United States Patent

[11] 3,577,613

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[54] **PORTABLE MOLDING APPARATUS**
11 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **25/118,** 25/41, 249/86, 249/94, 264/228

[51] **Int. Cl.** **B28b 7/00,** B28b 23/06

[50] **Field of Search** ..... 25/2, 118 (T), 41.1; 254/29.5; 249/83, 86, 97, 93, 94, 96; 264/228

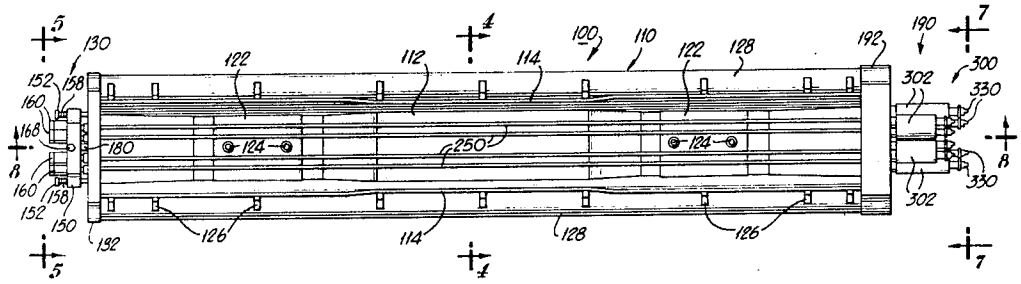
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Assistant Examiner—Ben D. Tobor
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ABSTRACT: A portable molding apparatus for prestressed concrete members including a hollow mold body for receiving a charge of concrete and reinforcing strand for emplacement in the molded concrete. Mold end members, at least one of which is moveable, define opposite end portions of the body and include strand gripping means to receive and engage a portion of reinforcing strand to retain a strand suspended within the mold cavity. Releasing means provided on each end member are engageable with the gripping means to disengage the gripping means from the strand, and at least one of the end members is moveable with respect to the mold body with the releasing and gripping means engaged so that the strand can be withdrawn from the gripping means and the cast concrete member removed from the mold body.



