

Aug. 24, 1954

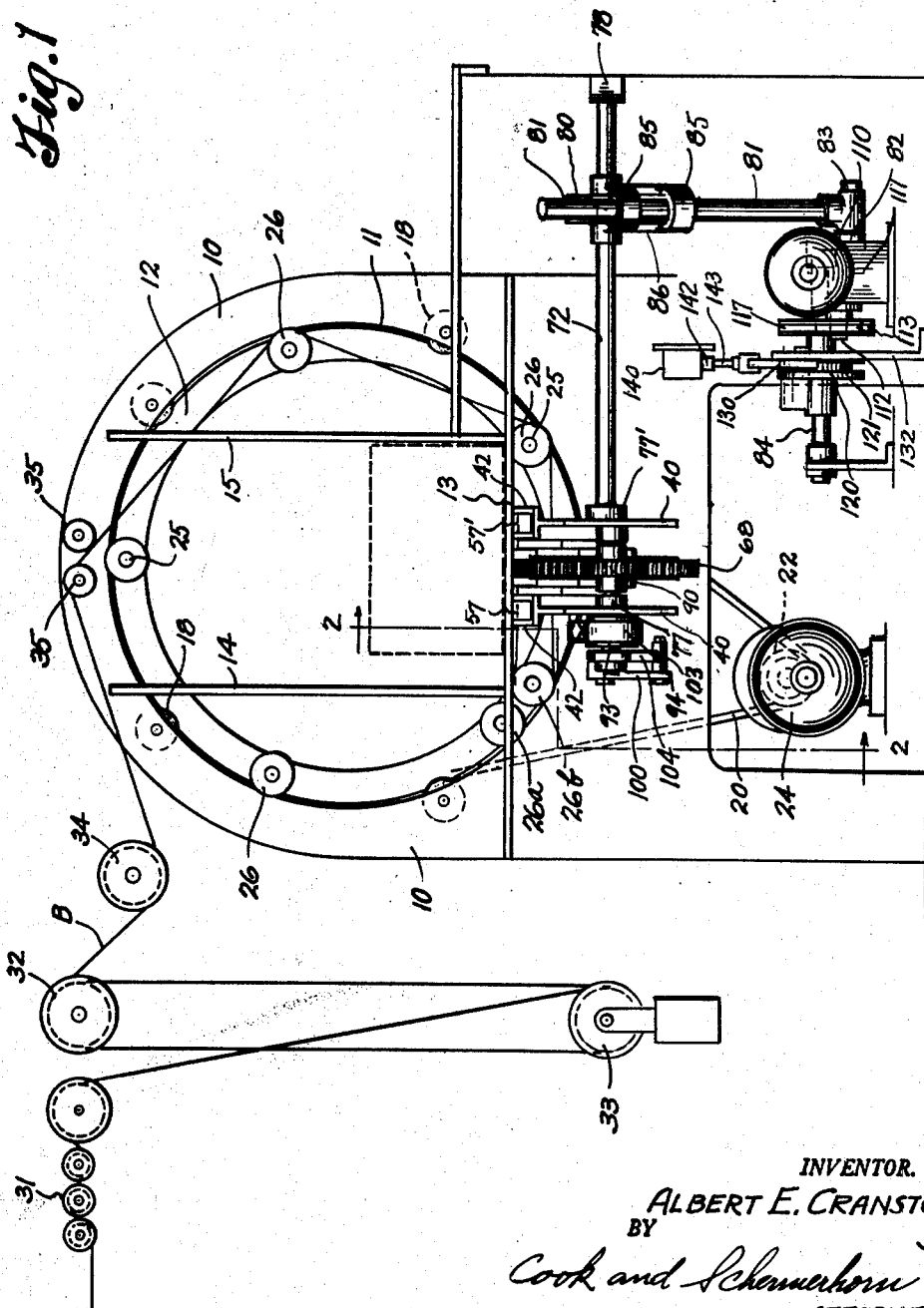
A. E. CRANSTON, SR.

2,687,083

WIRE BINDING MACHINE

Filed Jan. 10, 1949

11 Sheets-Sheet 1



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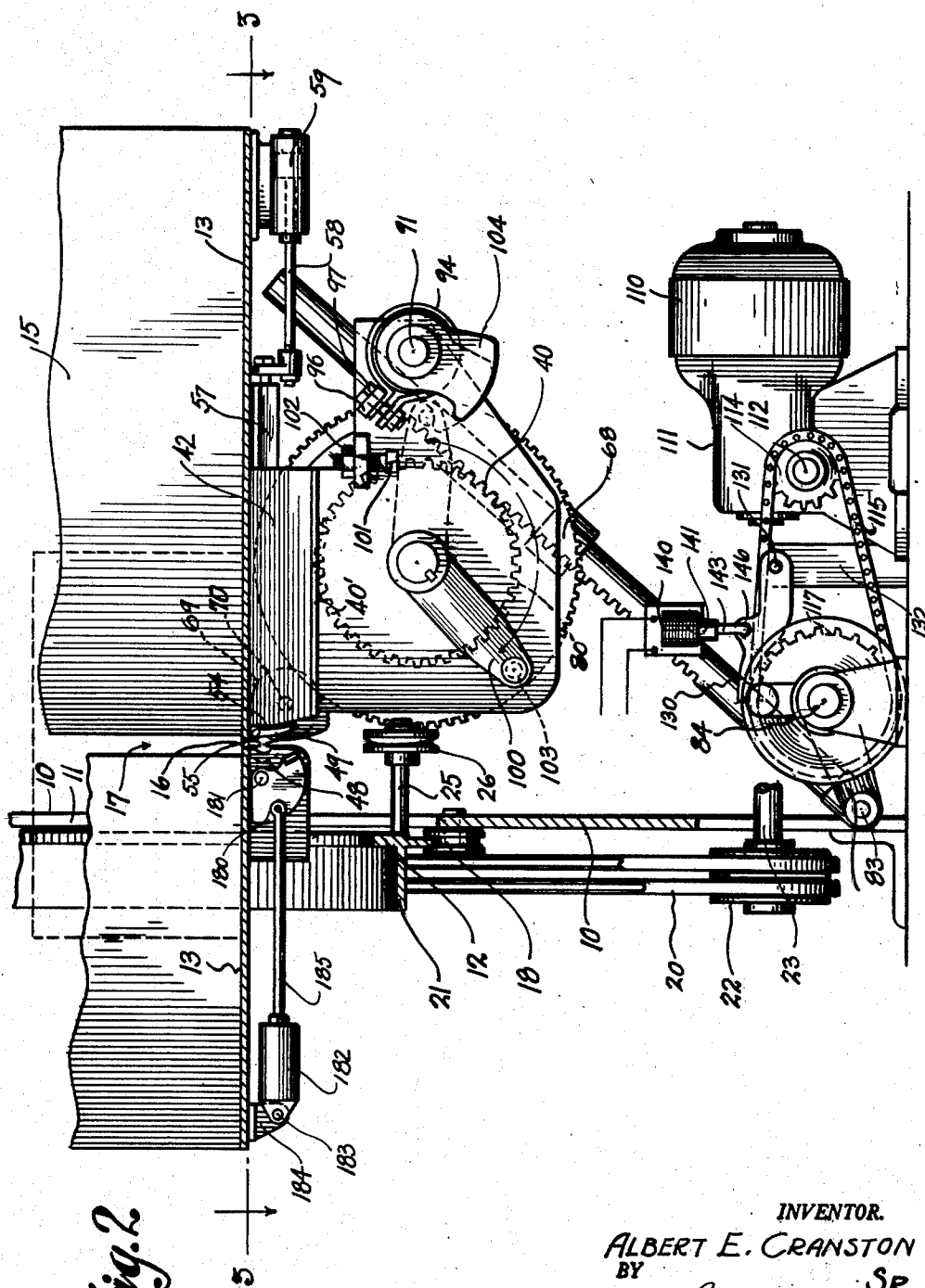
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WIRE BINDING MACHINE

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11 Sheets-Sheet 2



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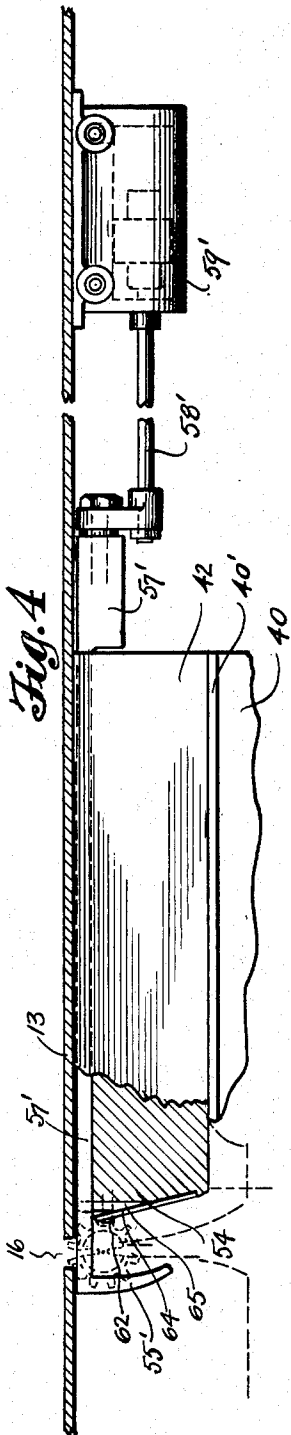
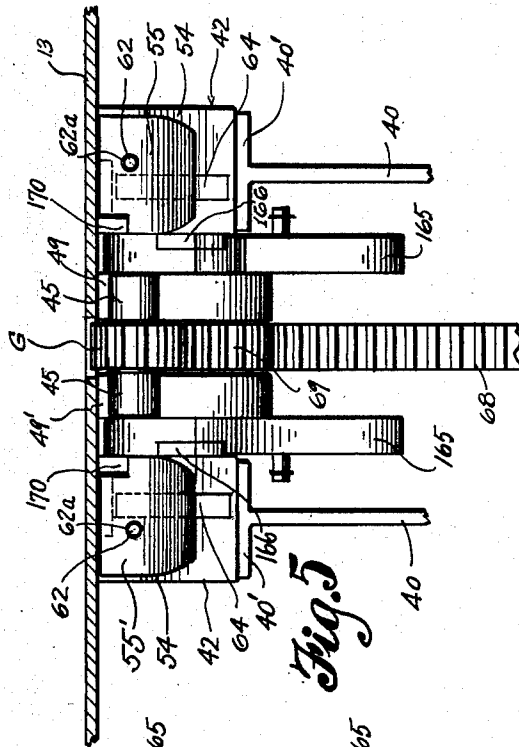
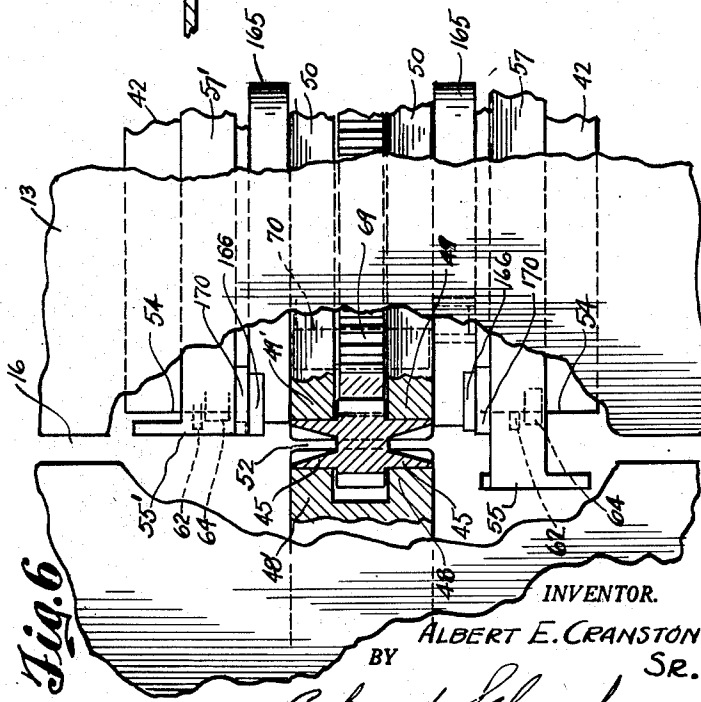
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11 Sheets-Sheet 4



