July 4, 1961 W. H. COBI 2,990,688

EXPANSIBLE PILE DRIVING MANDRELS

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Fig. 1.

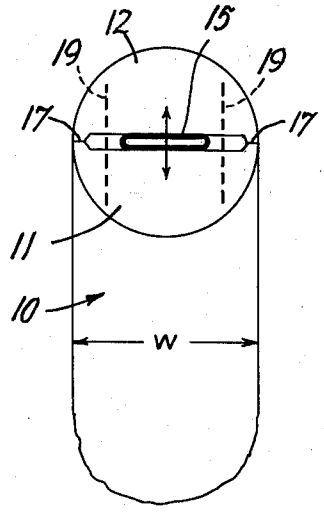


Fig. 2.

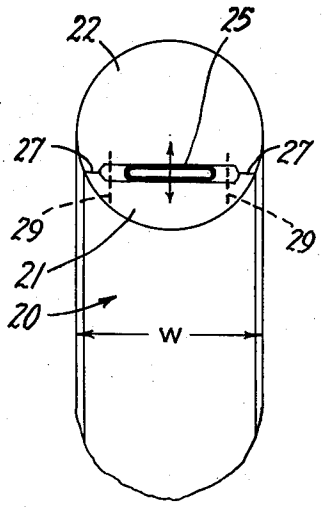


Fig. 3.

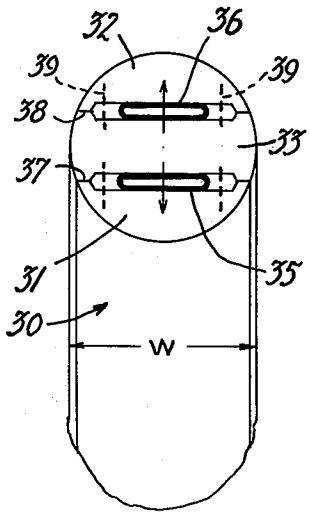


Fig. 4

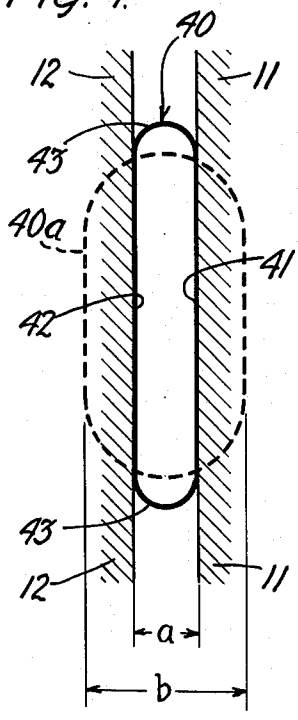


Fig. 5.

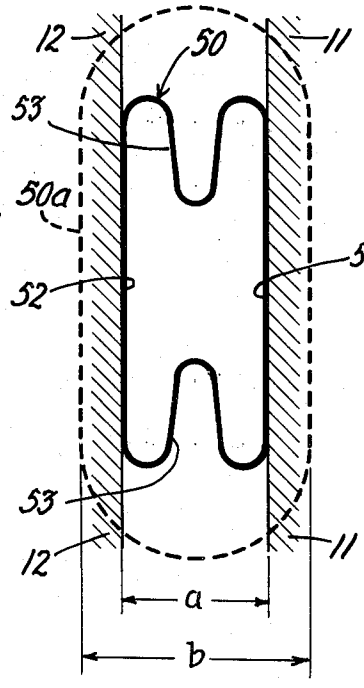
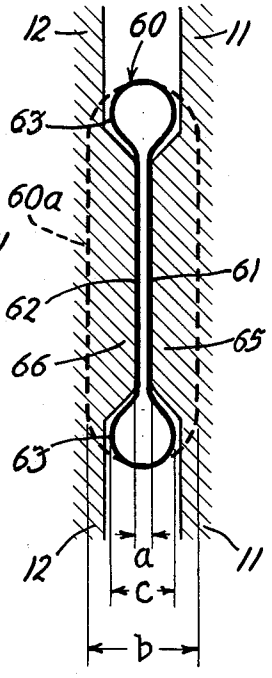


Fig. 6.



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EXPANSIBLE PILE DRIVING MANDRELS

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Fig. 7.

