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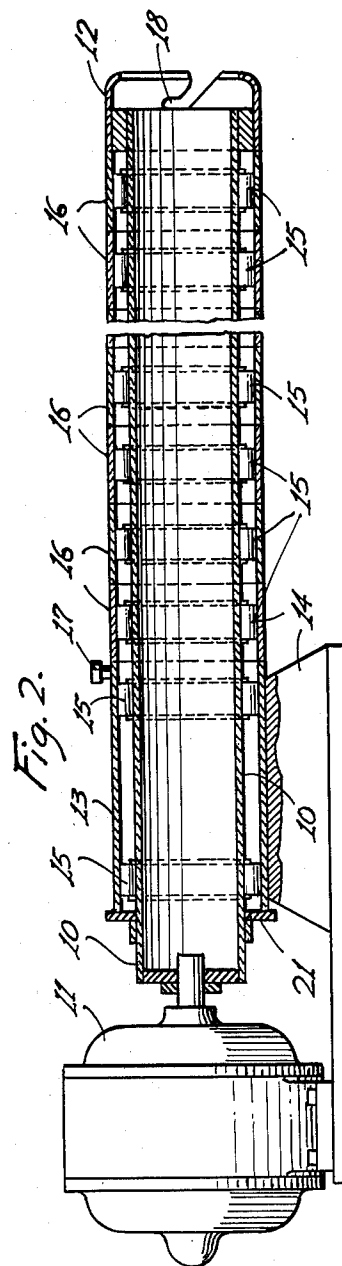
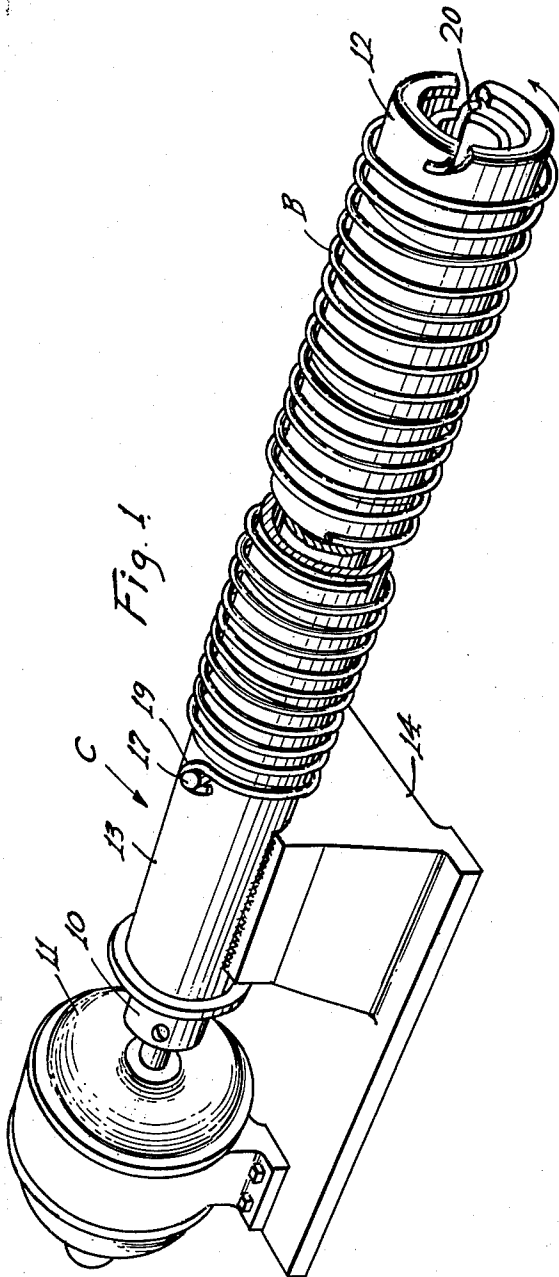
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METHOD AND APPARATUS FOR CASTING HOLLOW BUILDING UNITS

