Oct. 8, 1940. O. WENNBERG 2,217,301

TWISTING MACHINE

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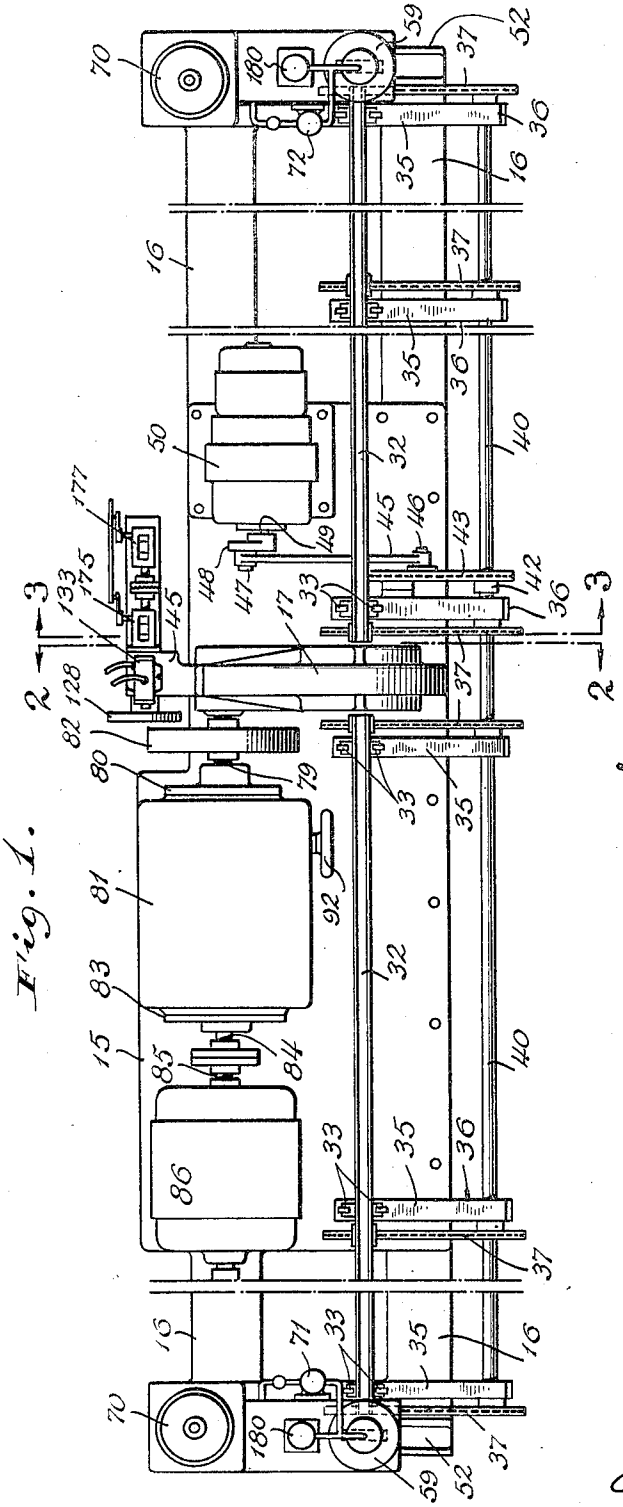


Fig. 1.

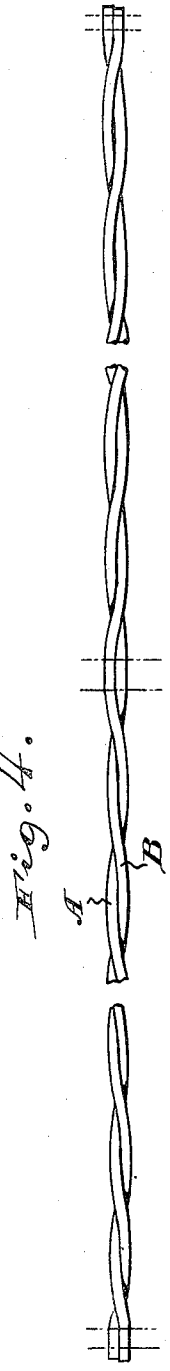


Fig. 4.

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TWISTING MACHINE

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Fig. 2.

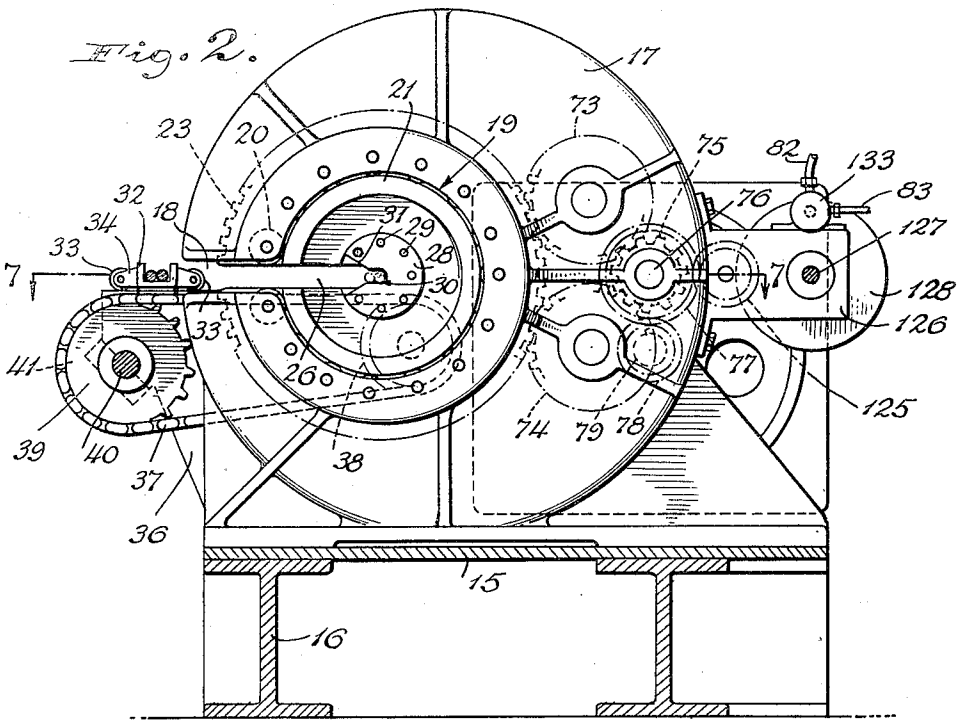
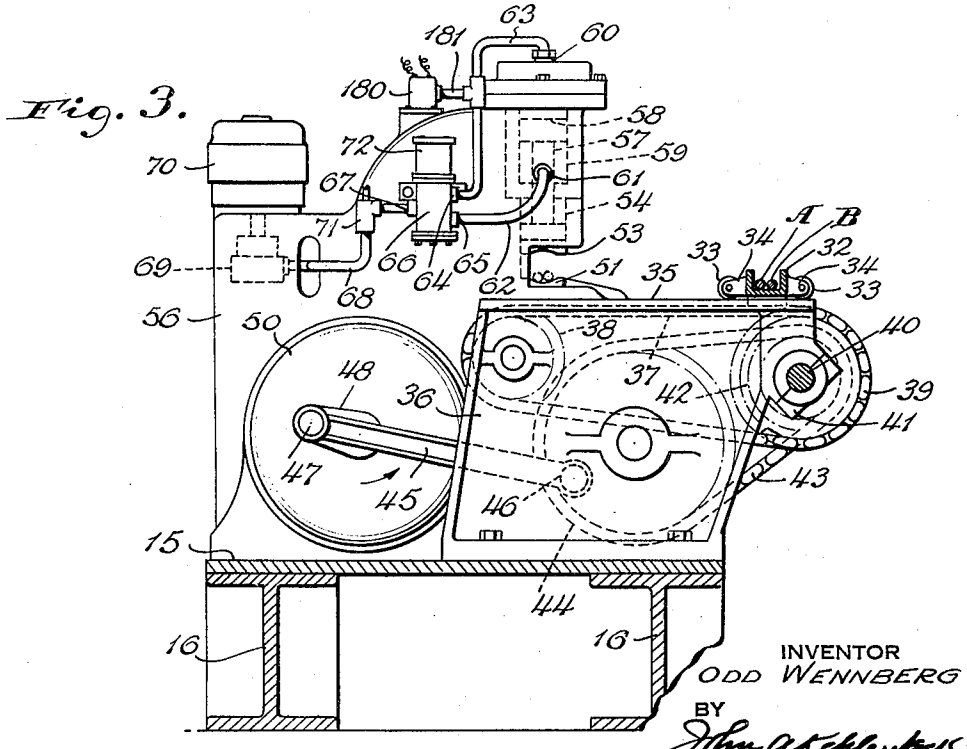


Fig. 3.