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WIRE BINDING MACHINE

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11 Sheets-Sheet 5

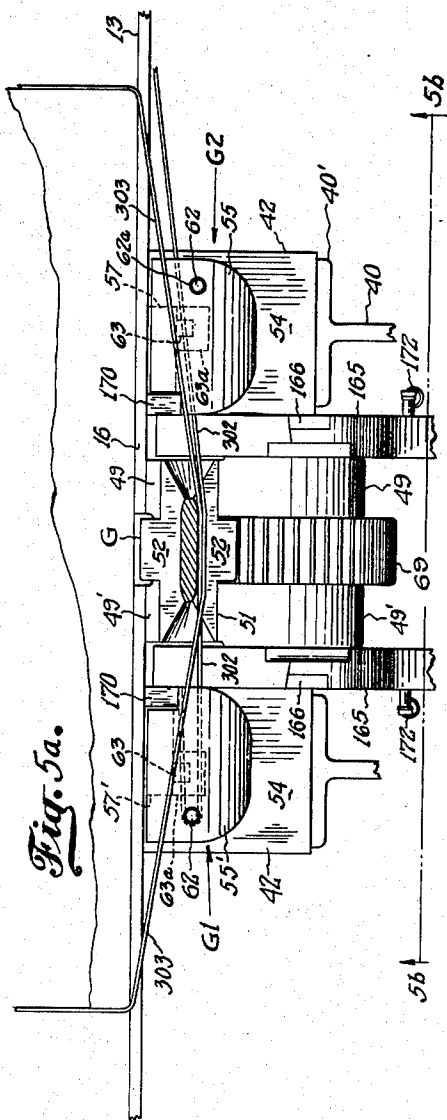
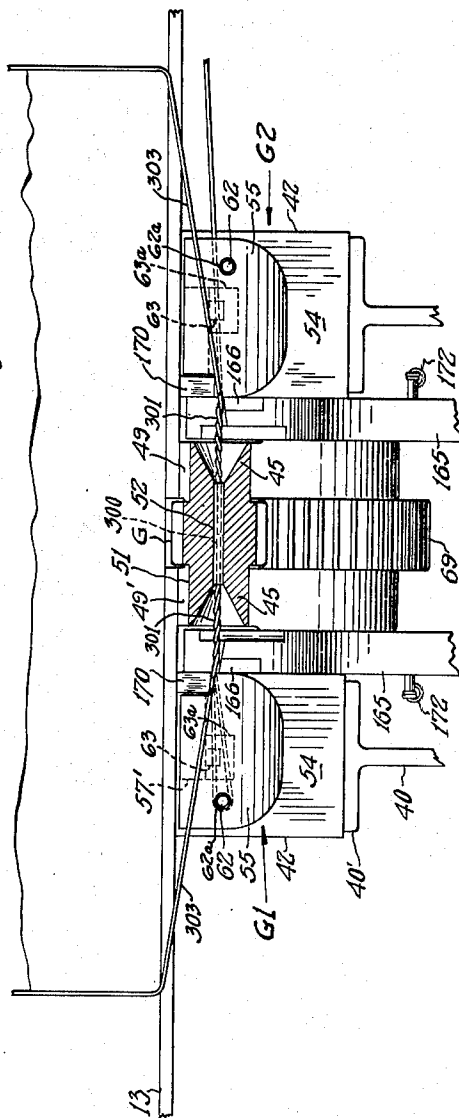


Fig. 5c.



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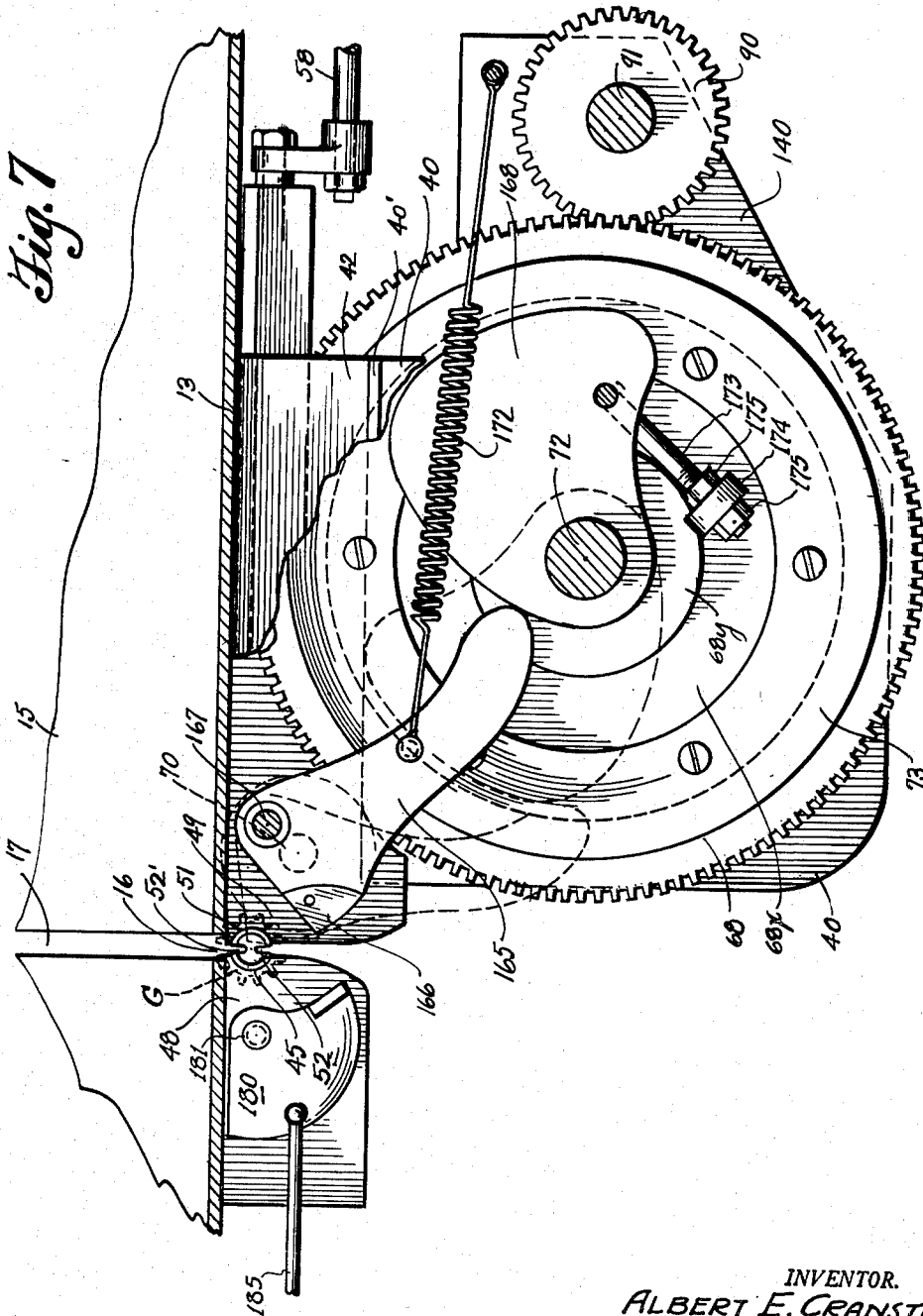
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11 Sheets-Sheet 6



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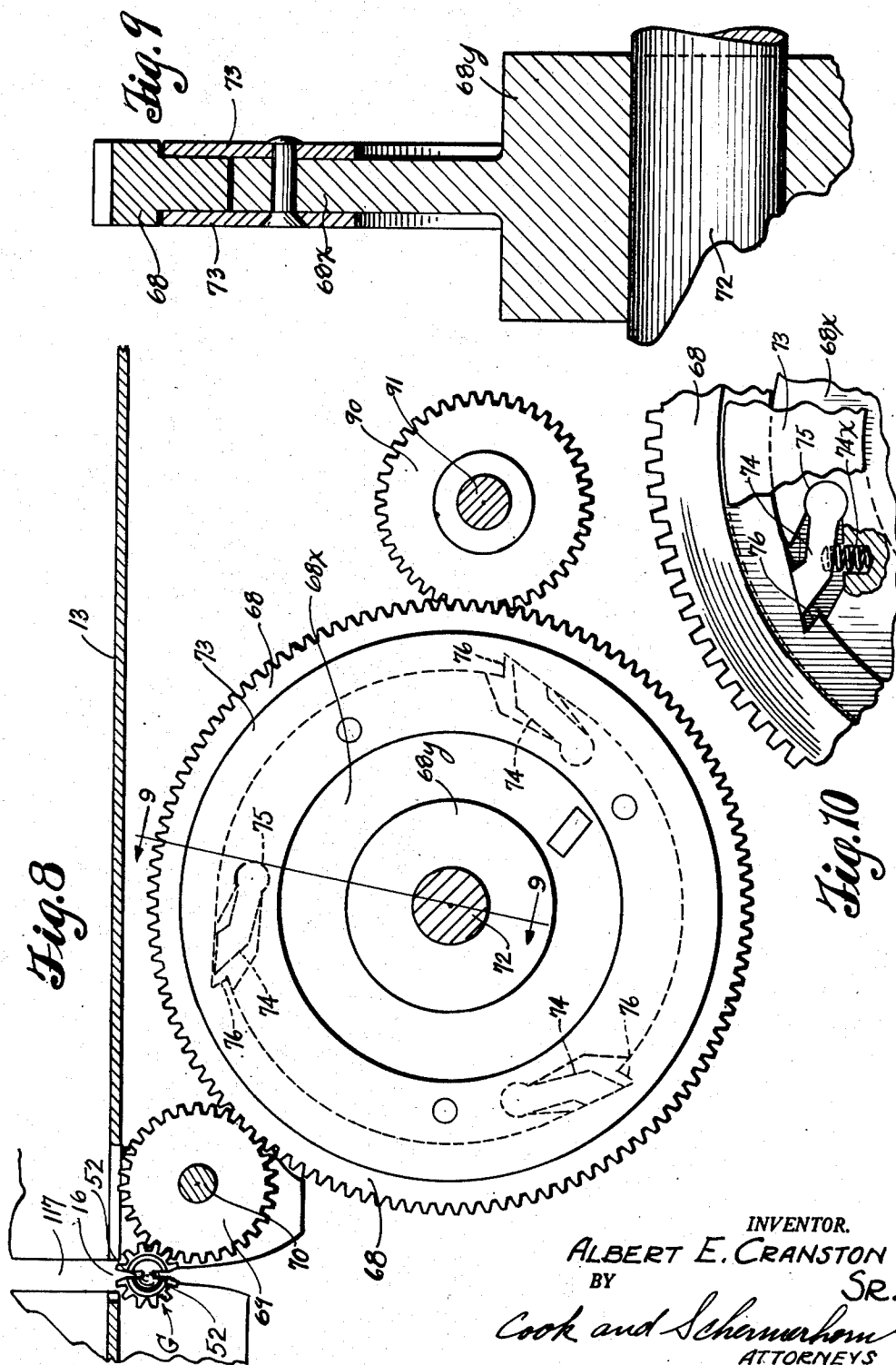
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WIRE BINDING MACHINE