Filed April 15, 1952

2 Sheets-Sheet 1



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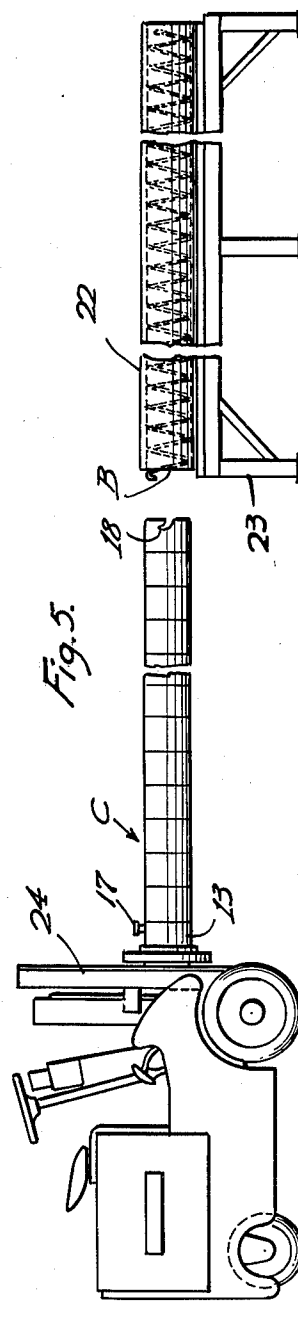
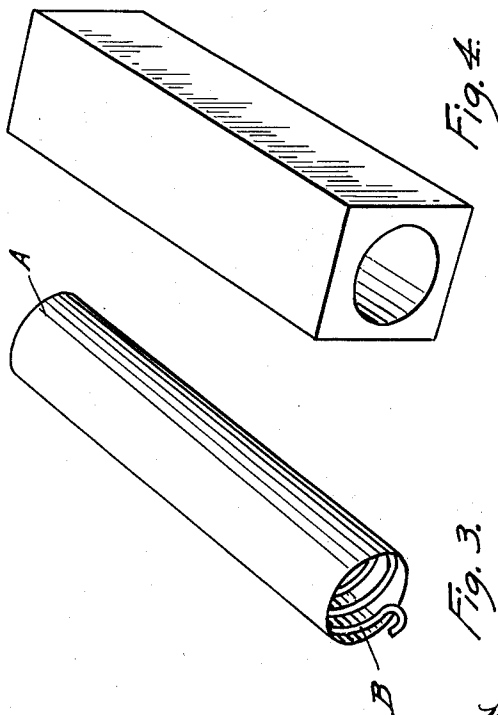
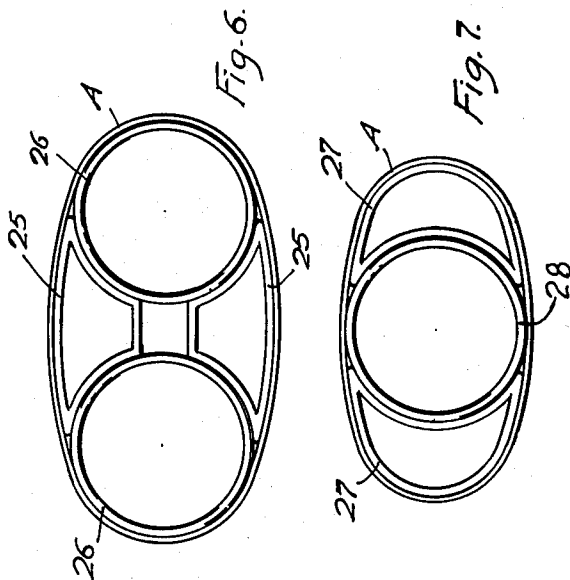
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METHOD AND APPARATUS FOR CASTING HOLLOW BUILDING UNITS

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2 Sheets-Sheet 2



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METHOD AND APPARATUS FOR CASTING HOLLOW BUILDING UNITS

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10 Claims. (Cl. 29—423)

This invention relates to a method and apparatus useful in the manufacture of hollow units such as hollow beams and girders and hollow panels for use in constructing walls of buildings. It may be used with concrete, or other moldable materials. It is also useful in the construction of conduits and tunnels or any other similar unit which is to be formed with a hollow bore.