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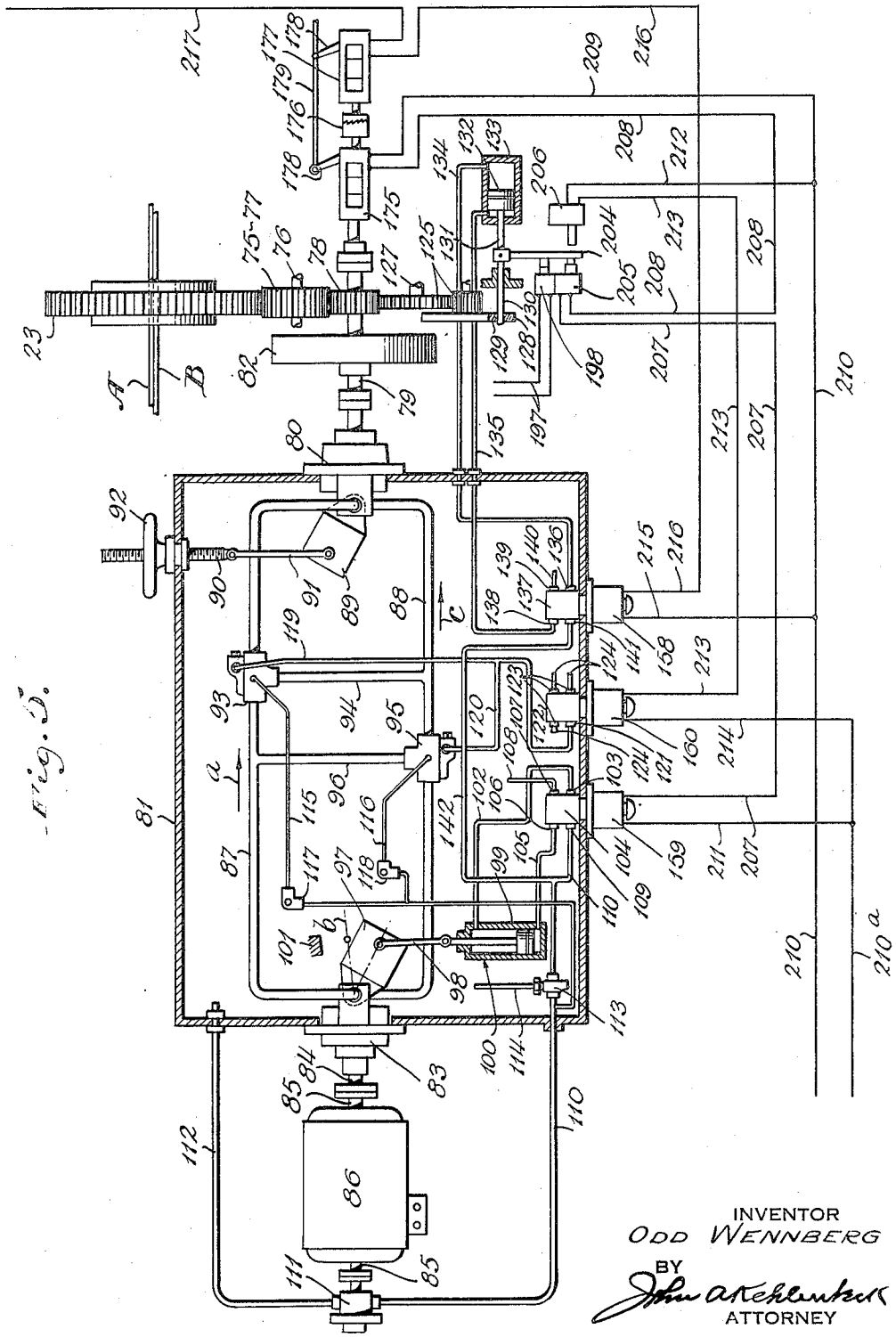


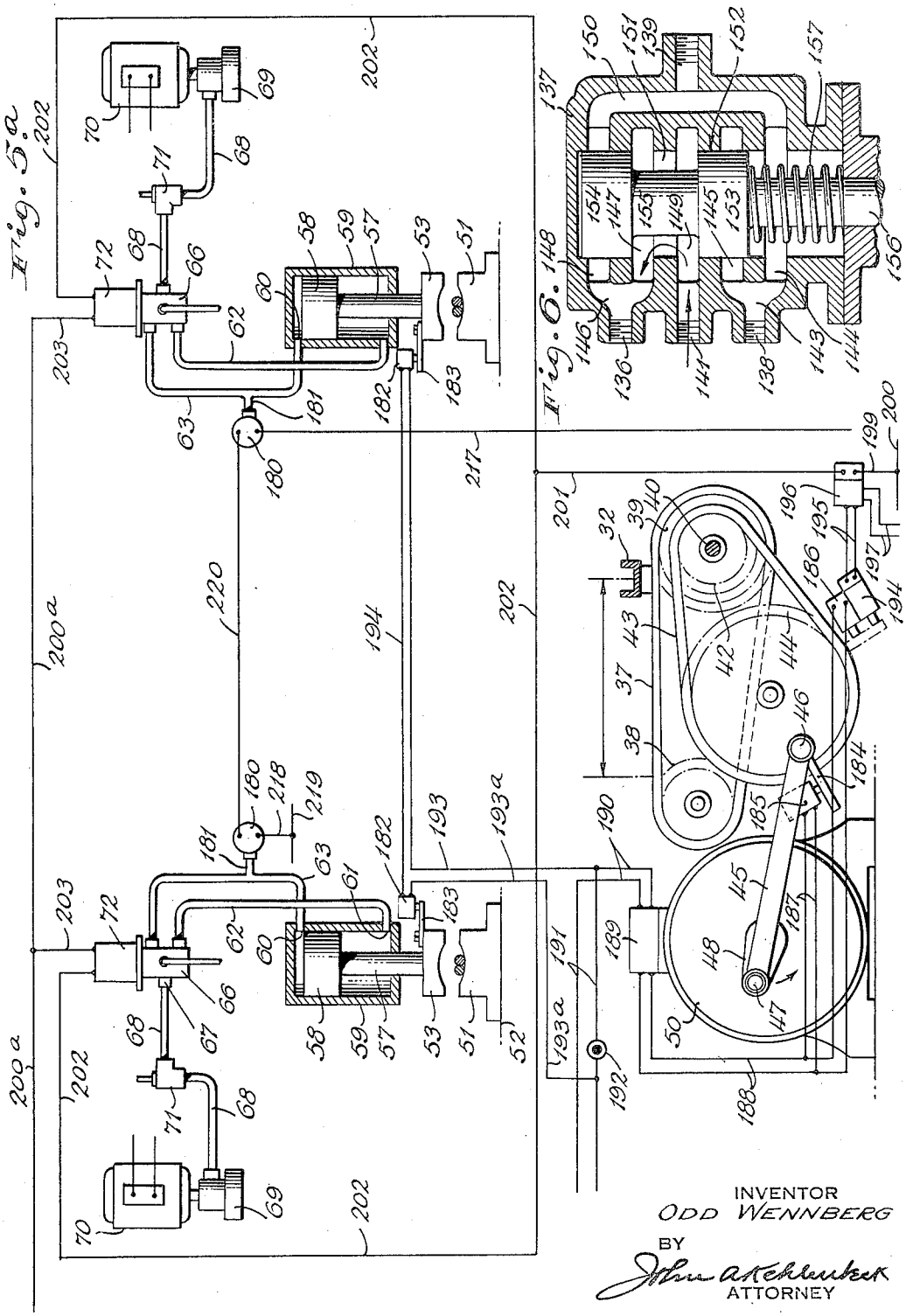
Fig. 3.

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TWISTING MACHINE

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Fig. 7.

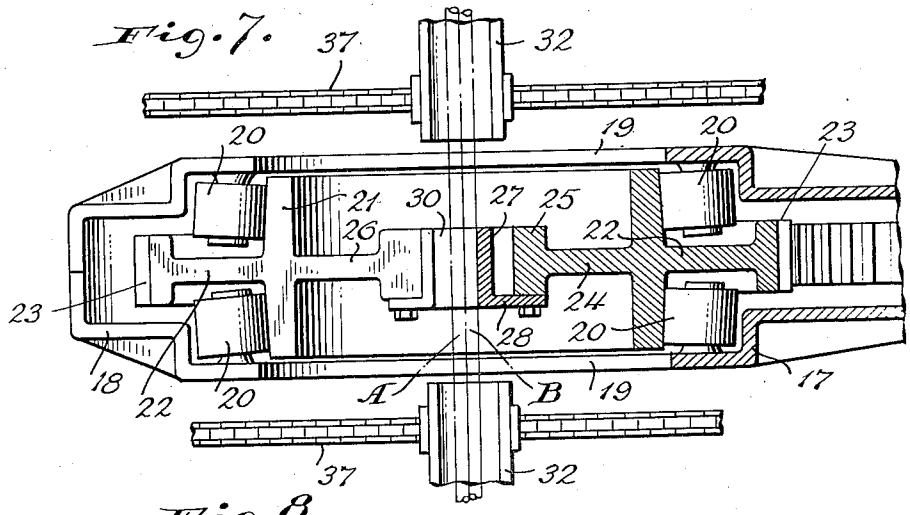


Fig. 8.