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11 Sheets-Sheet 7



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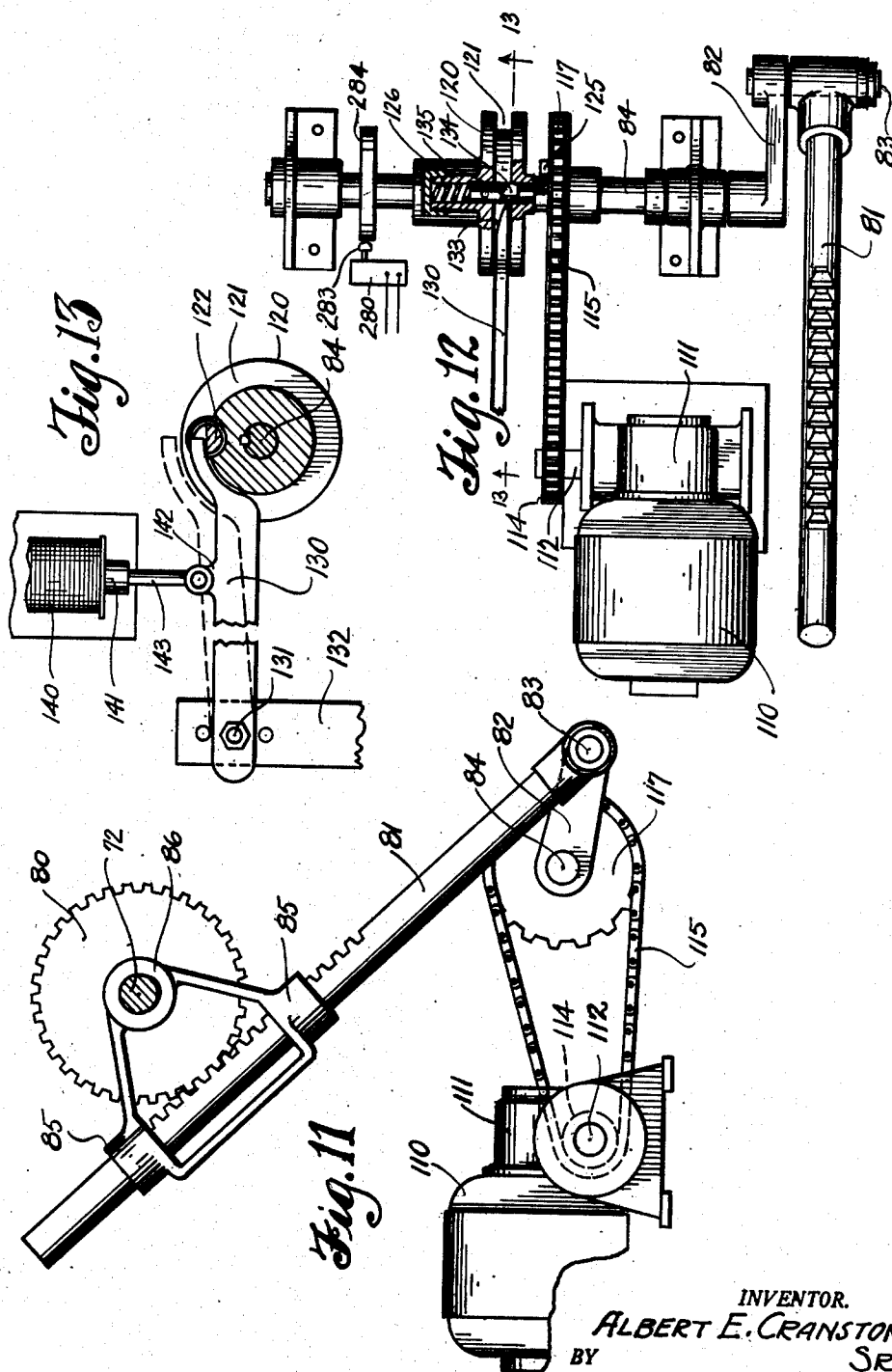
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WIRE BINDING MACHINE

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11 Sheets-Sheet 8



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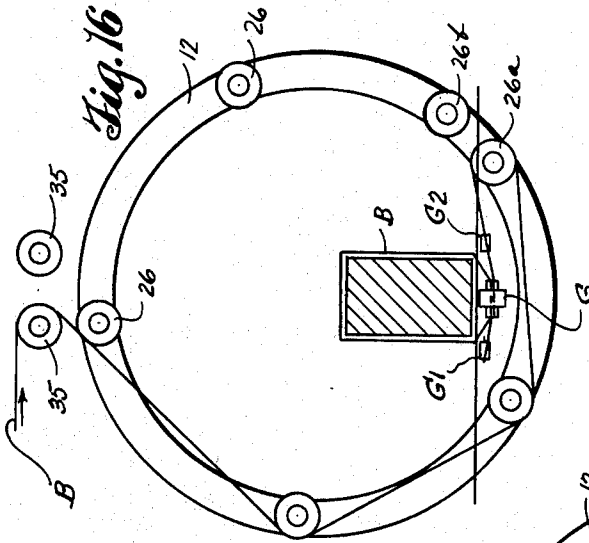
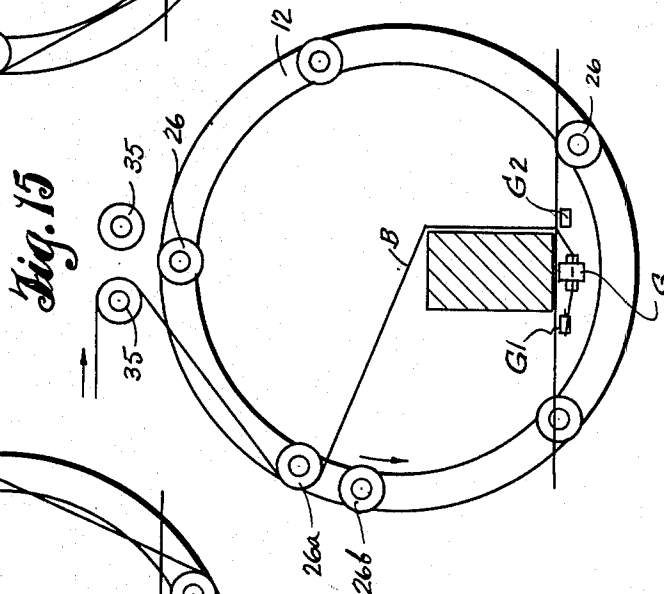
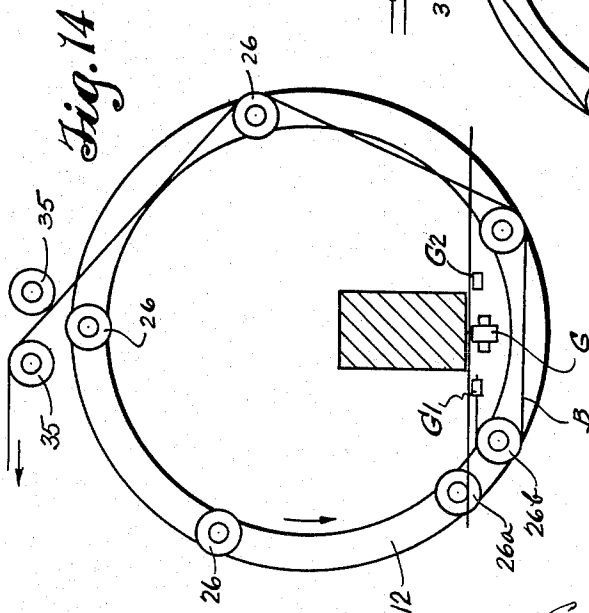
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11 Sheets-Sheet 9



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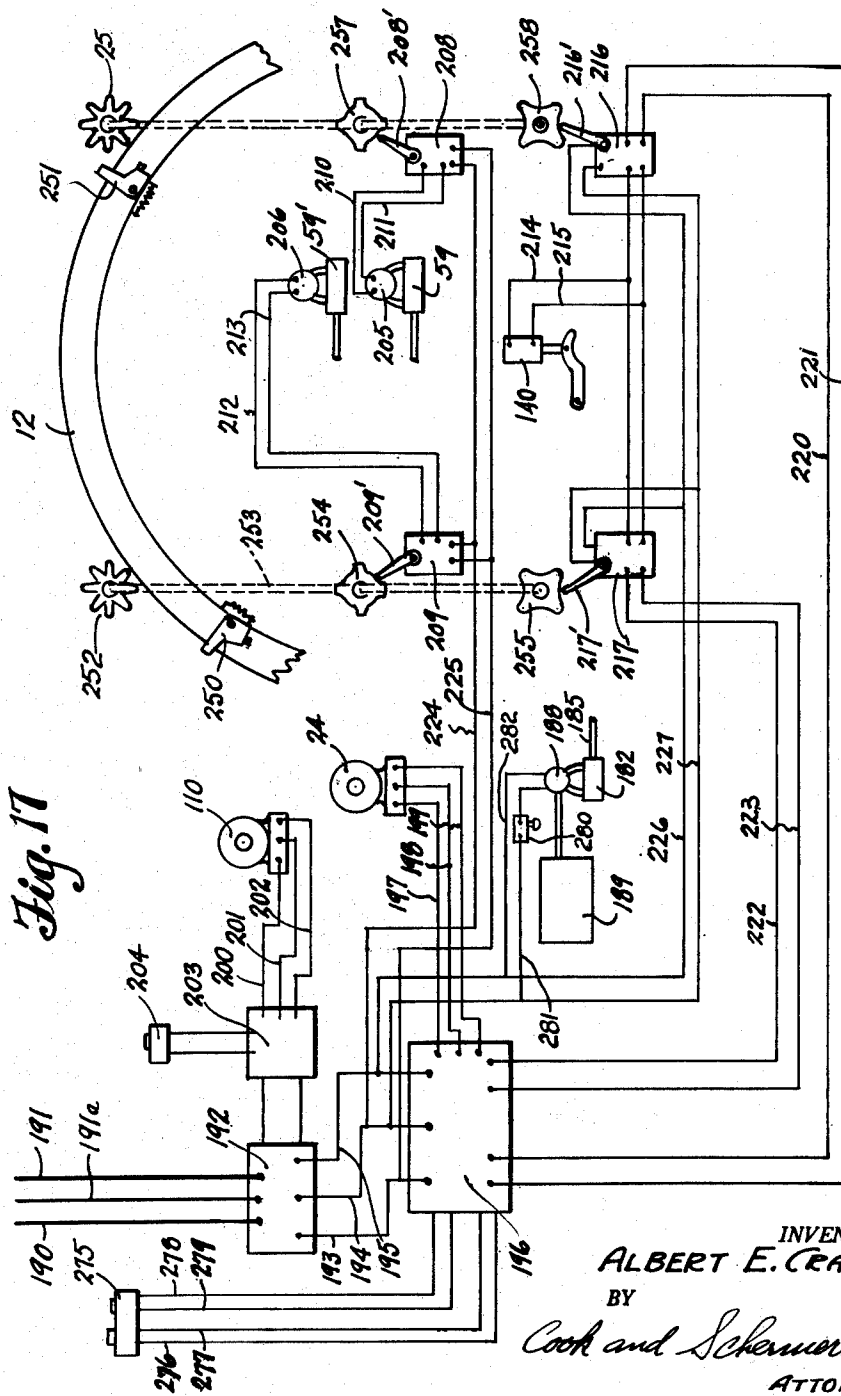
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WIRE BINDING MACHINE