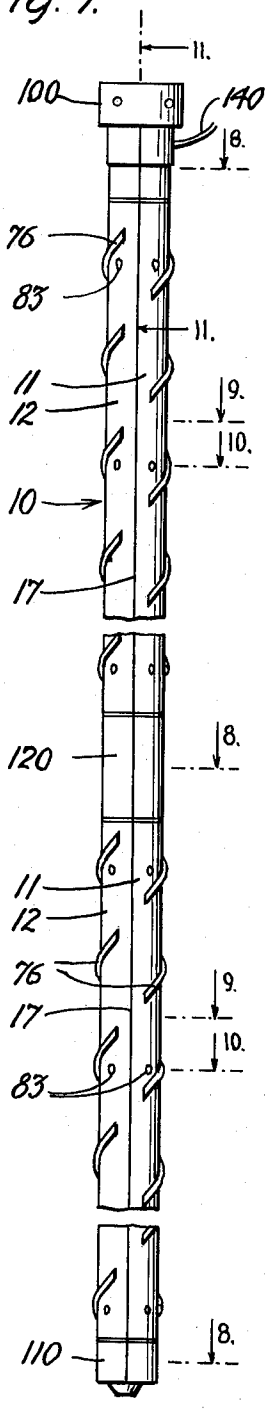
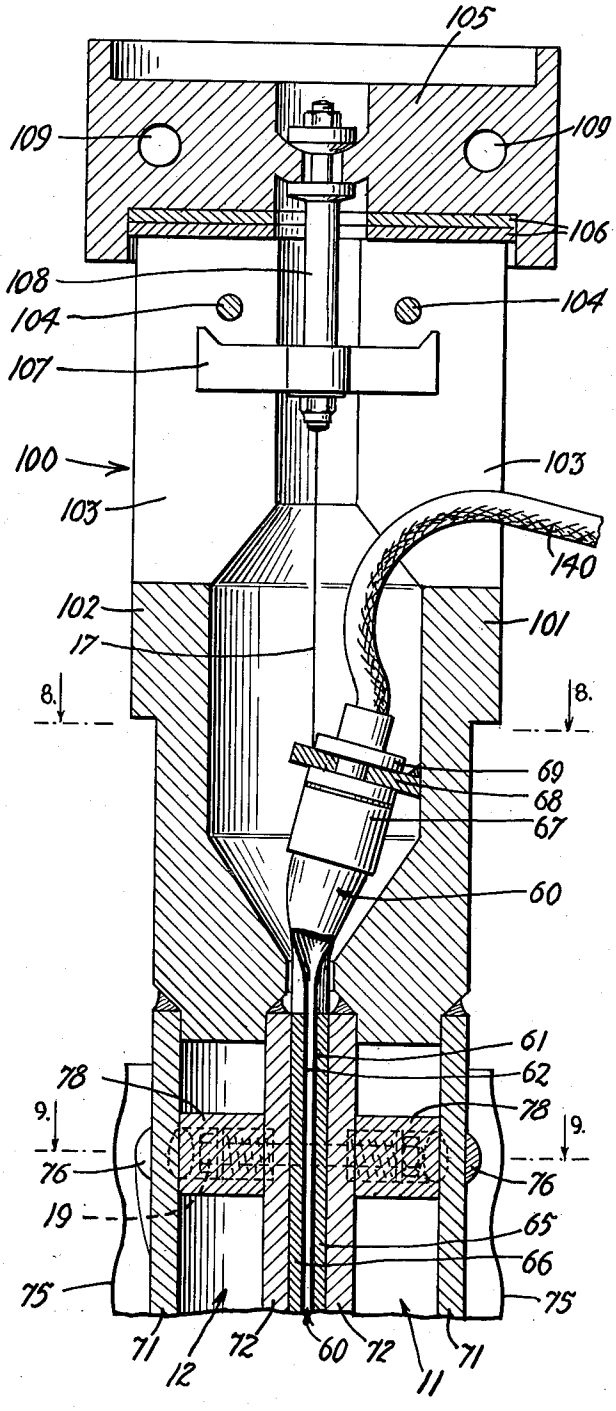


Fig. 11.



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EXPANSIBLE PILE DRIVING MANDRELS

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Fig. 8.

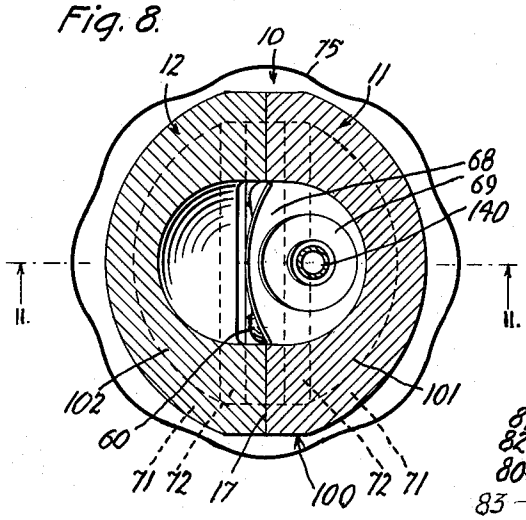

Fig. 9.

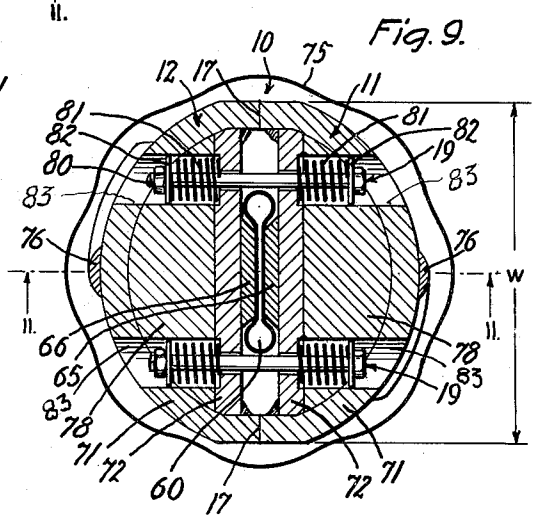

Fig. 10.

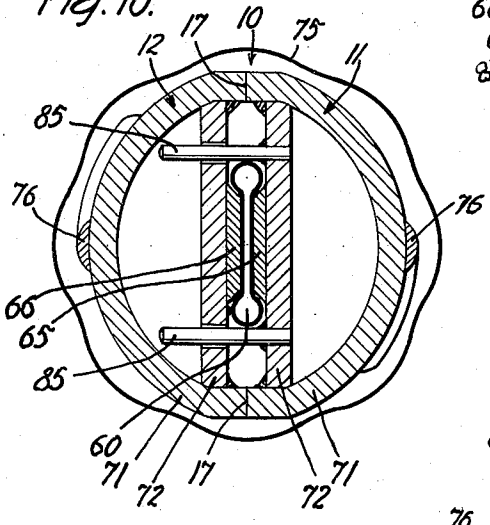

Fig. 9a.