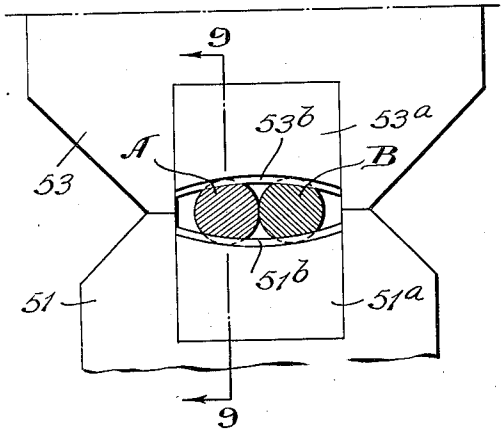


Fig. 9.

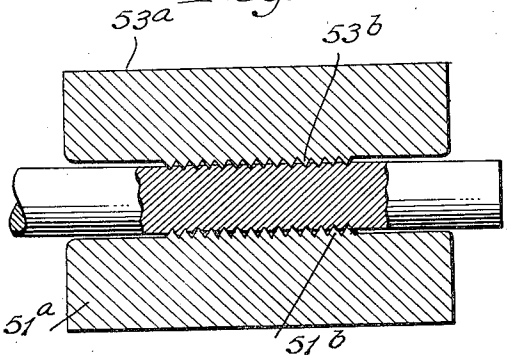


Fig. 10.

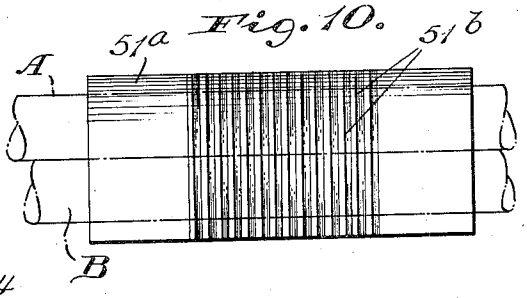
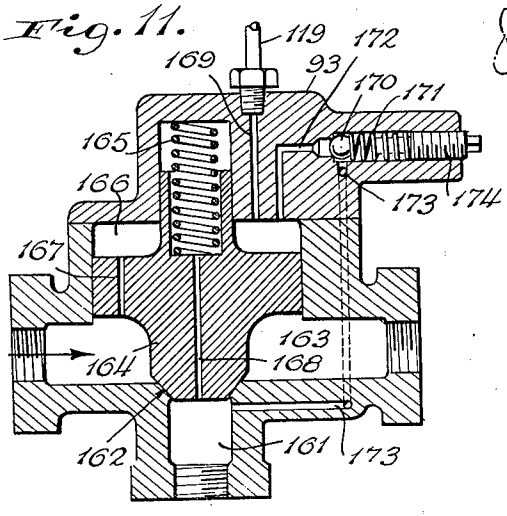


Fig. 11.



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UNITED STATES PATENT OFFICE

2,217,301

TWISTING MACHINE

Odd Wennberg, Laurelton, N. Y.

Application April 18, 1939, Serial No. 268,603

26 Claims. (Cl. 140—149)

The invention relates to machines for twisting metallic bars or rods and more particularly for helically twisting two adjacent steel bars or rods together for use in concrete reinforcement and the like. The object of the invention is to provide a machine of simple construction whereby the twisting of the bars or rods will be effected with maximum efficiency. The invention contemplates particularly the provision of novel mechanism in which the twisting operation is automatically controlled in accordance with predetermined requirements, and whereby a definite controlled recoiling operation is effected at the end of the twisting operation. Other more specific objects will appear from the description hereinafter and the features of novelty will be pointed out in the claims.

In the accompanying drawings, which illustrate an example of the invention without defining its limits, Fig. 1 is a plan view of the novel twisting machine; Fig. 2 is an enlarged cross-section thereof on the line 2—2 of Fig. 1; Fig. 3 is a similar view on the line 3—3 of Fig. 1; Fig. 4 illustrates the helically twisted bars or rods as produced by the novel machine; Figs. 5 and 5a are diagrammatic views which together show the complete layout; Fig. 6 is an enlarged detail section of a control valve which is utilized at various points in the machine; Fig. 7 is a horizontal section on the line 7—7 of Fig. 2; Fig. 8 is a fragmentary detail view illustrating clamping devices forming part of the machine; Fig. 9 is a detail section of the gripping jaws forming part of said clamping devices; Fig. 10 is a face view of one of said gripping jaws, and Fig. 11 is a detail sectional view illustrating a control valve embodied in the machine at several points thereof.

As shown in the drawings, the machine comprises a supporting base 15 mounted upon beams 16 or the like, said base 15 being of rectangular oblong shape as illustrated in Fig. 1, and of any suitable dimensions. At an intermediate point, the base 15 carries a preferably circular casing 17 fixed in place in any convenient manner and provided with a radially open slot 18 and having circular axially registering openings 19 in its opposite walls eccentrically located with respect to the casing 17 as shown in Fig. 2. A plurality of bearing rollers 20 are arranged in opposed groups about the openings 19, and are rotatably mounted upon opposite walls of said casing 17 so as to project toward each other as illustrated in Fig. 7; in the preferred arrangement the axes of the rollers 20 are inclined relatively to the casing walls on which said rollers 20 are journalled, the axes of the rollers 20 in the two respective groups converging toward each other as shown in Fig. 7.

An annular member 21 is rotatably supported on the rollers 20 and is provided with an outwardly projecting radial web 22 forming part of or secured to a toothed gear 23, and an inwardly directed web 24 terminating in a hub 25 located in concentric relation to the member 21. An outwardly open radial slot 26 extends from the periphery of the gear 23 to the axial bore of the hub 25 and is adapted to register with the radially open slot 18 of the casing 17 for the purpose to be more fully set forth hereinafter. A twisting head or bushing 27 is mounted in the axial bore of the hub 25 and forms part of an annular flange 28 which lies in surface engagement with the hub 25 for the accommodation of screws 29 whereby said bushing 27 is fixed interiorly of the hub 25. The bushing 27 and flange 28 include a common recess or seat 30 having its closed bottom in registry with the axis of the bushing 27 and communicating with the outwardly open radial slot 26; the flange 28 includes an outwardly flaring open slot 31 which leads to the recess or seat 30 as shown in Fig. 2.

The machine further includes carriers or troughs 32 located in spaced longitudinal alignment and extending in opposite directions upon opposite sides of the casing 17 as shown in Fig. 2. The carriers or troughs 32 are supported upon rollers 33 journalled in bearings 34 fixed thereon, said rollers 33 being arranged to traverse horizontal tracks 35 located at spaced intervals lengthwise of the machine as illustrated in Fig. 1. The tracks 35 are carried by brackets 36 mounted upon the supporting base 15, the arrangement being such that the bottoms of the carriers or troughs 32 are located approximately at the level of the recess or seat 30 of the twisting head or bushing 27 when the latter occupies the normal position shown in Fig. 2. At spaced intervals, preferably in contiguous relation to the brackets 36, the carriers or troughs 32 are connected with the upper runs of sprocket chains 37 or their equivalent; the latter pass over sprocket wheels 38 or the like rotatably mounted on the brackets 36, and over sprocket wheels 39 or the like fixed upon a shaft 40 extending lengthwise of the machine as illustrated in Fig. 1, and journalled in bearings 41 on the brackets 36, as shown in Fig. 3. During an operative period of the machine, the shaft 40 is rocked on its axis to correspondingly actuate the sprocket chains 37 or their equivalent to thereby intermittently reciprocate the

carriers or troughs 32 on the tracks 35 in the manner and for the purpose to be more fully set forth hereinafter. In the illustrated example, the shaft 40 accordingly carries an additional sprocket wheel 42 or its equivalent, which is operatively connected by means of a sprocket chain 43 or the like, with a sprocket wheel 44 rotatably mounted on one of the supporting brackets 36. A connecting rod or pitman 45 has its one end pivotally connected at 46 with the face of the sprocket wheel 44, and its other end pivotally connected at 47 with a crank 48; the latter is carried by or forms part of the shaft 49 of an electric motor 50 or equivalent source of power mounted upon the base 15 as illustrated in Figs. 1 and 3.

