Jan. 23, 1968 F. RUSCHE 3,365,220

JOINT FOR COUPLED PILE DRIVING MANDREL

Original Filed Nov. 15, 1963

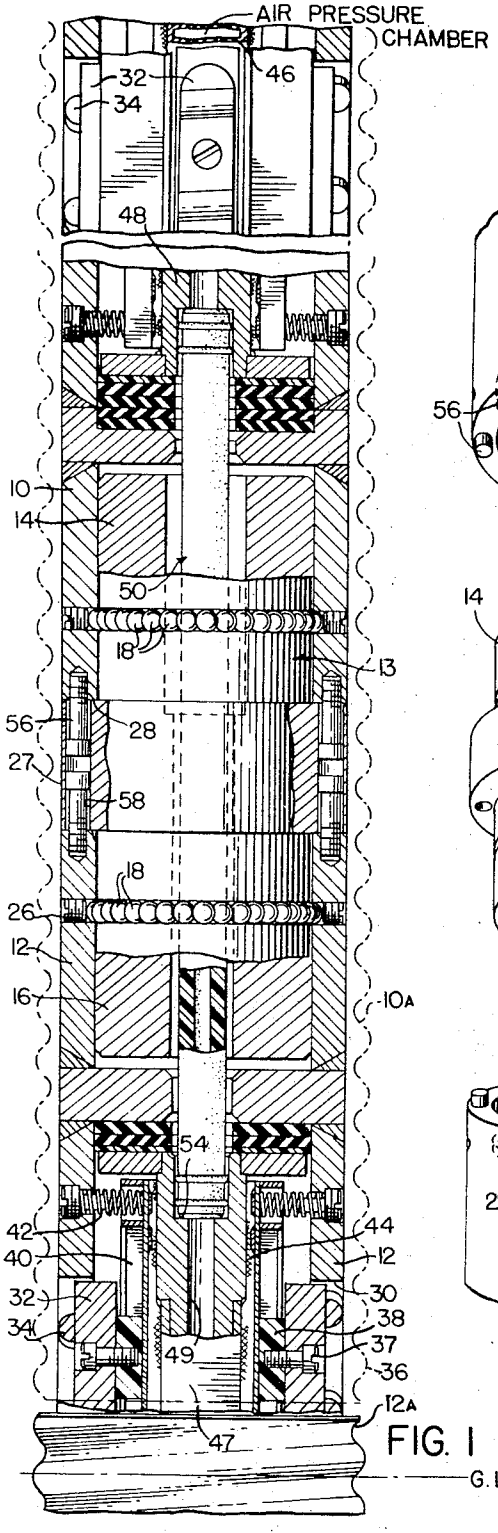


FIG. 1

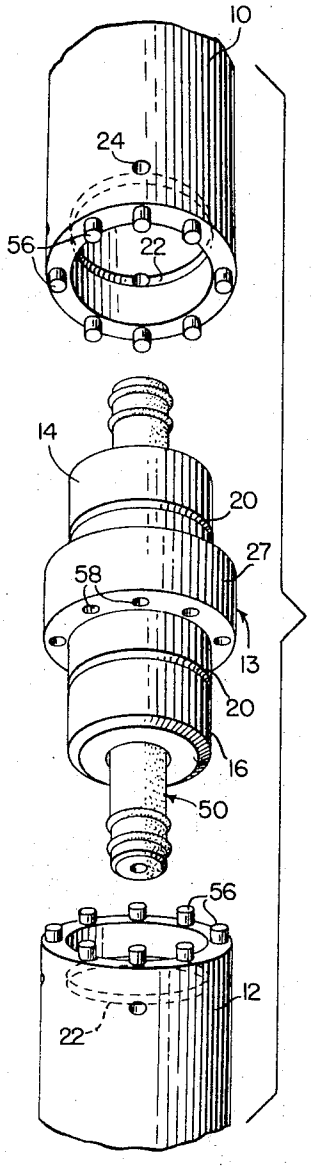


FIG. 2

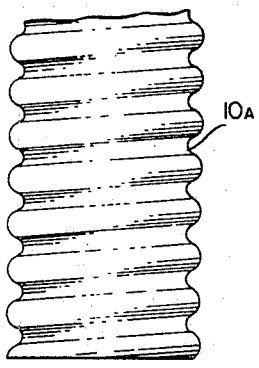


FIG. 4

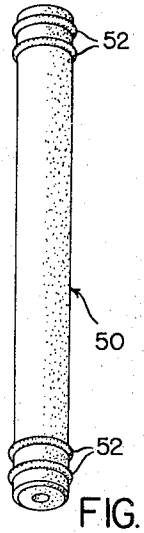


FIG. 3

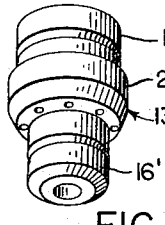


FIG. 5

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JOINT FOR COUPLED PILE DRIVING MANDREL

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Original application Nov. 15, 1963, Ser. No. 323,942, now Patent No. 3,269,128, dated Aug. 30, 1966. Divided and this application Oct. 21, 1965, Ser. No. 516,812
6 Claims. (Cl. 287—2)

ABSTRACT OF THE DISCLOSURE

Adjacent ends of two axially aligned tubes are joined by a coupler which comprises two male cylinders integrally joined to and extending oppositely from a central collar, and which respectively engage in female cylindrical ends of the tubes, with the collar in abutting engagement with the ends of the tubes. The male cylinders and female cylindrical ends of the tubes have opposed circumferentially extending mating grooves which accommodate balls. The balls transmit only tension forces between the tubes by keying the coupler and tubes together against endwise separating movement, and the collar transmits endwise compressive forces between the tubes. Pins on the collar engage in recesses in the ends of the tubes to prevent rotative movement of one tube relative to the ohter. A fluid conduit within the coupler transmits fluid from one tube to the other.

This application is a division of application Ser. No. 323,942, filed Nov. 15, 1963, and now Patent No. 3,269,128.

This invention relates to pile driving mandrels of the type disclosed in my U.S. Patent 3,006,152, issued Oct. 31, 1961, the disclosure of which is incorporated herein by reference.

In pile driving operations it is customary to drive into the ground a stout tubular mandrel surrounded by a thin, relatively delicate casing, which casing is to form a mold for a concrete pile. The piles may be of the order of a foot in diameter and may be required to be about 80 feet long. The casings are made of thin steel, for example of 16 gauge. They may be corrugated spirally as known in the art and as shown for example in the U.S. patent to McKee, 2,928,252. The assembly of mandrel and casing punches a hole in the earth, after which the mandrel is removed, leaving the casing in the hole to form a permanent mold for pouring the concrete pile.

