

Aug. 9, 1966

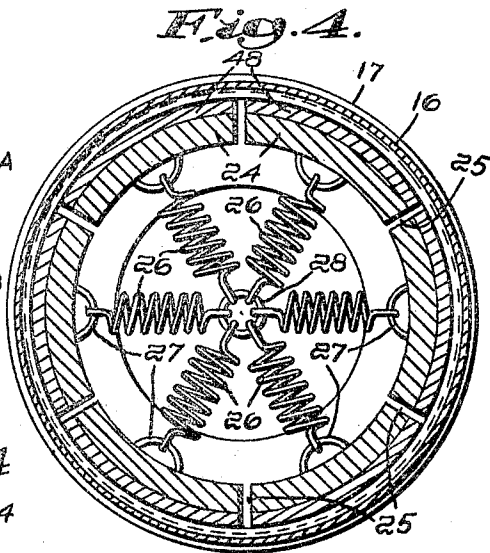
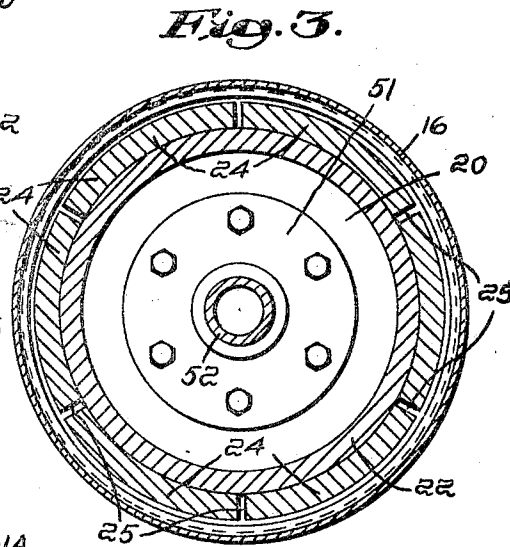
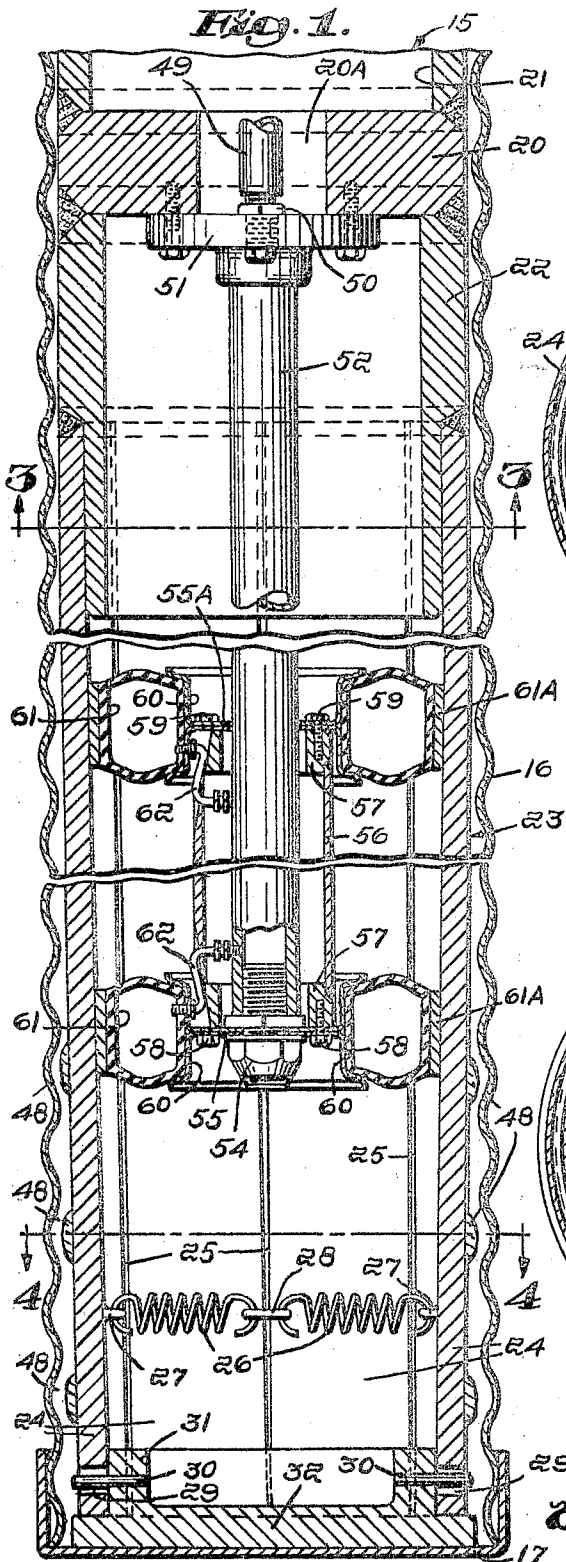
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3,264,834