The outer ends of the carriers or troughs 32 are movable into co-operative relation to clamping means located in spaced relation to the casing 17 upon opposite sides thereof, whereby the opposite end portions of the bars or rods are gripped and clamped against movement during the twisting operation as will be more fully described hereinafter. The clamping means, in its illustrated form, consists of stationary jaws or clamps 51 suitably mounted in the machine, as for instance, upon brackets 52 supported upon the beams 16 which project beyond the base 15 at opposite ends for this purpose. The aforesaid clamping means further includes movable jaws or clamps 53 slidably mounted for vertical movement in guides 54 forming part of or supported by auxiliary frames 56 suitably fixed upon the beams 16. As shown in Figs. 8, 9 and 10, the jaws 51 and 53 are preferably provided in the end or active faces with recesses in which clamping blocks 51^a and 53^a of predetermined metal are respectively fitted and secured in any convenient manner. The active clamping surfaces of the blocks 51^a and 53^a preferably are countersunk in the respective recesses and are transversely curved as illustrated in Fig. 8; in addition said surfaces are preferably provided with teeth 51^b and 53^b respectively, said teeth extending in the direction of the transverse curves and preferably tapering outwardly in cross-section to sharp gripping edges as shown in Fig. 9. The jaws or clamps 53 are carried by plungers 57 depending from pistons 58 slidable in cylinders 59 carried by the frames 56, the cylinders 59 having upper ports 60 and lower ports 61 respectively connected by means of pipes or conduits 62 and 63 with upper and lower ports 64 and 65 respectively of valve cylinders 66 in which piston valves 58 of conventional type are slidable. The cylinders 66 further include intermediate ports 67 which are connected by means of pipes 68 with fluid pressure pumps 69 of suitable type operated in any convenient manner and preferably by means of electric motors 70 fixed upon the frames 56; in the preferred arrangement relief valves 71 of suitable and conventional type are interposed in the pipes 68 between the cylinders 66 and pumps 69. The valves in the cylinders 66 are operated and controlled by solenoids 72 which themselves are electrically controlled in the manner to be more fully set forth hereinafter.

The previously mentioned toothed gear 23 in the casing 17 is interrupted by the radial slot 26, and meshes with pinions 73 and 74 journalled in the casing 17 at points respectively above and below the horizontal plane in which the axial center of the gear 23 is located. The pinions 73 and 74 both mesh with a pinion 75 carried by a shaft 76 rotatably mounted in the casing 17 in horizontal registry with the axial center of the gear 23. The shaft 76 carries an additional pinion 77 which meshes with a driving pinion 78 mounted within the casing 17 upon the power shaft 79 of the hydraulic motor 80 of a conventional hydraulic transmission of constant horsepower and variable speed and including a conventional oil tank 81; the aforesaid hydraulic transmission may be of any well-known type as exemplified for instance by the so-called "Vickers" hydraulic transmission. As the latter is well-known and as the hydraulic transmission per se forms no part of the invention, it has been deemed sufficient to illustrate the same diagrammatically as in Fig. 5. As shown in Figs. 1 and 5, the shaft 79 may also carry a fly wheel 82, the latter being located between the casing 17 and the hydraulic motor 80 in the illustrated example. The hydraulic transmission further includes the customary hydraulic pump 83, having its driving shaft 84 operatively connected with a suitable driving means, such as the shaft 85 of an electric motor 86.

The hydraulic pump 83 is connected by means of pipes 87 and 88 with the hydraulic motor 80, the speed of which is controlled by the customary tilting box 89 and associated elements in the well-known way; the tilting box 89 is adjustably set to develop the desired speed in the hydraulic motor 80 in any convenient manner as by means of an adjusting screw 90 connected with said tilting box 89 by a link 91. The adjusting screw 90 is in screwthreaded connection with a hand wheel 92 rotatably mounted on the casing 81 so as to be accessible exteriorly thereof, and fixed against movement in axial directions relatively to said casing 81 as shown in Fig. 5. A by-pass relief valve 93 is interposed in the pipe 87 and is connected by means of a by-pass pipe 94 with the pipe 88; a similar by-pass relief valve 95 is located in the pipe 88 and is connected by means of a pipe 96 with the pipe 87.

The hydraulic pump 83 is controlled by a conventional tilting box 97 and associated elements in the well-known way, said tilting box 97 being connected by means of a link 98 with a plunger 99 slidably mounted in a cylinder 100; a suitable stop 101 may be provided for arresting the adjustment of the tilting box 97 in one direction.

The one end of the cylinder 100 is connected by means of a pipe 102 with a port 103 of a valve casing 104 located within the tank 81, and the opposite end of said cylinder communicates with a pipe 105 leading to a port 106 of said valve casing 104. The latter is provided with an additional port 107 which connects with a tube 108 open to the interior of the tank 81. A further port 109 with which said casing 104 is provided communicates with a pipe 110 leading to an auxiliary pump 111 operatively coupled to the shaft 85 of the electric motor 86; the inlet side of the pump 111 is connected by means of a pipe 112 with the interior of the tank 81. An auxiliary relief valve 113 is interposed in the pipe 110 and is provided with a pipe 114 communicating with the tank 81. A supercharging line 115 communicates through the relief valve 93 with the pipe 87 and leads to the pipe 110 at a point ahead of the auxiliary relief valve 113, and a similar supercharging line 116 communicates through the relief valve 95 with the pipe 88 and is also connected with said supercharging line 115; check valves 117 and 118 are located in the line 115 and line 116 respectively

as illustrated diagrammatically in Fig. 5. The supercharging lines 115 and 116 being connected through the pipe 110 with the auxiliary pump 111, serve to keep the pipes 87 and 88 filled with oil at all times.

The by-pass relief valves 93 and 95 are further connected by means of a bleeder pipe 119 and a bleeder branch 120 with a port 121 of a valve casing 122 located in the tank 81, said valve casing 122 having additional ports 123 connected with tubes 124 open to the interior of said tank 81.

In the illustrated example of the novel machine, the pinion 77 in the casing 17 is connected by means of gearing 125 located within a gear reduction box 126 mounted on the casing 17, with a shaft 127 journalled in said gear box 126 and carrying an index disc 128 exteriorly thereof. The index disc 128 is provided at a predetermined point on its surface with at least one opening or recess 129 for the accommodation of a slidably mounted index pin 130 controlled by and constituting an extension of a stem 131 forming part of a piston 132 as shown diagrammatically in Fig. 5. The piston 132 is slidable in a cylinder 133 mounted for instance upon the gear reduction box 126 and having ports at its opposite ends in communication respectively with conduits or pipes 134 and 135 which lead into the oil tank 81 as illustrated in Fig. 5.

The pipe 134 communicates with a port 136 of a valve casing 137 located within the tank 81, while the pipe 135 is connected with a second port 138 of said valve casing 137 as shown in Fig. 5. Another port 139 of said valve casing 137 communicates with a tube 140 open to the interior of the tank 81, and still another port 141 of the valve casing 137 is connected by means of a pipe 142 with the pipe 110 leading to the previously mentioned auxiliary fluid pump 111. The interior arrangement of the valve casing 137 and its associated parts is shown in Fig. 6 and includes an internal chamber 143 communicating with the port 138 and with annular internal channels 144 and 145. The port 136 communicates with an internal chamber 146 which in turn leads to annular internal channels 147 and 148, while the port 141 is connected with an annular internal channel 149. An internal channel 150 connects the annular channels 144 and 148 and communicates also with the port 139 of the casing 137. The latter further includes axial openings 151 and 152 whereby communication between the port 141 and the ports 136 and 138 respectively is established and additional corresponding axial openings in which piston valves 153 and 154 are slidably guided; the piston valves 153 and 154 are connected with each other by a neck 155 of relatively reduced diameter. The valves 153, 154 and the connecting neck 155 are carried by a valve stem 156 slidably mounted in one end of the casing 137 and projecting exteriorly thereof, a coil spring 157 serving to yieldingly maintain the piston valves 153 and 154 with the connecting neck 155 in the position illustrated in Fig. 6, and to return said valves and neck thereto. For the purpose of controlling and operating the valves 153 and 154 with the neck 155, the valve stem 156 is operatively connected with a solenoid 158 mounted on the tank 81.

The valves in the valve casings 104 and 122 correspond in construction and arrangement to the aforesaid valve in the valve casing 137 and likewise are operatively connected respectively with solenoids 159 and 160 also fixed upon the tank 81.

The previously mentioned by-pass relief valves 93 and 95 may be of any conventional type constructed for instance as illustrated in Fig. 11 which shows the valve 93, it being understood that the valve 95 is of similar construction and arrangement. As indicated in Fig. 11, the pipe 94 leads to a port 161 which is provided at its inner end with a valve seat 162, while the pipe 87 is connected with the interior chamber 163 at opposite sides of the valve casing. A pressure valve 164 normally rests upon the seat 162 and is yieldingly maintained in place thereon by a spring 165 to control the communication between the pipe 87 and the by-pass pipe 94, said valve 164 being slidably fitted in an internal recess 166 as shown in Fig. 11. The arrangement is such that the valve 164 permits communication through the interior chamber 163 between the sections of the pipe 87 at all times. A vent 167 extends through the valve 164 and establishes communication between opposite sides thereof, that is between the chamber 163 and that part of the recess 166 which is above said valve 164; a second vent 168 extends through the latter in registry with its major axis as illustrated in Fig. 11. The vent pipe 119 leads to a channel 169 in the casing of the valve 93, which channel 169 in turn communicates with the recess 166 above said valve 164. A check valve 170 acted on by a spring 171 controls communication between a channel 172 leading to the recess 166 above the valve 164, and a channel 173 leading to the port 161 below said valve; the pressure exerted by the spring 171 on the valve 170 and consequently the resistance of the latter to developed pressure may be regulated by an externally accessible adjusting screw 174 against which one end of said spring 171 abuts as shown in Fig. 11. It will be understood that the description of the internal construction and arrangement of the by-pass relief valve 93 applies also to the by-pass relief valve 95.