When a hollow bore is to be formed in a concrete structure it is necessary to use a suitable form to define the wall of the bore while the concrete is being poured and to support the concrete while it hardens. These forms are usually made of wood or steel and are collapsible so as to permit their removal after the concrete has hardened. These collapsible wood or steel forms are relatively expensive and difficult to handle, and their use is therefore restricted.

According to the present invention, the walls of the bore are defined by a collapsible tubular membrane formed of some thin material such as paper or plastic that can be collapsed and shipped flat. In order to hold the collapsible tubular membrane in expanded position while the concrete is being formed around it, a helical support spring is inserted within the tubular membrane to make it sufficiently rigid to stand the pressure of pouring and hardening.

The invention also provides a winding device which may be used to wind up the helical spring in order to reduce its diameter and permit its insertion within the collapsible tubular membrane. This winding device is also used to remove the helical support spring from the tubular membrane after the concrete has been cast and has become hardened.

In the drawings:

Fig. 1 is a perspective view of the winding device with a helical support spring in position thereon.

Fig. 2 is a longitudinal section through the winding device.

Fig. 3 is a perspective view of a collapsible tubular membrane supported by a helical support spring.

Fig. 4 is a perspective view of a hollow concrete unit typical of the units that may be cast according to the present invention.

Fig. 5 is a side elevation of one form of apparatus incorporating the invention.

Fig. 6 is an end elevation of a modification of the invention which permits casting elliptical bores.

Fig. 7 is an end elevation of an additional modification which permits casting elliptical bores.

The apparatus of the present invention consists essentially of the following elements:

- A. A collapsible tubular membrane.
- B. A helical support spring.
- C. A winding device.

The invention will be most expeditiously explained by first describing these elements separately.

A. Collapsible tubular membrane

Let us assume that it is desired to cast a concrete unit

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such as is illustrated in Fig. 4, having a cylindrical bore. The present invention, instead of using a heavy wood or steel form to define the walls of this bore, provides a thin collapsible tubular membrane as illustrated at A in Fig. 3. This membrane may be formed of thin paper, such as water-proofed paper used for drinking cups, or of plastic, and is sufficiently flexible to permit of its being collapsed to a flat condition for shipping. By providing for this flat shipment considerable expense in handling and shipping is saved.

In some cases, where collapsibility is not important, the membrane may be made of thin sheet steel.

B. Helical support spring

Since the collapsible tubular membrane does not have sufficient strength to stand alone, it must be supported suitably from the interior during the casting of the concrete. According to the present invention this support is furnished by the helical support spring B as seen in Fig. 3 and shown in greater detail in Fig. 1. This helical support member is preferably made of spring steel but could be made of any other suitably resilient material such as plastic, etc. The support spring is formed to a uniform diameter and to a uniform pitch or lead, and is of overall diameter and length to suit the particular bore being formed.

An important feature of the present invention is that when the helical support spring B is in place within the collapsible tubular membrane A, the support spring is resiliently pressing outward against the inner wall of the tubular member A, thus transforming the relatively flexible and easily deformed tubular membrane into a cylindrical member of relatively great strength and rigidity.

C. Winding device

In order to provide for the ready insertion and removal of the helical support spring B from the collapsible tubular membrane A a special winding device C is provided.

The winding device includes a driving tube 10 which is driven at its left end (as viewed in Figs. 1 and 2) by a motor 11, and which carries at its right end a driving head 12 mounted to rotate with the tube. The driving head 12 is of larger diameter than the tube 10 for a purpose that will be presently explained.

The outer surface of the mandrel is segmented, that is it is built up from a number of separate cylindrical rings. At the left-hand end of the mandrel, the relatively long tubular section 13 forms the support member for the mandrel and is rigidly secured to the base 14, as by welding. Suitable bearings, such as the roller bearings 15 indicated diagrammatically in Fig. 2, permit the driving tube 10 to rotate within the tubular support section 13.