EXPANSIBLE MANDREL

Filed March 28, 1963

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Aug. 9, 1966

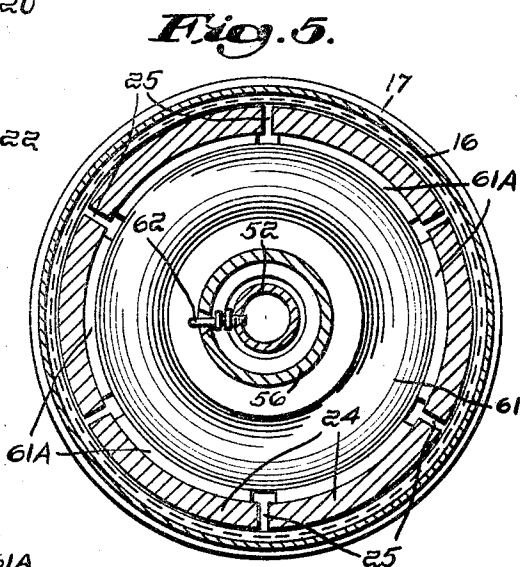
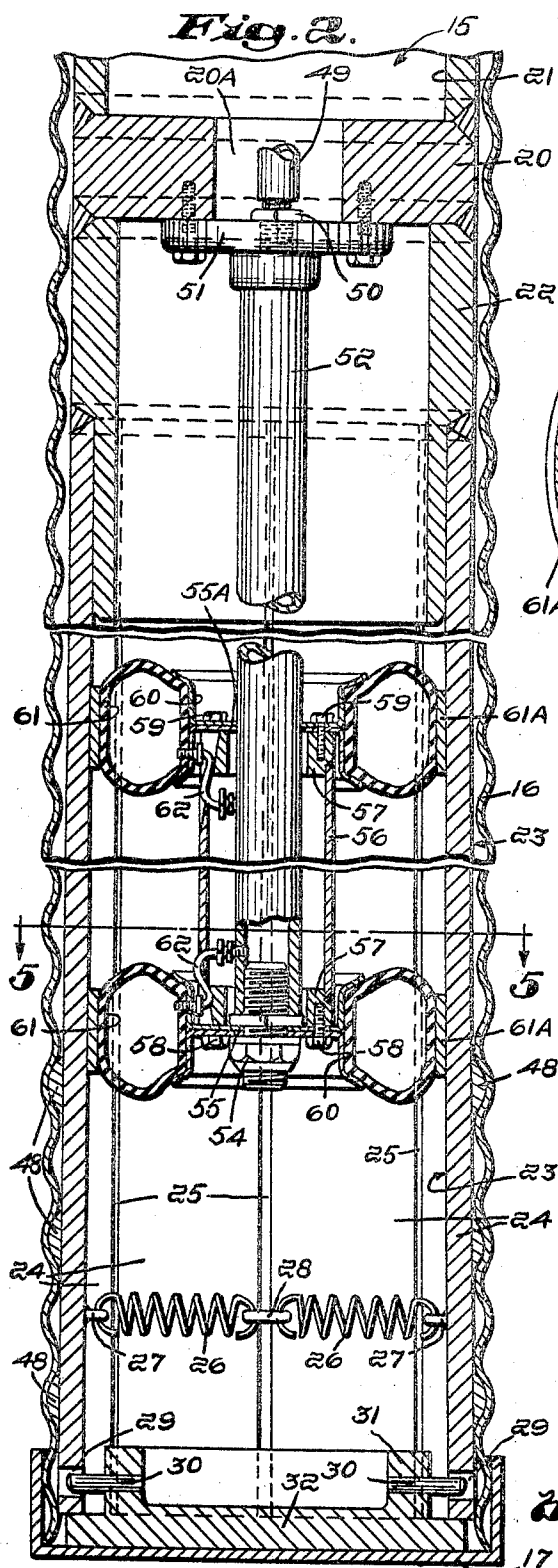
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EXPANSIBLE MANDREL

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Fig. 6.