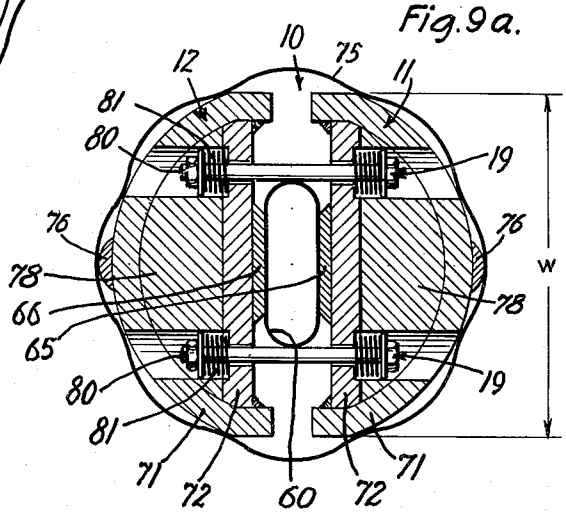

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Fig. 12.

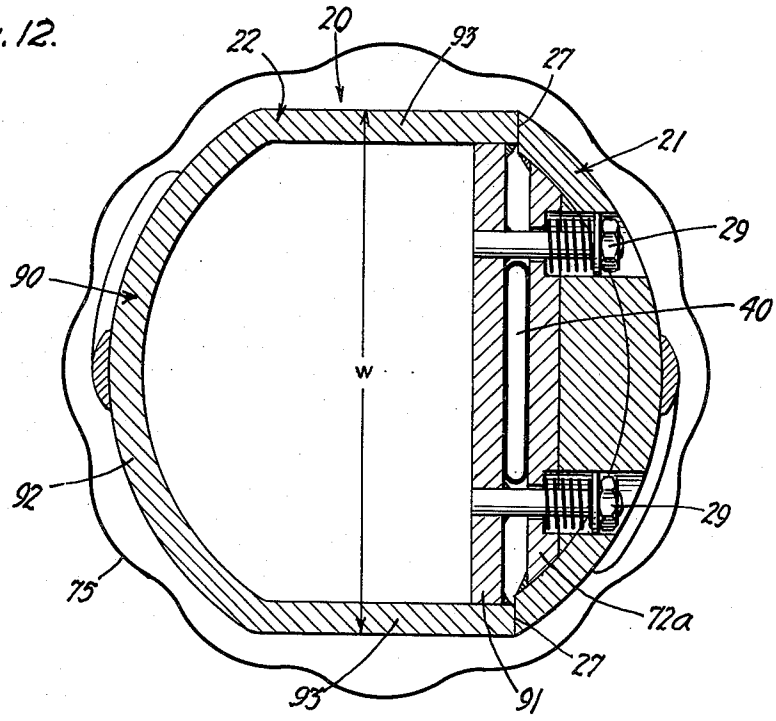
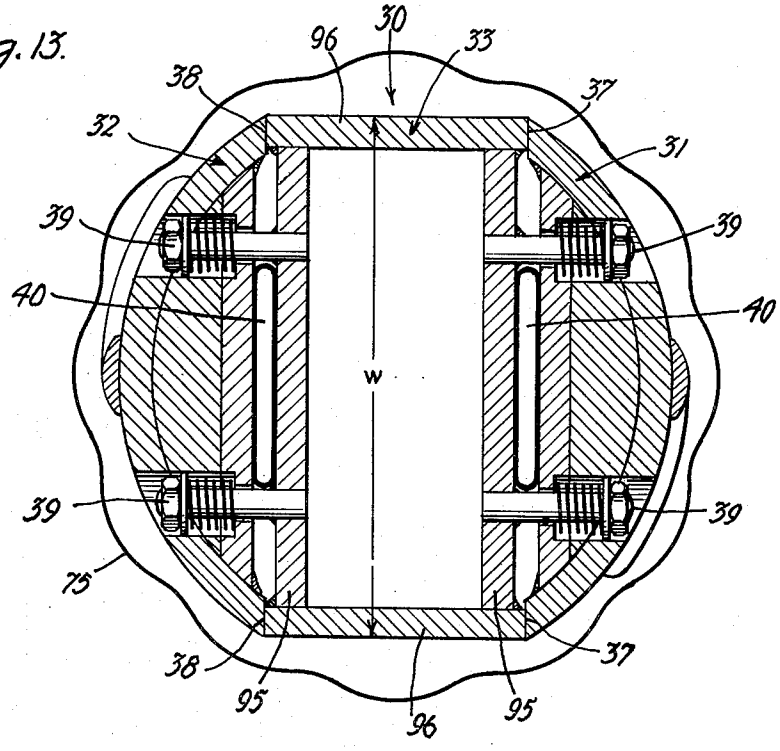


Fig. 13.



United States Patent Office 2,990,688 Patented July 4, 1961

2,990,688

EXPANSIBLE PILE DRIVING MANDRELS

Walter H. Cobi, 45 Upland St., Port Chester, N.Y.

Filed July 19, 1955, Ser. No. 522,909
10 Claims. (Cl. 61—53.72)

The invention relates to expansible pile driving mandrels, and particularly to expansible and contractable mandrels or cores capable of insertion into the empty shell or mold for a concrete or cast-in-place pile and of driving the shell into the ground under hammer blows.