Between the stationary support section 13 and the driving head 12 the outer surface of the mandrel is formed by a plurality of separate tubular rings 16 each of which is mounted for independent rotation on the driving tube 10 by a bearing indicated diagrammatically at 15.

It is to be noted that the tubular section 13, the driving head 12 and the tubular or "free-wheeling" segments 16 are all formed with the same outer diameter so that taken together these tubular members form a segmented mandrel of uniform diameter.

An anchor pin 17 is secured to the tubular support section 13 and the driving head 12 is formed with a bayonet slot 18. The left-hand end (as viewed in Fig. 1) of the helical support spring B is formed with a hook 19 which is adapted to engage over the anchor pin 17, and the right-hand end of the support spring has an inwardly bent end 20 which is adapted to engage in the bayonet slot 18 of the driving head.

A closure plate 21 is secured to the driving tube 10 at the left-hand end of the tubular support section 13 so as

to maintain tube 10 in its proper position within the support section 13.

Method of operation

Assuming that it is desired to cast a concrete member as shown in Fig. 4 having a hollow bore 4" in diameter. A helical support spring B is provided which has a free diameter slightly greater than 4", and a winding mandrel C is provided having a diameter such that when the spring is wound on it the outer diameter of the spring will be slightly less than 4". A tubular membrane A is provided having a size such that when expanded by spring B it will have a diameter of 4".

The helical support spring is then placed over the mandrel with its hook 19 engaged over the anchor pin 17, and its inwardly bent end 20 engaged in the bayonet slot 13 of the driving head 12. The motor 11 is now operated in order to rotate the driving head and wind the spring upon the mandrel. This winding operation will reduce the diameter of the spring below its normal 4" diameter and the free-wheeling segments 16 of the mandrel will permit this reduction in diameter without causing any distortion or unequal stressing of the spring. If these free-wheeling segments are not present the frictional drag of the spring on the mandrel causes over-stressing of the spring beyond its elastic limit at localized points, thereby ruining the shape of the spring for future operations. Because of the presence of these free-wheeling segments the only force which is applied to the spring is a pure circumferential or twisting force, and no local stresses of any consequence are built up within the spring. The mandrel therefore serves to insure uniform reduction of the support spring throughout the entire length of the springs.

In winding the spring to reduce its diameter, the torque is first transmitted to the outer end of the spring through the end 20. The first few convolutions are contracted and come into contact with and seat upon the head 12. Similarly, the first few convolutions at the opposite end of the spring contract and seat upon a sleeve. These convolutions, therefore, can contract no more and the winding forces are transmitted to the next convolution or few convolutions which are contracted and eventually seat upon the underlying ring 16. When these convolutions can no longer contract, the next convolution or several convolutions are contracted to seat upon the next ring 16. Thus the spring is contracted progressively from its ends toward the center. When one or more convolutions seat upon the underlying ring, the metal has not been flexed beyond its elastic limit and the underlying ring is gripped by the convolutions and is free to turn with the winding head.

After the helical spring has been wound closely upon the mandrel the rotation of motor 11 is stopped. The spring is now wound closely about the mandrel, and since the diameter of the spring has been reduced it will be referred to herein as being in "reduced" condition. A tubular membrane A of suitable size is now slipped over the reduced spring.

When the collapsible tubular membrane is in position the motor is reversed and the helical support spring B is permitted to unwind against the inner wall of the tubular membrane A. The ends of the helical support spring B are now unfastened from the mandrel and the mandrel may be withdrawn from the left hand end of the assembly.

Due to the fact that the spiral support spring has a normal diameter slightly larger than the diameter of the collapsible tubular membrane A the spring will now be pressing resiliently outward against the wall of the membrane so as to transform the thin and easily deformable membrane into a relatively strong and rigid tubular form.