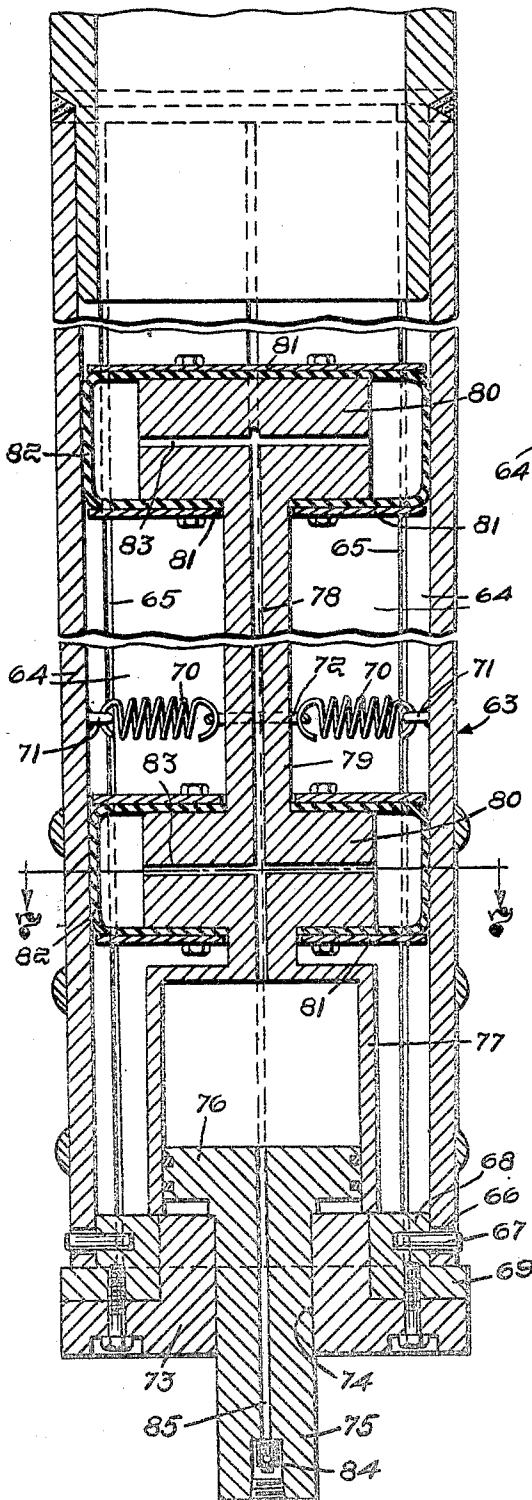
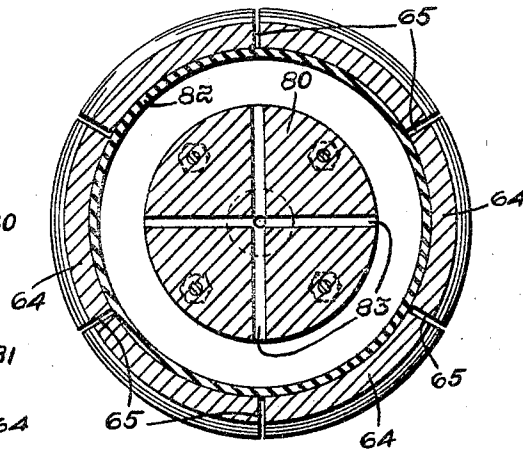


Fig. 7.



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Fig. 8.

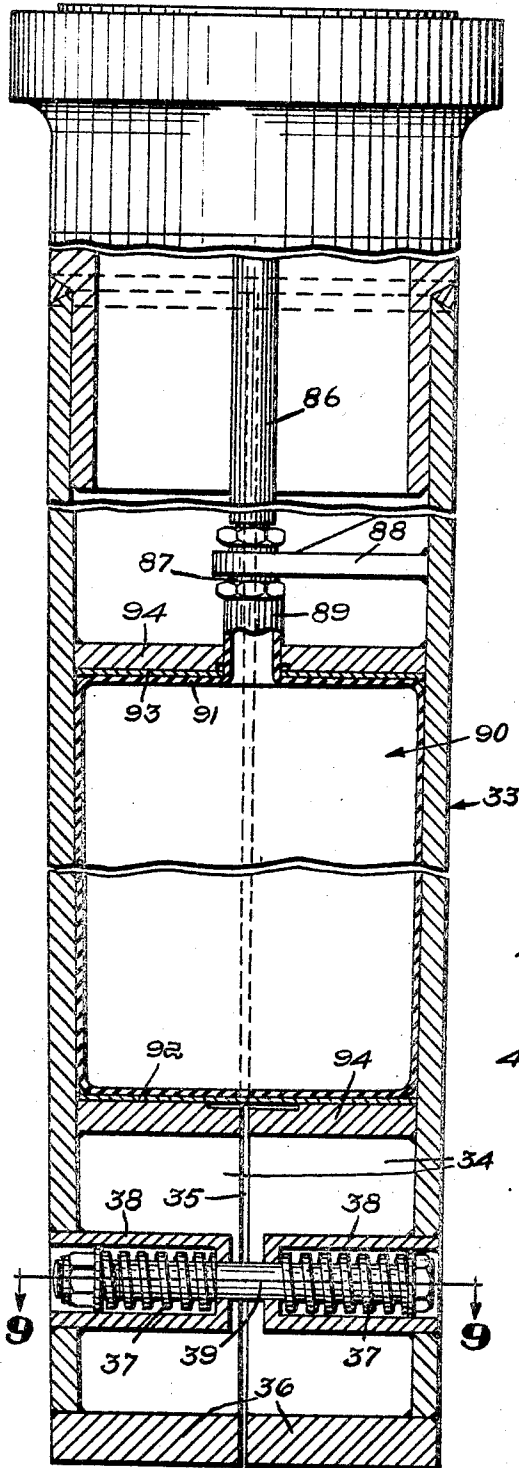


Fig. 9.