Such casings have been driven by mandrels constructed, for example, as shown in my Patent 3,006,152, particularly in FIGS. 9 to 12.

It is undesirable for a number of reasons to have a single mandrel as long as 80 feet. Such long mandrels are difficult and expensive to make and transport, and in some methods of driving piles they would require driving equipment of excessive size and height and there may be other objections depending on location and driving conditions.

According to this invention I propose to make a number of short mandrels and to join them by an improved coupling device which can: (*a*) readily be connected when the sections of mandrel are in vertical position, (*b*) be disposed flush with, or entirely within, the cylindrical surface defined by the sections of mandrel so as to provide a smooth exterior surface for the mandrel assembly, (*c*) transmit great compressive force due to impact of the driving hammer from one section of the mandrel to the next without damage to the coupling device so that the latter can be readily uncoupled when the mandrels are removed.

In mandrels of the type to which this invention relates, means is provided for containing and transmitting pressure fluid such as compressed air to operate lugs which protrude from the mandrel to engage the corrugations in the casing and form the driving connection between the mandrel and the casing, as shown in my patent referred to. Therefore the couplings embodying the invention must conduct the fluid from one section, or tube, of the mandrel to the other.

Accordingly it is one of the objects of the present invention to provide an improved coupling device for mandrels which can readily be assembled and taken apart either while the mandrels are in vertical position with one mandrel driven part way into the ground, or while the mandrels are horizontal.

It is another object of the invention to provide a coupling which is disposed wholly within the cylindrical surface defined by the external surfaces of the two mandrel tubes so that the jointed mandrel has a smooth outer surface of uniform diameter which can readily be withdrawn from the driven shell.