The power shaft 79 of the hydraulic motor 80 is operatively connected with a suitable counter 175 operating in the conventional manner to count revolutions of the shaft 79 and of the twisting head or bushing 27 for the purpose to be more fully described hereinafter. The counter 175 in turn is connected by means of a one-way clutch 176 with a second counter 177 which also is arranged to count revolutions of the shaft 79 and twisting head 27 but in a reverse direction for the purpose to be more fully set forth hereinafter. Both counters 175 and 177 include resetting levers 178 which, as shown in Fig. 5, may be connected with an operating rod 179 for concurrent operation to manually or otherwise reset said counters to zero or some other predetermined point. It will be understood that the counters 175 and 177 are arranged to open and close electric circuits at predetermined points in their operation as will appear more fully hereinafter.

The machine further includes pressure operated switches 180 of any conventional type connected by means of pipes 181 with the conduits 63 as illustrated diagrammatically in Fig. 5a. In addition switches 182 are controlled by arms or members 183 carried by and movable with the movable jaws or clamps 53 for the purpose to be more fully set forth hereinafter.

As shown in Fig. 5a, the sprocket wheel 44 is provided with a switch arm 184 projecting radi-

ally outward on said sprocket wheel 44 preferably at the point 46 of the connecting rod 45; the arm 184 controls the operation of limit switches 185 and 186 which are located in the path of movement of said arm 184. The limit switch 185 is connected by wires 187 with wires 188 which lead to a starting box 189 operating as a locking relay, said wires 188 being also connected with the limit switch 186. The starting box 189 is connected by means of wires 190 with wires 191 constituting a power line and including a manual switch 192, and further is connected by means of a wire 193 with one terminal of one of the switches 182. The other terminal of the latter switch 182 is connected by means of a wire 194 with one terminal of the other switch 182, which in turn has its other terminal connected by means of a wire 193a with the power line 191 at a point beyond the manual switch 192.

The switch arm 184 also controls a switch 194 which is connected by means of wires 195 with a conventional locking relay 196, the latter in turn being connected by wires 197 with a second switch 198 located as shown diagrammatically in Fig. 5. The relay 196 is further connected by means of a wire 199 with one wire 200 of a power line, and by means of a wire 201 with a wire 202 which leads to one terminal of each of the solenoids 72; the other terminal of each of the latter is connected by means of wires 203 with the other wire 200a of the last-mentioned power line.

The switch 198 is controlled by a switch arm 204 movable with the index pin 130, said switch arm 204 further controlling a limit switch 205 and a limit switch 206 as it moves in opposite directions with the index pin 130. The limit switch 205 is connected by means of a wire 207 with one terminal of the solenoid 159, and by means of a wire 208 with one terminal of the counter 175; the other terminal of the latter is connected by means of a wire 209 with a wire 210 constituting part of a power line. The other terminal of the solenoid 159 is connected by means of a wire 211 with the other wire 210a of said last named power line.

The limit switch 206 is connected by a wire 212 with the power wire 210 and by a wire 213 with one terminal of the solenoid 160, a wire 214 leading from the other terminal of said solenoid 160 to the other power wire 210a to complete the circuit. The one side of the solenoid 158 is connected by a wire 215 with the power wire 210, and the other side of said solenoid 158 is connected by a wire 216 with one terminal of the counter 177. A wire 217 connects the other terminal of the counter 117 with one terminal of one of the pressure operated switches 180, the other of which has its one terminal connected by means of a wire 218 with a power line 219; the other terminals of the switches 180 are connected with each other by a wire 220.

The product of the machine comprises two adjacent steel or other metallic bars A and B helically twisted together as illustrated in Fig. 4 in a predetermined helical pitch. When the twisting operation has been completed, the bars A and B because of inherent forces tend to untwist or uncoil; this untwisting or uncoiling of said twisted bars A and B will be transmitted to the twisting head or bushing 27 and accordingly will rotate the member 21 in a return direction on the rollers 20. Unless this tendency to uncoil is controlled, the possibility exists that the aforesaid operation of the member 21 in a return direction will bring the latter to rest in a position in which the slot 26 and with it the recess or seat 30 is out of registry with the open slot 18 of the circular casing 17 with the result that adjustments of the mechanism would have to be effected before the twisted bars A and B could be removed from the machine in the intended manner, and before another cycle of operation could be started on a successive pair of bars A and B. To avoid this possibility and to definitely restore the twisting mechanism to an accurate starting position, at the end of each twisting operation, the uncoiling or untwisting tendency of the twisted bars A and B is definitely controlled in the novel machine by recoiling the twisted bars A and B under definite control and to a predetermined extent; at the same time the aforesaid controlled recoiling of the twisted bars A and B will neutralize the inherent forces developed therein during the twisting operations and will produce a uniform finished product. To accomplish these results the counter 175 is set to operate as an electric circuit controller when the predetermined point in the twisting of the bars A and B has been reached, and the counter 177 has been set to similarly act as a circuit controller when the extent of recoil has been effected.

When the machine is at rest, the parts occupy the positions illustrated in Figs. 2 and 3, and diagrammatically in Figs. 5 and 5a. At this stage, the carriers or troughs 32 are located in the outer position shown in Figs. 2 and 3 and the movable jaws or clamps 53 are in the raised inoperative position illustrated in Fig. 5a. It will be understood that the motors 70 and pumps 69 are constantly in operation when the machine is in use so that pressure is provided in the cylinders 59 for maintaining the pistons 58 and consequently the jaws or clamps 53 in the raised inoperative position.

When it is desired to begin an operative period of the machine, two bars A and B are laid alongside of each other in the troughs or carriers 32, with intermediate portions of said bars spanning the space between opposed ends of said troughs or carriers 32, and opposite end portions of said bars A and B projecting beyond the outer ends thereof. When this has been done, the manual switch 192 is actuated to operate the starting box or locking relay 189 in a manner to start the motor 50 to thereby transmit power to the crank 48 and connecting rod 45 whereby the sprocket wheel 44 is rocked on its axis. Through the medium of the sprocket chain 43 this rotative rocking movement is transmitted to the sprocket wheel 42 and the shaft 40 and through the latter to the several sprocket wheels 39 carried by said shaft 40. This causes a corresponding actuation of the sprocket chains 37 and associated sprocket wheels 38, the operation being such that the upper runs of the chains 37 move toward the right in Fig. 2, which corresponds to a movement toward the left in Fig. 3. In any case, said upper runs of the chains 37 in the aforesaid movements carry along the troughs or carriers 32 and cause the latter to travel inwardly on the rollers 33 along the tracks 35. At this stage the parts occupy the position shown in Fig. 2 in which the slot 26 is horizontally disposed with its open end facing outwardly in registry with the open slot 18 of the circular casing 17. The previously mentioned inward movements of the carriers 32 accordingly transfer the intermediate portions of the bars A and B into and lengthwise of said slot 26 and into the recess or seat 30 of the twisting head or bushing 27 as shown by dotted lines in Fig. 2. At the

same time, the opposite outer end portions of said bars A and B are carried over and into the lower fixed clamps or jaws 51 as illustrated in Fig. 5a.

As the sprocket wheel 44 is rocked on its axis, the switch arm 184 will be shifted away from the limit switch 185 and into engagement with the limit switch 186 to thereby unlock the locking relay or starting box 139 and stop the motor 53; the carriers 32 accordingly remain or rest in the inner position with the intermediate portions of the bars A and B located in the seat 30 of the twisting head 27.

At the same time, the switch arm 184 will engage the locking relay 194 and bring about an energization and locking of said locking relay 194 which in turn energizes and locks the locking relay 196 to close the circuits which include the two solenoids 72 causing the latter to shift the valves in the cylinders 66. The operation of said valves is such that the pipes 63 are connected with the pipes 68 and consequently with the pumps 69; as a result pressure is exerted upon the pistons 58 which are forced downwardly in the cylinders 59 and thereby shift the jaws 53 downwardly to securely clamp the opposite end portions of the bars A and B between the jaws 53 and 51. Because of the transversely curved active surfaces of the clamping blocks 51a and 53a, the bars A and B will be forced toward each other and accordingly will be clamped together in close lengthwise engagement; at the same time, the teeth 51b and 53b of said blocks 51a and 53a will bite into said bars A and B and securely hold them against lengthwise movement.

