Aug. 24, 1954 A. E. CRANSTON, SR 2,687,082

BUNDLE BINDING MACHINE

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13 Sheets-Sheet 1

Fig. 1

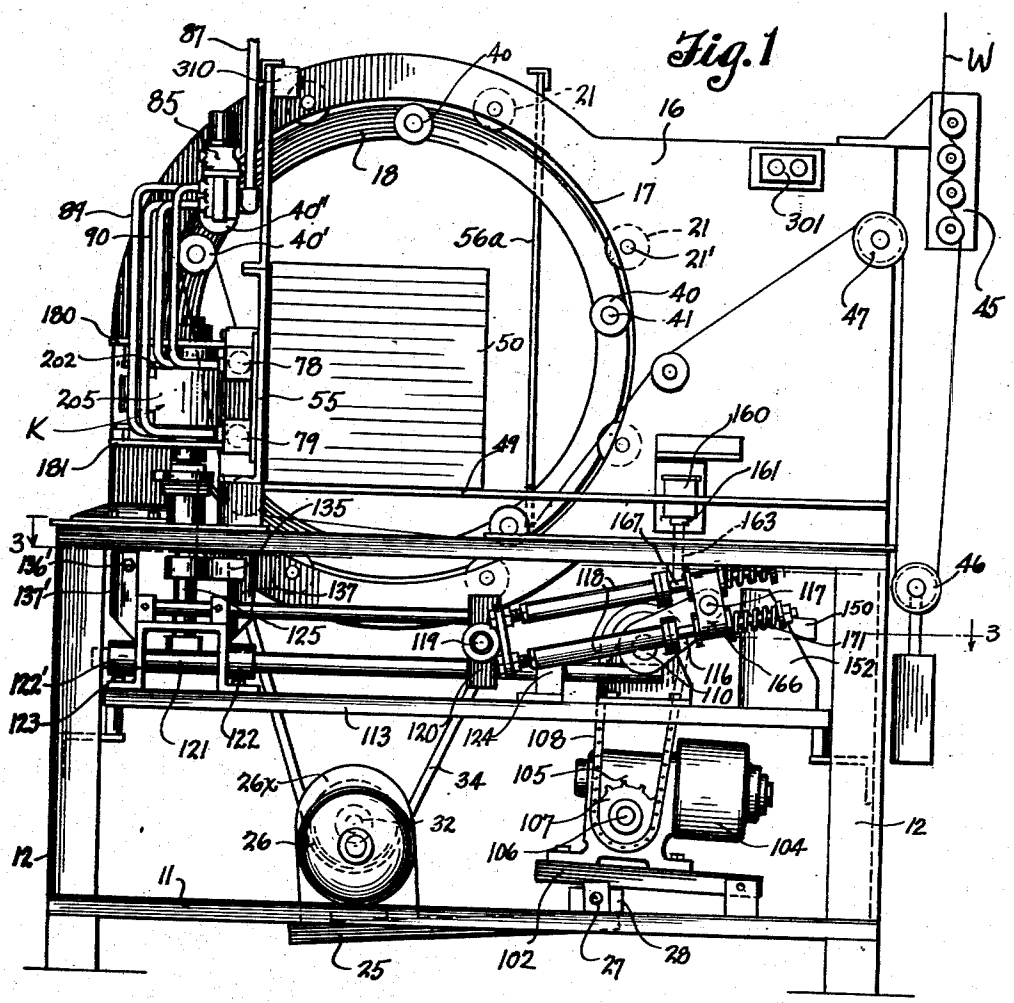
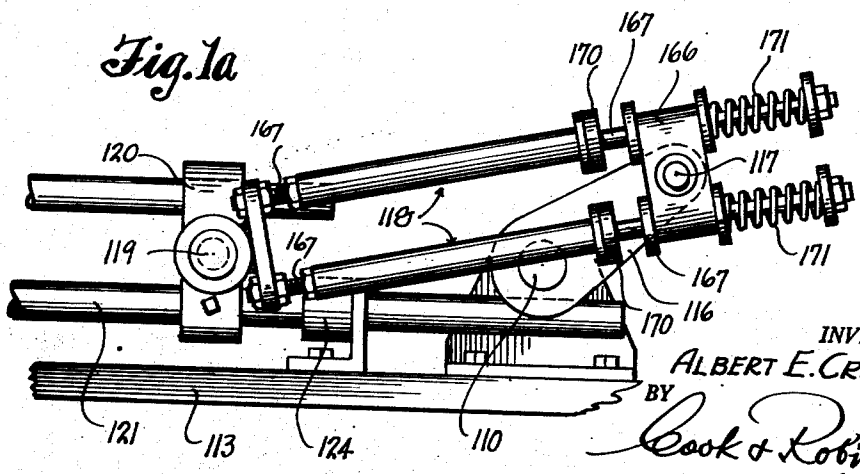