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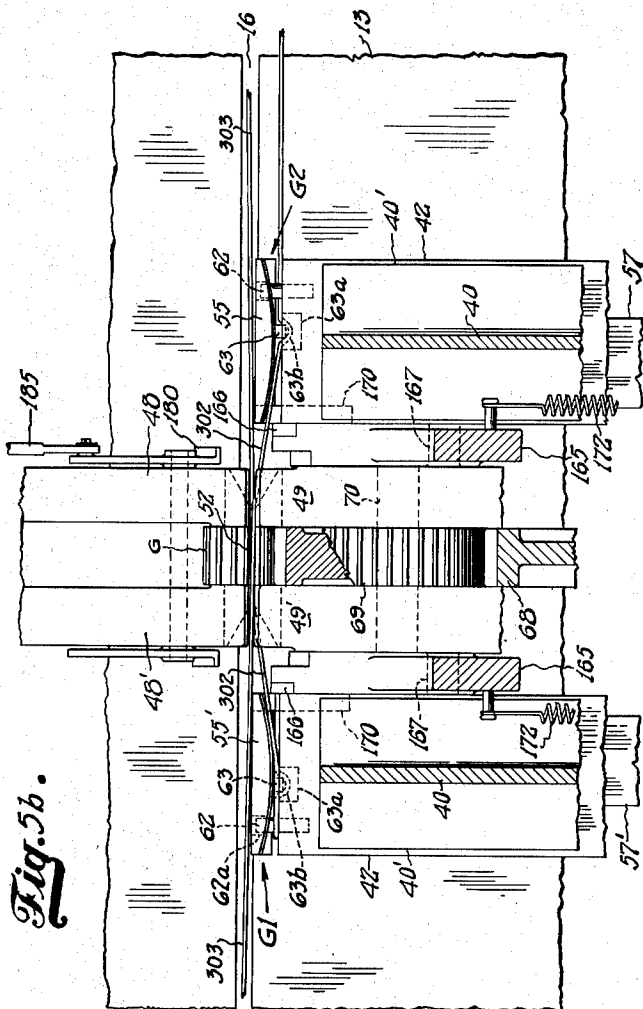


Fig. 19.

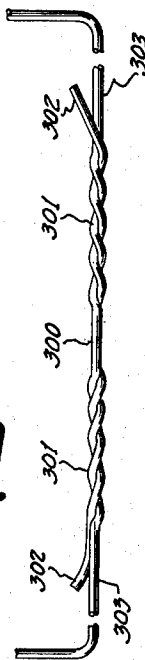


Fig. 18.



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UNITED STATES PATENT OFFICE

2,687,083

WIRE BINDING MACHINE

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Application January 10, 1949, Serial No. 70,088

27 Claims. (Cl. 100—28)

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This invention relates to what are generally known in the art to which it pertains as "wire binding machines." It has reference more particularly to improvements in the wire joining mechanisms, commonly called knotter mechanisms, of those types of binding machines wherein a rotary carrier is operable to draw a strand of wire from a source of supply and to lay it progressively and under tension about a bundle or package, and in so doing, to place opposite end portions of the band in the wire receiving slot of a twister gear; the gear then being rotated to join the ends of the band in a twisted wire splice of the type generally known in the art as a flat knot. Subsequent to the forming of the knot, the strand is cut to release the bound bundle from the wire supply and permit it to be discharged from the machine.

Machines of the types to which the present invention is applicable are typified by those disclosed in United States patents issued to George D. Parker under Nos. 1,875,260 and 2,191,082, and also, by the machines of my co-pending applications bearing Serial Nos. 713,224 and 39,568, filed November 30, 1946, and July 19, 1948, respectively.

It is the principal object of this invention to provide a new and improved wire joining mechanism, or knotter mechanism for wire binding machines of the types identified by the above numbered patents and pending applications, that makes possible a faster sequence of bundle binding operations, that permits a reduction in the number of operating parts as heretofore employed in connection with the twister gear operating mechanism, and makes possible the formation of a more satisfactory twisted wire splice, or knot, particularly in the final disposition of the cut end portions of the binding strand relative to the bound bundle and to the secured band.

Another object of the invention is to provide an improved knotter mechanism that is readily adaptable both to machines of the "one-way" and "reversible" types as typified, respectively, by the machines of my two co-pending applications above mentioned, and that is characterized by the use therein of a knot twisting gear formed with wire receiving slots at opposite sides, thereby making possible the formation of a knot in one slot and the releasing of the tied band from that slot in the usual manner, and eliminating that usual and necessary operation, where twister gears of the single slot type are used, of restoring the gear to its original position preparatory to the next binding operation.

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Other objects of my invention are to provide cutters for severing the ends of the wire strand after the knot is formed, that, by reason of a particular relationship to the formed knot, effect the final disposition of the cut ends of the binding strand closely against the surface of the bundle as an insurance against their possible injury to workmen, to provide means for adjusting the timing of the cutters to cut the wire when the twister gear is in a predetermined position approaching its discharge position, and to provide a novel arrangement of the cutters in relation to the twister gear so that the entire length of the cut ends of the wire will be twisted into the knot or splice.

Further objects are to provide an improved and simplified driving mechanism for the twister gear and cutters, to provide an improved arrangement for the grippers, cutters, and twister gear drive in a common removable unit mounted on one side of the wrapping plane of the machine, to provide an improved form of gripper, to provide novel structure for imparting the desired backturn to the twister gear to relieve twisting tension after a knotting operation, to provide brake means for holding the twister gear in a common wire discharging and wire receiving position, and to provide a knot ejector for removing the completed knot from the twister gear.

Still further objects of the invention reside in the details of construction and combination of the various parts embodied therein, and in their mode of operation that results in the fast, efficient and economical operation of the machine.

In accomplishing the above mentioned and other objects of the invention, I have provided the improved details of construction, the preferred forms of which are illustrated in the accompanying drawings, wherein:

Figure 1 is an elevation of a wire binding machine equipped with a knotter mechanism embodying the improvements of the present invention therein;

Figure 2 is an enlarged cross-sectional view of a portion of the machine taken substantially on line 2—2 in Figure 1;

Figure 3 is a horizontal section in the plane of line 3—3 in Figure 2, showing the relative location of the wire grippers, the twister gear, the wire cutters, and the twister gear driving means;

Figure 4 is a vertical section on line 4—4 in Figure 3, showing one of the grippers and gripper slide actuating means;

Figure 5 is a vertical section taken on line 5—5

in Figure 3 showing the relationship of twister gear, grippers and wire cutters;

Figure 5a is a view similar to Figure 5 but showing the twister gear in section and showing a wire in place about a bundle just prior to the twisting of the splice;

Figure 5b is a bottom plan view of the parts as shown in Figure 5a, taken on the line 5b—5b in Figure 5a;

Figure 5c is a view similar to Figure 5a showing the twister gear and splice at the instant the wire is engaged by the cutters to sever the wire;

Figure 6 is a top plan view of the twister gear, grippers and cutters with parts broken away and other parts shown in section; one gripper being shown with its movable jaw retracted and one with the movable jaw extended;

Figure 7 is a vertical section taken on line 7—7 in Figure 3, showing therein one of the wire cutter levers and its actuating cam;

Figure 8 is a section taken in the vertical plane of line 8—8 in Figure 3, showing the ratchet gear as employed in the gear train for driving the twister gear;

Figure 9 is an enlarged cross-section of a part of the ratchet gear, taken on line 9—9 in Figure 8;

Figure 10 is a detail of one of the ratchet gear driving pawls;

Figure 11 is an elevation of the knotter driving mechanism as seen from the right-hand end of the machine as shown in Figure 1;

Figure 12 is a plan view showing the "one-revolution" clutch mechanism as used to drive the knotter mechanism;

Figure 13 is a vertical section on line 13—13 in Figure 12;

Figures 14 to 16, inclusive, are views diagrammatically illustrating the laying of a wire band about a bundle, and showing relative positions of twister gear, grippers and cutters;

Figure 17 is a schematic wire diagram for the machine.

Figure 18 is a view of the splice made by the present machine; and

Figure 19 is a view of the conventional knot made by prior art machines.

General features of the machine

To impart a better understanding of the present invention, it will here be explained that, heretofore, in the use of wire binding machines of those types to which the present knotter mechanism is adaptable, it has been usual, in a binding operation, to hold the primary end of the wire strand in a gripper, adjacent one end of the twister gear, and by means of a rotary carrier to train the wire strand about the bundle, under tension, and in doing this, to lay the strand twice in the same direction within the wire receiving slot of the twister gear. However, twister gears, as heretofore used, have embodied but one wire receiving slot therein. Therefore, to permit this laying of the wire strand therein by the carrier, in its normal mode of operation, the gear, at the start of a binding operation, had to be disposed with the slot facing away from the bundle. Then, after the end portions of the wire band had been laid in the gear slot, and the gear had been rotated and the knot thus formed to secure the band ends together, it was necessary to so rotatably adjust the gear that the slot would be faced toward the bundle in order that the tied band could be disengaged from the gear and the bound bundle removed from the machine. Then,

to set the parts for the next binding operation, the twister gear had to be restored to its original position, with the slot faced away from the bundle.

The present invention, being characterized by the use of a twister gear having wire receiving slots therein at opposite sides, has not only eliminated the requirement for restoring the gear to its starting position after each binding operation, but also has eliminated the mechanism required for this operation; has reduced weight in the machine accordingly and has made possible a faster rate of successive binding operations.

The present knotter mechanism, considered as a whole, is not limited in its use to the machine illustrated, which is of the reversible type, but is likewise adaptable to machines which are "one-way" in their mode of operation. Furthermore, insofar as the present two-slot twister gear is concerned, it can be used with powered or hand operated machines, so long as they are associated with means whereby a wire strand can be wrapped under tension about a bundle, the ends of the band laid within a slot of the twister gear and held while the gear is rotated to form the knot. For the purpose of explanation, my invention has been illustrated as applied to a reversible type, power-driven machine that is like, or similar, in design and mode of operation, to that of my application filed under Serial No. 39,568 on July 19, 1948.

The accompanying drawings show parts of a machine that are essential to the functional use of the present knotter mechanism therein but omit many of those parts that do not have any direct bearing on the present improvements; this being apparent in the omission of parts of the frame structure and those automatic means fully described in the above application for the control of the rotary carrier that lays the wire strand about the bundles.

Referring more in detail to the drawings and particularly to Figures 1 and 2:

10 designates a vertically disposed frame plate, formed in its upper portion with a large circular opening 11. Closely adjacent the plate, at one side of the circular opening 11 and coaxial thereof, is a ring 12 which constitutes the rotary carrier means by which a continuous wire strand is drawn from a source of supply and a part thereof trained about the bundle that is to be bound. Supported in the frame structure, at the level of the lower portion of the opening 11 and ring 12, is a horizontal table 13 on which bundles are disposed for wrapping. Erected on the table in vertical, parallel planes, perpendicular to the plane of the ring 12, are plates 14 and 15, which, together with the table 13, form a bundle guide-way directly through the ring 12.