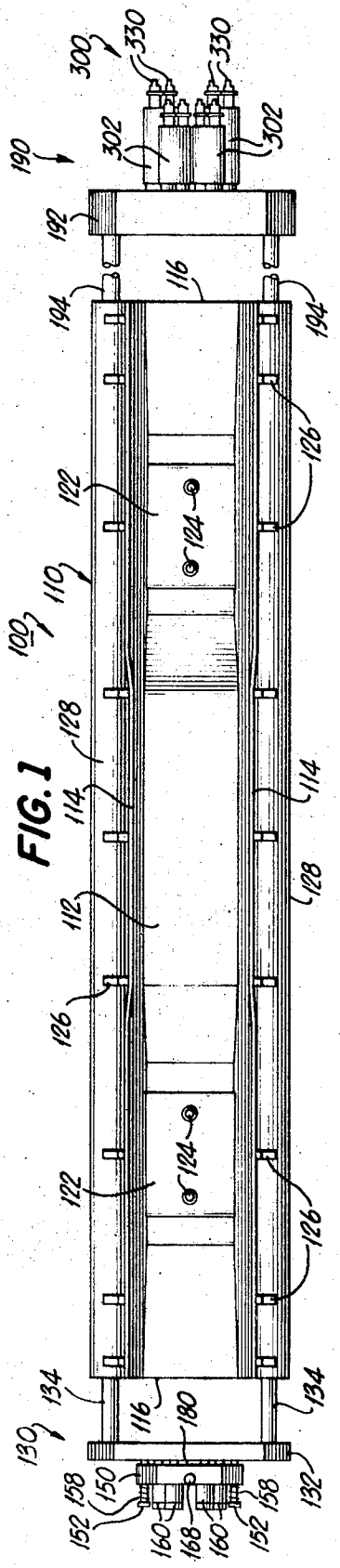


FIG. 1

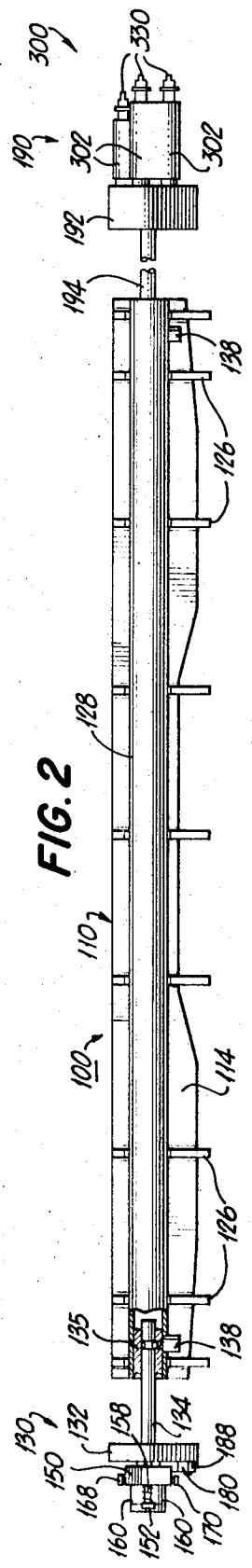


FIG. 2

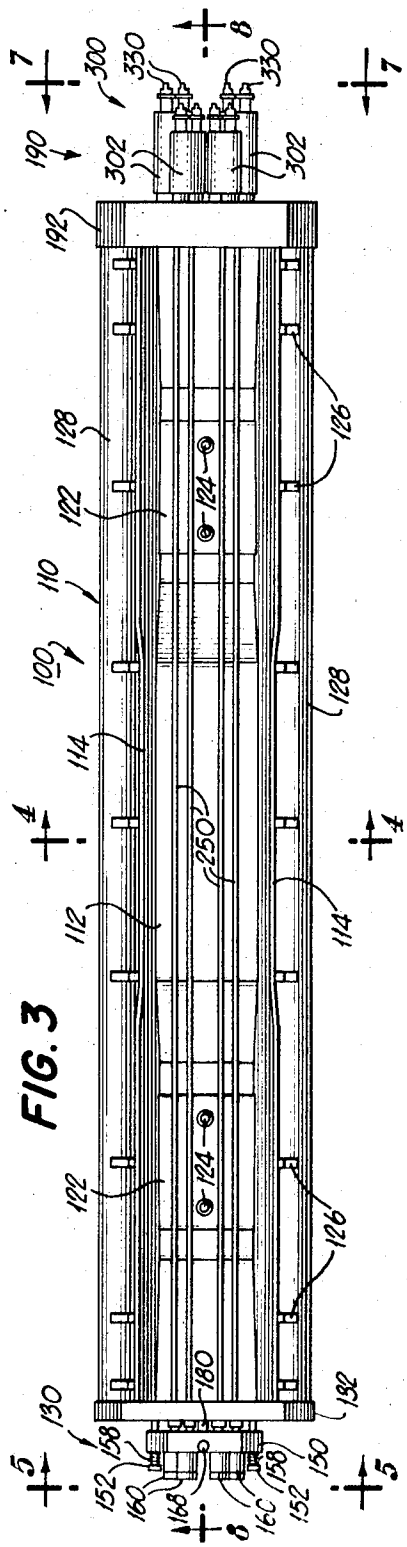


FIG. 3

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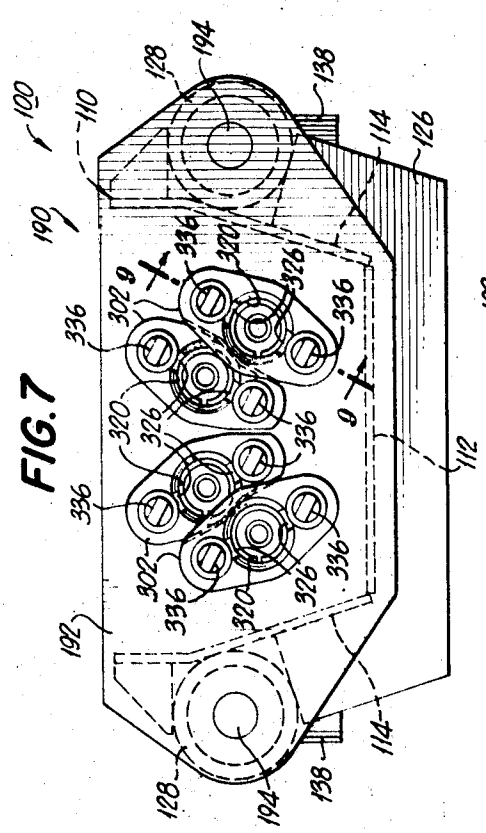