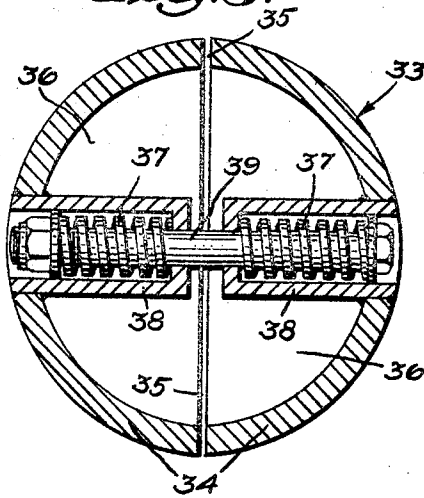
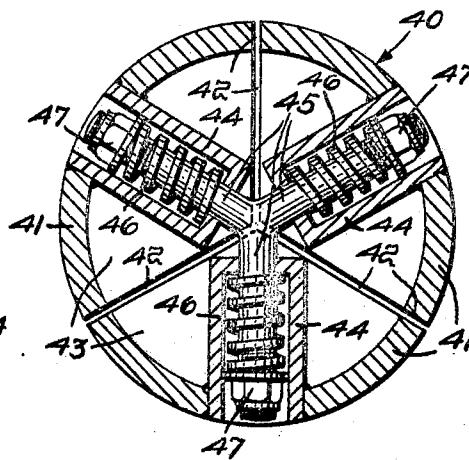


Fig. 10.



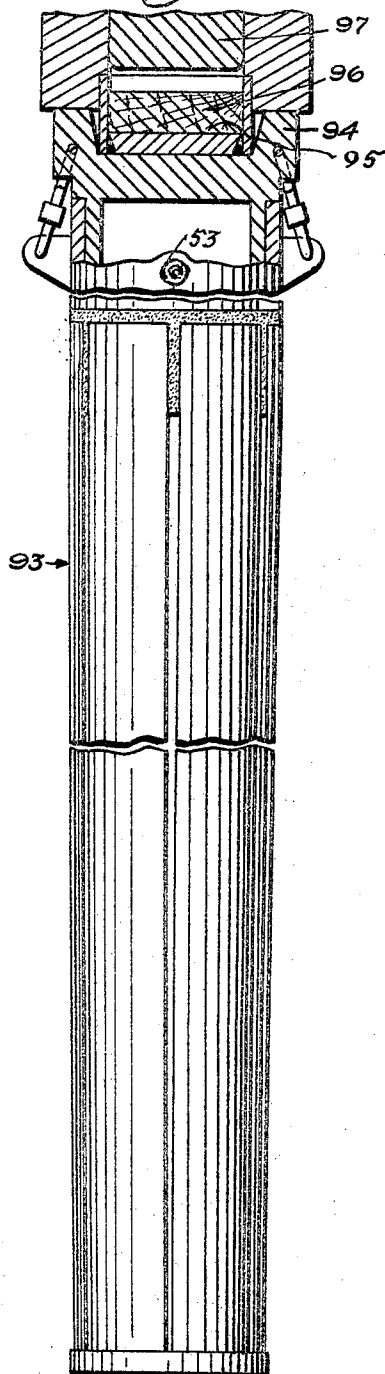
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Fig. 12.



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3,264,834

EXPANSIBLE MANDREL

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14 Claims. (Cl. 61—53.72)

The present invention relates to expansible mandrels for insertion into and for driving engagement with forms for cast-in-place piles.

Cast-in-place concrete piles are widely used and have proved to be highly satisfactory under a wide range of conditions and with piles varying greatly in length. In forming such piles, it is necessary to drive a form, such as tubing, light gauge pipe, and corrugated shells, into the ground, withdraw the driving mandrel, and then fill the form with concrete.

As such forms are relatively thin walled, it is the practice to use a mandrel that is a close but free fit within a form and that is expansible so that, after insertion, it can be so expanded as to provide a tight driving connection with the interior of the form and, after driving, so contracted that it may be withdrawn therefrom.

The available expansible piles are relatively complicated and expensive and often fail to provide a sufficiently tight driving engagement with the form to ensure that it is properly driven. The present invention, accordingly, has its principal objectives concerned with the above generally stated shortcomings of existing mandrels of expanding types and in accordance with it, these objectives are attained by providing a mandrel in the form of a tubular member whose form-entering end includes circumferentially spaced, arcuate sections defining longitudinally extending, open-ended slots and so drawn together at their free ends by resilient means as to materially reduce the cross sectional area of its end thus to facilitate its entry into the form. Fluid pressure operated means, within the tubular member and operable by fluid pressure, are in peripheral engagement with the interior surface of said sections in a circumferential zone where the sections are inclined inwardly by the resilient means and the fluid pressure operated means are operative to force the sections outwardly into tight driving engagement with the forms.

In one embodiment of the invention, the fluid pressure operated means are in the form of at least one and, typically, a plurality of vertically spaced pneumatic tires, held by depending supporting means connected to the mandrel above the upper ends of the sections. One of the advantages flowing from the use of pneumatic tires is the fact that each may be mounted on a wheel-like mount enabling the mount to be easily connected to the supporting means and to each other. The supporting means may be and typically is a length of pipe which is part of the supply conduit for air under pressure from an outside source.

In another embodiment of the invention, the fluid pressure operated means may be substantially cylindrical, inflatable members, in which case, the mandrel sections are provided with means confining them against axial movement.