It is shown in Figure 2 that the table 13 is formed at one side of the plane of the ring 12 with a transverse passage 16. Also, the wall plates 14 and 15 are formed with vertical passages as at 17 in Figure 2, that are aligned with the ends of passage 16, thus providing for the laying of the wire strand therethrough and about the bundle, as carried by the ring in the bundle binding operation.

The ring 12 is supported for rotation in a vertical plane by a plurality of grooved wheels 18 that are rotatably mounted on the frame plate 10 as has been shown in Figure 2, and it is adapted to be rotatably driven, in its reverse operations, by a pair of V-belts 20 that extend about a belt flange 21 that is formed as a part of the

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ring, and about a pulley 22 fixed on a driven shaft 23 which, in this instance, is the drive shaft that extends from a gear reduction mechanism operated by a reversible electric motor 24, shown in Figure 1.

Mounted on the ring 12 to extend laterally therefrom and through the opening 11 of plate 10 as seen in Figure 2, are posts 25, each of which rotatably mounts a grooved, wire-carrying wheel 26 at its end. These grooved wheels, shown in Figure 1 to be six in number, are disposed in the vertical plane of the table passage 16 and wall passages 17.

In Figure 1, the binding strand, which is designated by reference character B, extends from a source of wire supply, not shown, over tension rolls 31, about slack take-up wheels 32—33, thence over a guide wheel 34, thence between paired guide wheels 35—35 mounted on the frame 10 directly above the ring 12, thence it is trained over some of the guide wheels 26, and passed from the ring 12 to the knotter mechanism. It is to be understood that the wire strand B, in passing from the ring 12, is led between two of the wire carrier wheels on the ring that are closely spaced. These particular wheels are designated by reference numerals 26a and 26b. For successive binding operations, the ring 12 rotates in opposite directions, and therefore the wire strand B, as held at its primary end in one or the other of the grippers of the knotter mechanism, will be payed out alternately over wheel 26a and wheel 26b. The wheels 26 operate to support the strand in the clear of the ring passage so as not to interfere with the bundle movement. The vertical plane in which the wire strand is carried by wheels 26 about the bundle will for purpose of explanation be referred to as the "wrapping plane." This coincides with the vertical plane of the table passage 16 and for binding purposes, a bundle is placed on the table so as to extend through this wrapping plane.

Twister gear

The wire joining, or knotter, mechanism of the present invention is shown best in Figures 2 to 10, inclusive. It is contained, for the most part, within a housing that is fixed to the under side of the table 13, closely adjacent one side of the wrapping plane. This housing comprises two parallel, vertically disposed and laterally spaced plates 40—40, extending at right angles to the wrapping plane. Along their top edges these plates are flanged, as at 40', and are secured thereby to guideways 42—42 that, in turn, are bolted by bolts 43 (Figure 3) or otherwise fixed to the under side of table 13. The guidewalls, as seen in Figure 3, are parallel, spaced apart and have inner ends terminating closely adjacent the wrapping plane. These guideways contain the wire gripper actuating slides, as presently described.

The twister gear of the present invention is designated in its entirety by reference character G, and it is mounted horizontally and axially coincides with the wrapping plane. It is shown in Figures 3 and 7 that the twister gear body is formed coaxially, at opposite ends, with trunnions 45—45 whereby it is rotatably supported in bearings 48—48' and 49—49' located, respectively, at opposite sides of the wrapping plane.

The gear supporting bearings 48—48' at one side of the wrapping plane comprise metal blocks fixed to the under side of the table 13. The bearings 49—49' at the other side of the wrap-

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ping plane comprise the adjacent end portions of metal bars 50—50 that, as seen best in Figure 3, are located between and extend parallel with the guideways 42—42. These blocks and the bars are formed with coacting seats, as at 51, that rotatably contain the gear trunnions 45—45 therein.

The distinctive feature of the present twister gear is that it is formed along opposite sides with wire receiving slots 52—52' which have a width substantially equal to the diameter of the wire, are continuous and extend to the full length of the trunnions. The bottoms of these slots are brought close to the axial center of the gear, leaving metal between them consistent with safety, as will be understood by reference to Figure 8.

Wire grippers

The grippers which are designed to hold the ends of the wire band as applied about a bundle, and while a knot is being formed, are located just beyond the ends of the twister gear trunnions, as shown best in Figures 3, 4 and 5. Each gripper comprises a stationary gripper jaw 54 and a movable jaw 55. The stationary jaws are located at, and are set within the ends of the guideways 42—42 as in Figure 4, and somewhat outwardly offset from the wrapping plane. The movable jaws 55 and 55' are shown to be fixed to the outer ends of slides or bars 57—57' longitudinally and slidably contained in the guideways 42 and 42 as noted in Figure 3. These bars extend from the guideways, at their ends opposite those which carry the grippers, and at these ends have operative connections, respectively, with the piston rods 58—58' of air cylinders 59 and 59'. The air cylinders are controlled, respectively, by air valves 205—206 (Figure 17), in such manner, as presently explained, as to open and close the movable jaws in proper timing with the laying of the strand by the ring 12. When a movable jaw is shifted to its extended or open position, as is the lower jaw in Figure 6, the wire strand B, as laid by the ring 12 in the receiving slot of the twister gear, will be laid directly between this movable jaw and its complemental stationary jaw. When the movable jaw is extended, it is disposed at the inside of the wrapping plane, and in closing upon a wire strand, will pull the strand to the outside of the wrapping plane. By reference to Figure 4, it will be understood that the complemental jaws of an open gripper provide a downwardly opening mouth into which a binding strand will be laid coincident with its being laid in the receiving slot of the twister gear.

As a feature of the gripper construction, the stationary jaw, in each instance, has a short stud 62 extending outwardly therefrom to project into a hole 62a in the movable jaw when the latter is in closed position. When the movable jaw is in open position it extends out considerably beyond the end of the stud as shown in Figure 6, the stud being of a length to exceed the diameter of the wire strand but of insufficient length to reach out to the wrapping plane. The rear or inside clamping surface of each movable jaw is also provided with a small projection 63 of somewhat greater height perpendicular to the jaw surface than the wire diameter and arranged to project into a complementary recess 63a in the face of the stationary jaw at one side of the stud 62 when the movable jaw is closed. The dimensions of the recess 63a are considerably larger than the projection 63 so that a portion of the wire strand may be engaged by the projection 63 and bent rather sharply into the recess, without inter-

fering with the closing of the movable jaw, to clamp adjacent portions of the wire against the stationary jaw. This feature of the jaw construction is best shown in Figures 5a, 5b and 5c.

When a wire strand is laid in the open gripper by the carrier, and the movable jaw is then closed against this wire, the wire will be carried between the stud 62 and the gripper slide bar and will lie across the end of projection 63. As the movable jaw is pulled up tightly into its gripping position, the end of projection 63 enters a slight distance into the recess 63a forming a small loop or crimp 63b in the wire as shown in Figure 5b. This crimp is disposed in a horizontal plane and is bent rather sharply around the corners of the projection and recess to afford a firm grip on the wire with the wire tension being sustained primarily by the stationary jaw member. Then, with the cutting of the wire and reversal of the machine, while this gripper is still closed, the wire band will be drawn downwardly, and about the stud 62, which serves as a turning point and as a further anchor to insure against any accidental slippage of the end of the wire band from between the closed jaws.

In Figures 5a, 5b and 5c the wire end 302 in gripper G1 thus comprises a hairpin loop in a vertical plane around stud 62 and having the horizontal crimp 63b in the upper leg of the hairpin. The lower leg of the hairpin may also extend across the depression 63a but is not engaged by the projection 63 to form a crimp. The other wire end 302 in gripper G2 is anchored primarily by its crimp 63b but is not bent around the stud 62 until the band laying ring is reversed for the next binding operation. A very reliable and secure anchor for the wire is thereby obtained by reason of the fact that the wire cannot slip off the end of stud 62 and also because of the fact that stud 62 and depression 63a both serve to anchor the wire to the stationary jaw member so that the stress of the wire tension is not applied to the slide bar of the movable jaw.

After the wire has been cut, and when the jaws subsequently are opened apart, the U-shaped end of the wire which is looped about stud 62 is positively disengaged therefrom by a leaf spring 64. This spring is set in a recess 65 in the face of the stationary jaw and is fixed in such manner that one end portion thereof will be sprung inwardly by the wire as the jaws close upon it, but with the opening of the jaws, the spring forces the looped end of wire from the stud and it drops from the machine. The leaf spring 64 is intended merely to be illustrative of one form of disengaging or ejector means as this means may take various forms as may be devised by persons skilled in the art. The recess 65 may communicate with or form a part of the recess 63a. Spring 64 is shown in Figures 4 and 5 but is omitted for clearness in Figures 5a, 5b and 5c.

Twister gear drive mechanism

The twister gear G is rotated for the knot forming operation through the mediacy of a gear train that comprises a relatively large gear wheel 68, which I will refer to as a ratchet gear, and an idler gear wheel 69. The idler gear operates directly in mesh with the teeth of the twister gear and also is in mesh with the teeth of the ratchet gear as is best shown in Figure 8. The idler is mounted freely on a shaft 70 that extends between the bearing bars 50 and 50. The ratchet gear wheel 68 is of annular form and is mounted for one-way rotation on a wheel body disk 68x, hav-

ing a central hub portion 68y fixed on a horizontally mounted drive shaft 72. The gear wheel 68 is retained on the disk between ring plates 73—73 fixed to opposite sides of the disk 68x as seen in Figure 9. A plurality of pawls 74 are set pivotally in sockets 75 in the disk edge, and are urged outwardly by springs 74x to engage in ratchet notches 76 formed at 120-degree intervals in the inner edge of gear 68 for the one-way rotation of this gear.

The shaft 72 is rotatably supported in bearings 77—77' formed on the plates 40—40 and extends from the knottter housing as shown best in Figure 1 to the right-hand end of the machine, where it is rotatably supported in a bearing 78. Near its outer end, shaft 72 has a driving gear wheel 80 keyed or otherwise fixed thereon.

Operating in mesh with the gear 80 is a rack bar 81. This, as seen best in Figures 11 and 12, is pivotally fixed at one end to a crank arm 82 by means of a crank pin 83. The crank arm is fixed on a crank shaft 84 that is periodically rotatably driven, as presently explained. The rack bar 81 is reciprocally mounted in bearings 85—85 (Figure 11) formed on a bracket 86 that has pivoted support on the shaft 72 at opposite sides of gear 80. The arrangement of these parts is such that with each rotation of the crank shaft 84, the rack bar 81 is reciprocated, and the extent of reciprocation is such as to oscillate the gear 80 and shaft 72 through an arc of slightly more than 120 degrees. Since the hub portion 68y of the ratchet gear 68 is fixed to shaft 72, it will be understood that with each oscillation of the shaft and wheel body disk 68x, the pawls 74 carried by the disk will be caused to engage in notches 76 of the gear 68 to rotatably advance the gear and thus, through the idler gear wheel 69, to rotate the twister gear for a knot twisting operation. In the present arrangement, the twister gear G is turned from a starting position at which a wire receiving slot is faced directly downward, slightly more than three and one-half turns, then is slightly reversed to bring the knot-containing slot to a directly upwardly faced position for release of the band from the gear.

The ratchet gear 68 is yieldingly held against free reverse rotation by means illustrated best in Figure 3, wherein it is shown that a gear wheel 90 is disposed in mesh with the gear 68. Gear 90 is fixed on a shaft 91 that is revoluble in bearings 92—92 formed in the plates 40—40. One end of shaft 91 extends through and beyond the adjacent supporting plate and is equipped with a brake drum 93 about which a brake band 94 is applied; the band being supported from a bracket 96 on the adjacent plate 40 and its braking tension adjusted as desired by a bolt 97 applied through the bracket and ends of the brake band.