FIG. 7

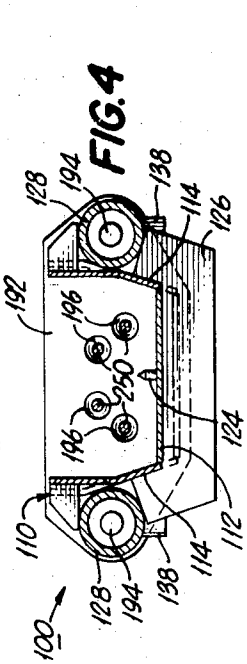


FIG. 4

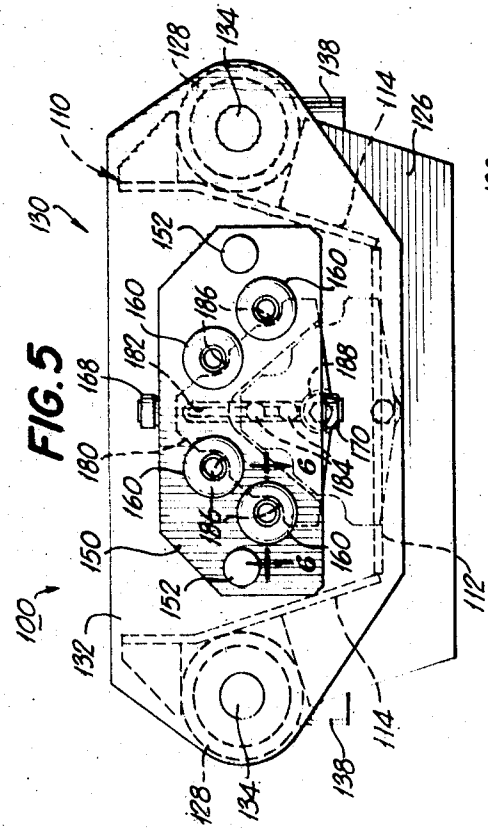


FIG. 5

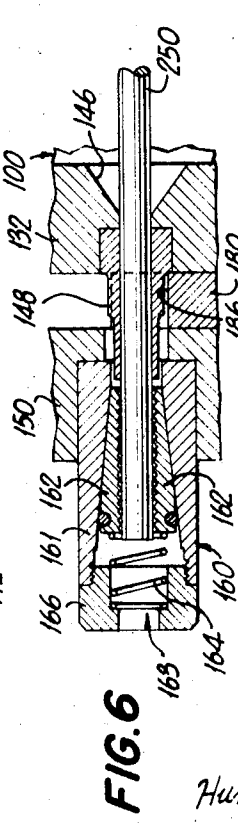


FIG. 6

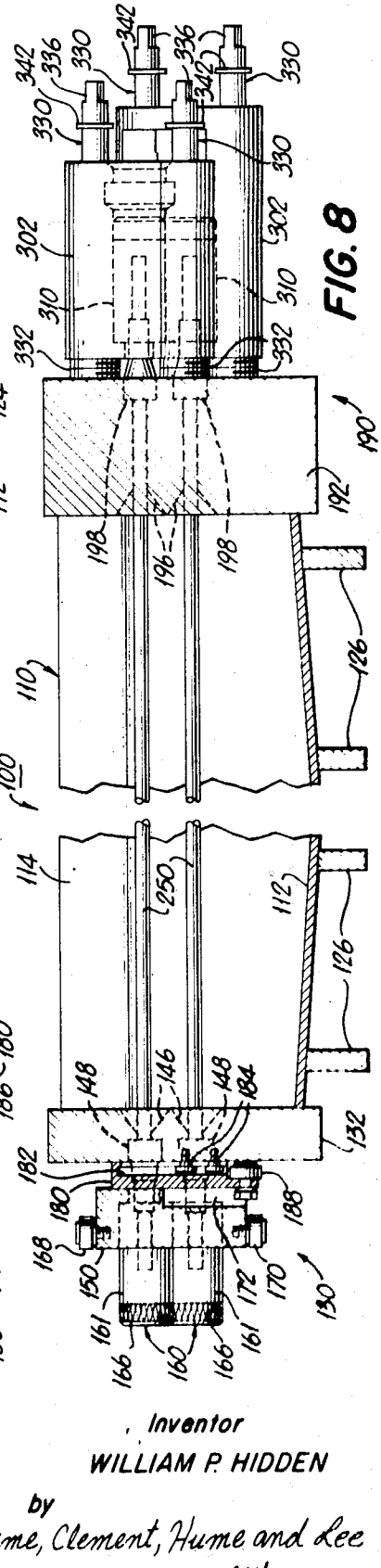


FIG. 8

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FIG. 9

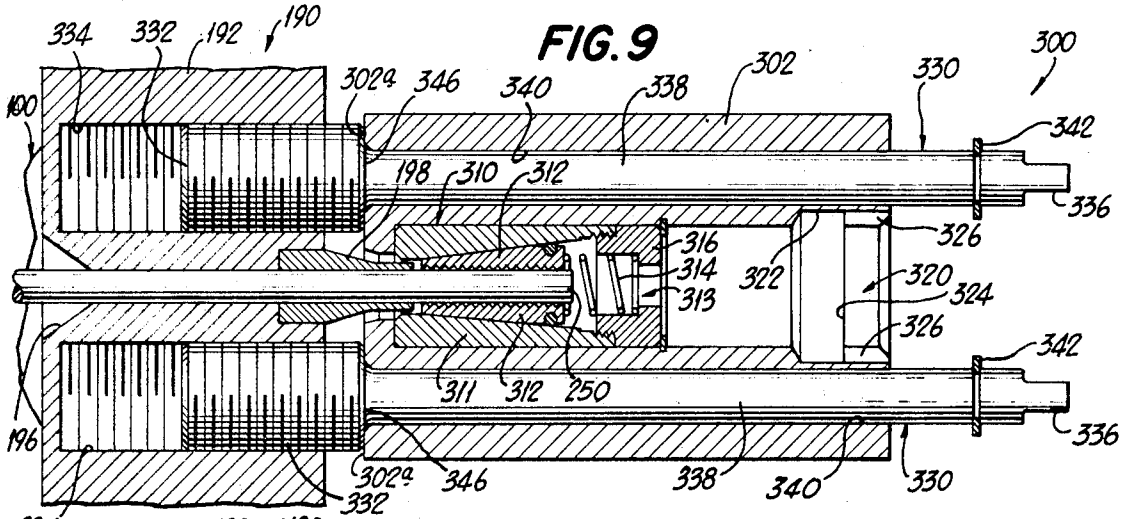


FIG. 10

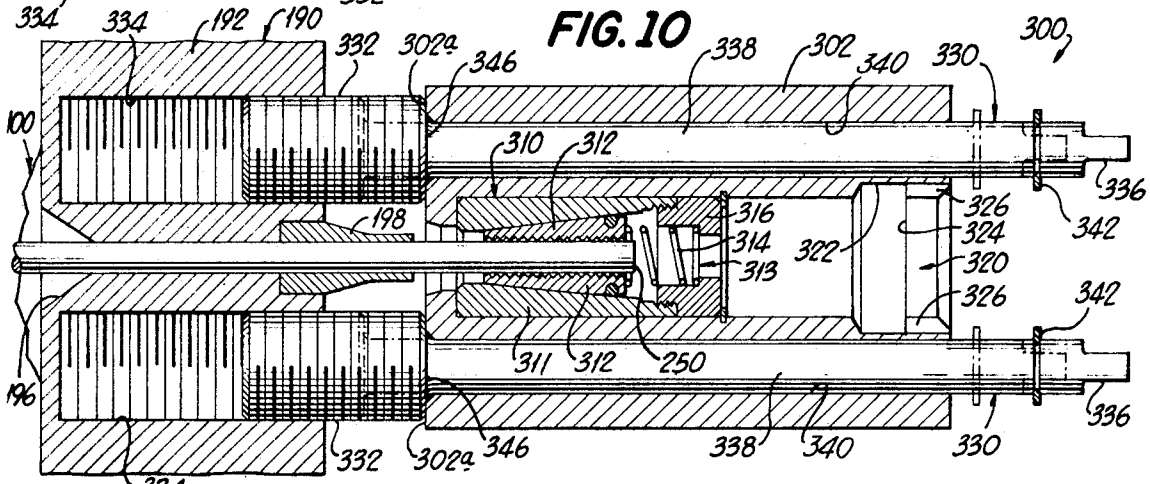
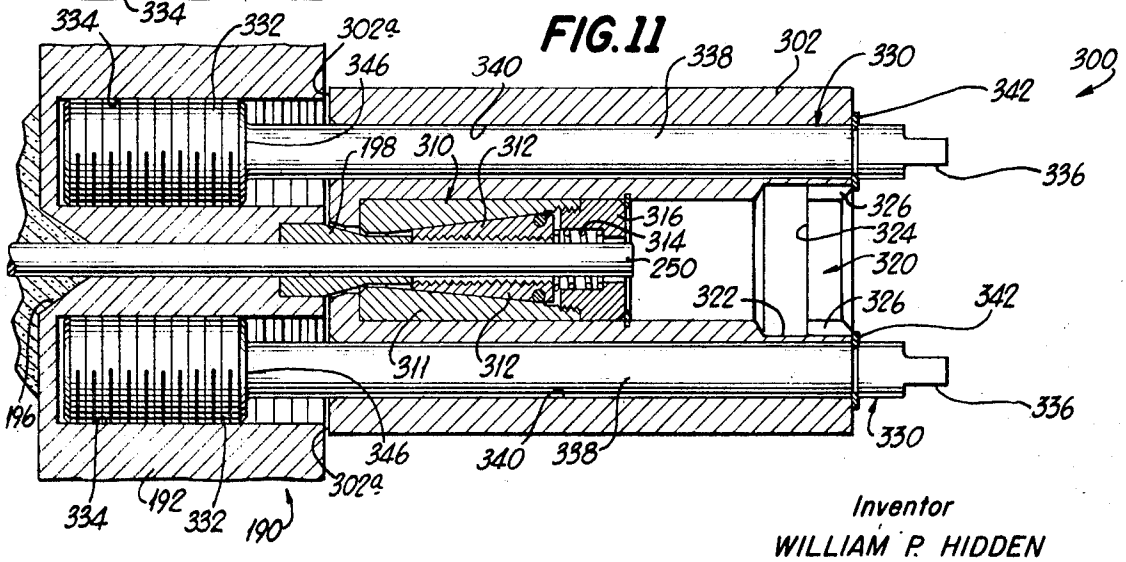


FIG. 11



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PORTABLE MOLDING APPARATUS

RELATED APPLICATIONS

This invention relates generally to the inventions disclosed and claimed in the application of Stanley V. Margolin, Paul W. Glaser, and Leonard V. Gallagher, entitled "Method and Apparatus for Manufacturing Prestressed Concrete members," Ser. No. 721,834; the application of William P. Hidden, and Robert E. Hunt, entitled "Cleaning and Oiling System For Molding Apparatus," Ser. No. 721,808; and the application of William P. Hidden, and Robert Yetman, entitled "Method and Apparatus for Making Prestressed Concrete Members," Ser. No. 721,793, each of which was filed concurrently and commonly assigned with the present application.