The invention particularly relates to mandrels of this type which have come to be known as pneumatic mandrels, and in which the expansion is caused by the application of fluid pressure to container means within the mandrel.

It is a principal object of the invention to provide a mandrel of the pneumatic type, comprising a plurality of longitudinal metallic segments or divisions contacting during operation the inner surface of the shell or casing for a pile and in which the forces from the hammer blows are substantially evenly distributed over the cross-sectional area of the mandrel at any point along its length, thereby insuring substantially straightline driving of the pile into the ground, at least to the extent permitted by the nature of the strata.

It is another object of the invention to provide such a mandrel in which the longitudinal elements will be firmly positioned within the shell in the expanded condition of the mandrel to insure stable operation.

It is a further object to provide an expansible and contractable mandrel which can be effectively expanded by a lower fluid pressure per unit area than in previous arrangements.

It is a more specific object to provide stronger, inflatable, flexible container means, than has been previously provided, for expanding the mandrel, and which is subject to less wear by depending for effective action upon a change of the cross-sectional shape from deflated to inflated condition and by substantially avoiding any expansion or stretching of the wall material of the container during such action.

It is still another object to simplify the construction and assemblage of such a mandrel by reducing the number of parts and simplifying their adjustments for operation.

In a preferred form of the invention the mandrel is made up of a plurality of parallel metallic segments disposed throughout the length of the mandrel for contacting the inner surface of the shell or casing for a pile and of one or more flexible, tubular container means for the pressure fluid disposed between and parrallel with the metallic segments for separation of the segments, when expanded, and forcing them into contact with the shell during driving operations.

In accordance with a principal feature of the invention the segments and the container means are disposed in such a manner that the mandrel will be expanded in only two opposite directions and therefore will retain a constant width during both expansion and contraction.

In accordance with another feature the mandrel is divided lengthwise along one or more planes at right angles to the directions of expansion and contraction.

In accordance with another feature the container means for pressure fluid is in the form of flat type tubing extending throughout the length of the mandrel with the flat sides parallel with the planes of division for expansion at right angles to the flat sides of the tubing.

In accordance with still another feature, the segments or divisions present flat surfaces at the plane or planes of division for full contact with the flat sides of the tubing, so that the mandrel may engage opposite inner areas of the pile shell by the application of a low specific pressure to the tubing, thereby simplifying operations and increasing the life of the tubing.

In accordance with a further specific feature, the contraction of the mandrel is accomplished by a series of springs and guide bolts acting in direct opposition to the direction of expansion by the tubing and disposed at intervals along the mandrel to also serve to hold the tubing in place during operations.

Other features and advantages of the invention will be apparent from the following detailed description and attached drawings of preferred forms of the invention.

It should be understood that the invention is not intended to be limited by the terms or expressions used in this description, nor by the specific details or arrangements of parts described or shown in the drawings. The scope of the invention in its various aspects is defined by the annexed claims.

For the sake of simplicity and distinction certain terms will be used in the following more detailed description as well as in the claims, namely:

"Segment" is intended to mean any main division of the cross-sectional circle of the mandrel and the corresponding parts extending throughout the length of the mandrel.

"Section" is intended to mean a lengthwise subdivision of the mandrel or its segments.

"Junction" is intended to mean portions of the mandrel which join adjacent sections of the mandrel or its segments.

"Spring bolt" is intended to include the combination of guide bolt and compression spring usually formed into a cooperating unit.

In the drawings:

FIGS. 1, 2 and 3 show in simplified form three mandrels with segments and pressure fluid containers arranged in three different ways;

FIGS. 4, 5 and 6 show show details of container and contacting surfaces of adjacent segments for three different cross-sectional shapes of the container;

FIG. 7 is a simplified side view of a mandrel;

FIGS. 8, 9 and 10 are cross-sectional views of the mandrel in contracted condition, the views being taken along corresponding lines **8—8**, **9—9** and **10—10** at different points of the mandrel in FIG. 7 and the mandrel being of the type shown in FIG. 1;

FIG. 9*a* is a view similar to FIG. 9 but showing the mandrel in expanded condition;

FIG. 11 is a vertical cross-sectional detail view taken along line **11—11** in FIG. 7;

FIG. 12 is a cross-sectional view of a mandrel of the type shown in FIG. 2, and

FIG. 13 is a cross-sectional view of a mandrel of the type shown in FIG. 3.

In the preferred form the mandrel is of a type for use with long mainly cylindrical pile shells or casings which are made of corrugated sheet iron with watertight welded seams. The corrugations may be assumed to run helically down the whole length of the pile shell. The bottom end of the shell is closed by a boot, which may be formed of sheet steel and is welded watertight to the shell. This boot may be suitably shaped for driving through strata of different nature and density. For an example of a somewhat pointed boot see the copending patent application Serial No. 450,405 filed by Walter H. Cobi on August 17, 1954. It should be understood that the mandrel may be constructed in accordance with the invention for use with pile casing tapered to have a smaller diameter at the bottom than at the top.

For driving of a shell of this general type the mandrel,

constructed in accordance with the invention, may be of the general form shown in FIG. 7.

As shown in FIG. 7 the mandrel **10** is made up of two long parallel segments **11** and **12**. At the top end **100** the segments are suitably reinforced and padded to receive the hammer of the driving rig and provision is made for connecting the top end to the hammer, as by steel cable, for insertion of the whole mandrel into a shell for driving and for lifting it out of the shell after driving has been completed.