Another objective of the invention is to provide an expansible mandrel having self-contained means to deliver fluid under pressure to the fluid pressure operated means to eliminate dependence on outside sources. In accordance with the invention, this objective is achieved by providing a piston-cylinder unit within the mandrel which has such a capacity that on a single, predetermined stroke, the fluid pressure operated means forces the mandrel sections into driving engagement with the form. In this embodiment, either the piston member or the cylinder member of the unit is exposed beyond the end of the mandrel and is axially movable so that the predetermined stroke results when the mandrel is bottomed in the form.

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The length of the section depends, in part, on the driving means used. With a conventional hammer, the sections must be sufficiently long to provide such a sufficient flexing length as to prevent over-stressing. With a pile driver of the sonic-type, the sections may be substantially shorter. The length of the sections also determines the type and number of pressure operated means employed.

In practice, an expansible mandrel in accordance with the invention has a plate secured to the free ends of the sections to permit them to be flexed inwardly by the resilient means to a predetermined extent and in some embodiments, the sections are movable outwardly by the expansible means independently of the plate but with the plate underlying the free ends of the sections at all times.

Illustrative embodiments of the invention are shown in the accompanying drawings from which its several objectives and its many novel features and advantages will be readily apparent.

In the drawings:

FIGURE 1 is a fragmentary vertical section of a mandrel in accordance with the invention with the free ends of its sections flexed inwardly by the resilient means for entry into the form,

FIGURE 2 is a like view but with the sections forced outwardly by fluid pressure operated means into driving engagement with the form,

FIGURE 3 is a section taken approximately along the indicated lines 3—3 of FIGURE 1,

FIGURE 4 is a section taken approximately along the indicated lines 4—4 of FIGURE 1,

FIGURE 5 is a section taken approximately along the indicated lines 5—5 of FIGURE 2,

FIGURE 6 is a fragmentary vertical section of a mandrel in accordance with another embodiment of the invention,

FIGURE 7 is a section taken approximately along the indicated lines 7—7 of FIGURE 6,

FIGURE 8 is a fragmentary, vertical section illustrating another embodiment of the invention,

FIGURE 9 is a section taken approximately along the indicated lines 9—9 of FIGURE 8,

FIGURE 10 is a view similar to FIGURE 9 but illustrating a different spring arrangement,

FIGURE 11 is a fragmentary, elevational view of a mandrel in accordance with the invention for use with a sonic pile driver, and

FIGURE 12 is a like view but with the mandrel to be driven by a steam operated pile driver.

In FIGURE 11, there is shown a generally indicated mandrel 15 for entry into the form 16, see FIGURES 1 and 2, which is to be driven into the ground. The form 16 is shown as of circular section and of a type having helical corrugations with its lower end closed by a boot 17. The mandrel 15 is a free but close fit in the form 16 and has a head 18 by which it is attached to the attaching flange 19 of a pile driver of the type including a vibration generator, not shown, the generated vibrations being in the subsonic or sonic ranges.

The mandrel 15 is shown in FIGURES 1—5 as including an annular part 20 to which an upper mandrel member 21 and an adapter member 22 are welded. The adapter member 22 has its outside diameter reduced to enable a generally indicated tubular member 23 of the same outside diameter but of a lesser wall thickness, to fit thereon and to be welded thereto.

The member 23 is shown as divided, throughout its entire length, into sections 24 by slots 25 opening through its lower end adjacent which there are resilient means interconnecting them and shown as consisting of a series of tension springs 26, one for each section 24 and attached at one end to an eye 27 on its inner surface, and at its other end to a ring 28. The springs 26 are of such size

and strength that the sections 24 are drawn inwardly throughout a substantial part of their length to so reduce the cross sectional area of the form-entering end of the mandrel 15 as to facilitate its entrance into the form 16, see FIGURE 1.

The free end of each section 24 has a passage 29 slidably receiving a radially disposed pin 30 carried by a circular stop 31 extending between the free ends of the section 24 to limit the extent to which they are flexed inwardly by the resilient means and carried by an end plate 32.

Reference is now made to FIGURES 8 and 9 wherein the generally indicated mandrel member 33 is divided into sections 34 by slots 35 opening through its lower end. Each section 34 is shown as having an inwardly disposed stop portion 36 welded thereto which engage to limit the extent to which the sections 34 may be flexed inwardly by the resilient means.

In FIGURES 8 and 9, the resilient means are shown as comprising compression coiled springs 37 each seated in an inwardly extending socket 38. A bolt 39 extends from one socket to the other and through the springs 37 to maintain them under section-flexing compression.

Reference is also made to FIGURE 10 wherein there is shown a generally indicated mandrel member 40 divided into three sections 41 by slots 42 with each section including an inwardly disposed stop portion 43. Each section 41 has a socket 44 extending inwardly thereof and slidably receiving one of the centrally interconnected radial arms 45. In each socket, there is a coiled compression spring 46 through which an arm 45 extends with its outer end threaded to receive a nut 47 enabling the springs 46 to be maintained under compression urging the sections inwardly with their inward flexing being limited by the interengagement of the stop portions 43.