BACKGROUND & SUMMARY OF THE INVENTION

This invention generally relates to a portable molding apparatus for stress-molding concrete members such as concrete railway ties, concrete beams and the like.

As fully set forth in the copending application of Messrs. Hidden and Yetman, Ser. No. 721,793, there is a continuing need for providing improved methods and apparatus for manufacturing stress-molded concrete members, such as concrete railway ties and the like, on a mass production basis. As also mentioned in that copending application, one of the important aspects of any such manufacturing system relates to the provision of suitable apparatus for applying and maintaining the desired pretensioning force in the reinforcing strands to be cast within the concrete member. Accordingly, said copending application, in addition to other aspects of a concrete casting system, discloses portable molding apparatus which can be effectively utilized in a mass production system to apply and maintain a pretensioning force in the reinforcing strand, either by measuring the applied tensioning force or by measuring the strand elongation.

It is well known to those skilled in the art that in the manufacture of prestressed concrete members, particularly on a mass production basis, there are many instances where the pretensioning of the reinforcing strand must be very accurately maintained throughout the molding operations. Accurate application and maintenance of such pretensioning is particularly important when the concrete members being molded are relatively small and must be capable of withstanding substantial loads. In such instances, the manufacturing criteria or the product specifications often call for a strand pretensioning load which approaches the ultimate strength of the specified or desired reinforcing strand.

By way of example, the American Association of Railroads specifications for railway ties of a current design specify the use of four reinforcing strands, and require a total strand pretensioning load of 100,000 pounds. Such specifications, calling for the application of approximately 25,000 pounds of pretensioning force to each of the four strands, results in a strand tensioning force approaching about 80 percent of the ultimate strength of the strand, if the preferred seven-sixteenths of an inch diameter strand is used.

Accordingly, to solve these above-mentioned problems, the present invention provides a portable molding apparatus with means for accurately applying and maintaining a predetermined pretensioning force in the reinforcing strands which are to be cast within the concrete member. In accordance with this invention, variable locking means engages the reinforcing strands and is operable to releasably secure the strands so that the desired pretensioning force in each of the strands is applied and maintained substantially undiminished during subsequent casting operations. In the preferred embodiment, a variable locking means is provided for each of the reinforcing strands so that the pretensioning force in each strand can be individually applied and maintained. Such an arrangement permits the pretensioning force on each strand to be applied with substantial accuracy, since separate tensioning of each individual strand compensates for any variations in the dimensions or composition of the strands which may otherwise affect the tensioning operations. The portable molding apparatus embodying the features of the present invention also can be readily adapted for manufacturing concrete units on an efficient mass production basis.

The portable molding apparatus in accordance with the preferred embodiment of this invention is designed so as to be compatible with the reinforcing strand placement and tensioning methods and apparatus disclosed in said application Ser. No. 721,793, and further is adaptable for use with the manufacturing system disclosed in the above-mentioned application Ser. No. 721,834, and with the mold oiling and cleaning system disclosed in the above-mentioned application Ser. No. 721,808.

EXEMPLARY EMBODIMENT

The exemplary embodiment of the portable molding apparatus embodying the present invention is particularly adapted for use in stress-molding concrete railway ties of a current design. Of course, it will be recognized by those skilled in the art that the present invention is readily adaptable for use in manufacturing many types of prestressed concrete units, other than railway ties, with substantially the same results and advantages.

The various features of the present invention will be more fully understood by considering the following description of an exemplary embodiment, taken in conjunction with the drawings, in which:

FIG. 1 is a plan view of a portable molding apparatus embodying the features of the present invention, illustrating the mold end assemblies in an extended or open position with respect to the mold body;

FIG. 2 is an elevational view of the portable molding apparatus shown in FIG. 1;

FIG. 3 is a plan view of the portable molding apparatus illustrated in FIG. 1 having reinforcing strand placed therein, showing the mold end assemblies closed against the mold body before the strand is pretensioned.

FIG. 4 is a cross-sectional view of the molding apparatus taken along the line 4–4 in FIG. 3;

FIG. 5 is an elevational view of the left mold end assembly of the molding apparatus, as viewed along the line 5–5 in FIG. 3;

FIG. 6 is an enlarged partial sectional view taken along the line 6–6 in FIG. 5, showing the strand receiving and gripping means provided on the left mold end assembly in a "ready" position, prepared to grip the reinforcing strands;

FIG. 7 is an elevational view of the right end assembly of the portable molding apparatus, as viewed along the line 7–7 in FIG. 3, illustrating the variable strand locking means in accordance with this invention;

FIG. 8 is a sectional view of the portable molding apparatus taken along the line 8–8 in FIG. 3;

FIG. 9 is a cross-sectional view taken along the line 9–9 in FIG. 7, showing the variable strand locking means in accordance with this invention in a "ready" position, prepared to grip the reinforcing strands;

FIG. 10 is a cross-sectional view of the strand locking means as shown in FIG. 9, illustrating the locking means in a "locked" or strand-gripping position, after the strands have been pretensioned; and

FIG. 11 is a cross-sectional view of the strand locking means shown in FIGS. 9 and 10, illustrating the locking means in an "unlocked" position which permits the strand to be released by the locking means.

Referring generally to the drawings, the portable molding apparatus 100 embodying the features of the present invention includes a portable mold body 110 which defines a hollow mold cavity for receiving a charge of suitable concrete mix, and for receiving lengths of reinforcing strand 250. The mold body 110 is provided with mold end assemblies 130 and 190 which are designed to receive the free ends of strand 250 and to support the strand in the desired position within the cavity

of the mold body 110. In the preferred embodiment, the mold body 110 has an open-ended construction, and the mold end assemblies 130 and 190 are movably mounted on the mold body so that the end assemblies can be engaged with the mold body to define the end portions of the mold cavity. Further, in the preferred embodiment the end assemblies 130 and 190 are adapted to releasably grip the strands 250 and to apply a desired pretensioning force to the strands. In accordance with this invention, the end assembly 190 is provided with a variable locking means 300 which operates to maintain the strands 250 under the desired pretensioning force with substantial accuracy.

Referring to FIGS. 1 through 3 in more detail, the portable molding apparatus 100, illustrating an exemplary embodiment of this invention, has the same general construction as the concrete railway tie mold disclosed in the copending application Ser. No. 721,793. As set forth in detail in that copending application, the mold body 110 of the portable mold 100 defines an open ended mold cavity adapted to receive a charge of concrete and four precut lengths of the reinforcing wire strand 250.