It is another object of the invention to provide a coupling which has one means for transmitting compression force between the mandrel sections to drive the shell and another and independent means for transmitting tension force between the sections for withdrawal of the mandrel from the casing and to arrange these means so that the tension means is not exposed to compression force transmitted under the impact of the hammer. This prevents damage to the coupling which would otherwise prevent its ready separation.

Another object is to provide an improved coupling having means for conducting pressure fluid from one mandrel section to the next.

Other objects and advantages of the invention will be apparent from the following description and accompanying drawings in which the same reference character always designates the same part wherever it occurs, and a primed number designates a modified form of a part identified by the same number not primed.

In the drawings:

FIG. 1 shows, partly in section and partly in elevation, a shell surrounding the adjacent ends of a pair of joined mandrel sections and including a coupling embodying one form of the present invention.

FIG. 2 is an exploded perspective view of the coupling and adjacent ends of the mandrels shown in FIG. 1.

FIG. 3 is a perspective view of a fluid pressure transmitting conduit forming part of the coupling mechanism.

FIG. 4 is an elevation of a portion of a casing, and

FIG. 5 is an elevation, on a smaller scale, of a modified form of coupling.

Referring to the drawings **10** and **12** designate tubular mandrels of the solid core type which may be constructed, for example, generally as disclosed in FIGS. 9 to 12 of my Patent 3,006,152 referred to. Solid core means that each tube **10** or **12** is circumferentially integral or complete, and is not split nor made in longitudinal sections. The section or tube **12** may be sunk in the ground with the ground line GL appearing with relation to the mandrel as illustrated at the lower end of FIG. 1. The lower end of the upper section or tube **10** is illustrated as joined to the upper end of the lower section **12**. The mandrels may be inside of separate corrugated shells **10***a* and **12***a*.

A coupling device for joining these two sections is designated generally by **13** and is shown in perspective in FIG. 2. It is shown partly in elevation and partly in section in FIG. 1. The coupling includes a male cylindrical member or element **14** which is placed within the lower end of the mandrel section **10** and is integrally joined to a second male cylindrical member **16** which is placed in the mandrel section **12**. Each mandrel section is held to the coupling and consequently to the other mandrel against axial separation by a number of balls **18** placed in a closed

chamber formed by opposite mating grooves 20 in the cylindrical members 14 and 16 and 22 in the mandrel tubes. As shown in FIGS. 1 and 2, each groove is closed, by which I mean that there is no end of the groove out of which the balls can roll. Thus the mating grooves together form a closed chamber which positively confines the balls.

Preferably each groove extends about the entire outer circumference of a cylinder 14 or 15 and about the entire inner circumference of the mandrel tube 10 or 12. This facilitates insertion and removal of the balls but it is not absolutely essential since some of the advantages of the invention can be obtained with grooves which do not extend entirely around the members in which they are formed. Grooves extending only part way of the circumference could be used in which case the material in which the grooves are formed would automatically provide closed ends which would prevent the balls from rolling out of the grooves. Each groove may be of arcuate cross section and is preferably approximately a semi-circle.

The balls are inserted into the closed chamber formed by the oppositely mating grooves and removed therefrom through one or more openings 24 through the mandrel tubes into the grooves 22. Preferably four such openings are provided into each groove 22 but this is not essential. In order to retain the balls positively within the chamber formed by the pair of grooves the openings 24 are closed in any suitable manner after the balls have been placed in the grooves, for example by threaded plugs 26 which lie entirely within the cylindrical outer surface of the mandrel to provide a smooth and unobstructed surface.

The balls transmit tension force between the two mandrel tubes 10 and 12 which enables the mandrel 10 to withdraw the mandrel 12 from the shell after it has been driven. It is important however that the coupling be arranged so that the balls cannot receive or transmit compression forces due to the impact of the hammer, since these forces are very great and would destroy the balls. It is important that the balls remain intact so that they may be readily removed from the groove when it is desired to take the mandrel apart.