To effect the slight reverse turning of the twister gear after a knot has been formed, which is for a purpose presently fully explained, an arm 100 is fixed to the end of shaft 72 as seen in Figures 2 and 3. With the turning of the shaft 72 as effected by the upward reciprocal action of the rack bar 81, this arm 100 is caused to swing counter-clockwise from the full-line position shown in Figure 2 to the dotted-line position, at which latter position it is definitely stopped by engagement with a stop bolt 101 mounted adjustably in a lug 102 extended from the adjacent plate 40. Mounted in the end of arm 100 is a stud 103. Also, it is shown in Figures 2 and 3 that an arm 104 is fixed on the adjacent end of shaft 91 in the plane of travel of the stud 103.

The arrangement of these parts is such that, incident to the swinging of arm 100 in a counter-clockwise direction from the full-line position of Figure 2, up against the stop bolt 101, the arm 104, by reason of the geared connection between shafts 72 and 91, is caused to rotate in a clockwise direction from the full-line position shown, through slightly more than one complete turn, stopping in its dotted-line position of Figure 2, up against the under side of stud 103. Then, with the downward reciprocal action of the rack bar and the return of the lever arm 100 to starting position, the stud 103, in passing, will engage with and cause the arm 104 to be turned back a slight amount, thus to rotate the shaft 91 and gear 90 accordingly. This slight turning action of gear 90, operating through the ratchet gear wheel 68, results in the slight back turning of the twister gear, which in a knot twisting operation is stopped after turning somewhat past its wire discharge point. This back turning of the twister gear brings the wire-containing slot back to the discharge point and incidentally relieves that twisting tension in the wire that tends to hold the knot in the slot.

For the present operation, the knot is formed by turning the twister gear through approximately three and one-half turns. In accomplishing this, the crank shaft 84 is operated through exactly one complete turn for each binding operation, and this takes place following each wire-laying operation. The timing of crank shaft operation is controlled by the wire carrier ring 12 as presently explained. The knotter driving means is independent of the wire carrier means. It comprises an electric motor 110, shown best in Figures 1, 2, 11, and 12, which operates through a gear reduction mechanism, indicated at 111, to continuously drive a horizontal shaft 112. A sprocket wheel 114 is fixed on the shaft 112 in alignment with a larger sprocket 117 that is rotatably mounted on the crank shaft 84. A chain belt 115 operates about sprockets 114 and 117 to continuously drive the latter. This sprocket may be connected, under automatic control, with shaft 84 through the use of a one-revolution clutch mechanism comprising parts as shown best in Figure 12. The wheel 117 is revolvably mounted on the crank shaft 84 adjacent a wheel 120 that is keyed on the shaft 84 to serve as its driving member. The wheel 120 is formed with a circumferential groove 121 and a clutch locking bolt 122 is slidably mounted in the wheel, parallel with its axis, to extend transversely through the base of the groove 121 and beyond the face of the wheel, as in Figure 13, to such extent that it may be engaged in driving contact with one of a plurality of lugs 125 formed on the adjacent face of the near sprocket wheel 117. A coiled spring 126 is contained in the bolt guide bearing 127 and bears against the clutch bolt and urges it toward position for driving contact by one of the sprocket wheel lugs.

A clutch bolt release lever 130 is pivoted at its outer end by a bolt 131 on a bracket 132 fixed in the frame. The other end of the lever rides in the wheel groove 121, see Figure 13, and at this end has a beveled side surface 133, as seen in Figure 12. It is also shown in Figure 12 that the bolt is formed on its outer side with a cross channel 134 with an angularly sloping side surface 135. With the rotation of wheel 120 that engages the beveled end surface 133 of the lever with the bolt surface 135, the bolt will be retracted against the pressure of spring 126 and thus disengaged

at its outer end from the sprocket wheel lug 125 to stop the driving of shaft 84.

A solenoid 140 is mounted in the frame directly above the lever 130, and the solenoid core 141 is connected to a lug 142 on lever 130 by a link 143. To engage the clutch for a cycle of operations, the solenoid is momentarily energized by means presently described, thus causing the lever 130 to be momentarily lifted from the clutch wheel 120 and the bolt 122 released. Spring 126 then pushes the bolt outwardly, causing it to effect a driving connection between the continuously driven sprocket wheel 117 and wheel 120, thus to drive the crank shaft 84. The lever 130 immediately drops back into the wheel groove 121 and effects disengagement of the clutch bolt from the sprocket, and thus stops the crank shaft upon its making one complete rotation.

Wire cutters

After a wire has been wrapped about a bundle and the knot formed to secure the band, the ends of the wire are cut to release the bundle from the wire supply and for removal from the machine. The wire cutting means will now be described.

Located in the housing between the grippers and the adjacent ends of the twister gear trunnions, are the wire cutters. Each cutter comprises a lever 165 that has a hardened cutter plate 166 set therein adjacent its outer end. Each lever is pivoted adjacent its upper end by a stud 167 extending from the side of the adjacent bar 50. The cutter bars extend in downwardly directed positions, as seen in Figure 7, with their lower ends positioned to be engaged and simultaneously actuated downwardly and toward the wrapping plane by adjustable cams 168 on the shaft 72. This action will cause the upper end portions of the levers to swing upwardly and cause the cutter plates 166 that are set therein to coact, with shearing effect, with similar hardened cutter plates 170 that are set within the adjacent faces of the guideways 42-42. Coiled springs 172 are attached under tension to the levers 165 and to studs set in the plates 40 to normally retain the levers 165 in retracted positions as in full line in Figure 7.

It is shown in Figure 6 that the cutters 170 have downwardly faced shearing edges that project slightly beyond the ends of the guideways 42 toward the wrapping plane. These shearing edges are in such position that when the end portion of a wire strand is pulled, by closing movement of a movable jaw of a gripper, up against a stationary gripper jaw, to hold the wire, it will thus be drawn out of the wrapping plane to a position below this shearing edge as shown in Figures 5a and 5b. Then, when the corresponding cutter lever 165 is actuated upwardly, its shearing plate will coact with the fixed plate to cut the strand.

The shearing edges of each pair of cutters define a cutting plane, and the distance between the two cutting planes may be designated as the cutting length. Both the fixed and movable gripper jaws have edge portions extending into the respective cutting planes, and, since these edge portions determine the over-all twisted length of the splice, the twisted length is thereby made equal to the cutting length. In other words, the entire length of each cut end of the wire is contained in the twisted part of the splice.

An important feature of the present machine resides in the provision of means for adjusting

the timing of the cutters in relation to the rotation of the twister gear. This is accomplished by mounting the cams 168 loosely on shaft 72 and driving the cams through links 173 connected with lugs 174 on the hub 68y. One end of each link is pivotally connected with the cam and the other end is threaded to receive nuts 175 on opposite sides of the lug 174 so that the effective length of each link may be shortened or lengthened to change the angular position of the cams on the shaft. It is thereby possible to cut the strand when the twister gear is in a predetermined position, and in motion, approaching its knot discharge position, so that the entire knot will be rotated in the final movement of the twister gear to place the cut ends on the bundle side of the knot, to make an improved splice of the so-called flat knot type. The adjustment to accomplish this new result, and the form of the new splice, will be described hereinafter in greater detail.

Another feature of importance is the association of the cutters, grippers, and immediate driving mechanism for the twister gear in a single removable unit mounted on one side of the wrapping plane and table passage 16. By merely unbolting the guideways 42 from the under side of the table and detaching the piston rods 53 for the grippers this unit may easily be taken out of the machine for adjustment or other purposes without dismantling any other part of the machine. It will be apparent that the twister gear will be freed by the removal of this unit so that it may be laid in place in its bearing halves 49-49' to index the positions of the other co-operating parts when the unit is out of the machine.

The objects and advantages of the invention may also be attained by mounting this removable unit behind one of the vertical side plates 14 or 15 in the same relation to vertical passage 17 that the unit bears to the horizontal table passage 16 in the present embodiment. The changes necessary for a side mounting of the unit will be apparent to a person skilled in the art.

The improved splice

The conventional form of flat knot type of twisted wire splice formed by wire binding machines known in the prior art is shown in Figure 19. A flat knot type of splice is characterized by a short untwisted portion 300 between two twisted portions 301, whereby the cut wire ends 302 extend in opposite directions away from the splice and along the standing parts 303 of the wire as shown. The central flat portion 300 of the splice is formed by the narrow part of the slot in the center of the twister gear where the wires are not allowed to twist. The twisted portions 301 extend from the edge of the narrow part of the slot in the twister gear back along the standing parts 303 of the wire part of the distance to the cut ends 302. In conventional machines the wire portions 302 are confined in fixed slots between the twister gear and cutters during the twisting operation, with the result that the straight ends 302 must necessarily extend from the twisted portion 301 to some length in the finished knot. It is a common occurrence for one or the other of these untwisted ends to project out from the bundle at the completion of the binding operation, or to become caught later in the handling of such bundles and bent out so that it is in a position to cause damage to other bundles and constitute a hazard to workmen.

The present machine forms a flat knot type of splice as shown in Figure 18 in which the cut ends 302 are twisted right up to their extremities so that there will be no untwisted ends to possibly project angularly from the splice, and by adjusting the timing of the cutters in the manner hereinabove described the cut ends will always be insured of disposition on the bundle side of the standing parts 303. Figures 5a and 5c are sequence views showing how the present splice is formed in the wire joining mechanism of the machine, Figure 5b being a bottom plan view of the sequence step shown in Figure 5a. Figures 5a and 5b show the wire wrapped around a bundle and laid twice in the bottom slot of the twister gear with the portions 302 secured in the respective grippers. At this stage of operation, prior to twisting of the splice, the portions 302 are still attached to adjoining parts of the wire, one of these wire parts being a short hair pin loop secured in the gripper G1 and the other part being the wire from the wire supply extending through gripper G2. The grippers hold the two parts 302 beneath the bottom shearing edges of the stationary cutter blades 170 at one side of the wrapping plane while the standing parts 303 remain in the wrapping plane so as to pass outside of the grippers and beyond the ends of the stationary cutter blades 170. In Figures 5a and 5b the twister gear and cutters 165 are in the same positions shown in full lines in Figure 7.

Figure 5c shows the condition of the splice at the instant the movable cutter blades 166 have moved to their broken line position in Figure 7 to engage the portions 302 of the wire against the lower shearing edges of the stationary cutters 170 to cut the wires. The cam 168 (Figure 7) is positioned on shaft 72 by adjustment of the nuts 175 so that the movable cutting blades 166 reach their cutting position just before the twister gear reaches its discharge position. Thus, in Figure 5c, which is an elevation view, the wire containing slot of the twister gear is in approximately horizontal position on the rear side of the gear and rotating upwardly toward the bundle. At the instant of cutting, the splice is already twisted from the gear out to the cutters, and in the final ninety degrees or so of rotation of the twister gear the cut ends are frictionally engaged by the cutting blades to tighten the splice to the very extremities of the cut ends.

In the present device it is important to note that there are no wire confining slots between the twister gear and the cutters, the twisting of the wire being continuous and uniform from the narrow part of the twister gear slot to the shearing edges of the cutters. As previously mentioned, the spacing of the grippers determines the twisting length for the splice, and by making this length equal to the cutting length the whole length of the cut ends is twisted into the splice. The wire is confined only by the twister gear and the grippers, the latter being beyond the splice and having no contact with parts of the wire which will be on the bundle after the wire is cut. After the wire is cut the twisting tension holds the knot in the twister gear slot as the gear continues to rotate.