At the bottom end **110** the mandrel is terminated by a plate, common to the driving segments and linked thereto for removal with the segments. The plate is shaped to fit into the boot of the shell and takes part of the driving thrusts from the segments. If desired, the construction of this plate may also be similar to that disclosed in my copending application Serial No. 450,405 referred to.

In operation the two segments **11** and **12** are separated by expansion of the pressure fluid container disposed between them through the whole length of the mandrel and are thus forced into contact with opposite portions of the inside corrugated surface of the shell. For the purpose of preventing slipping and to aid in overcoming the frictional resistance of the shell in the tight hole being formed in the ground each driving segment has a series of driving ridges or projections **76** (see FIG. 7) extending a short distance from the surfaces of the two opposite engaging portions of the mandrel to fit into corrugations in the shell aligned therewith. When these ridges are of appreciable length they are disposed along the helical pattern of the shell corrugations.

Depending on the overall length of the mandrel or on the feasible manufacturing lengths of the driving segments and the tubular containers, the mandrel may be made in one continuous length or it may be sectionalized into two or more sections which then will be rigidly joined by junctions, such as the junction **120** indicated in FIG. 7.

The tubular containers within mandrels of this type are suitably terminated at top and bottom portions **100** and **110**, and would be similarly terminated within junctions **120** with a suitable hose connection between the terminations for the pressure fluid circuit. The termination at the top end is connected through flexible hose **140** (see FIG. 7) to the compressor equipment. The termination at the bottom end is closed or tightly plugged.

FIGS. 1, 2 and 3 show schematically typical examples of cylindrical mandrels constructed in accordance with the invention.

The mandrel **10** shown in FIG. 1 is divided through its entire length into two equal half segments **11** and **12** with flat type expansion tubing **15** placed centrally of the mandrel in the plane of division **17** between the two segments for separation of them in the two opposed directions indicated by the double arrow. Two rows of parallel spring bolts **19** for restoring the two segments into contacted position upon contraction of the tubing are indicated by dotted lines **19**.

The mandrel **20** shown in FIG. 2 differs from the mandrel **10** mainly in being divided into two unequal segments **21** and **22**, so that the plane of division **27** is offset from the centerline of the mandrel and the tubing **25** extends off-center through the mandrel in the plane **27**. The parallel spring bolts, indicated by dotted lines **29**, are shown as being disposed across the plane of division to act in opposition to the expansion of the tubing **25** in opposite directions, as indicated by the double arrow.

The mandrel **30** shown in FIG. 3 is made up of two movable segments **31** and **32**, similar to the narrow segment **21** in mandrel **20**, and a central stationary segment **33** located between them. The two planess of division **37** and **38** are parallel and off-center and the two flat tubings **35** and **36**, located in these planes, extend with their flat surfaces parallel and off-center, through the mandrel. They expand in opposite directions in the directions of the individual arrows to separate the segments **31** and **32** from the substantially stationary center segment **33**. Spring bolts, indicated by dotted lines **39**, may be common to both movable segments **31** and **32** for restoring them into contact with the stationary segment **33** upon contraction of the tubings **35** and **36**, or they may be individual to the segments as indicated in FIG. 2.

Thus it will be noted that the three mandrels **10**, **20** and **30** change their overall transverse dimension only in two opposite directions, as indicated by the arrows, while their width W considered as being along a plane at right angles to the directions of expansion, remains constant.

The flat type tubings **15**, **25** or **35**, as indicated in FIGS. 1, 2 and 3 are placed between inner, parallel, substantially flat surfaces of the longitudinal segments, such as segments **11** and **12**, of the mandrel.

The tubings are of the flat type but may be shaped in cross-section in different ways, three examples of such shapes being shown in FIGS. 4, 5 and 6. Any of these may be used in mandrel **10**, and they are equally suitable for mandrels **20** and **30**, or other variations of mandrel segments.

FIG. 4 shows the tubing **40** as having two wide flat parallel surfaces **41** and **42** for engagement with inner surfaces of the segments **11** and **12** with normal contracted spacing *a*. The flat surfaces **41** and **42** are interconnected by semi-circular portions **43**. When the tubing **40** is expanded by an internal pressure fluid, such as compressed air or steam, it will separate the segments **11** and **12** to a distance *b*, determined by the size of the pile shell with which the segments are brought into engagement. The tubing then may assume the shape **40***a*, indicated by heavy dotted line, which approaches the circular shape. It will be noted that as the distance *b* is increased relatively to the distance *a* the contacting areas of the tubing with the surfaces of the segments **11** and **12** are likely to become considerably reduced.

FIG. 5 shows a tubing **50** as having two wide flat surfaces **51** and **52** similar to surfaces **41** and **42** in FIG. 4 and similarly engaging segments **11** and **12** with contracted spacing *a*. The flat surfaces are interconnected along each side by a fold portion **53** extending toward the center of the tubing **50**. The depth of the folds **53** depends on the distance *b* to which the inner surfaces of segments **11** and **12** are to be separated. In the expanded condition the shape of the tubing **50** will be as indicated by the dotted line **50***a*, with the contacting areas **51** and **52** remaining substantially of the same size as under the contracted condition since the folds supply the extra wall area for the increased distance between the segments. Thus, for a given required total pressure to be exerted by the tubing during the driving operation, the tubing **50** will require a lower specific pressure than will the tubing **40**. This type of tubing requires a wider spacing *a* than does tubing **40**.