To accomplish this objective, the mandrel tube 10 could abut directly against the mandrel tube 12 for the transmission of compression or driving force, but I prefer to transmit the driving force from one mandrel tube to the other through a collar or abutment 27. This may be a separate member surrounding the cylinders 14 and 16 but is preferably formed integral with these cylinders. In either case the distance from the end face 28 of each mandrel tube to the adjacent groove 22 is approximately equal to the distance of the abutment 26 from the adjacent groove 20. Thus under impact of the driving hammer the grooves 20 and 22 are maintained in alignment or opposite one another so that compression force in the mandrel tube 10 cannot be transmitted to the balls 18, but is absorbed entirely by the abutment 27.

As shown in FIG. 1, and in my patent referred to, the mandrel tube 12 has a number of circumferentially distributed openings 30 through its wall. In these openings are plugs 32 which form the driving connections between the mandrel and the shell. Each plug 32 has slanted projections or lugs 34 which fiit into the corrugations 36 of the shells when the plugs are expressed. The plugs are radially reciprocable in the openings 30 to express the lugs 34 into the corrugation and withdraw the lugs therefrom. The plugs 32 are joined by bolts 37 and nuts 38 to longitudinal channel members 40 which are urged radially inward by springs 42 and may be urged radially outward against the force of the springs by fluid pressure in expansible flat hoses 44, as more fully disclosed in detail in my Patent 3,006,152. As shown in that patent a number of sets of lugs are distributed along the length of the mandrel.

As regards the driving lugs, hoses, channel supports 40

and springs 42, the mandrel tube 10 is arranged like the mandrel tube 12 and has plugs 32 and slanting plugs 34 corresponding to those shown in the mandrel tube 12. In order to supply air to the hoses 44 for expression of the lugs 34, each mandrel tube 10 or 12 contains a chamber for air under pressure which is supplied from outside the mandrel and is connected to the hoses in any suitable manner for example as shown in my patent referred to.

This chamber includes the square tube 46 in the tube 10 or the square tube 47 in the tube 12. When a single mandrel tube such as 10 is used alone the lower end of the tube 46 is capped or stoppered in any suitable manner. When a pair of mandrel tubes 10 and 12 is to be coupled it is necessary to supply a connection between the lower end of the tube 46 in mandrel section 10 to the upper end of the tube 47 in the mandrel section 12. To this end each of the tubes 46 and 47 terminates in a round tubular section 48 or 49 .These two round tubular sections are pneumatically connected by a conduit 50 which extends from the tubular section 48 in mandrel tube 10 to the tubular section 49 in mandrel tube 12. This conduit 50 is preferably a round nylon tube and is sealed to each tubular section 48 and 49 by elastic O-rings 52 which provide sliding seals. The coupling cylinders 14 and 16 are made hollow to permit the passage of the conduit 50 through the coupling.

When the mandrel sections are to be joined the tube 12 is in the shell 12*a* in the ground. The conduit 50 may first be inserted in the tubular portion 49 as far as is permitted by a stop 54, the coupling is then lowered around the conduit 50 until the collar 27 abuts the end face of the tube 12. The mandrel tube 10 is then lowered over the upper end of the conduit 50 and the coupling, the conduit 50 being thereby inserted in the circular tubular portion 48 of the air chamber, while the tubes 10 and 12 are still separated, that is before the tube 10 is seated on the coupling. When the end faces of the mandrel sections 10 and 12 are accurately seated against the collar 27 the balls 18 are fed into both sets of grooves 20, 22 through two or more of the openings 24 and the openings are closed by the plugs 26.

This establishes a mechanical connection between the mandrel tubes 10 and 12 which transmits compressive or driving force from the mandrel 10 to the mandrel 12 through the abutment 27 and which transmits tension force from the mandrel 10 to the mandrel 12 through the balls 18 to permit withdrawal of the jointed mandrel from the casing. It also establishes a fluid pressure connection between the fluid pressure chambers in the two mandrel sections so that whenever fluid pressure is supplied to the upper mandrel 10 to express its lugs 34 fluid pressure is also supplied to the lower mandrel section to express its lugs 34. Conversely when air pressure is exhausted from the upper tube 10 to permit the springs 42 to retract the lugs 34 fluid pressure is exhausted from the tube 12 to permit its springs 42 to retract its lugs 34. This will permit the mandrels to be withdrawn from the casing.