By these or equivalent means, the form-entering ends of the mandrel sections are normally flexed to so reduce the cross sectional area as to facilitate entry into the form. The fluid pressure operated means by which the mandrel sections can then be forced outwardly into tight driving engagement with the form will now be discussed and it is preferred that, when the forms 16 are of the above indicated corrugated type, the mandrel sections have lengths of half-round bars 48 welded thereto in vertically spaced relationship and on the proper helical path to engage the shell corrugations when the mandrel sections are in driving contact with the shell.

In the embodiment of the invention illustrated by FIGURES 1-5, the annular part 20 has a central opening 20A to enable an air line 49 to be attached to the fitting 50 on a plate 51 bolted to the undersurface of the part 20 and including a rigid conduit 52 with which the fitting 50 is in communication. The air line 49 extends upwardly through the upper mandrel member 21 and it is connected to a fitting 53 opening through its wall adjacent the upper end thereof. The conduit 52 depends axially into the lower portion of the mandrel member 23 with the lower end internally threaded to receive a plug 54 by which a wheel-like member 55 is clamped to the conduit 52. A supporting sleeve 56 has annular ends 57 by the lower of which it is locked, as by bolts 58, to the upper surface of the wheel member 55 and to the upper of which another wheel-like member 55A is clamped by bolts 59. Each of the wheel-like members 55, 55A has a rim 60 on which an inflatable member, shown as a tire 61 is mounted. Each tire 61 is shown as having tread portions 61A each in engagement with the inner surface of a section 24. Each tire 61 is placed in communication with the interior of the conduit 52 by connectors 62 so that they may be inflated to force the sections 24 outwardly against the action of the resilient means into tight driving engagement with the form, see FIGURE 2.

In FIGURES 6 and 7, a different type of fluid pressure operated means is shown. A mandrel member 63 consists of sections 64 established by the slots 65 extending

through the form-entering end of the mandrel member 63 and having bores 66 through which loosely extend pins 67 carried by the annular wall 68 which is part of an end plate 69 and entrant of the mandrel to establish a stop against which the lower ends of the sections 64 are seated by springs 70 of which there is one for each section and attached at one end to the inwardly disposed eye 71 and with its other end secured to a ring 72.

A boot-engaging plate 73, bolted to the plate 69 has an axial bore 74 slidably supporting the stem 75 of the piston 76. The stem 75 is shown as having its free end protruding axially downwardly below the plate 73 to provide a predetermined piston stroke, as the mandrel is bottomed in a form. The piston 76 is within a cylinder 77 having an outlet passage 78 extending upwardly through an axial support 79 passing through the ring 72. The support 79 has a pair of vertically spaced bosses 80, each having plates 81 secured thereto to clamp and seal the margins of expansible boots 82 thereto. Each boss has radial air passages 83 effecting communication between the axial passage 78 and the interior of an appropriate one of the boots 82.

The predetermined piston stroke and the cylinder 77 are so dimensioned that, when the mandrel is bottomed in the form, the expansible boots 82 are so inflated as to force the sections 64 outwardly as required to securely lock the mandrel to the form. In order that the boots 82 may be partially preinflated, the stem 75 is provided with a valve 84 in an axial supply passage 85.

In the embodiment of the invention illustrated by FIGURE 8, an air conduit 86 is connected to a fitting 87 supported by one of the mandrel sections 88 and to which the inlet 89 of a generally cylindrical bladder 90 is connected. The bladder 90 has end plates 91 and 92 engaging retainers 94 carried by each of the mandrel sections 34.

In FIGURE 12, there is shown a generally indicated mandrel 93 for use with a steam activated pile driver but which, except for its attaching means, may be the same as the mandrels previously described. The mandrel 93 has a drive head 94 secured thereto and the drive head 94, as is conventional, has a central recess 95 for the wood block 96 to receive the driving impact of the ram 97.

In practice, it is desirable that the flexible mandrel sections be of such length as to allow for their gradual deflection to keep the bending stresses down. In practice, such sections may be in the order of twenty feet in length and the number of sections can, of course, be varied.

I claim:

1. An expansible mandrel for insertion into and for driving an earth entering form for a cast-in-place pile, said mandrel comprising a tubular member whose cross sectional dimensions are such that it is a free but close fit in said form, the form-entering end of said tubular member including spaced arcuate sections defining longitudinally extending, open-ended slots; resilient means interconnecting said sections adjacent said end and drawing them inwardly to materially reduce the cross sectional area of said end to facilitate entry of said tubular member in said form; annular, expansible fluid pressure operated means within said tubular member peripherally engaging the interior surfaces of said sections in a circumferential zone where they are inclined inwardly by said resilient means but above said resilient means; and fluid pressure delivery means extending lengthwise of the interior of said tubular member and in communication with and operable to so expand said expansible means as to force said sections outwardly into tight driving engagement with the interior of said form.