The cams 168 are, of course, individually adjustable through sufficient range to accommodate variations in different kinds and sizes of wire so that each of the cut ends 302 may be invariably disposed on the bundle side of the adjacent standing part 303 after the splice has been ejected from the twister gear and is disposed against the side of the bundle. By reason of the

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slight overturn of the twister gear and then its reverse movement to direct its wire holding slot toward the bundle (vertically upward in the present machine) the central untwisted portion 300 of the splice stands in a vertical position as shown in Figure 18. It is found that the present type of action wherein the completed splice is bodily rotated through an adjustable angle to its desired final position after the cutting operation produces uniform splices in which the cut ends can be depended upon to lie against the bundle in every case and not occasionally twist around to a more exposed position.

In prior known knotter mechanisms, this uniformity of the splice has not been achieved. In splices made in the prior machines, it may be observed that the flat central portions 300 vary in orientation from the position shown in Figure 19 to that shown in Figure 18 with consequent variations in the positions assumed by the untwisted projecting ends 302. In the present splice shown in Figure 18, the cut ends do not project more than the thickness of the wire in any position, so that even if the cutters are not carefully adjusted, a superior splice will be formed which is safer to handle and which is also stronger than the conventional machine made flat knot. The additional twisted length and extra turn of the present splice make the splice stronger whereby the same strength of binding may be obtained with a smaller size wire. With a tight twist of three and one-half turns, as shown, the splice, in common binding wire, is found to have a strength in tension equal to the strength of the wire.

Knot ejector

To positively insure the ejection of the knot from the twister gear slot, I have provided an ejector means as shown in Figure 2. Mounted on the bearing blocks 48 that support the twister gear G at one side of the wrapping plane is a plate 180. This is supported pivotally by a shaft 181 so that one end portion thereof may be swung upwardly and into the wrapping plane to engage against the wire band as applied about a bundle and as contained in the twister gear slot just prior to the wire cutting operation. This plate is actuated in timing with the knotting operation by means of an air cylinder 182 which is pivoted by a bolt 183 on a bracket 184 attached to the under side of plate 13, and the cylinder contains a piston from which a rod 185 extends and which rod is connected pivotally to the plate 180 in a manner whereby, upon the application of air under pressure to the cylinder, the rod will be extended to pivotally actuate the plate to cause an upwardly swinging edge thereof to engage the band and positively insure its upward displacement from the twister gear slot, which slot, at the time of engagement of the wire, is faced toward the bundle.

The operation of the air cylinder 182 is under control of a solenoid valve 188 which admits air to and exhausts it from the cylinder in proper timing with the binding operation. A source of supply of air under pressure is designated in Figure 17 at 189, and this also furnishes air for operation of the cylinders 59 and 59' under control of the solenoid valves 205 and 206 that are indicated in Figure 17.

Primary mechanical functions of the machine

With the parts so constructed and assembled as so far described, and with the strand of wire extended from the wire supply, over the various

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tensioning and guide wheels, and then about grooved wheels 26 of the ring 12 and secured at its primary end in one of the grippers, and with a bundle in position for binding as designated in Figures 1 and 2, a binding operation would be as follows: Starting with the ring 12 in position of Figure 14 and the end of the strand held in the gripper designated G1, and gripper G2 also retracted, out of the wrapping plane, the motor 24 is energized and ring 12 set in motion, turning counter-clockwise. The turning of the ring 12 causes the primary end of the wire strand first to be laid in that wire receiving slot of the twister gear that faces downward and away from the bundle, then as the ring continues to turn, the strand is laid under tension completely about the bundle and again laid in the twister gear slot. The other slot of the twister gear would not be used in this particular binding operation. Immediately after the wire strand has been laid in the twister gear slot the first time and the ring has carried the strand across the bottom surface of the bundle, the gripper G2 is opened and thus the movable jaw thereof is extended to the opposite side of the wrapping plane. Therefore, when the ring 12 lays the wire the second time in the twister gear slot, the secondary end of the band will be laid directly in the open gripper G2, whereupon gripper G2 is closed and its movable jaw pulls the end portion of the wire strand to a position below the cutter blade at that side of the knot.

It is intended that the present machine may be operated under automatic control as does the machine of my co-pending application Serial No. 39,568. This requires that the motor 110 shall run continuously and that the ring driving motor 24 shall be started by closing a switch that supplies current thereto and that at the end of a binding operation, which requires that the ring 12 be rotated through about one and one-fourth turns, the switch will be automatically opened to stop the motor. Also, it is intended that with the opening of the switch to stop the ring driving motor, a circuit will be closed to energize the solenoid 140 to cause the engaging of the one-revolution clutch and thus effect one complete turn of the shaft 84 and, by reciprocal action of rack bar 81, to effect the knot-forming operation.

In this operation, the twister gear is turned through approximately three and one-half turns. With the final twisting action, the cams 168 actuate the wire cutter levers against the held end portions of the wire strand at points between the knot and grippers and thus cut the strands and free the bundle from the wire supply. Then with the slight reverse turning of the gear 63, as previously explained, the twisting tension on the wire is relieved and the knot is freed from the gear slot. Positive ejection of the knot is insured by knot ejector 180.

The knot discharge position of the twister gear in one binding operation is the wire receiving position of the gear for the next binding operation without any movement of the gear between successive operations. When the wire containing slot of the gear is facing the bundle for discharge of one completed knot the opposite empty slot faces away from the bundle to receive the wire for the next knot. Thus, the two twister gear slots are used alternately, one slot always being empty.

Electrical control system

The general mode of operation of the present

machine is substantially like that of my co-pending application Serial No. 39,568 and the same electrical system is used for its control. The control system provides that upon closing an electric circuit through the driving motor 24 for the reversible ring 12, the ring will be set in motion and will be rotated through approximately $1\frac{1}{4}$ turns, thus as has been explained, to lay a band of wire about the bundle and in so doing to place the opposite end portions thereof in the downwardly facing slot of the twister gear. At the end of the wire-laying operations, a pawl that is mounted on the ring 12 engages with and actuates a switch control mechanism whereby a switch is opened to open the motor circuit and thus stop the rotation of the ring. At the same time, the mechanism causes another switch to be momentarily closed to energize the solenoid 140, thus to engage the one-revolution clutch to effect a driving connection between the twister gear mechanism and motor 110 as previously explained, to perform the wire-twisting operation and to cut the ends of the bands free from the grippers.

In the wiring diagram shown in Figure 17, power input wires 190, 191, and 191a lead to a main switch 192 from which line connections 193, 194, and 195 are made with a standard type of reversing switch 196. Line connections 197, 198, and 199 lead from switch 196 to the motor 24. Also, line connections 200—201 and 202 are made between the power input lines and a control box 203 and from the latter to the knoter motor 110, which latter motor may be turned on or off by means of a control switch, here designated at 204. This motor runs continuously during operation of binding bundles.

Solenoid valves 205 and 206, which, respectively, control the application of air to the cylinders 59 and 59', are connected with their respective switches 208 and 209 by wires 210—211 and 212—213. The clutch-controlling solenoid 140 has connections 214 and 215 with limit switches 216 and 217, and these switches, respectively, have connections 220—221 and 222—223 with the reversing switch 196 for its control, and there are power line connections 224—225 leading to switches 208 and 209 and connections 226—227 leading to switches 216 and 217.

Switches 209 and 217 are synchronously actuated by the ring 12 when turning in one direction, and switches 208 and 216 likewise are synchronously actuated by the turning of the ring in the other direction. To accomplish this, two oppositely faced pawls 250 and 251 are mounted on the ring 12 as indicated in Figure 17. Pawl 250 is arranged to twice engage a ratchet wheel 252 when the ring lays the band about a package in one direction, and pawl 251 twice engages a ratchet wheel 252a when the wheel lays the band in the other direction.

Ratchet wheel 252 is mounted on a rotatably supported shaft 253 which mounts wheels 254 and 255 thereon. Ratchet wheel 252a, likewise, is mounted on a rotatably mounted shaft 256 which mounts wheels 257 and 258 thereon.

The switches 209 and 217 have actuating levers 209' and 217' which are disposed to be actuated by wheels 254 and 255, while switches 208 and 216 are likewise arranged to be actuated by wheels 257 and 258, through the switch levers 208' and 216'.

The starting of the machine for successive binding operations is under control of a switch designated at 275 that has switch buttons that may be selectively depressed to cause the ring

12 to rotate either in clockwise or counter-clockwise direction. This switch is connected to the reversing switch by wires 276—277 and 278—279.

Solenoid valve 188 for the knot ejector air cylinder 182 is momentarily energized after the completion of each knotting operation by a switch 280 in a circuit 281, 282 connected with the wires 226, 227. As shown in Figure 12, the switch 280 has a spring biased button operator 283 arranged to be engaged by a cam disc 284 on the crank shaft 84. This shaft makes one complete revolution in each knotting operation and the cam 284 is designed to depress the button 283 to close the switch for a short interval in the down stroke of the rack bar 81 after the twister gear has been back turned to relieve the twisting tension and place the wire-containing slot in its discharge position. At this time the disc 68x (Figure 8) is rotating freely within the ratchet gear 68 while the latter, and hence also the twister gear, is held stationary by the brake band 94 (Figure 2). By the time the crank shaft 84 has completed its revolution the switch 280 is again opened causing the air pressure in double acting cylinder 182 to retract the ejector plate 180 back to its Figure 2 position to clear the passage 16 for the next wire laying operation.

It is to be understood that the invention is not intended to be limited to the exact details of construction shown and described, as obvious modifications will occur to persons skilled in the art.

Having now described my invention and in what manner the same may be used, what I claim as new and desire to protect by Letters Patent is:

1. In a wire binding machine, a double slotted twister gear having one slot in wire receiving position when the other slot is in wire discharge position, a gear for rotating said twister gear, an oscillating shaft, a ratchet connection between said shaft and said gears for rotating said gears in one direction of oscillation of said shaft, and a brake mechanism associated with said gears to prevent rotation of the gears when the shaft oscillates in the opposite direction.

2. In a wire binding machine, a twister gear, a gear for driving said twister gear, an oscillating shaft having a ratchet connection with said gears to rotate said twister gear in only one direction, a third gear in mesh with said gears, and means on said shaft for rotating said third gear a relatively small amount by the reverse oscillation of said shaft to impart sufficient back turn to said twister gear to relieve the twisting tension in the wire after a knotting operation.

3. In a wire binding machine, a twister gear, a gear for driving said twister gear, an oscillating shaft having a ratchet connection with said driving gear to rotate said twister gear in one direction for a knotting operation, a second shaft having a gear in mesh with said driving gear, a brake mechanism on said second shaft to hold said twister gear stationary when said oscillating shaft reverses, and means on said oscillating shaft operable to overcome the holding effort of said brake mechanism to impart a relatively small reverse movement to said second shaft upon reversal of said oscillating shaft to back turn said twister gear to knot discharging position after the completion of a knotting operation.

4. In a wire binding machine having a twister gear, a driving gear for rotating said twister gear in one direction to twist together the ends of the

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wire band after a band laying operation, an oscillating shaft having a ratchet connection with said driving gear to rotate the gear in said one direction, a third gear in mesh with said driving gear, an arm mounted in fixed rotative relation with said third gear, and an arm on said oscillating shaft engageable with said first mentioned arm in the reverse rotation of said shaft to rotate said third gear in a direction to impart back turn to said twister gear after a knotting operation to release the knot from the twister gear.