As shown in FIG. 4, a bottom wall 112 and inclined sidewalls 114 of the mold body 110 are shaped so that a concrete railway tie can be cast in an inverted position within the cavity of the mold body 110. Rail pad plates 122 on the bottom wall 112 are provided to form the rail bearing surfaces in the cast railway tie, and studs 124 are provided for receiving suitable threaded inserts which are to be cast within the tie at the rail bearing surfaces. The mold body 110 is further provided with transverse reinforcing struts 126, to assure that the desired internal configuration of the mold cavity is maintained throughout the concrete casting operations. Longitudinal compression members or tubes 128 are also provided on the mold body 110 to reinforce against the substantial longitudinal compressive forces to which the mold body is subjected by the pretensioning of the reinforcing strands 250. As seen in FIGS. 1 and 2, the compression tubes 128 preferably extend the full length of the mold body 110 so that the tubes terminate at the open mold ends 116.

The left end mold assembly 130 of the portable molding apparatus 100 is preferably similar to the multiple-position mold end assemblies described in the copending application Ser. No. 721,793. The illustrated end assembly 130 is a two-position assembly, since the components of the assembly are capable of being adjusted between two positions ("unlocked" and "ready") to facilitate the placement and tensioning of the reinforcing strands 250 within the mold 100.

Although a multiple-position end assembly such as assembly 130 is preferred, it will be appreciated by those skilled in the art that the main functions of the end assembly 130 in a mold embodying the features of the present invention are to support the strand 250 in the desired position within the mold body 110, and to securely grip the adjacent ends of the strands. By such an arrangement, the strands 250 can be tensioned by a force applied to the strands from the opposite end of the mold body 110. The left end of the mold body 110 (the end opposite the variable locking means 300) accordingly can be provided with other suitable means for supporting and gripping the left ends of the strands 250.

Referring to FIGS. 1, 3 and 5 in more detail, the left end assembly 130 is movably mounted on the mold body 110 and is designed to close against the left end of the mold body 110 and thereby from the left end of the concrete member being cast in the mold 100. The end assembly 130 is further adapted to receive and grip the free ends of the reinforcing strands 250 which project outwardly from the left end of the mold body 110. The assembly 130 includes a mold end plate 132 joined to the mold body 110 by suitable guide rods 134 and bushings 135, as illustrated in FIGS. 1 and 2. The rods 134 are thereby slidably mounted within the compression tubes 128 on the mold body 110, and permit the assembly 130 to translate longitudinally with respect to the mold body 110. The end assembly 130 thus can be retained in an open position spaced from the mold body 110, as shown in FIGS. 1 and 2, to facilitate the placement of the reinforcing strands 250 within the cavity of the mold body 110. Thereafter, the assembly 130 can be translated into a closed position against the mold body 110, as shown in FIGS. 3 and 8. The movement of the assembly 130 from the opened to such closed position causes the end assembly 130 to engage with and grip the left free ends of the reinforcing strands 250, and permits the assembly to define the left end of the mold cavity. Suitable detent means 138, shown schematically in FIGS. 2 and 5, can be employed to releasably retain the mold end assembly 130 in the open position with respect to the mold body 110.

As illustrated in FIG. 5, the end plate 132 of the end assembly 130 is provided with an array of strand-receiving openings 146, so that the assembly is adapted for receiving the free ends of the reinforcing strands 250. The openings 146 are countersunk on the inward face of the plate 132, as shown in FIG. 6, to facilitate the feeding of the strands 250 outwardly through the openings from within the mold body 110. The openings 146 also include elongate bushings 148 to further guide the strands 250. As illustrated in FIG. 6, the bushings 148 preferably have a predetermined internal diameter, selected to correspond to the desired size of the reinforcing strands 250, and preferably project outwardly beyond the end plate 132 by a predetermined distance.

The left mold end assembly 130 further includes a strand anchoring or chuck plate 150, as illustrated in FIGS. 5 and 8. The chuck plate 150 is slidably mounted on the outward side of the end plate 132 by means of guide pins 152 and guide apertures 154. The chuck plate 150 can thereby translate longitudinally with respect to the adjacent mold end plate 132 upon the guide pins 152. As illustrated in FIGS. 1—3, compression springs 158 or the like may be positioned around the guide pins 152, to bias the chuck plate 150 inwardly toward the mold end plate 132.

The chuck plate 150 is also provided with an array of strand-receiving openings 156, positioned in direct longitudinal alignment with the openings 146 in the end plate 132. By this arrangement, the free ends of the strands 250 can be fed outwardly through the aligned strand-receiving openings 146 and 156 as the mold end assembly 130 is closed against the end of the mold body 110. As shown in FIG. 6, each of the openings 156 in the chuck plate 150 is dimensioned so that the outward portion of each bushing 148 can extend into the adjacent opening 156.

Additionally, a strand-gripping chuck 160 is positioned on the chuck plate 150, a direct alignment with each of the strand-receiving openings 156, to secure the free ends of the strands 250 to the chuck plate. As explained in detail in the copending application Ser. No. 721,793, the chucks 160 are preferably designed to permit the strands 250 to move outwardly through the aligned openings 146 and 156, but are operable to secure the strands 250 from any inward movement. Thus, the strands 250 can be readily placed within the mold body 110 and extended outwardly through the aligned openings 146 and 156 of the end assembly 130. In contrast, the chucks 160 will preclude any inward retraction of the strands 250, and thereby secure the strands 250 to the left end assembly 130.

The desired construction of the strand chucks 160 is illustrated in detail in FIG. 6. In the illustrated form, each of the chucks 160 includes a set of wedge-shaped jaws 162 positioned within a chuck housing 161. The jaws 162 thereby define a chuck throat 163 through which the free ends of the strands 250 may extend. A compression spring 164 is positioned within a chuck cap 166, and operates to urge the jaws 162 inwardly within the chuck housing 161 (rightward in FIG. 6). Due to the wedge-shaped configuration of the jaws 162, the force of the compression spring 164 continuously urges the jaws into the chuck throat 163. The configuration of the jaws 162 also permits the jaws to be retracted from the chuck throat 163 when a force against the jaws overcomes the biasing force of the spring 164. Thus, one of the lengths of the

strands 250 can be fed through the chuck throat 163 in an outward direction (leftward in FIG. 6), but the jaws 162 and the springs 164 cooperate to urge the jaws into the chuck throat 163 and against the strands 250 to thereby prevent the strands from being retracted inwardly. The general construction and operation of this type of strand chuck are fully described in U.S. Pat. No. 3,163,904, issued Jan. 5, 1965, to Ziolkowski, entitled "Strand Chucks".