FIG. 6 shows a tubing **60** somewhat similar to tubing **40** but having its flat contacting surfaces **61** and **62** brought closer together and having its interconnecting edge portions **63** of at least as great semi-circular dimension as the portions **43** of tubing **40**. The opposing surfaces of the segments **11** and **12** present raised areas **65** and **66** which reach beyond the edge portions **63** into light contact with the flat areas **61** and **62** of the tubing. Thus, with this type of tubing the contracted spacing *a* between the segments **11** and **12** is appreciably reduced from that with tubing **40** and, for the same extent of expansion as with tubing **40**, the expanded spacing *b* is similarly reduced. The arrangement may be such that the transverse diameter C of the edge portions **63** of the tubing will be approximately equal to the average of the dimensions *a* and *b*, so that, similar to the case of tubing **50**, the edge portions will provide enough wall areas for both the contracted and the expanded conditions to cause the contacting surfaces **61** and **62** to retain their full width in engagement with the raised surface portions **65** and

66 of segments 11 and 12. The expanded tubing is shown by heavy dash line 60*a*. This tubing shape therefore is well adapted for use particularly in mandrels which are of comparatively small diameter or which for other reasons are crowded. Like tubing 50 it also requires a comparatively low specific pressure, since the contacting surfaces are not narrowed under expansion, as in the case of tubing 40.

It should be understood that the shapes of the tubings shown in FIGS. 4, 5 and 6 may be varied somewhat. Thus the flat areas of the tubings may be impressed on them by the pressure of the contacting surfaces of the segments 11 and 12, whereas the inherent uninflated shape of the flat areas would be somewhat bulging; and even the depressed areas 61 and 62 of tubing 60 may be formed by the raised portions 65 and 66 of the segment surfaces pressing into a tubing shaped like tubing 40.

The wall of the expansion tubing is made up of layers of a rubberlike composition capable of heat curing for imparting thereto an inherent or cured-in tendency to retain the particular wall thickness and wall shape given thereto during curing. This material may include rubber, neoprene, buna or other similar substances in suitable proportions. The wall also includes one or more layers of fabric reinforcement imbedded between the rubberlike layers, these layers being of thin strong yarn, such as nylon, applied in the form of strands or tapes and in a manner to form a practically non-elastic or non-stretchable reinforcement for the wall, such manner of applying being known in the art. With this reinforcement and with the comparatively low specific pressure needed for the flat type tubing the tubing will be practically non-elastic in operation.

In the preferred form the tubing presents an outer surface of the rubberlike material, which tends to make an intimate contact with the contacting metal surfaces, almost resembling an adhesion, thereby reducing wear, which would result from constant rubbing between these surfaces during the violent vibrations under operating conditions.

Also in the preferred form the tubing is cured to have the dimensions and shapes which it is to assume under contracted condition, so that the contracting springs operating through the segments will not be required to compact the tubing in contracted condition. Consequently the tubing may be kept down to a size sufficient to hold the segments 11 and 12 in close contact while the mandrel is shifted from shell to shell. This is of particular advantage in the smaller size mandrels where space is limited.

FIGS. 8 to 11 show details of a mandrel 10 of the type shown in FIG. 1. It is shown with one expansion tubing 60, shown in FIG. 6, but other flat type tubings may be used, including those shown in FIGS. 4 and 5.

FIG. 9 shows a cross-section of the mandrel 10 taken at lines 9—9 in FIG. 7. From FIG. 9 it will be seen that each of the segments 11 and 12 is composed of an outer contacting plate 71 curved throughout its length to have a nearly semi-circular cross-section, and an inner pressure plate 72 which is substantially flat. The plates 71 engage along their edges at the plane of division 17, and are slightly short of representing a semi-circle, so that under expanded condition they may conform closely to the circular shape of the pile shell 75 (see FIG. 9*a*). Near their mutual point of engagement the plates 71 are brought inward toward the center a short distance in cross-section, as by bending to establish a safe constant width W of the mandrel that will insure ready removal of it from the shell in contracted condition.

The flat plates 72 are welded to the inner surfaces of plates 71 a distance inside the edges thereof which will allow space for the expansion tubing 60 between them in contracted condition. The plates will be in parallel relation in both contracted and expanded condition and extend crosswise of the width of the mandrel.

These plates may be of wrought iron, cast steel, or other suitable structural material. The should be of sufficient thickness and their cross-sectional configuration should be such that the two segments 11 and 12 will be rigid enough to transmit the hammer blows through the length of the mandrel to the bottom section 110 and the boot of the shell without danger of bending the segments out of alignment.

The outside plates 71 are provided with the driving ridges 76, as indicated in FIG. 7, these ridges being segment shaped in cross-section and helically disposed on the outside surface of the mandrel to fit into the helical corrugations in the pile shell 75 in expanded condition of the mandrel. The ridges may be spaced apart along the mandrel as desired and their length is limited so that their ends are well within the width W of the mandrel to insure ready removal of the mandrel from the shell 75.

The segments 11 and 12 are guided in their inward and outward movements by means of a set of spring bolts 19, as shown in FIGS. 9 and 9*a*, and also by means of a set of pins 85, as shown in FIG. 10; these two sets preferably alternating along the length of the mandrel. Each set is placed in two rows along opposite edges of the pressure tubing 60 and close enough to the tubing to aid in holding it in position in the center with respect to the width of the mandrel despite the violent vibrations set up by the hammer blows during driving operations.