Since these mandrels are used in spirally corrugated shells it is important the lugs 34 in the section 12 be accurately aligned with the lugs in section 10 so that when they are expressed they will both be in phase and will accurately fit into the corrugations of a single shell. It is also important that this alignment be maintained throughout the driving operation and that one mandrel tube 10 be prevented from rotating with respect to the other mandrel tube 12. For this purpose I provide studs 56 which project axially from the end faces of the mandrel tubes 10 and 12. These studs may be conveniently formed of allen head bolts threaded into the mandrel tubes. These studs are received in holes 58 in the collar 27. When both sets of studs are placed in the holes 58 the lugs 34 on the tube section 10 are accurately aligned with the lugs 34 on the tube section 12 and this alignment is maintained throughout the driving operation regardless of any vibra-

tion due to the impact of the driving hammer. The studs **56** and holes **58** thus constitute indexing means for maintaining the mandrel sections in predetermined positions of angular rotation with respect to one another, whereby the lugs on the expandible members of one mandrel section are in predetermined phase with respect to the lugs on the other mandrel section.

In FIGS. 1 and 2 the coupling **13** joins mandrel sections of the same diameter used to drive shells of the same diameter. The invention is equally well adapted to joining mandrels of different sizes to drive a smaller lower shell and a larger upper shell. FIG. 5 shows such a coupling **13'** having an upper cylinder **14'** for a large mandrel (e.g., 11 inches O.D.) and lower cylinder **16'** for a smaller mandrel (e.g., 9¾ inches O.D.) joined by a tapered abutment **27**.

It is a feature of my invention that with either form of the invention, the mandrels can be connected and disconnected either when vertical or horizontal. If disconnected while vertical, the balls may be removed from the grooves by removing opposite plugs **26** and blowing them out by compressed air. If horizontal, the tubes **10** and **12** may be brought together by a come-along. The balls then may be dropped into the grooves. In separating horizontal joined mandrels the balls may be blown out as described, or dropped out through a hole at the bottom, possibly assisted by rolling or rocking the tubes.

It is to be understood that the invention may be carried out or practiced in various ways other than the illustrative embodiment described herein and that the terminology employed is illustrative only and does not limit the invention.

I claim:

1. A jointed mandrel for casings comprising in combination a pair of axially aligned cylindrical tubes, a coupling including a first male cylinder engaged in one end of one tube and a second male cylinder attached to said first male cylinder and engaged in the adjacent end of the other tube, each male cylinder having an outer diameter closely approaching the inner diameter of the tube in which it is engaged, each cylinder having a first circumferentially extending groove in its periphery, each tube having a mating second groove extending circumferentially along its inner surface, means for transmitting tension force only between the tubes including balls between the grooves preventing separation of the tubes, the grooves together forming a substantially closed chamber positively holding the balls in the chamber, the diameters of the balls being more than one-half the radial extent of the chamber, each tube having an opening through its wall into its second groove through which the balls can be inserted into the chamber and removed therefrom, removable means for closing said openings, there being no substantial projection of said removable means radially outward of the respective tubes whose openings they close, and means for transmitting compression forces between the tubes including an abutment engaged between the ends of the tubes, the spacing between the end of each tube and its groove being substantially equal to the spacing between the abutment and the mating groove on a cylinder, so that the grooves are maintained opposite one another under compressive forces between the tubes whereby the balls cannot transmit compressive force between a tube and the coupling, said tubes, coupling and abutment all being constructed and arranged so that the outer surface of at least one of said tubes and coupling forms a substantially uninterrupted outer surface having a substantially constant diameter.

2. A jointed mandrel for casings comprising in combination a pair of axially aligned cylindrical tubes, a coupling including a male cylinder engaged in one end of one tube and secured to the other tube, said male cylinder having an outer diameter closely approaching the inner diameter of said one tube, the cylinder having a first circumferentially extending groove in its periphery, said one tube having a mating second groove extending circumferentially along its inner surface, means for transmitting tension force only between the tubes including balls between the grooves preventing separation of the tubes, the grooves together forming a substantially closed chamber positively holding the balls in the chamber, the diameters of the balls being more than one-half the radial extent of the chamber, stid one tube having an opening through its wall into the second groove through which the balls can be inserted into the chamber and removed therefrom, removable means for closing said opening, there being no substantial projection of said removable means radially outward of the respective tubes whose openings they close, and means for transmitting compression forces between the tubes including a surface in abutting engagement with the end of said one tube, the spacing between the end of said one tube and its groove being substantially equal to the spacing between said surface and the mating groove on the cylinder, so that the grooves are maintained opposite one another under compressive forces between the tubes whereby the balls cannot transmit compressive force between said one tube and the coupling, said one tube, coupling, and means for transmitting compression forces all being constructed and arranged so that the outer surfaces of said one tube and the means for transmitting compression forces from a substantially uninterrupted outer surface having a substantially constant diameter.