At the same time, the pressure developed by the pumps 69 to operate the clamping jaws 53 is effective through the pipes 181 on the pressure operated switches 180 to close the circuit which includes the solenoid 158; this circuit also includes the counter 177 which is so arranged that at this point in said circuit, the latter is normally closed. As a result of the energization of the solenoid 150, the connected valves 153 and 154 in the valve casing 137 are drawn downwardly against the tension of the spring 157 to connect the port 138 through the chamber 143 with the port 141. At this stage the pipe 135 is accordingly connected with the pipes 142, 110 and the auxiliary pump 111 which is being operated by the motor 86. Pressure will therefore be effective in the left hand end of the cylinder 133 on the piston 132 whereby the latter will be shifted to the right in said cylinder 133 in Fig. 5. By this operation of the piston 132 the stem 131 will be correspondingly shifted to the right and the index pin 130 will be withdrawn from the opening or recess 129 in the index disc 128 thereby unlocking or releasing the latter.

As these operations take place, the switch arm 204 will likewise be moved to the right in Fig. 5 away from the switch 198 and limit switch 205. As the arm 204 leaves the switch 205, the circuit in which the latter is located is closed by said switch 205; as this circuit also includes the counter 175 and is normally open thereat, the aforesaid movement of the arm 204 away from the switch 205 has no operative effect and the tilting box 97 of the hydraulic pump 83 accordingly remains in the set position shown in Fig. 5. As the movement to the right continues, the arm 204 will engage the limit switch 206 and operate the same to close the circuit in which this switch 206 is located; it will be understood that the latter normally maintains its circuit in an open condition. As the last-mentioned circuit also includes the solenoid 160, the latter will be energized when the switch 206 is operated; this causes the valve in the valve casing 122, which valve is similar to the one shown in Fig. 6, to be actuated in a manner to close the port 121 and the bleeder pipes 119 and 120 of the relief valves 93 and 95. This causes the hydraulic pump 83 to force oil or equivalent fluid through the pipe 87 in the direction of the arrow *a* in Fig. 5 to the hydraulic motor 80, and back through the pipe 88 to the hydraulic pump 83 in the customary manner. The hydraulic motor 80 is thereby operated to actuate the shaft 79 and pinion 78 whereby power is transmitted to the shaft 76 and pinion 75. The latter transmits power to the pinions 73 and 74 which in turn apply power to the toothed gear 23 whereby the annular member 21 is caused to rotate on the rollers 20 and the twisting head 27 is correspondingly rotated on its axis.

As the opposite end portions of the bars A and B are securely clamped in the jaws 53 and 51 at this stage, the rotation of said twisting head 27 by means of the recess or seat 30 will act on the intermediate portions of said bars A and B to helically twist the latter together in the manner illustrated in Fig. 4; due to the fact that the seat 30 of the twisting head 27 is effective at an intermediate point of the bars A and B, the latter will be twisted together in opposite helices upon opposite sides of said twisting head 27. This twisting operation is continued for a predetermined period or until a predetermined number of twists for which the counter 175 is set have been effected. At this point said counter 175 will act to close the circuit in which it is located and thereby will cause the solenoid 159 to be energized. The valve in the casing 104, which also is similar to the valve shown in Fig. 6 will thereby be shifted to open the port 109 to the port 106, and connect the pipe 105 with the pipe 110 and through the latter with the auxiliary pump 111; at the same time the port 103 will be opened to the port 107 to connect the pipe 102 with the pipe 108 leading to the interior of the tank 81. As a result of these operations, oil or other suitable fluid under pressure will be forced into the lower end of the cylinder 100 and will raise the plunger 99 therein; this movement will be transmitted by the link 98 to the tilting box 97 of the hydraulic pump 83 and swing said tilting box 97 upward against the stop 101 to the position indicated by the broken line *b* in Fig. 5. As this takes place, the oil or its equivalent above the plunger 99 will be forced from the cylinder 100 through the pipe 102, ports 103 and 107, and through the pipe 108 back to the tank 81.

The circulation of oil or its equivalent will accordingly be reversed, so that said oil now flows through the pipe 88 in the direction of the arrow *c* in Fig. 5 and through the pipe 87 back to the hydraulic pump 83. The hydraulic motor 80 will thereby be reversed to correspondingly reverse the direction of operation of the shaft 79 and associated gearing, as well as the toothed gear 23 and annular member 21. As a result of this, the twisting head 27 is also reversed and the seat 30 will become effective on the intermediate portions of the twisted bars A and B in a correspondingly reverse direction to recoil or untwist said bars A and B. This recoiling is continued for a predetermined period or until the slot 26 of the member 21 is in accurate registry with the open slot 18 of the circular casing 17 and until any inherent tendency in said bars to untwist is neutralized; the counter 177 is set to

become operative at this point to open its circuit and thereby bring about a de-energization of the solenoid 158.

As this occurs, the valve 153—154 will be shifted by its spring 157 back to its normal position in the casing 137 as illustrated in Fig. 6; this will restore communication between the ports 138 and 141 and will connect the pipe 134 with the pipe 142 and through the pipe 110 with the auxiliary pump 111. Oil or its equivalent will now be forced under pressure into the right hand end of the cylinder 133 and will force the piston 132 to the left therein and cause the index pin 130 to bear against the face of the index disc 128 and to enter the opening or recess 129 thereof when the latter and said pin are in registry with each other. When this takes place, the switch arm 204 will engage and operate the limit switch 205 to open its circuit and as the switch arm 204 moves away from the limit switch 206, the latter will open its circuit and thereby de-energize the solenoid 160; when index pin 130 enters the opening or recess 129 in the index disc 128, the switch arm 204 will engage and operate the limit switch 205 to open its circuit and thereby de-energize the solenoid 159. As the solenoid 160 is de-energized as mentioned above, the valve in the casing 122 will open the pipes 119 and 120 of the relief valves 93 and 95, while the de-energization of the solenoid 159 will shift the valve in the casing 104 in a manner to connect the upper end of the cylinder 100, through the pipe 102, ports 103 and 104, and pipe 110 with the auxiliary pump 111. Pressure accordingly will be exerted on the plunger 99 to force the same downwardly in the cylinder 100 and thereby restore the tilting box 97 of the hydraulic pump 83 to the position shown in Fig. 5.

As the switch arm 204 operates the switch 205 to bring about the aforesaid operations, said arm 204 at the same time engages and operates the switch 198 to unlock the locking relay 196 and thereby break the circuit in which the solenoids 72 are located. The latter are accordingly de-energized whereupon the valves in the cylinders 66 are operated to connect the lower ends of the cylinders 59 through the pipes 62 and 68 with the pumps 69. The pistons 58 are thereby raised and the jaws 53 are lifted to the inoperative positions shown in Fig. 5a to release the opposite end portions of the twisted bars A and B. It will be understood that de-energization of the solenoids 159, 160 and 72 takes place at approximately the same time, so that the operations described above are performed more or less simultaneously.

In the raised position of the jaws 53, the arms or members 183 carried thereby engage and operate the switches 182 to close the circuit in which the latter are located in series and thereby operate the locking relay 189 in a manner to start the motor 50. The latter will rock the gear 84 in a return direction and correspondingly operate the associated parts whereby the carriers 32 with the twisted bars A and B carried thereby are shifted outwardly to the position shown in Figs. 2, 3 and 5a in which position the twisted bars A and B are easily removable from the machine. As the gear 84 is thus rocked in the return direction, the switch arm 184 will engage and operate the limit switch 185 to break all circuits and complete the operative cycle. The twisted bars A and B may now be removed from the carriers 32 and replaced by other bars after which the described cycle of operations may be repeated.

It will be noted that the toothed periphery of the gear 23 is interrupted by the open entrance end of the slot 26. To avoid the possibility that this interruption may interfere with the operation of the twisting operations of the machine, the two pinions 73 and 74 are provided upon opposite sides of a horizontal line passing through the axis of said gear 23. As the slot 26, in transversing its rotative path during said twisting operations, reaches one of said gears 73 or 74, the other gear, either 73 or 74 will be positively in mesh with the gear 23; the latter is thus subjected to a continuous application of rotative power so that the aforesaid twisting operations are carried out uniformly and without interruption.

The machine is relatively simple in construction and of maximum efficiency, and enables the bars A and B to be handled with a minimum of effort and without difficulty, before and after the twisting thereof has been accomplished. The machine enables the bars A and B to be twisted cold in helices of any predetermined pitch, and by the controlled recoiling of the twisted bars neutralizes any inherent tendency therein to uncoil and therby definitely insures a uniform product of the desired type. Because of the fact that the bars A and B are securely clamped during the twisting operation, said bars as a result of the helical twisting thereof will be stretched or elongated; this brings about a material increase in the yield point of the twisted bars which is of maximum importance in reinforced concrete work. At the same time, as previously stated herein, the recoiling operation is so controlled that it also definitely and positively restores the annular member 21 to its initial position of rest in which the recess or seat 30 and with it the slot 26 is accurately in registry with the open slot 18 of the circular casing 17. In other words, the twisting mechanism is definitely adjusted to a position in which the twisted bars A and B may be readily shifted for removal from the machine; at the same time the twisting mechanism is set in position for the beginning of another cycle of operations on succeeding bars A and B.