As shown in FIGS. 9 and 9*a* the segmental space in both segments 11 and 12 between curved plate 71 and flat plate 72 is filled in by a wall or filler block 78 at each place along the mandrel where a pair of spring bolts 19 is located. Each spring bolt 19 comprises a bolt 80 with head and nut at opposite ends and with a spring 81 and washer 82 at each end. The bolts 80 pass through the two flat inner plates 72, which are held under inward pressure by the springs 81 at opposite ends of the bolts. For insertion of the bolts, when the mandrel is being assembled holes 83 are provided in the filler blocks 78 and the curved plates 71. The thickness of the filler blocks 78 therefore is somewhat greater than the diameter of the holes 83, and may in fact be two to three inches. The filler blocks are welded in position to plates 71. The bolts 80 fit snugly but slidably in the holes in plates 72 and the washers 82 fit snugly but sildably in the holes 83, so that the two halves 11 and 12 of the mandrel will be kept in alignment at all times. The contracted condition of these elements is shown in FIG. 9 and the expanded condition, in FIG. 9*a*. The spring bolts 19 may readily be removed from both mandrel segments 11 and 12 if and when it becomes necessary to repair or replace the pressure tubing 60.

Each guide pin 85 is fastened, as by welding in one plate 72 and extends through and is slidable in a registering hole in the other plate 72, and thus further aids in keeping the two mandrel halves 11 and 12 in proper alignment. There may be one or more pairs of pins 85 between successive pairs of spring bolts 19. The pins may also be staggered, if desired. These pins are not only less expensive than the bolts, but they simplify the assembling and dismantling of the mandrel.

In the preferred form of this type of mandrel, as shown in FIGS. 8 to 10, the central pressure tubing is of the type 60 shown in FIG. 6. The flat sides engage the raised surfaces 65, 66 of the plates 72. The raised surfaces 65 and 66 may be effected by welding strips of iron to the plates 72. The contracted condition is shown in FIG. 9 and the expanded condition, in FIG. 9*a*. It will be noted that under both conditions the effective contacting surfaces between the tubing and the raised areas of the plates 72 are of full width. The overall width of the tubing fits closely between the bolts 19 and also between the pins 85 shown in FIG. 10.

As already stated the mandrel is terminated at top and bottom by special end portions 100 and 110. When the mandrel is built up of two or more sections these will

be permanently connected by junction portions **120**, as shown in FIG. 7.

These top, bottom and junction portions are constructed alike for the purposes of connection with the two halves **11** and **12** of the mandrel, and the details involved are shown in FIGS. 8 and 11 as an example for all three locations. FIGS. 8 and 11 furthermore shown the adaptation thereof for the top portion **100** which is constructed to receive the hammer blows. These figures are cross-sectional views taken along lines **8** and **11** in the alternate figures and in FIG. 7.

FIG. 11 shows in the lower part of the figure the top end of the two mandrel halves **11** and **12** brought up into connection with the top portion **100**. The figure shows the curved plates **71**, the flat plates **72** with their raised portions **65** and **66** in engagement with pressure tubing **60** and the two upper-most walls or filler blocks **78** for the spring bolts **19**.

The top portion **100** comprises two similar steel castings **101** and **102**, one for each mandrel segment **11** and **12**. They are substantially semi-circular and meet along the division plane **17** in contracted condition. They are shouldered at the bottom to receive the top edges of plates **71** and **72** which are welded thereto. The castings are hollowed to provide space for the termination of tubing **60**, which at this point is clear of the pressure surfaces **65**, **66** and assumes a circular shape as it enters a pressure proof cap **67**. This cap is clamped to the rigid shelf **68** by means of a nut **69**. The shelf is welded to the inside wall of the hollow casting **101** at an angle to accommodate the deviated direction of the tubing and cap. With only one tubing within the mandrel only one shelf is provided. The nut **69** has a fitting for connecting a hose **140** for extending to the outside for connection with an air compressor (not shown) for passing air from the compressor through inner passages in nut **69** and cap **67** into the pressure tubing **60**. The pressure may be released by a flow back over the same circuit through a control mechanism (not shown) known in the art.

It may be noted here that two castings similar to castings **101** and **102** are provided for the bottom terminal portion **110**, one having a shelf similar to shelf **68** for mounting of a cap termination similar to termination **67**, **69** for the pressure tubing. In this place at the bottom end the tubing is closed or plugged.

Similar castings are provided for any junction connection **120** for interconnecting sections of the two mandrel halves **11** and **12** and with a cap connection for the end of each tubing fastened to a shelf, as shown in FIGS. 8 and 11, the caps being connected together by a hose connection, as hose **140**, for continuing the pressure circuit from one section of tubing to the next. The shelves may, of course, be welded to either casting.

Returning to the top end **100** as shown in FIG. 11 the two castings **101** and **102** are extended upward each by a heavier substantially semi-circular portion **103** having a flat upper surface, to receive a common buffer section or cushion **105** with intervening soft steel pads **106**. The driving hammer strikes directly on this buffer section **105**. The semi-circular extensions **103** are slit vertically along a plane at right angles to the plane of division **17**, to provide a passage for hose connection **140** and also to provide space for a crossbar **107** fastened by a downwardly pending bolt **108** to the common section **105**. The bar extends crosswise and under two rods or bolts **104** extending across the slit in casting extensions **103**. Two holes **109** in buffer section **105** are for steel cables attaching the mandrel to the hammer. When the mandrel is to be raised the cable pulls up on section **105** which brings the crossbar **107** into engagement with the cross-pieces **104** in the mandrel segments. Thus the mandrel will be lifted upwardly as a unit.

FIG. 12 shows a cross-section of a mandrel **20** of the type shown in FIG. 2. The mandrel is unsymmetrical in that segment **21** is much shallower than segment **22** in the direction of expansion and contraction, namely at right angles to the constant width W of the mandrel.