5. In a wire binding machine, a double slotted twister gear having one slot in wire receiving position when the other slot is in wire discharge position, a reciprocating rack bar for rotating said twister gear an odd number of half revolutions to twist a splice and leave the gear in position to discharge said twisted splice, a crank shaft pivotally connected with said rack bar, an electric motor for driving said crank shaft, a one revolution clutch in the driving connection between said motor and said crank shaft, a band laying member for laying the wire to be spliced in one of said slots when the other slot is in discharge position, and means operated by said band laying member for actuating said clutch.

6. In a binding machine, a double slotted twister gear having one slot in wire receiving position when the other slot is in wire discharge position, a gear for rotating said twister gear in one direction to perform a knotting operation, an oscillating shaft engageable with said second gear in one direction of rotation to perform said knotting operation, a rack gear on said shaft, a sliding rack bar engaging said rack gear, a revolving crank arm pivotally connected with said rack bar to reciprocate the rack bar and oscillate said shaft, a motor for rotating said crank arm, a one-revolution clutch in the driving connection between said motor and said crank arm to cause rotation of said crank arm through one revolution in each binding operation of the machine, a band laying member for laying the wire to be spliced in one of said slots when the other slot is in discharge position, and means operated by said band laying member for actuating said clutch.

7. In a wire binding machine having a twister gear, a pair of stationary gripper jaws disposed on opposite sides of said twister gear and adapted to receive wire from a reversible band laying ring, studs in said jaws to form loops in said wire when the band laying ring is reversed, movable gripper jaws to grip said wire against said stationary jaws, said movable jaws having openings to receive the ends of said studs, said stationary and movable jaws having complementary recesses and projections to crimp and grip straight portions of said wire, and fluid pressure operated means connected to said movable gripper jaws for moving said jaws to gripping position.

8. In a wire binding machine having a twister gear, a pair of stationary gripper jaws disposed on opposite sides of said twister gear and adapted to receive wire from a reversible band laying ring, studs in said jaws to form loops in said wire when the band laying ring is reversed, movable gripper jaws to grip said wire against said stationary jaws, said stationary jaws having recesses facing said movable jaws, and projections in said movable jaws to crimp portions of said wire into said recesses.

9. In a wire binding machine having a twister gear, a pair of stationary gripper jaws disposed on opposite sides of said twister gear and adapted

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to receive wire from a reversible band laying ring, studs in said jaws to form loops in said wire when the band laying ring is reversed, and movable gripper jaws to grip said wire against said stationary jaws, said stationary and movable jaws having complementary recesses and projections to crimp and grip straight portions of said wire before said band laying ring is reversed to form said loops about said studs.

10. In a binding machine, a slotted twister gear, a fluid pressure operated ejector for removing a knot from said twister gear, a motor for driving said twister gear, a shaft intermediate between said motor and said twister gear, driven to make one revolution in each knotting operation of the twister gear, and switch means actuated by said shaft for controlling the fluid pressure supply of said ejector.

11. In a wire binding machine, a rotatable band laying ring, a motor for driving said ring, a twister gear, a second motor for driving said twister gear, wire grippers associated with said twister gear, fluid pressure cylinders for operating said grippers, means operable by said ring to control the operation of said gripper cylinders, and means operable by said ring to control the operation of said twister gear.

12. In a wire binding machine, a rotatable band laying ring, a motor for driving said ring, a twister gear, a second motor for driving said twister gear, wire grippers associated with said twister gear, switch means operable by said ring to control the operation of said grippers, a driving connection between said second motor and said twister gear including a crank shaft, a clutch on said crank shaft, and a reciprocating rack bar pivotally connected with a crank on said crank shaft, and switch means operable by said ring to control the operation of said clutch.

13. In a wire binding machine, a rotatable band laying ring, a motor for driving said ring, a twister gear, a second motor for driving said twister gear, wire grippers associated with said twister gear, fluid pressure cylinders for operating said grippers, a knot ejector associated with said twister gear, a fluid pressure cylinder for operating said ejector, means operable by said ring to control the operation of said gripper cylinders, a driving connection between said second motor and said twister gear including a crank shaft and a clutch on said crank shaft, means operable by said ring to control the operation of said clutch, and means operable by said crank shaft to control the operation of said ejector cylinder.

14. In a wire binding machine, a double slotted twister gear for splicing the wire having one slot in wire receiving position when the other slot is in wire discharge position and having said other slot in receiving position when said one slot is in discharge position, means for rotating said gear in successive splicing operations starting each time from the last previous discharge position of the gear and ending in a different discharge position, and means to lay the wire in said two slots alternately in successive binding operations.

15. In a wire binding machine, a double slotted twister gear having two different wire discharge positions, one for each slot, means for rotating said gear in successive knotting operations starting each time from the last previous discharge position and ending in the other discharge position, and means to lay the wire for each knotting

operation in the other slot when one slot is in discharge position.

16. In a wire binding machine, a double slotted twister gear having a first position for discharging wire from one slot and receiving wire in the other slot and a second position for discharging wire from said other slot and receiving wire in said one slot, means for rotating said gear in successive knotting operations starting each time from the discharge position of the previous knotting operation and ending in the other discharge position, and means to lay the wire in said two slots alternately in successive wire laying operations.

17. In a wire binding machine having a twister gear adapted to receive wire strand on one side of the gear axis as the wire is laid about a bundle and to discharge the wire on the other side of said axis after a knotting operation, oppositely directed wire receiving slots in said gear whereby one slot is in receiving position when the other slot is in discharge position and the gear has two different discharge and receiving positions, means to rotate said gear in successive knotting operations to said different positions alternately, and means to lay the wire in said two slots alternately in successive wire laying operations.

18. In a wire binding machine having a twister gear mounted for rotation adjacent a bundle to be bound, a first slot in one side of said gear for receiving a wire strand laid about the bundle in a first binding operation, means to rotate said gear to twist a splice in said wire and leave said slot in wire discharge position, and a second slot in the opposite side of said gear in position to receive a wire strand laid about the bundle in a second binding operation while said first slot is still in discharge position, said rotating means then twisting a splice in the wire in said second slot and leaving said gear with said second slot in discharge position and said first slot again in receiving position.

19. In a wire binding machine having means for laying a wire strand about a bundle, a double slotted twister gear having wire receiving slots in its opposite sides for splicing the wire, said gear having two different rest positions with one slot facing toward said bundle in wire discharge position and the other slot facing away from said bundle in wire receiving position, and means to rotate said gear to twist a splice in said wire starting from one rest position and ending in the other rest position without rotating the gear between splicing operations.

20. In a wire binding machine, a twister gear having wire receiving slots in opposite sides of the gear, said gear having a rest position with one of said slots facing away from a bundle to be bound, means for laying a wire strand about the bundle and in said one slot, means for rotating said gear, to splice the wire, to a second rest position with said one slot facing the bundle to discharge the wire from said one slot, and means to hold said gear in said second rest position to receive a wire strand in the opposite slot in the next strand laying operation of the machine.

21. In a wire binding machine, means to lay a wire strand about a bundle in a wrapping plane, a twister gear mounted for rotation in said wrapping plane, wire receiving slots in diametrically opposite sides of said twister gear, said gear having a rest position with one slot facing away from the bundle to receive overlapped portions of said strand as the strand is laid about the bundle and one slot facing toward the bundle

to discharge a twisted knot from a previous knotting operation, and means for rotating said gear to a second rest position to splice the wire and turn said one slot toward the bundle to discharge said splice from said one slot and turn the other slot away from the bundle to receive strands for the next splicing operation.

22. In a wire binding machine, a twister gear having a pair of wire receiving slots in opposite sides of the gear, means for rotating said gear an odd number of half revolutions to twist a splice in one of said slots and leave the gear in position to discharge the splice, and means for laying wires to be spliced in said two slots alternately in successive discharge positions of said gear.

23. In a wire splicing mechanism of the type forming a flat knot against the side of a bundle, a twister gear having a pair of wire receiving slots in opposite sides of the gear, said gear having two different rest positions with one slot disposed in wire discharge position facing toward the bundle and the other slot disposed in wire receiving position facing away from the bundle, means for laying a binding wire about the bundle and twice in overlapped relation in the slot which is in receiving position, and means for rotating said gear an odd number of half revolutions to twist a splice in said overlapped wire portions and leave said wire containing slot in discharge position and an empty slot in receiving position.

24. In a wire binding machine, a slotted twister gear for forming a twisted wire splice, stationary gripper jaws on opposite sides of said twister gear defining the twisted length of the splice, movable gripper jaws cooperating with said stationary jaws to grip the wire while a splice is being formed, a band laying ring arranged to lay a wire band about a bundle under tension and in said grippers and the slot of said twister gear, wire cutters at the edges of said grippers facing toward said twister gear defining a cutting length equal to said twisted length of the splice, means turning said twister gear through a predetermined angle of rotation, and means actuating said cutters prior to completion of said predetermined angle of rotation of the twister gear to cause the cut ends of the wire to rotate in frictional engagement with said cutters to tighten the splice to the very extremities of said cut ends by the rotation of the splice bodily during the remaining movement of the twister gear.

25. In a wire binding machine, a slotted twister gear for forming a twisted wire splice, stationary gripper jaws on opposite sides of said twister gear defining the twisted length of the splice, movable gripper jaws cooperating with said stationary jaws to grip the wire while a splice is being formed, a band laying ring arranged to lay a wire band about a bundle under tension and in said grippers and the slot of said twister gear, wire cutters at the edges of said grippers facing toward said twister gear defining a cutting length equal to said twisted length of the splice, means turning said twister gear through a predetermined angle of rotation, and means actuating said cutters sufficiently in advance of completion of said angle of rotation of the twister gear to cause the splice to be rotated bodily in the remaining movement of the twister gear until the cut ends of the wire are turned toward the bundle.

26. In a wire binding machine, a slotted twister gear for forming a twisted wire splice, stationary gripper jaws on opposite sides of said twister

gear defining the twisted length of the splice, movable gripper jaws cooperating with said stationary jaws to grip the wire while a splice is being formed, a band laying ring arranged to lay a wire band about a bundle under tension and in said grippers and the slot of said twister gear, wire cutters at the edges of said grippers facing toward said twister gear defining a cutting length equal to said twisted length of the splice, a shaft driving said twister gear through a predetermined angle of rotation, and means on said shaft for actuating said cutters sufficiently in advance of completion of said angle of rotation of the twister gear to cause the splice to be rotated bodily in the remaining movement of the twister gear until the cut ends of the wire are turned toward the bundle.

27. In a wire binding machine, a slotted twister gear for forming a twisted wire splice, stationary gripper jaws on opposite sides of said twister gear defining the twisted length of the splice, movable gripper jaws cooperating with said stationary jaws to grip the wire while a splice is being formed, a band laying ring arranged to lay a wire band about a bundle under tension and in said grippers and the slot of said twister gear, wire cutters at the edges of said grippers facing toward said twister gear defining a cutting length equal to said twisted length of the splice, a shaft driving said twister gear through

a predetermined angle of rotation, cams on said shaft for actuating said cutters, and adjustable connections between said cams and said shaft to effect the cutting of the wire sufficiently in advance of completion of said angle of rotation of the twister gear to cause the splice to be rotated bodily in the remaining movement of the twister gear until the cut ends of the wire are turned toward the bundle.

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