The twisted bars are designed primarily for use as concrete re-inforcements although they are not limited to such use, nor is the machine restricted to the production of such reinforcement bars.

Various changes in the specific forms shown and described may be made within the scope of the claims without departing from the spirit of the invention.

I claim:

1. In a machine for twisting bars as described, a base, a circular casing mounted on said base and provided with eccentrically located openings in its opposite walls, and having a radial slot open at the outer periphery of said casing and at said openings, a plurality of rollers arranged in opposed groups about said openings and rotatably mounted on said opposite walls of said casing, an annular member rotatably supported on said rollers, webs extending inwardly and outwardly respectively from said annular member, a toothed gear carried by said outwardly extending web, a hub carried by said inwardly extending web in eccentric relation to said annular member, said annular member and webs having a radial slot extending from the periphery of the toothed gear to the bore of said hub, a twisting head mounted in said hub and having a twisting seat

at its axis in open communication with said radial slot, clamping means located in spaced relation to said casing upon opposite sides thereof, a pair of movable carriers located in spaced, longitudinal alignment and extending in opposite directions upon opposite sides of said casing and terminating at their outer ends adjacent to said clamping means, the bars to be twisted being supported by said carriers and having intermediate portions bridging the space between opposed inner ends thereof, and having outer end portions projecting outwardly beyond the outer ends of said carriers, rollers supporting said carrier, stationary tracks for said rollers, means for moving said carriers on said tracks whereby said intermediate portions of said bars are moved lengthwise of said radial slot into said twisting seat, and the opposite end portions are shifted into operative relation to said clamping means, means for operating said clamping means to clamp said opposite end portions of said bars against movement, means operatively connected with said toothed gear for operating said twisting head to thereby helically twist said bars together, means for automatically arresting the twisting operation at a predetermined point and reversing the operation of said twisting head to recoil the twisted bars to a predetermined extent, and means for arresting the operation of said twisting head and operating said clamping means to release said twisted bars and for shifting said carriers to their initial position to permit removal of said twisted bars.

2. In a machine for twisting bars as described, a base, a circular casing mounted on said base and provided with eccentrically located openings in its opposite walls, and having a radial slot open at the outer periphery of said casing and at said openings, a plurality of rollers arranged in opposed groups about said openings and rotatably mounted on said opposite walls of said casing, an annular member rotatably supported on said rollers, webs extending inwardly and outwardly respectively from said annular member, a toothed gear carried by said outwardly extending web, a hub carried by said inwardly extending web in eccentric relation to said annular member, said annular member and webs having a radial slot extending from the periphery of the toothed gear to the bore of said hub, a twisting head mounted in said hub and having a twisting seat at its axis in open communication with said radial slot, clamping means located in spaced relation to said casing upon opposite sides thereof, a pair of movable carriers located in spaced, longitudinal alignment and extending in opposite directions upon opposite sides of said casing and terminating at their outer ends adjacent to said clamping means, the bars to be twisted being supported by said carriers and having intermediate portions bridging the space between opposed inner ends thereof, and having outer end portions projecting outwardly beyond the outer ends of said carriers, rollers supporting said carriers, stationary tracks for said rollers, means for moving said carriers on said tracks whereby said intermediate portions of said bars are moved lengthwise of said radial slot into said twisting seat, and the opposite end portions are shifted into operative relation to said clamping means, means for operating said clamping means to clamp said opposite end portions of said bars against movement, means operatively connected with said toothed gear for operating said twisting head to thereby helically twist said bars together, and means for reversing the operation of said twisting head to recoil the twisted bars to a predetermined extent.

3. In a machine for twisting bars as described, a base, a circular casing mounted on said base and provided with eccentrically located openings in its opposite walls, and having a radial slot open at the outer periphery of said casing and at said openings, a plurality of rollers arranged in opposed groups about said openings and rotatably mounted on said opposite walls of said casing, an annular member rotatably supported on said rollers, webs extending inwardly and outwardly respectively from said annular member, a toothed gear carried by said outwardly extending web, a hub carried by said inwardly extending web in eccentric relation to said annular member, said annular member and webs having a radial slot extending from the periphery of the toothed gear to the bore of said hub, a twisting head mounted in said hub and having a twisting seat at its axis in open communication with said radial slot, clamping means located in spaced relation to said casing upon opposite sides thereof, a pair of movable carriers located in spaced, longitudinal alignment and extending in opposite directions upon opposite sides of said casing and terminating at their outer ends adjacent to said clamping means, the bars to be twisted being supported by said carriers and having intermediate portions bridging the space between opposed inner ends thereof, and having outer end portions projecting outwardly beyond the outer ends of said carriers, rollers supporting said carriers, stationary tracks for said rollers, means for moving said carriers on said tracks whereby said intermediate portions of said bars are moved lengthwise of said radial slot into said twisting seat, and the opposite end portions are shifted into operative relation to said clamping means, means for operating said clamping means to clamp said opposite end portions of said bars against movement, and means operatively connected with said toothed gear for operating said twisting head to thereby helically twist said bars together.

4. In a twisting machine of the kind described, a twisting head, clamping means in spaced relation to said twisting head upon opposite sides thereof, carrying means normally occupying a receiving position for receiving the bars to be twisted and for conveying the latter from said receiving position to shift intermediate portions of said bars into operative connection with said twisting head and to coincidentally shift opposite end portions of said bars into operative relation with said clamping means, means for operating said clamping means to clamp said opposite end portions of said bars against movement, and means for operating said twisting head to develop twisting forces at said intermediate portions of said bars to helically twist said bars together.

5. In a twisting machine of the kind described, a twisting head, clamping means in spaced relation to said twisting head upon opposite sides thereof, carrying means normally occupying a receiving position for receiving the bars to be twisted and for conveying the latter from said receiving position to shift intermediate portions of said bars into operative connection with said twisting head and to coincidentally shift opposite end portions of said bars into operative relation with said clamping means, means for operating said clamping means to clamp said opposite end portions of said bars against movement, means for operating said twisting head to develop twist-

ing forces at said intermediate portions of said bars to helically twist said bars together, and means for reversing the operation of said twisting head to recoil said twisted bars to a predetermined extent.

6. In a machine for twisting bars as described, a twisting head having an open twisting seat, clamping means located in spaced relation to said twisting head upon opposite sides thereof, conveying means for shifting intermediate portions of the bars into said twisting seat, and opposite end portions of said bars into operative relation with said clamping means, means for operating the latter to clamp said opposite end portions of said bars against movement, means for operating said twisting head to helically twist said bars together, means for reversing the operation of said twisting head at a predetermined point in the twisting operation to recoil the twisted bars to a predetermined extent, and means operative at the end of said recoiling operation to arrest the operation of the twisting head, to operate the clamping means to release the twisted bars, and to operate the conveying means in a return direction to thereby shift the twisted bars away from the twisting head and clamping means for removal from the machine.

7. In a machine for twisting bars as described, a twisting head having an open twisting seat, clamping means located in spaced relation to said twisting head upon opposite sides thereof, conveying means for shifting intermediate portions of said bars into said twisting seat, and opposite end portions of said bars into operative relation with said clamping means, a hydraulic transmission, gearing connecting said transmission with said twisting head, an index disc operatively connected with said gearing, an index pin for locking said index disc and said gearing against operation, electrically controlled means for shifting said index pin to release said index disc and gearing, electrically controlled means set in motion as said index pin is shifted to its releasing position whereby said hydraulic transmission is actuated to operate said twisting head to helically twist said bars together, a counter, electrically controlled means controlled by said counter whereby said hydraulic transmission is reversed to reverse the operation of said twisting head whereby said twisted bars are recoiled, a second counter whereby the electrically controlled means is de-energized to shift said index pin into locking engagement with said index disc to thereby lock the latter and said gearing, electrically controlled means controlled by said index pin in its locking position to bring about an operation of said clamping means to release the opposite end portions of the twisted bars and an operation of said conveying means to shift said twisted bars out of said twisting seat and away from said clamping means for removal from the machine, and switching means effective when said conveying means has completed the last named shifting of the twisted bars to arrest the operation of all parts of said machine.

8. In a machine for twisting bars as described, a twisting head having an open twisting seat, clamping means located in spaced relation to said twisting head upon opposite sides thereof, conveying means for shifting intermediate portions of said bars into said twisting seat, and opposite end portions of said bars into operative relation with said clamping means, a hydraulic transmission, gearing connecting said transmission with said twisting head, locking means for locking said gearing against operation, electrically controlled means for operating said locking means to release said gearing and for starting said hydraulic transmission to operate said twisting head to thereby helically twist said bars together, electrically controlled means for reversing the hydraulic transmission to correspondingly reverse the operation of said twisting head to thereby recoil said twisted bars to a predetermined extent, and for operating the locking means to re-lock said gearing against operation, electrically controlled means for operating said clamping means to release said opposite end portions of the twisted bars and for operating said conveying means to shift said twisted bars out of said twisting seat and away from said clamping means for removal from the machine, and switching means effective when said conveying means has completed the last named shifting of the twisted bars to arrest the operation of all parts of the machine.

