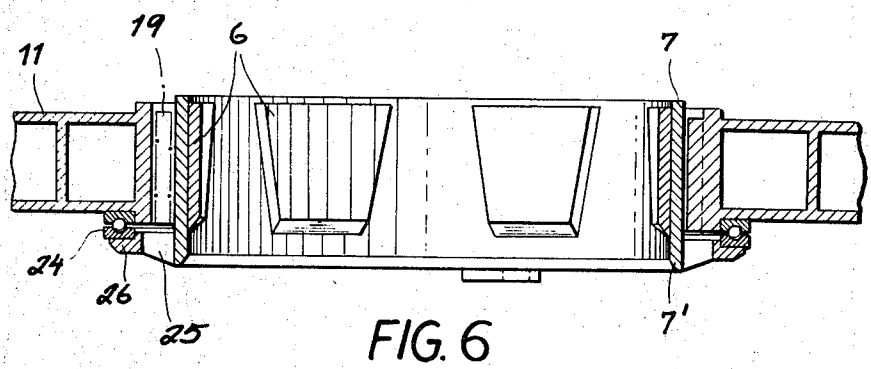


FIG. 6

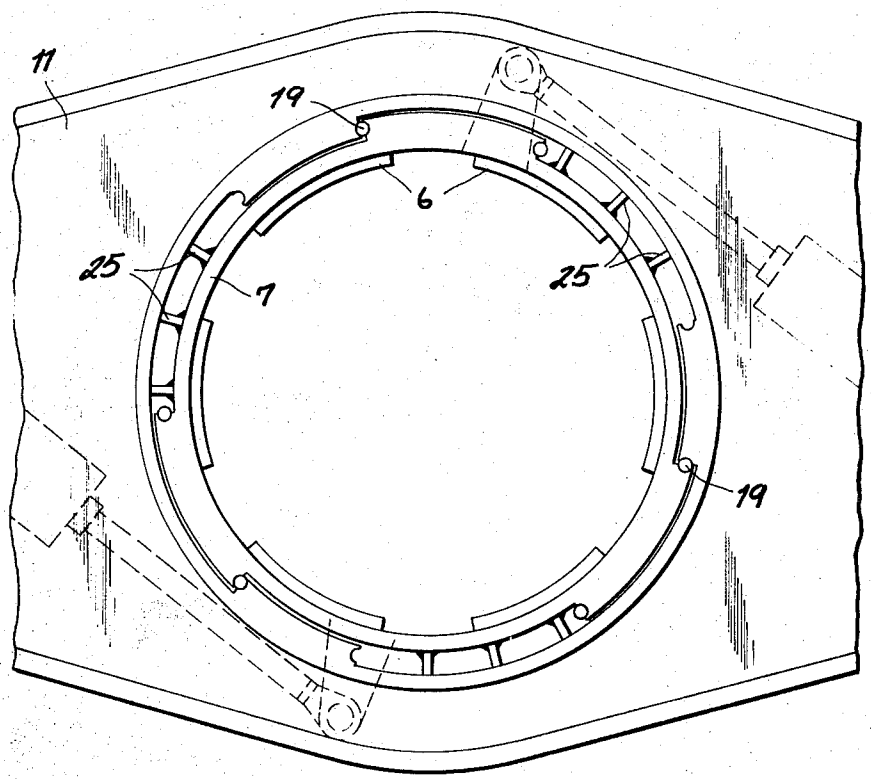


FIG. 7

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ROTARY APPLIANCE FOR FACILITATING THE DRIVING OR WITHDRAWAL OF PILES, PIT-PROPS AND THE LIKE

This invention relates to a rotary appliance for facilitating the driving or withdrawal of piles, pit-props or the like. It has been proposed previously to provide an alternating rotary appliance operating in opposite directions, for facilitating the driving or withdrawal of piles, pit-props or the like. Such a device has an inertial mass mounted to rotate about the pile, the alternating rotary movement of the mass being produced by a device linking the inertial mass with the pile and by stops provided on the periphery of the pile. The kinetic energy of the inertial mass being converted into hammer blows acting tangentially in relation to the pile periphery. In this known arrangement, the inertial mass consists of a weighted disc rotatably mounted upon an attachment ring on the pile. The cylinder of a pneumatic servomotor is articulatedly connected to the periphery of this disc while its piston rod engages the periphery of the attachment ring.

Moreover, in this known appliance, the piston rods of the pneumatic cylinders directly engage the casing pipe, and the stops for transmitting the tangential blows are likewise arranged directly on the casing pipe. Therefore the casing pipe and the complete rotary appliance, i.e. the inertial mass, form a single entity so that the pit-prop or pile, complete with rotary appliance, has to be lifted by a crane. This known design is suitable where small pile diameters and short pipe lengths are concerned. When larger pipes 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 metric tons per impact are used, this known design is no longer suitable since cranes of a capacity sufficient to cope with the higher weight of both pipe and rotary appliance, are not economically feasible.