As explained in detail in the copending application Ser. No. 721,793, the bushings 148, projecting outwardly from the end plate 132, control the action of the strand chucks 160. The bushings 148 become disengaged from the chucks 160 as the chuck plate 150 is spaced a sufficient distance from the adjacent mold end plate 132, as illustrated in FIG. 6. Under such a condition, the chuck jaws 162 are activated, and each of the chucks 160 is "ready" to operate in a normal manner for gripping the reinforcing strands 250. This "ready" position for the chuck plate 150 and the end plate 132 permits the strands 250 to be fed outwardly through the chucks 160 and gripped by the chuck jaws 162. In contrast, inward movement of the chuck plate 150 toward the adjacent end plate 132 will cause the bushings 148 to engage with the adjacent chuck jaws 162. Under such a condition (not shown) the bushings 148 will overcome the biasing force of the chuck springs 164, and force the adjacent chuck jaws 162 outwardly (leftward in FIG. 6). The bushings 148 will thereby deactivate the chuck jaws 162, and "unlock" the chucks 160 so that the strands 250 can be moved outwardly or inwardly through the throats of the chucks. This "unlocked" position for the chucks 160 facilitates the removal of the strands 250 from the mold after the molding operation is completed.

The chuck plate 150 of the exemplary embodiment of this invention is further provided with a pair of aligned guide rollers 168 and 170, as shown clearly in FIGS. 5 and 8. As fully explained in copending application Ser. No. 721,793, the rollers 168 and 170 are designed to engage with suitable camming means or the like to control the positioning of the chuck plate 150 with respect to the end plate 132 during the feeding, placement and tensioning of the strands 250 within the mold 100, when the mold 100 is used in an automated production process. The rollers 168 and 170 will also control the longitudinal positioning of the left mold end assembly 130 with respect to the mold body 110.

Referring to FIGS. 5 and 8, the inward face of the chuck plate 150 in this embodiment includes a triangular channel 172 which opens at the lower end of the chuck plate. The channel 172 thereby provides the chuck plate 150 with a recessed bearing surface 174 which, together with the inward face of the chuck plate 150, defines a two-stepped abutment surface between the end plate 132 and the chuck plate 150. By this arrangement, the chuck plate 150 is adapted to receive a slidable locking plate 180 within the triangular channel 172.

In this regard, the locking plate 180 on the mold end assembly 130 also is preferably triangular in configuration, and includes a vertical slot 182 which permits the plate 180 to be slidably mounted upon pins 184. Thus, the locking plate 180 can slide vertically on the pins 184 between the opposed faces of the adjacent end and chuck plates 132 and 150, respectively.

As illustrated in FIGS. 5, 6 and 8, the locking plate 180 is movable from a lowermost position, within the chuck plate channel 172, into a raised position in engagement between the adjacent faces of the end plate 132 and the chuck plate 150. Recesses 186 are provided in the locking plate 180 so that the movement of the plate 180 into the upward position will not interfere with the strands 250 extended through the apertures 146 and 156. Additionally, the locking plate 180 may include a cam roller 188 which is engageable with a cam track or other actuating means for controlling the position of the locking plate during the various molding operations.

The right mold end assembly 190 embodying the features of the present invention is also movably mounted on the mold body 110. Accordingly, the end assembly 190 includes an anchoring or end plate 192 which is designed for engagement with the open right end of the mold body 110. In contrast to the left end plate 132, the end plate 192 is of substantial thickness so that the plate is capable of withstanding the substantial tensioning forces applied by the variable locking means 300, as explained hereinafter. In order to slidably mount the right end assembly 190 on the mold body 110, the end plate 192 is provided with guide rods 194 which extend inwardly into bushings 135 in the compression tubes 128. By this arrangement, the right mold end assembly 190 can translate longitudinally with respect to the mold body 110 from an outward position, as shown in FIGS. 1 and 2, to an inward position against the right end of the mold 110, as shown in FIGS. 3 and 8.

As shown in FIGS. 7 and 8, the end plate 192 is further provided with an array of strand-receiving openings 196 which are in longitudinal alignment with the above-described openings 146 in the left end plate 132. The openings 196 are also countersunk on the inward side of the end plate 192, to facilitate the feeding of the reinforcing strands 250 into the openings. The openings 196 also include chuck-releasing bushings 198 which are preferably identical, in construction and operation, to the above-described bushings 148 on the left mold end plate 132. Therefore, as shown in FIGS. 8 through 11, the bushings 198 will operate to guide the right free ends of the reinforcing strands 250, and will control the gripping of the strands during the strand placement and tensioning operations.

In accordance with this invention, the right mold end assembly 190 incorporates a variable locking mechanism 300 for applying and maintaining a selected pretensioning force to each of the reinforcing strands 250. As shown in FIG. 7, the end assembly 190 thus includes a plurality of locking members 302 mounted outwardly adjacent the end plate 192, with one of the locking members 302 arranged in longitudinal alignment with each strand-receiving aperture 196. By this arrangement, each of the four lengths of reinforcing strand 250 can be engaged by one of the locking members 302.

Referring to FIGS. 9 through 11, each of the locking members 302 is generally U-shaped in configuration, and includes a strand-receiving chuck 310 for releasably gripping the right free ends of the reinforcing strands 250. Each of the chucks 310 is preferably the same as the above-described chucks 160. Thus, each of the chucks 310 comprises a chuck housing 311 which contains wedge-shaped jaws 312 spaced around a chuck throat 313. Also, a compression spring 314, retained by a chuck cap 316, urges the jaws 312 downwardly and inwardly toward the chuck throat 313.

As shown in FIGS. 9—11, each of the chucks 310 is mounted on the respective locking member 302 so that the chuck throat 313 is substantially aligned with the adjacent strand-receiving opening 196. By the above arrangement of the locking mechanism 300, the right free end of each of the strands 250 can be fed outwardly through the adjacent opening 196 in the end plate 192, and through the bushing 198, into the strand chuck 310 on the adjacent locking member 302.

In accordance with this invention, each of the locking members 302 may be arranged with respect to the adjacent end plate 192 so that the strand chuck 310 is "ready" to releasably grip the projecting free end of the reinforcing strand 250. To accomplish this, each locking member 302 is moved outwardly with respect to the end plate 192, into the position illustrated in FIG. 9, so that the adjacent strand bushing 198 is disengaged from the chuck jaws 312. The chuck jaws 312 are thereby activated, and will grip the strand 250 as the strand is extended outwardly through the chuck 310. The wedge-shaped chuck jaws 312 then prevent the strand from being retracted inwardly from the chuck 310 (leftward in FIG. 9).