9. In a machine for twisting bars as described, twisting mechanism, clamping means located in operative relation to said twisting mechanism, conveying means for shifting said bars into operative relation with said twisting mechanism and said clamping means, means for operating the latter to clamp predetermined portions of said bars against movement and for subsequently releasing said clamping means, a hydraulic transmission for operating said twisting mechanism in one direction to helically twist said bars together and subsequently in a reverse direction to recoil said twisted bars to a predetermined extent, and means for automatically controlling the operation of said hydraulic transmission, and the operation of said conveying means whereby the twisted and recoiled bars are moved out of operative relation with said twisting mechanism and clamping means for removal from the machine.

10. In a machine for twisting bars as described, twisting mechanism, clamping means located in operative relation to said twisting mechanism, means for supporting said bars in operative relation with said twisting mechanism and said clamping means, means for operating the latter to clamp predetermined portions of said bars against movement and for subsequently releasing said clamping means, and a hydraulic transmission for operating said twisting mechanism to helically twist said bars together and to subsequently recoil said twisted bars to a predetermined extent.

11. In a machine for twisting bars as described, twisting mechanism, means for supporting two bars in operative relation to said twisting mechanism during the twisting operation, and clamping jaws for clamping predetermined portions of said bars against movement during said twisting operation, the active clamping surfaces of said jaws being concave whereby said bars are forced into close lengthwise engagement with each other on said supporting means and clamped.

12. In a machine for twisting bars as described, twisting mechanism, means for supporting two bars in operative relation to said twisting mechanism during the twisting operation, clamping jaws for clamping predetermined portions of said bars against movement during said twisting operation, and clamping blocks countersunk in the opposed faces of said jaws, the active surfaces of said clamping blocks being transversely curved and provided with grooves extending in the di-

rection of the curves whereby said bars are forced into close lengthwise engagement with each other on said supporting means and clamped.

13. In a machine for twisting bars as described, means for clamping predetermined portions of the bars to be twisted, against movement, twisting means for helically twisting said bars together to a predetermined extent, and means for reversing the operation of said twisting means to a controlled extent subsequent to the twisting operation to restore the latter to its initial starting position independently of any uncoiling tendencies inherent in the twisted bars.

14. In a twisting machine of the kind described, a twisting head, clamping means in spaced relation to said twisting head upon opposite sides thereof, carrying means normally occupying a receiving position for receiving the bars to be twisted and for conveying the latter from said receiving position to shift intermediate portions of said bars into operative connection with said twisting head and to coincidentally shift opposite end portions of said bars into operative relation with said clamping means, means for operating said clamping means to clamp said opposite end portions of said bars against movement, means having an operative period of predetermined length for operating said twisting head to develop twisting forces at said intermediate portions of said bars during said operative period whereby said bars are helically twisted together to provide a predetermined number of twists, and means effective at the end of said operative time period for reversing the operation of said twisting head to restore the latter to its initial starting position and to coincidentally recoil said twisted bars to thereby neutralize uncoiling tendencies inherent in the twisted bars.

15. In a machine for twisting bars as described, clamping means for developing clamping forces on two adjacent bars, twisting means for helically twisting said bars together, a hydraulic transmission including a hydraulic pump and a hydraulic motor operatively connected with said twisting means, and means for controlling the operation of said hydraulic transmission to cause said hydraulic pump and motor to operate said twisting means in one direction for a predetermined time period and in a reverse direction for a subsequent predetermined time period.

16. In a machine for twisting bars as described, clamping means for clamping two adjacent bars against movement, twisting mechanism for helically twisting said bars together, a hydraulic transmission including a hydraulic motor operatively connected with said twisting mechanism, a hydraulic pump for operating said hydraulic motor, and an adjustable control for controlling the operation of said hydraulic pump, electro-magnetic controlled means for actuating said hydraulic transmission to operate said twisting mechanism to helically twist said bars together, electro-magnetic controlled means whereby the operation of said twisting mechanism is arrested after a predetermined number of helical twists have been effected, electro-magnetic controlled means for shifting the adjustable control of said hydraulic pump to reverse the operation of said hydraulic motor and the twisting mechanism whereby said twisted bars are recoiled to a predetermined extent, and means operative at the end of said recoiling operation to arrest the reverse operation of said twisting mechanism, and to operate said clamping means to release the twisted bars.

17. In a machine for producing helically twisted bars of the kind described, twisting mechanism including a rotatable twisting member provided with a slot extending from the periphery of said member to substantially the center thereof, means for conveying the stock to be twisted into the slot of said twisting member, clamping means for holding the stock against rotative as well as axial movements during the twisting operation, means for driving said twisting mechanism, and control means for controlling said driving means in a manner to subject said stock to a predetermined number of helical twists in one direction and subsequently to allow said twisted stock a predetermined number of recoils in the reverse direction.

18. In a machine for producing twisted bars of the kind described, twisting mechanism including a gear provided with a slot extending from the circumference of the gear to substantially the center thereof, means for inserting the stock to be twisted into the slot of said twisting gear, clamping means for holding said stock against rotative as well as axial movements during the twisting operation, means for driving said twisting mechanism, control elements for controlling said driving means in a manner to subject said stock to a predetermined number of recoils in the reversed direction, and additional means for releasing said clamping means subsequent to said predetermined number of recoils.

19. In a machine for producing twisted bars of the kind described, twisting mechanism for twisting the stock, constant horse power driving means for rotating said twisting mechanism at decreasing speeds during the twisting process, the decrease in twisting speed being proportionate to the increase in required twisting torque, and control means for adjusting the magnitude of the constant horse power output of said driving means dependent on the desired range of twisting speeds during the twisting process, to obtain predetermined physical properties in the twisted bars.

20. In a machine for producing twisted bars of the kind described, in combination with a twisting mechanism for twisting the stock and clamping means for holding said stock against rotative and axial movements, driving means for rotating said twisting mechanism at varying speeds during the twisting process, and control means for adjusting the constant horse power output of said driving means in dependence upon the desired final physical properties of the twisted bars.

21. In a machine for producing twisted bars of the kind described, in combination with a twisting mechanism for twisting the stock, constant horse power driving means for actuating said twisting mechanism, controls for said driving means to automatically decrease the twisting speed as the twisting process progresses, the decrease in twisting speed being proportionate to the increase in twisting torque required, and auxiliary control means for pre-setting the magnitude of the constant horse power output in dependence upon the desired final strength of the twisted bars.

22. In a machine for producing twisted bars of the kind described, clamping means for holding the stock against rotative and axial movements, a twisting mechanism located at an intermediate point of said stock, driving means op-

eratively connected with said twisting mechanism, control means for said driving means to adjust the driving power and the twisting speed, auxiliary control elements for said driving means to subject said stock to a predetermined number of twists in one direction and to a predetermined number of recoils in the opposite direction, and an indexing mechanism for arresting said twisting mechanism in a predetermined angular position after the recoiling operation to facilitate loading of the machine for subsequent twisting cycle.

23. In a machine for producing twisted bars of the kind described, clamping means for holding predetermined sections of the stock to be twisted against rotative and axial movements, an intermittently rotatable twisting head located between said clamping means, a gear carrying said twisting head at its centre and provided with a relatively wide slot extending from the periphery of said gear into communication with said twisting head for feeding the stock to be twisted into the twisting head, the latter having a relatively narrow recess connected with the inner end of said wide slot for locating said stock against relative movement relatively to the twisting head, driving means operatively connected with said gear, control means for controlling said driving means in a manner to subject said stock to a predetermined number of helical twists in one direction and to limit the number of recoils of the twisted stock in the reverse direction, and indexing means for locating said twisting head in a predetermined angular position subsequently to the recoiling operation.

24. In a machine for producing twisted bars of the kind described, clamping means for developing clamping forces on two adjacent bars, twisting means for helically twisting said bars, a hydraulic transmission including a variable displacement pump and a variable displacement motor operatively connected with said twisting means, and means for controlling the operation of said hydraulic pump in a manner to give high volume delivery for twisting said bars in one direction and to give low volume delivery in opposite direction for controlling the recoil of said twisted bars.

25. In a machine for producing twisted bars of the kind described, clamping means for holding the ends of two adjacent bars, twisting means for helically twisting said bars together, driving means for operating said twisting means, and means for controlling the operation of said driving means in a manner to obtain a predetermined number of twists in one direction, and to obtain subsequently a predetermined number of recoils in the reverse direction.

26. In a machine for producing twisted bars of the kind described, clamping means for holding the ends of two adjacent bars, twisting means for helically twisting said bars together, driving means for operating said twisting means, and means for controlling the operation of said driving means to obtain a predetermined number of twists in one direction, and to obtain subsequently a predetermined number of recoils in the reverse direction, and employing the driving means for effecting a slow recoil speed.

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