In producing foundation structures, 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 harbor installations and for artificial islands. Nowadays too, they are required to support very large vertical forces in the form of single piles at junction points in all kinds of structures. These large diameter piles can withstand substantial bending moments, which have to be avoided in the case of conventional piles.

It is an object of the present invention to improve upon known rotary pile drivers and extractors to the extent that they can be used in an economical fashion to handle the large pile diameters presently required. In accordance with the invention, this object is obtained by providing the inertial mass as a rotating beam with several (preferably two) arms extending symmetrically relative to the pile axis. The ends of the arms carry detachably mounted weights and the beam is provided centrally with a ring element able to rotate with the beam through the action of drive rams. The ring element is detachably mounted on the pile.

According to a feature of the invention, stops serving to transfer the impact energy to the pile, consisting of several (preferably three pairs), projections are formed on the external part of the ring element and on the internal periphery of the rotating beam.

The invention is based upon the recognition of the fact that a rotary appliance suitable for handling large diameter pipe can be handled by the cranes normally available on the construction site, if there is facility for separating the casing pipe from the rotary appliance and for splitting the inertial mass needed to produce a high impact energy of the order of several hundreds of matric tons, into a plurality of individual weights which are arranged in the rotary appliance in such a way as to be individually detachable.

In the appliance of the present invention, first of all the casing pipe can be separately set up in the bore hole, then the rotary appliance can be mounted on the casing pipe without the weights, and finally the individual weights can be assembled in the rotary appliance.

To this end, the appliance takes the form of a rotary beam with several arms, at the ends of which the individual weights are accommodated. Using the rotary appliance in accordance with the invention, it is possible to produce practically any desired impact energy by arranging for it to have not simply two arms, but three arms angularly equispaced at 120° intervals or four arms arranged at 90° intervals. Likewise, when extracting the casing pipe, the rotary appliance in accordance with the invention can be handled by the usual lifting tackle, because, prior to extraction, the individual weights can be removed from the rotary beam; with the weights removed, the rotary appliance remains in position on the pipe, during extraction, and the impact energy produced by the weightless beam is sufficient, with the pipe under tension, to rotate the pipe a small amount with each blow with the result that there develops around the pipe a lubricating film which facilitates the extracting operation, overcoming the adhesion so that pipe and beam can be withdrawn. When driving in the casing pipe, the assembled weights produce the necessary high impact energy for this operation.

A further feature of the invention is that around the internal periphery of the ring element there are symmetrically disposed projecting coupling dogs whose lateral faces taper downwardly and on the pile there is fixed a coupling ring equipped with corresponding recesses between corresponding projections of the jaw-type clutch. The ring element provided in accordance with the invention, forms, together with the rotary beam and the drive elements (the latter preferably in the form of pneumatic or hydraulic rams) a single unit which, through the medium of the coupling dogs on the ring element, can be inserted into a coupling ring fixed to the pipe and thus provides proper torsional transfer of the developed impact energy.

The coupling between the ring element and the coupling ring on the pipe, is so constructed and arranged 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 pipe, without it being possible for the appliance, under the action of the impact forces, to rise off the coupling tube. In this context, it is also possible for the internal peripheral surface of the ring element and the external peripheral surface of the coupling ring to taper conically outwardly in the downward direction. By this measure, axial location of the rotary appliance vis-a-vis the pipe is ensured, so that the side faces of the coupling dogs on the ring element 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 boxlike attachments are fixed in place at the ends of the arms of the rotary beam, into which the individual weights are lowered by the lifting tackle, or from which they can be removed. It is an essential feature here that the internal walls of the boxlike attachment have projecting seating faces, and that the external walls of the weights contain corresponding downward-tapering recesses.

A further feature of the invention is that the pairs of stops on the ring element and the rotary beam, are provided on their mutually cooperating lateral surfaces with vertically disposed circularly arcuate groove-like recesses and 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 other stop. The rotary beam is provided on its internal diameter with inwardly projecting, symmetrically distributed stops which, with operation of the beam, engage corresponding stops arranged on the external periphery of the ring element and thus transfer the impact energy from the beam through the coupling to the pipe being driven. The impact energy is not transmitted directly to the pairs of stops; it is transferred through an exchangeable (replaceable) pin which is releasably attached in the groovelike recess in one stop and is receivable in the similar recess in the other to transfer the energy.

It is clear that these pins are subjected to heavy wear; for this reason, their replaceable design is of especial advantage. The pins can for example be made of copper or synthetic material. The pairs of stops, distributed symmetrically above the periphery of the ring element and the rotary beam, ensure that the developed impact energy is symmetrically transferred.