2. An expansible mandrel for insertion into and for driving an earth entering form for a cast-in-place pile, said mandrel comprising a tubular member whose cross sectional dimensions are such that it is a free but close fit in said form, the form-entering end of said tubular member including circumferentially spaced, arcuate sec-

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tions defining longitudinally extended, open-ended slots; resilient means interconnecting said sections adjacent said end and drawing them inwardly to materially reduce the cross sectional area of said end to facilitate entry of said tubular member into said form; annular, expandable, fluid pressure operated means within said tubular member peripherally engaging the interior surfaces of said sections in a circumferential zone where they are inclined inwardly by said resilient means; fluid pressure delivery means extending lengthwise of the interior of said tubular member and in communication with and operable to so expand said expandable means as to force said sections outwardly into tight driving engagement with the interior of said form; and an end plate whose cross sectional area is approximately that of said mandrel, said end plate underlying the free ends of said sections when deflected outwardly by said expandable means and including a central annular part entrant of said mandrel end against which said sections are seated by said resilient means, and a loose connection between said end plate and said sections enabling the extremities of said sections to be deflected relative to said end plate.

3. The mandrel of claim 2 in which the loose connection includes a series of outwardly projecting, radial pins carried by the annular part of the end plate and the sections having apertures loosely receiving the pins.

4. An expandable mandrel for insertion into and for driving an earth entering form for a cast-in-place pile, said mandrel comprising a tubular member whose cross sectional dimensions are such that it is a free but close fit in said form, the form-entering end of said tubular member including circumferentially spaced, arcuate sections defining longitudinally extending, open-ended slots; resilient means interconnecting said sections adjacent said end and drawing them inwardly to materially reduce the cross sectional area of said end to facilitate entry of said tubular member into said form; annular, expandable, fluid pressure operated means; means supporting said expandable means within said tubular member in peripheral engagement with the interior surfaces of said sections in a circumferential zone where they are inclined inwardly by said resilient means but above said resilient means, said supporting means being carried by said member above said sections; and fluid pressure delivery means extending lengthwise of the interior of said tubular member and in communication with and operable to so expand said expandable means as to force said sections outwardly into tight driving engagement with the interior of said form.

5. An expandable mandrel for insertion into and for driving an earth entering form for a cast-in-place pile, said mandrel comprising a tubular member whose cross sectional dimensions are such that it is a free but close fit in said form, the form-entering end of said tubular member including circumferentially spaced, arcuate sections defining longitudinally extending, open-ended slots; resilient means interconnecting said sections adjacent said end and drawing them inwardly to materially reduce the cross sectional area of said end to facilitate entry of said tubular member into said form; annular, expandable, fluid pressure operated means; means supporting said expandable means within said tubular member in peripheral engagement with the interior surfaces of said sections in a circumferential zone where they are inclined inwardly by said resilient means but above said resilient means, said supporting means being carried by said member above said sections and including a fluid pressure delivery conduit in communication with and operable to so expand said expandable means as to force said sections outwardly into tight driving engagement with the interior of said form.

6. An expandable mandrel for insertion into and for driving an earth entering form for a cast-in-place pile, said mandrel comprising a tubular member whose cross sectional dimensions are such that it is a free but close

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fit in said form, the form-entering end of said tubular member including circumferentially spaced, arcuate sections defining longitudinally extending, open-ended slots; resilient means interconnecting said sections adjacent said end and drawing them inwardly to materially reduce the cross sectional area of said end to facilitate entry of said tubular member into said form; a pneumatic, expandable, tire-like element, a wheel-like support for said element, supporting means to which said support is attached to position said element within said tubular member in peripheral engagement with the interior surfaces of said sections in a circumferential zone where they are inclined inwardly by said resilient means, said supporting means being carried by said member above said sections, and fluid pressure delivery means extending lengthwise of the interior of said tubular member and in communication with and operable to so expand said element as to force said sections outwardly into tight driving engagement with the interior of said form.

7. An expandable mandrel for insertion into and for driving an earth entering form for a cast-in-place pile, said mandrel comprising a tubular member whose cross sectional dimensions are such that it is a free but close fit in said form, the form-entering end of said tubular member including circumferentially spaced, arcuate sections defining longitudinally extending open-ended slots; resilient means interconnecting said sections adjacent said end and drawing them inwardly to materially reduce the cross sectional area of said end to facilitate entry of said tubular member into said form; and a plurality of pneumatic, tire-like elements; a wheel-like support for each element; supporting means for said supports positioning said elements within said tubular member in peripheral engagement with the interior surfaces of said sections in a circumferential zone where they are inclined inwardly by said resilient means, said supporting means being carried by said member above said sections; and fluid pressure delivery means extending lengthwise of the interior of said tubular member and in communication with and operable to so expand said elements as to force said sections outwardly into tight driving engagement with the interior of said form.

8. An expandable mandrel for insertion into and for driving an earth entering form for a cast-in-place pile, said mandrel comprising a tubular member whose cross sectional dimensions are such that it is a free but close fit in said form; the form-entering end of said tubular member including circumferentially spaced, arcuate sections defining longitudinally extending open-ended slots; resilient means interconnecting said sections adjacent said end and drawing them inwardly to materially reduce the cross sectional area of said end to facilitate entry of said tubular member into said form; a pair of pneumatic, tire-like elements within said tubular member, a wheel-like support for each element; a sleeve including end portions to which said supports are attached, a depending member extending axially of said mandrel and of said sleeve to which the lowermost support is attached, the elements being in peripheral engagement with the interior surfaces in a circumferential zone where they are inclined inwardly by said resilient means, said depending member being carried by said tubular member above said sections; and fluid pressure delivery means extending lengthwise of the interior of said tubular member and in communication with and operable to so expand said elements as to force said sections outwardly into tight driving engagement with the interior of said form.