After the locking members 302 have been arranged in the above-described "ready" position, with the ends of the reinforcing strands 250 gripped by the chucks 310, the locking mechanism 300 can be operated to apply the desired preten-

sioning force to the reinforcing strands 250. Accordingly, the outer end of each locking member 302 is provided with a large aperture 320 which is preferably coaxial with the chuck throat 313. In turn, each of the apertures 320 includes a recessed gripping ring 322 which defines an annular bearing surface 324, as seen in FIGS. 9—11. In addition, each of the apertures 320 includes a keyway 326, as best seen in FIG. 7, connecting the ring 322 with the aperture mouth.

The apertures 320 permit each of the locking members 302 to receive a suitable pulling tool, such as a T-shaped element which can be fed inwardly into the aperture 320 through the keyway 326. The pulling tool (not shown) then can be rotated within the aperture 320 into engagement with the annular bearing surface 324 so that an outwardly directed force on the tool will forcefully separate the locking member 302 from the adjacent end plate 192. Of course, it will be appreciated by those skilled in the art that the keyways 326 could be eliminated and the pulling tool could be provided with spring-biased jaws (not shown) which would snap into engagement with the bearing surface 324. The locking plate thereby moves from an inward position, as shown in FIG. 9, into an outwardly spaced position, such as shown in FIG. 10. Since the left ends of the strands 250 are secured by the chucks 160 in the end assembly 130, such a pulling force on the locking member 302 will be transmitted to the strands 250 through the chucks 310, and will thereby tension the strands. Hence, the application of a measured pulling force to each of the locking members 302, such as by means of a dynamometer (not shown), will subject the strands 250 to a selected pretensioning load.

The application of a pulling force to the locking members 302, and the resulting outward translation of the locking plates with respect to the end plate 192, also results in an elongation of the strands 250 in proportion to the amount of pulling force applied. Moreover, the pretensioning force in the strands 250 will be maintained as long as the strands are maintained in their resultant elongated condition. Thus, by means of the present invention, the strands 250 can be tensioned to the desired load by the application of a measured pulling force to the locking members 302, and the desired strand pretensioning force can be maintained by accurately "locking" the members 302 in the resulting outward positions, spaced from the end plate 192.

To accomplish such "locking" of the pretensioning force in the strands 250, each of the locking members 302 is provided with a pair of threaded connecting rods 330 which will operate to releasably retain the adjacent locking member in a plurality of spaced positions with respect to the end plate 192. As seen from FIGS. 9—11, each of the rods 330 includes an inner threaded portion 332 which is received within a threaded aperture 334 in the end plate 192. Each rod 330 is thereby secured to the end plate 192, but can be rotated and advanced outwardly from the end plate 192 by the action of the threads in the aperture 334 and on the rod portion 332. The outer end of each rod 330 is provided with suitable connecting means, such as a flat male portion 336, for connecting a rotating power tool (not shown) to the rods.

In addition, each of the connecting rods 330 includes an outer unthreaded portion 338 which is slidably received within an aperture 340 in the locking member 302. The locking member 302 can slide upon this unthreaded portion 338 of the connecting rods as the member 302 translates with respect to the end plate 192. In the preferred embodiment, each rod 330 includes a retaining washer 342, as seen in FIGS. 9—11, to retain the locking member 302 engaged with the rod and to move the member 302 toward the end plate 192 as the rod 330 is threaded into the end plate 192. As also shown in FIGS. 9—11, the threaded rod portion 332 also defines a bearing surface 346 which is adapted to abut against the inner edge 302*a* of the locking member 302, to thereby restrain the locking member 302 from further inward movement.

In operation, the mold 100 including the locking mechanism 300 in accordance with this invention is first placed in the condition illustrated in FIG. 1. In such a condition, the end assemblies 130 and 190 are opened away from the mold body 110, and the reinforcing strand 250 can be placed within the mold body between the end assemblies. During this initial placement of the strand 250, the end assemblies 130 and 190 are maintained in the above-described "ready" positions so that the respective strand chucks 160 and 310 are adapted to receive and releasably grip the adjacent ends of the strand 250.

Thus, the end assembly 130 is arranged so that the locking plate 180 is in the uppermost position, as shown in FIG. 8. As explained in the copending application Ser. No. 721,793, the locking plate 180 thereby engages with the opposing faces of the end plate 132 and the chuck plate 150, and spaces the chuck plate 150 so that the bushings 148 are disengaged from the jaws of the chucks 160. The chucks 160 are accordingly activated and "ready" for gripping the left ends of the strands 250.

During the initial placement of the strands 250 the right mold end assembly 190 is also maintained in a "ready" position, as shown in FIG. 9. To accomplish this, the threaded rods 330 connected to each of the locking members 302 are advanced so that the bearing surfaces 346 on the threaded rod portions 332 abut against the inner locking member edge 302*a*. Thereafter, the threaded rods 330 can be further advanced to force the locking members 302 outwardly away from the end plate 192 (rightward in FIG. 9), and to disengage the bushings 198 from the chuck jaws 312. The chucks 310 are thereby activated and "ready" to grip the right ends of the strands 250.

Next, a suitable pulling tool and a dynamometer (not shown) can be engaged with each of the locking members 302 within the gripping rings 322 and operated to apply a measured tensioning force to each locking member. Such a force will translate the locking members outwardly with respect to the end plate 192 (rightward in FIGS. 9—11) into a position such as shown in FIG. 10. The measured tensioning force is transmitted to the strands 250 by means of the chucks 310, so that the movement of the locking members 302 into such an outward position (FIG. 10) applies a measured pretensioning force to the strands 250.

The locking mechanism 300 in accordance with this invention operates to secure the locking members 302 in the above strand-tensioning position in a manner which assures that the desired pretensioning of the strands 250 is accurately maintained. Thus, before the tensioning force applied to each of the locking members 302 is released, the connecting rods 330 are threadably advanced by rotating the rods with a suitable power tool (not shown) connected to the rod portion 336. Such threaded advance is continued until the bearing surfaces 346 on the rods 330 forcibly abut against the inner edge 302*a* of the adjacent locking members 302. The bearing surfaces 346 will thereby prevent any inward movement or retraction of the locking members 302 upon release of the tensioning force.

As well known to those skilled in the art, the application of the same measured tensioning force to the four strands 250 may cause each strand to elongate to a slightly different length, due to small variations in the dimensions and composition of the various strands. In addition, there will be a variation in the amount of movement required to firmly seat the chuck jaws 312 against the various strands. Accordingly, the rods 330 of the locking mechanism 300 embodying the present invention are operable to secure the locking members 302 in various pretensioning positions, spaced outwardly from the end plate 192. The locking mechanism 300 thereby compensates for any variances in the dimensions or composition of the strands 250, and operates to accurately maintain the strands under the desired pretensioning load despite differences in the elongation of the various strands which may result from the same tensioning force, or differences in the amount of movement required to seat the strand chucks 310. Thus, by means of the present invention, the pretensioning force in each of the strands 250 can be individually applied and can be maintained with a substantial degree of accuracy.