As the spring unwinds within the membrane there is a certain amount of frictional resistance between the outer surface of the spring and the membrane and this friction tends to resist uncoiling of this spring. It is desirable now

to vibrate the assembly. This vibration tends to reduce the friction between the spring and the membrane, permitting the spring to further uncoil and come closer to reaching its original free diameter. This operation increases the outward pressure of the spring on the membrane and gives even greater strength and rigidity to the assembly.

The assembly, that is the spring B and the surrounding membrane A, are now ready to be used as an interior form in concrete work. The assembly is strong, yet light and may readily be placed in any desired position within an exterior form so as to define the hollow bore in the finished piece of concrete.

If the helical support spring is formed of ferrous material which is liable to rust, the membrane should be sufficiently water-proofed to prevent water from reaching the spring.

In the process of hardening, concrete shrinks, and this shrinkage results in the concrete mass tightening itself around the interior form. The form of the present invention is slightly compressible, particularly between the leads of a helical spring where the membrane covering itself must carry the load of the concrete. This slight compressibility permits the concrete to shrink to the required extent during the setting of the concrete, thereby producing a concrete of higher strength than results from the use of a rigid form. In shrinking, the concrete compacts itself about the spring and the convolutions of the spring, in resisting the shrinking concrete, form a helical groove in the hollow of the concrete.

After the concrete has hardened and has attained sufficient strength the helical support spring B may be removed. This is done by merely re-inserting the mandrel within the assembly, securing the ends of the spring as previously described, and repeating the winding operation. During this operation the spring is drawn inwardly away from the hardened concrete, and since this inward motion takes place uniformly along the entire length of the spring, every coil of the spring is out of contact with the hardened concrete before any longitudinal withdrawing force is applied to the support spring. The spring may now be easily removed longitudinally from the form. The tubular membrane A is, of course, left within the concrete member, but this lining, being a very thin material, is not objectionable. Inasmuch as after the concrete has set, the convolutions of the spring are seated in the helical groove formed by the spring when the concrete shrinks, it is necessary to contract each convolution of the spring for proper removal thereof. The sectional mandrel which makes it feasible to contract the spring uniformly throughout its length without overstressing the spring at any point is important in this connection.

While the mandrel is shown as driven by an electric motor 11, it is apparent that any suitable prime movers, such as hydraulic or air motors, may be used. The prime movers may be connected to the mandrel through reduction gearing.

The mandrel about which the spring is wound serves to limit the extent to which the spring can be compressed. A more positive limit can be imposed by providing control means to predetermine the number of revolutions taken by the mandrel in both the winding and unwinding directions.

After the helical spring B has been removed from the formed concrete it is ready for use in producing another form, and since the spring is never stressed beyond its elastic limit, it never becomes deformed and may be reused indefinitely.

Mobile mounting

The basic construction of the winding device C has been described in connection with Figs. 1 and 2. This winding mandrel may be used in a variety of ways. Fig. 5 illustrates an embodiment in which a winding device C is mounted on a standard industrial truck. The winding

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device is illustrated in this figure in a position to remove a helical support spring B from a concrete part 22 which has been cast on a support frame 23. The lifting mechanism 24 of the truck provides means for raising and lowering the mandrel so as to align it with the openings in cast concrete members at different heights or stacked in different relations to each other. The truck provides convenient means for using the mandrel at different locations. The mandrel may, of course, be detachable, so that mandrels of different sizes may be interchangeably mounted on the same truck.

The numerous advantages of this mobile mounting in the pre-casting of large concrete units will be obvious to those skilled in the art.

Non-circular bores

Bores of shape other than cylindrical may be formed by this invention. Figs. 6 and 7 illustrate modifications which provide for casting elliptical bores in concrete.

In Fig. 6 two roughly V-shaped metal forms 25 complement two of the springs 26 to produce a form having an elliptical cross section, which is surrounded by a membrane.

In Fig. 7 two arc-shaped metal forms 27 complement a single spring 28 to produce a form having an elliptical cross section, which is surrounded by a membrane A.