The construction of the segment **21** is substantially the same as that of segment **11** in FIG. 9. The other segment **22**, comprising the outer contacting plate **90** and the inner pressure plate **91**, is, however, modified. Thus the plate **90** has a curved portion **92** for conforming contact with the pile shell **75** in expanded condition and of substantially the same dimensions as the outer curved plate of segment **21**. The curved portion **92** is extended into two parallel side plate portions **93** having sufficient length to contact the segment **21** at the plane of division **27** and defining the constant width W of the mandrel. The pressure plate **91** is welded to the side plates **93** parallel with the pressure plate **72***a* of segment **21**. The pressure tubing **40** is shown as being of the type in FIG. 4, though either of the other flat type tubings may be used. It is placed between the pressure plates for separation of the two elements **21** and **22** into driving contact with the shell **75**.

The mandrel **20** presents a special feature for operating conditions in that the segment **92** provides a wide passageway down through the length of the mandrel, the passageway being formed within the segment **22** by the deeply U-shaped plate **90** and the flat plate **91**. This passageway may be utilized for pouring materials, such as a cement mix, down to the bottom of the pile shell **75**, after the bottom plate of the mandrel has been removed. To eliminate obstructions within the passageway the spring bolts **29** have only one operating end, the other end being welded into the plate **91**.

FIG. 13 shows a cross-section of a mandrel **30** of the type shown in FIG. 3. The mandrel is a three element type with two flat pressure tubings **40** placed in the two planes of division **37** and **38** between the three segments **31**, **32** and **33**. The two tubings expand in opposite directions for displacement of the two outer segments **31** and **32** relative to the essentially stationary middle segment **33** and into driving contact with the shell **75**.

The construction of the outer segments **31** and **32**, is again substantially the same as that of segment **11** in FIG. 9 and resembles even closer the smaller segment **21** in FIG. 12. The intermediate segment **33** has a rectangular cross-section, being comprised of two parallel flat pressure plates **95**, corresponding closely to plate **91** in FIG. 12 and of two parallel side plates **96**, welded to the plates **95** and otherwise corresponding to the side plates **93** in FIG. 12 in contacting the plates **31** and **32** in the planes of division **37** and **38** and in defining the constant width W of the mandrel. By the use of two pressure tubings between the inner pressure plates this type of mandrel is adapted for use in driving pile shells of greater diameter than those for which the mandrel, shown in FIG. 9 is normally designed.

The terms and expressions which have been employed herein are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, and it is to be recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. An expansible mandrel for driving pile shells, said mandrel comprising a pair of driving segments having arcuate outer surfaces for engaging diametrically opposite portions of the shell, each of said segments having an inner surface forming an integral portion of said segment and defining a chord across the curvature of said segment from one side portion of said segment to the opposite side portion thereof, and extending longitudinally along substantially the length of said segment, and flexible pneumatic pressure container means interposed between said inner surfaces of said segments for exerting pressures thereon simultaneously in opposite directions to drive said segments outwardly along the directions of

said oppositely exerted pressures into firm engagement with said diametrically opposite portions of said shell.

2. An expansible mandrel as defined by claim 1, wherein spring bolts are provided at opposite sides of said pressure container means and extending through one of said segments into the other for withdrawing said segments from engagement with said shell when pressure in said container is released.

3. An expansible mandrel as defined by claim 1, in which the cross-sectional areas of the two driving segments are of substantially different sizes and the peripheral length of the arc of the plate of the element having the larger area is substantially greater than the peripheral length of the arc of the curved plate of the other element.

4. An expansible mandrel as defined by claim 1, which includes a stationary segment between the inner surfaces of the two driving segments, and the pressure container means comprises an inflatable and deflatable tubing between the inner surface of one of said driving segments and said stationary segment and an inflatable and deflatable tubing between the inner surface of the other of said driving segments and said stationary segment.

5. An expansible mandrel as defined by claim 1, in which said flexible pressure container means comprises a container which, in inflated condition, is generally flat in cross section and in deflated condition has flat areas in contact with the inner surfaces of said driving segments.

6. An expansible mandrel as defined in claim 1, in which said inner surfaces have raised portions in contact with said pressure container means, and the latter comprises a tubing which, in deflated condition, has an intermediate flattened portion with outer end portions bulbous in cross section.

7. An expansible mandrel as defined by claim 1, in which the pressure container means comprises a tubing

which in deflated condition has flat outer surfaces connected by intermediate folds.

8. An expansible mandrel as defined by claim 1, in which the pressure container means comprises a tubing terminating at its upper end in a circular fitting.

9. An expansible mandrel as defined by claim 1, in which at least one of said segments provides a hollow concrete pouring conduit through which concrete may be poured while said mandrel is in a driven shell.

10. An expansible mandrel for driving pile shells, said mandrel comprising a pair of driving segments, having outer arcuate members for engaging diametrically opposite portions of the shell, an inner member having a flat surface extending across one of said arcuate members from one side edge portion to the other of said arcuate member and integral therewith, a second inner member having a flat surface and extending parallel to the first mentioned inner member across the second of said arcuate members from one side edge portion to the other of said second arcuate member and integral therewith, the length of each of said inner members being substantially coextensive with that of the corresponding arcuate member, and flexible pneumatic container means interposed between said flat surfaces of said inner members for exerting pressures simultaneously in opposite directions upon said surfaces for driving said segments outwardly in the directions of said pressures into firm engagement with said diametrically opposite portions of said shell.

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