9. The expandable mandrel of claim 8 in which the depending member is a length of rigid pipe stock and is part of the fluid pressure delivery means.

10. An expandable mandrel for insertion into and for driving an earth entering form for a cast-in-place pile, said mandrel comprising a tubular member whose cross sectional dimensions are such that it is a free but close fit in said form, the form-entering end of said tubular

member including circumferentially spaced, arcuate sections defining longitudinally extending, open-ended slots; resilient means interconnecting said sections adjacent said end and drawing them inwardly to materially reduce the cross sectional area of said end to facilitate entry of said tubular member into said form; approximately cylindrical, expandable fluid pressure operated element within said tubular member with its long axis coaxial with the axis of said tubular member and engaging the interior surfaces of said sections in a circumferential zone where they are inclined inwardly by said resilient means; and fluid pressure delivery means extending lengthwise of the interior of said tubular member and in communication with and operable to so expand said expandable means as to force said sections outwardly into tight driving engagement with the interior of said form.

11. An expansible mandrel for insertion into and for driving an earth entering form for a cast-in-place pile, said mandrel comprising a tubular member whose cross sectional dimensions are such that it is a free but close fit in said form, the form-entering end of said tubular member including circumferentially spaced, arcuate sections defining longitudinally extending, open-ended slots; resilient means interconnecting said sections adjacent said end and drawing them inwardly to materially reduce the cross sectional area of said end to facilitate entry of said tubular member into said form; approximately cylindrical, expandable fluid pressure operated element within said tubular member with its long axis coaxial with the axis of said tubular member and engaging the interior surfaces of said sections in a circumferential zone where they are inclined inwardly by said resilient means; and element confining means carried by said sections above and below said element, and fluid pressure delivery means extending lengthwise of the interior of said tubular member and in communication with and operable to so expand said expandable means as to force said sections outwardly into tight driving engaging with the interior of said form.

12. An expansible mandrel for insertion into and for driving an earth entering form for a cast-in-place pile, said mandrel comprising a tubular member whose cross sectional dimensions are such that it is a free but close fit in said form, the form-entering end of said tubular member including circumferentially spaced, arcuate sections defining longitudinally extending, open-ended slots, resilient means interconnecting said sections adjacent said end and drawing them inwardly to materially reduce the cross sectional area of said end to facilitate entry of said tubular member into said form, annular, expandable, fluid pressure operated means within said tubular member peripherally engaging the interior surfaces of said sections in a circumferential zone where they are inclined inwardly by said resilient means, and means to deliver air under pressure to said air delivery means including mating and relatively movable axially disposed cylinder and piston members having a capacity such that a single predetermined stroke provides enough air under pressure to inflate said means to a predetermined extent, one member of said air delivery means being carried by said tubular member and the other member protruding beyond the end thereof to an extent providing said stroke when said mandrel is bottomed in said form, said fluid pressure operated means, when inflated to said extent, forcing said

sections outwardly into tight driving engagement with the interior of said form.

13. An expansible mandrel for insertion into and for driving an earth entering form for a cast-in-place pile, said mandrel comprising a tubular member whose cross sectional dimensions are such that it is a free but close fit in said form, the form-entering end of said tubular member including circumferentially spaced, arcuate sections defining longitudinally extending, open-ended slots, resilient means interconnecting said sections adjacent said end and drawing them inwardly to materially reduce the cross sectional area of said end to facilitate entry of said tubular member into said form, annular, expandable, fluid pressure operated means within said tubular member peripherally engaging the interior surfaces of said sections in vertically spaced circumferential zones where they are inclined inwardly by said resilient means, and means to deliver air under pressure to said fluid pressure operated means, said fluid pressure operated means including mating and relatively movable axially disposed cylinder and piston members having a capacity such that a single predetermined stroke provides enough air under pressure to inflate said means to a predetermined extent, one member of said air delivery means being carried by said tubular member and the other member protruding beyond the end thereof to an extent providing said stroke when said mandrel is bottomed in said form, said fluid pressure operated means, when inflated to said extent, forcing said sections outwardly into tight driving engagement with the interior of said form.

14. An expansible mandrel for insertion into and for driving an earth entering form for a cast-in-place pile, said mandrel comprising a tubular member whose cross sectional dimensions are such that it is a free but close fit in said form, the form-entering end of said tubular member including circumferentially spaced, arcuate sections defining longitudinally extending, open-ended slots, resilient means interconnecting said sections adjacent said end and drawing them inwardly to materially reduce the cross sectional area of said end to facilitate entry of said tubular member into said form, annular, expandable, fluid pressure operated means within said tubular member peripherally engaging the interior surfaces of said sections in a circumferential zone where they are inclined inwardly by said resilient means but above said resilient means, and means to deliver air under pressure to said fluid pressure operated means to force said sections outwardly into tight driving engagement with the interior of said form.

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