The forms of Figs. 6 and 7 are used in the same manner as the forms previously described. By changing the shape of the complementary forms, final forms may be produced having a wide variety of shapes.

The invention is not limited to the pre-casting of concrete units in a plant and transporting them to the building site. The units may be cast at the building site, and by using parts of suitable size, conduits, sewers, tunnels, etc., may be constructed in situ.

While the invention has been described as applied to concrete, it is also useful in forming hollow units of plaster or other moldable materials.

According to the provisions of the patent statute, I have explained the principles of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practised otherwise than as specifically illustrated and described.

I claim:

1. In the forming of concrete into a body with an elongated hollow formation, the method which comprises, winding an elongated helical spring in a direction to reduce the diameter of its convolutions, placing a covering of material of paper or the like over the spring, releasing the winding forces for the normal expansion of the spring to make the covering material taut to constitute a core, pouring concrete around the core and allowing the concrete to set, again winding the elongated spring in a direction to reduce the diameter of its convolutions to an extent that all convolutions are free from the inner surface of the covering material, and then removing the helical spring from the hollow of the formed concrete by simultaneous axial movement of all convolutions thereof with the covering material remaining in the hollow of the formed concrete.

2. In the forming of concrete into a body with an elongated hollow formation, the method which comprises, winding an elongated helical spring in a direction to reduce the diameter of its convolutions, placing a tube of covering material of paper or the like over the spring, releasing the winding forces for the normal expansion of the spring to make the covering material taut to constitute a core, pouring concrete around the core and allowing the concrete to set, again winding the elongated spring in a direction to reduce the diameter of its convolutions to an extent that all convolutions are free from the inner surface of the covering material, and then removing the helical spring from the hollow of the formed concrete by simultaneous

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axial movement of all convolutions thereof with the covering material remaining in the hollow of the formed concrete.

3. In the forming of concrete into a body with an elongated hollow formation, the method which comprises, winding an elongated helical spring in a direction to reduce the diameter of its convolutions, limiting the reduction of one or more convolutions at the ends of the spring and limiting the reduction of one or more convolutions of the spring in successive increments from the ends of the spring toward the center thereof, so that all convolutions of the spring are substantially uniformly reduced in diameter, placing a covering of material of paper or the like over the spring, releasing the winding forces for the normal expansion of the spring to make the covering material taut to constitute a core, pouring concrete around the core and allowing the concrete to set, again winding the elongated spring in a direction to reduce the diameter of its convolutions to an extent that all convolutions are free from the inner surface of the covering material, and then removing the helical spring from the hollow of the formed concrete by simultaneous axial movement of all convolutions thereof with the covering material remaining in the hollow of the formed concrete.

4. In the forming of concrete into a body with an elongated hollow formation, the method which comprises, winding an elongated helical spring in a direction to reduce the diameter of its convolutions, placing a covering of material of paper or the like over the spring, releasing the winding forces for the normal expansion of the spring to make the covering material taut to constitute a core, vibrating the spring with the covering material thereon to facilitate expansion of the spring, pouring concrete around the core and allowing the concrete to set, again winding the elongated spring in a direction to reduce the diameter of its convolutions to an extent that all convolutions are free from the inner surface of the covering material, and then removing the helical spring from the hollow of the formed concrete by simultaneous axial movement of all convolutions thereof with the covering material remaining in the hollow of the formed concrete.

5. An apparatus for manipulating an elongated helical spring useful as a core element in the forming of hollow bodies of concrete or the like comprising, an elongated inner member, an outer member in the form of a plurality of separate sleeves, said sleeves being independently turnable relative to each other and the inner member and adapted to have an elongated helical spring placed thereover, means on the inner member for engaging one end of the helical spring, means for engaging the opposite end of the helical spring, and means for rotating the inner member to wind up the spring and reduce the diameter of its convolutions, the sleeves limiting the reduction of the diameter of the convolutions and each sleeve being rotatable by the convolutions thereover as the same are contracted into engagement therewith, whereby, a membrane type core element may be placed over the spring element.