3. A jointed mandrel for casings comprising in combination a pair of axially aligned cylindrical tubes, a coupling including a first male cylinder engaged in one end of one tube and a second male cylinder attached to said first male cylinder and engaged in the adjacent end of the other tube, each male cylinder having an outer diameter closely approaching the inner diameter of the tube in which it is engaged, each cylinder having a first circumferentially extending groove in its periphery, each tube having a mating second groove extending circumferentially along its inner surface, means for transmitting tension force only between the tubes including balls between the grooves preventing separation of the tubes, the grooves together forming a substantially closed chamber positively holding the balls in the chamber, the diameters of the balls being more than one-half the radial extent of the chamber, each tube having an opening through its wall into its second groove through which the balls can be inserted into the chamber and removed therefrom, removable means for closing said opening, there being no substantial projection of said removable means radially outward of the respective tubes whose openings they close, and means for transmitting compression forces between the tubes including an abutment integral with said cylinders and engaged between the ends of the tubes, said tubes, coupling and abutment all being constructed and arranged so that the outer surface of at least one of the tubes and coupling forms a substantially uninterrupted outer surface having a substantially constant diameter.

4. The combination claimed in claim **3**, said abutment comprising an annular collar whose outer surface forms a substantially uninterrupted surface having a constant diameter with both of said tubes.

5. A jointed mandrel for spirally corrugated casings comprising in combination a pair of axially aligned cylindrical tubes, a coupling including a first male cylinder engaged in one end of one tube and a second male cylinder attached to the first and engaged in the adjacent end of the other tube, each male cylinder having an outer diameter closely approaching the inner diameter of the cylinder in which it is engaged, each cylinder having a first circumferentially extending groove in its periphery, each tube having a mating second groove extending circumferentially along its inner surface, means for transmitting tension force only between the tubes including balls between the grooves preventing separation of the

tubes, the grooves together forming a substantially closed chamber positively holding the balls in the chamber, the diameters of the balls being more than one-half the radial extent of the chamber, each tube having an opening through its wall into the second groove through which the balls can be inserted into the chamber and removed therefrom, removable means for closing said openings, there being no substantial projection of said removable means radially outward of the respective tubes whose openings they close, means for transmitting compression forces between the tubes including an abutment integral with said cylinders and engaged between the ends of the tubes, and means on the abutment for preventing rotation of one tube relative to the other, said tubes, coupling and abutment all being constructed and arranged so that the outer surface of at least one of said tubes and coupling forms a substantially uninterrupted outer surface having a substantially constant diameter.

6. A jointed mandrel for casings comprising in combination a pair of axially aligned cylindrical tubes, a coupling including a first male cylinder engaged in one end of one tube and a second male cylinder attached to the first and engaged in the adjacent end of the other tube, each male cylinder having an outer diameter closely approaching the inner diameter of the tube in which it is engaged, each cylinder having a first circumferentially extending groove in its periphery, each tube having a mating second groove extending circumferentially along its inner surface, means for transmitting tension force only between the tubes including balls between the grooves preventing separation of the tubes, the grooves together forming a substantially closed chamber positively holding the balls in the chamber, the diameters of the balls being more than one half the radial extent of the chamber, each tube having an opening through its wall into the second groove through which the balls can be insered into the chamber and removed therefrom, removable means for closing said openings, there being no substantial propection of said removable means radially outward of the respective tubes whose openings they close, and means for transmitting compression forces between the tubes including an abutment engaged between the ends of the tubes and aligned therewith, said tubes, coupling and abutment all being constructed and arranged so that the outer surface of at least one of said tubes and coupling forms a substantially uninterrupted outer surface having a substantially constant diameter.

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