Yet another feature of the invention is that there are two mutually opposite drive rams, which are preferably attached to the underside of the base or hub of the rotary beam, in jointed (articulated) fashion, whose piston rod ends engage in diametrally opposite eyes underneath the ring element. A further important feature is that at the top side of the base of the rotary beam, there are attached several support and guide rollers distributed symmetrically about the central axis of the beam and bearing against the top conical edge of the ring element, which serves as a race, the rollers having a tapered form to correspond with the inclination of the race. Outside the ring element, another ring can be arranged which is designed as a ball race and is attached to said ring element through several brackets; the brackets themselves can also take the form of a ball race.

The invention will now be described with reference to the accompanying drawing, which illustrates the invention but is not restrictive of it. In the drawing:

FIG. 1 is a side elevation of the rotary appliance in accordance with the invention, partially in section;

FIG. 2 is a plan view of the device of FIG. 1;

FIG. 3 is a section through the boxes containing the weights;

FIG. 4 is an enlarged fragmentary view of the ring element, with the rollers and the base of the rotary beam, in section;

FIG. 5 is a plan view of the structure of FIG. 4; and

FIG. 6 is a cross section similar to FIG. 4 but illustrating another embodiment of the invention and FIG. 7 is a plan view thereof.

The rotary appliance consists of three independent parts, namely the casing pipe 1, the rotary beam 2 and the weights 3. The rotary beam 2 has two diametrically opposite arms carrying boxes 4 angularly equispaced (about the axis of the device) at the ends in which the weights 3 can be assembled.

On the external peripheral surface of the casing pipe 1, six coupling dogs or jaws 5 are attached. The rotary beam 2 carries a ring element 7 whose internal peripheral surface carries six mating dogs or jaws 6. The coupling dogs 5 on the pipe 1 and the mating dog 6 on the ring element 7 are provided with tapered lateral surfaces 6'. As the drawing clearly shows, the dogs 5 and 6 engage one another and form a releasable connection between the pipe 1 and the rotary beam carrying the ring element 7. The dogs 5, 6 locate the rotary beam on the pipe in the axial sense, thanks to their downwardly tapered side faces 6' and serve at the same time to transfer the torsional impacts exerted by the rotary beam 2 upon the pipe 1. The ring element 7 possesses two diametrically opposite eyes or lugs 10, in which there are pivotally secured the piston rods 9 of two rams 8, the latter being hingedly attached through the pins 23 at the underside of the base plate 11 to the rotary beam 2. The base plate 11 of the rotary beam 2 carries an annular collar 12 disposed concentrically vis-a-vis the ring element 7. On the top side of the base plate 11 of the rotary beam 2, rollers 13 are mounted in bearings 14; the rollers 13 have inwardly tapered surfaces 15 which run upon a corresponding conical race 16 formed at the top side of the ring element 7. The ring element 7 is in this way attached to the rotary beam 2 so as to be swingable by the rams 8 and their piston rods 9.

The ring element 7, as FIGS. 4 and 5 particularly clearly illustrate, is provided on its external periphery with three symmetrically arranged projecting stops 17. On the internal periphery of the collar 12 on the base plate 11, likewise three projecting stops 18 are attached, which, with rotational movement on the part of the rotary beam through the agency of the ram arrangements 8, 9, engage the stops 17 of the ring element 7 so that the structure is analogous to a jaw clutch and the impact energy produced by the rotation of the rotary beam with its weights 3, is transmitted to the ring element 7 and through the coupling dogs 5, 6 to the pipe 1. The stops 17 and 18, as FIG. 5 indicates, are provided in their lateral surfaces with semicircular (semicylindrical) vertically directed recesses. In the semicircular recesses in the stops 17, there are releasably attached to the impact pins 19, 20. In the illustration of FIG. 5, after rotation on the part of the rotary beam 2 in the clockwise direction, complementary sets of formations the stops 17 and 18 come into impact-transmitting relationship with one another through the impact pin 19.

The actuation of the ram arrangements 9 and 8 in mutually opposite directions produces rotation of the rotary beam in the 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 ram arrangements 8, 9, the pipe 1 is subjected to successive torsional impacts in opposite directions. The weights 3, as FIG. 1 shows, are equipped with hooks 21 by means of which they are assembled in the boxes 4. As FIG. 3 indicates, the weights 3 and the boxes 4 have a tapered seat 22 which facilitates assembly and withdrawal of the weights 3 into and from the boxes 4, respectively.