The manner in which the pretensioning force in the strands **250** can be released is illustrated in FIG. **11**. After the casting operations are completed, and an external pretensioning load in the strands **250** is no longer necessary, the connecting rods **330** are threadably retracted so that the locking members **302** will move inwardly, such as from the position shown in FIG. **10** to the position shown in FIG. **11**. This inward movement of the locking members **302** is accomplished by the engagement between the members **302** and the retaining washers **342** on the associated connecting rods **330**. As shown in FIG. **11**, the retraction of the rods **330** thereby forces the bushings **198** into engagement with the chuck jaws **312** to deactivate the chucks **310** and release the strands **250**. The right mold end assembly can then be moved into the open position with respect to mold body **110** (FIGS. **1** and **2**) and the cast concrete member, including the strands **250**, can be removed from the right end of the mold **100**.

As explained further in the copending application Ser. No. 721,793, the grip of the strand chucks **160** on the left end assembly **130** is similarly released, by lowering the locking plate **180** from a raised position, engaged between the chuck plate **150** and the end plate **132** (FIG. **8**), into the lower position shown in phantom lines in FIG. **5**. The locking plate **180** is thus positioned within the recessed channel **172**, and the jaws of the chucks **160** are deactivated, as described above, by the bushings **148**. Then the left end assembly **130** can also be opened (FIGS. **1** and **2**) to permit the completed concrete member to be removed from the left end of the mold **100**.

It will be appreciated by those skilled in the art that the above-described embodiment of this invention is only exemplary. Consequently, numerous changes in details of construction, size and arrangement of components, as well as in modes of application, can be resorted to without departing from the invention as set forth in the following claims.

I claim:

1. In a molding apparatus for molding prestressed concrete members having a mold body defining a cavity for receiving a charge of concrete and having means to support reinforcing strand within the cavity, the improvement comprising an adjustable variable locking means for maintaining the strand under a selected tensioning force with substantial accuracy, said locking means comprising:

an anchoring member positioned in substantial alignment with said mold cavity;

moveably mounted for translating movement with respect to said mold body;

a locking member positioned adjacent said anchoring member and moveably mounted for translating movement with respect to said anchoring member within a selected range of distance, said locking member including strand gripping means to receive and releasably grip a free portion of the reinforcing strand supported within said cavity as said locking member translates with respect to said anchoring member;

releasing means engageable with said strand-gripping means to disengage said gripping means from said strand;

adjustable infinitely variable locking means positioned between said locking and anchoring members in engagement with and slidably moveable with respect to said locking member; and

means to apply a force to said locking member to translate said locking member with respect to said anchoring member into a tensioning position within said range which subjects said strand to a tensioning force of predetermined magnitude;

said variable locking means being infinitely adjustable between said anchoring and locking members to releasably retain said locking member in any selected tensioning position with respect to said anchoring member within said range, so that the strand tensioning force will be accurately maintained at a predetermined magnitude, and being further adjustable to permit said releasing means to engage with said gripping means and release the tensioning force from the strand.

2. A molding apparatus in accordance with claim **1** wherein said variable locking means comprises a rotatable threaded member extending between said locking and anchoring members and engageable with said locking member upon threaded advancement to releasably maintain said locking member in a plurality of tensioning positions with respect to said anchoring member within said range.

3. A molding apparatus in accordance with claim **1** wherein said mold body is adapted to support a plurality of lengths of reinforcing strand and wherein said molding apparatus includes a corresponding plurality of locking members and variable locking means to individually apply and maintain a selected tension force in each of the plurality of reinforcing strands.

4. A molding apparatus in accordance with claim **2** wherein said rotatable threaded member includes a portion threadably engaged with said anchoring member and an unthreaded portion slidably connected to said locking member so that said locking member translates with respect to said anchoring member on said unthreaded portion.

5. A portable molding apparatus in accordance with claim **4** including a pair of rotatable threaded members connected between said anchoring and locking members and uniformly spaced with respect to said strand gripping means.

6. A portable molding apparatus for molding prestressed concrete members comprising:

a hollow mold body defining a cavity for receiving concrete to be molded and reinforcing strand for placement in the molded concrete;

mold end members defining opposite end portions of said mold body;

strand gripping means positioned on each end member to receive and engage a portion of reinforcing strand to retain a strand within said mold cavity; and

releasing means on each end member engageable with said strand gripping means to disengage said gripping means from said strand;

one of said end members being moveably mounted on said mold body and moveable with respect to said body, with the releasing means engaged with the gripping means, to withdraw the strand from the associated gripping means and thereby permit the removal of the cast concrete member from the mold body.

7. A portable molding apparatus in accordance with claim **6** wherein both end members are moveably mounted on said mold body and are moveable with respect to said body, with the releasing means engaged with the gripping means, to withdraw the strand from the gripping means on both end members and thereby permit the ready removal of the cast concrete member from the mold body.

8. A portable molding apparatus in accordance with claim **7** wherein said mold body is open ended and wherein both mold end members are slidably mounted on the adjacent ends of said body and are moveable from an opened position spaced from said mold body into a closed position against the adjacent mold body ends to thereby define the end portions of said mold cavity.

9. A portable molding apparatus in accordance with claim **6** wherein each of said end members includes a first plate containing said strand gripping means and a second plate containing said strand releasing means and wherein said first and second plates are moveable with respect to each other from a relatively spaced position, permitting said gripping means to engage with the strand, into a relatively close position engaging said releasing means with said gripping means so that the gripping means releases the strand and the strand can be withdrawn from said gripping means, and further wherein each end member includes locking means to selectively retain said first and second plates in said spaced position.

10. A portable molding apparatus in accordance with claim **9** wherein said strand gripping means comprises strand chucks mounted on each of said first plates and having chuck jaws moveable into engagement with reinforcing strand to restrain

movement of said strand through said chucks inwardly into said mold body, and wherein said strand releasing means comprises projection means mounted on each of said second plates and engageable with said chuck jaws to release said jaws and permit said strand to move inwardly relative to said end members.

11. A portable molding apparatus in accordance with claim 1 wherein said strand gripping means comprises strand chucks mounted on said locking member and having chuck jaws moveable into engagement with said free portion of reinforcing strand, and wherein said releasing means comprises projection means mounted on said anchoring member and engageable with said chuck jaws as said locking member is spaced adjacent said anchoring member to release said jaws and permit the strand to be removed from said chucks.