6. An apparatus for manipulating an elongated helical spring useful as a core element in the forming of hollow bodies of concrete or the like comprising, an elongated inner member, an outer member in the form of a plurality of separate sleeves all of substantially the same outside diameter, bearings mounting each sleeve on the inner member so that they are turnable relative to each other and relative to the inner member, means on the inner member for engaging one end of the helical spring, means for engaging the opposite end of the helical spring, and means for rotating the inner member to wind the spring and reduce the diameter of its convolutions, the sleeves limiting the reduction of the diameter of the convolutions and each sleeve being rotatable by the convolutions thereover as the same are contracted into engagement therewith, whereby a membrane type core element may be placed thereover.

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7. An apparatus for manipulating an elongated helical spring useful as a core element in the forming of hollow bodies of concrete or the like comprising, an elongated inner member, an outer member in the form of a plurality of separate sleeves all of substantially the same outside diameter, bearings mounting each sleeve on the inner member so that they are turnable relative to each other and relative to the inner member, a head on one end of the inner member having a cylindrical portion of substantially the same outside diameter as the sleeves and having means for engaging one end of the helical spring, means for engaging the opposite end of the helical spring, and means for rotating the inner member to wind the spring and reduce the diameter of its convolutions, the cylindrical portion of the head and the sleeves limiting the reduction of the diameter of the convolutions, and each sleeve being rotatable by the convolutions thereover as the same are contracted into engagement therewith, whereby a membrane type core element may be applied over the spring element.

8. An apparatus for manipulating an elongated helical spring useful as a core element in the forming of hollow bodies of concrete or the like comprising, an elongated inner member, an outer member in the form of a plurality of separate sleeves, said sleeves being independently turnable relative to each other and the inner member and adapted to have a helical spring placed thereover, means on the inner member for engaging one end of the helical spring, fixed means for engaging and holding the opposite end of the helical spring, means for rotating the inner member to wind the spring and reduce the diameter of its convolutions, the sleeves limiting the reduction of the diameter of the convolutions and each sleeve being rotatable by the convolutions thereover as the same are contracted into engagement therewith, whereby a membrane type core element may be placed over the spring element.

9. An apparatus for manipulating an elongated helical spring useful as a core element in the forming of hollow bodies of concrete or the like comprising, an elongated inner member, a fixed tubular support through which the inner member extends, a head on the inner member, a plurality of separate sleeves positioned over the inner member and disposed between the fixed support and the said head, said sleeves constituting an outer member and being independently rotatable relative to each other and to the inner member, means on the head for engaging one end of the spring, means on the support for engaging

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and holding the opposite end of the spring, means for rotating the inner member to wind the spring and reduce the diameter of its convolutions, the sleeves limiting the reduction of diameter of the convolutions and each sleeve being rotatable by the frictional engagement of the convolutions thereover as the same are contracted into engagement therewith, whereby a membrane type core element may be placed over the contracted spring element.

10. An apparatus for manipulating an elongated helical spring useful as a core element in the forming of hollow bodies of concrete or the like, comprising, an elongated inner member, an outer member in the form of a plurality of separate sleeves, said sleeves being independently turnable relative to each other and relative to the inner member and adapted to have an elongated helical spring placed thereover, means on the inner member for engaging one end of the helical spring, means for engaging the opposite end of the helical spring, and means operable selectively in opposite directions, which, when operated in one direction winds the spring to reduce the diameter of convolutions, and when operated in the opposite direction unwinds the spring for increase in the diameter of its convolutions, said sleeves limiting the reduction of the diameter of the convolutions and each sleeve being turnable by the convolutions thereover as the same are contracted into engagement therewith, whereby a membrane type core element may be placed over the contracted spring element and then rendered taut by the unwinding of the spring element, and whereby after forming the hollow body, the spring element may be wound to reduce the diameter of its convolutions for removal thereof axially from the formed hollow body and membrane core element.

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