The mode of operation of the appliance in accordance with the invention is as follows. First of all, the casing pipe 1, equipped with the coupling dogs 5, is set up in the bore hole. Then, the rotary beam 2, with its ring element 7, is placed on the casing pipe, the mating dogs 6 being made to mesh with the coupling dogs 5 on the casing pipe 1. The rotary beam 2 is now attached to the casing pipe 1. Subsequently, the weights 3 are deposited in the boxes 4. The rotary appliance is now ready for operation. By actuating the ram arrangements 8, 9, the rotary beam 2, with the weights 3, is alternately in opposite directions, the inertial energy being transferred to the casing pipe 1 through the stops 17, 18 and the impact pins 19, 20, so that the pipe experiences successive alternating rotational movements and in so doing, under the effect of the weight of the rotary beam, with its assembled inertial weights, is driven into the ground. If the casing pipe is to be extracted, the weights 3 are first removed from the boxes 4. While a crane attached to the casing pipe exerts a tractive effort on it, the ram arrangements 8, 9 are actuated to produce slight rotary movements in the casing pipe, as a consequence of which the adhesion between pipe and earth is overcome and the withdrawal of the pipe facilitated.

The advantage of the rotary appliance in accordance with the invention resides in the fact that the casing pipe, the rotary beam and the weights, can be handled separately so that even where casing pipes of large diameter are concerned, the rotary appliance in accordance with the invention can be employed and the device and its parts can be manipulated by the normal cranes available

In FIGS. 6 and 7 there is shown an arrangement wherein, outside the ring element 7 there is formed a ring 26 serving as a ball race, which is attached through numerous brackets 25 to the ring element at 7'. The race 26 cooperates with a race 24 formed on the underside of the hub of the beam 11 via the usual balls of a ball bearing.

It is claimed:

1. A device for driving or withdrawing piles, pit-props and like bodies, comprising:

a rotatable beam having a plurality of angularly equispaced arms extending outwardly from an upright axis of rotation of the beam;

respective weights carried by the free ends of the arms of said beam;

a ring element received in said beam and centered on said axis, said beam being vertically detachable from said ring element and having an opening receiving same, said ring element being provided along its external periphery and said beam being provided along the periphery of said opening with complementary sets of angularly spaced formations mutually engageable upon relative angular displacement of said beam and said ring element to transmit rotational impact to a body coupled with said ring element;

means for detachably securing said ring element to said body in force-transmitting relationship therewith; and

at least one fluid-operated drive ram connected to said ring element and to said beam for relatively displacing said ring element and said beam angularly with respect to said axis.

2. The device defined in claim 1 wherein two fluid-operated drive rams are provided on said beam on diametrically opposite sides of said opening with respect to said axis, each of said rams including a cylinder pivotally secured to one of the arms of said beam and a piston rod, said ring element being formed with diametrically opposite outwardly projecting lugs on the underside of the ring element pivotally connected with the respective piston rods.

3. The device defined in claim 1 wherein said beam is formed with a hub from which said arms extend radially and are provided with a plurality of angularly spaced support and guide rollers disposed symmetrically around said opening and resting upon the top of said ring element, said ring element serving as a race and having a frustoconical configuration, said rollers having tapered peripheral surfaces corresponding to the conicity of said race.

4. The device defined in claim 1, wherein said ring element is formed with an outwardly extending ring constituting a ball race, said device further comprising respective bearing elements between said race and said beam for rotatably supporting same.

5. The device defined in claim 1 wherein mutually confronting flanks of each of the formations of said beam and the corresponding formation of said ring element are provided with vertically oriented semicircular groovelike recesses, said device further comprising at least one force-transmitting pin received in a recess of the confronting faces for transferring impact energy from the formations of one set to the formations of the other.

6. The device defined in claim 5 wherein said pins are cylindrical and are composed of copper.

7. The device defined in claim 5 wherein said pins are cylindrical and are composed of a synthetic material.

8. The device defined in claim 1 wherein the free ends of the arms of said beam are provided with upwardly open compartments, said weights being removably received in said compartments and upwardly withdrawable therefrom.

9. The device defined in claim 8 wherein said compartments are formed by boxlike attachments fixed on said arms, said attachments being provided internally with mutually opposite projecting seating surfaces tapering in the downward direction, said weights being recessed complementarily to said projections for seating engagement therewith.

10. The device defined in claim 8 wherein said ring element is provided with a plurality of angularly spaced, symmetrically disposed projecting coupling dogs on the inner periphery of said ring element, said coupling dogs having downwardly tapering side faces, said body being formed with a complementary set of coupling dogs along its external periphery interfitting with the coupling dogs of said ring element.

11. The device defined in claim 10, further comprising a coupling ring carrying said complementary set of couplings dogs affixed to said body.

12. The device defined in claim 11 wherein the internal peripheral surface of said ring element and the external peripheral surface of said coupling ring are conically flared downwardly.