Fig. 1a



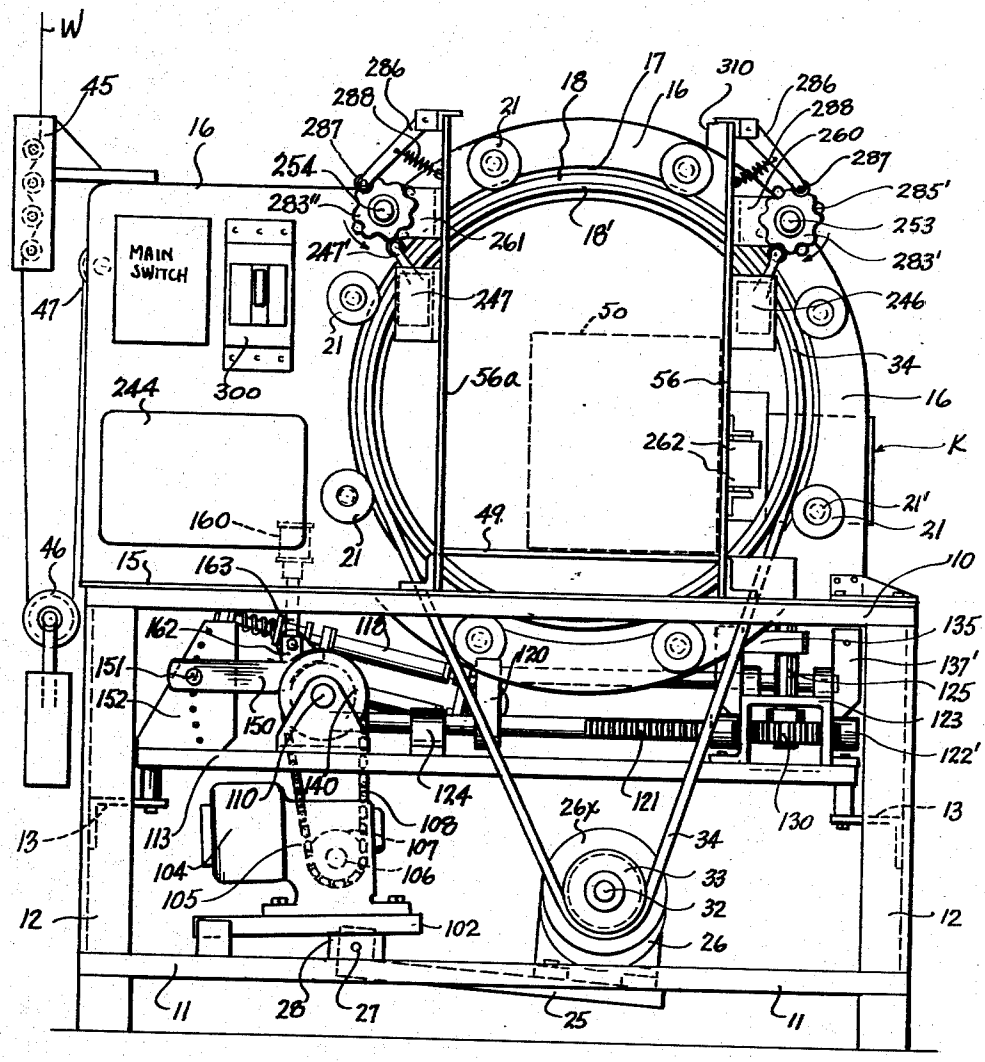
INVENTOR.
ALBERT E. CRANSTON, SR.
BY
Cook & Robinson
ATTORNEYS

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BUNDLE BINDING MACHINE

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Fig. 2



INVENTOR.
ALBERT E. CRANSTON, Sr.
BY
Cook & Robinson
ATTORNEYS

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BUNDLE BINDING MACHINE

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Fig. 3

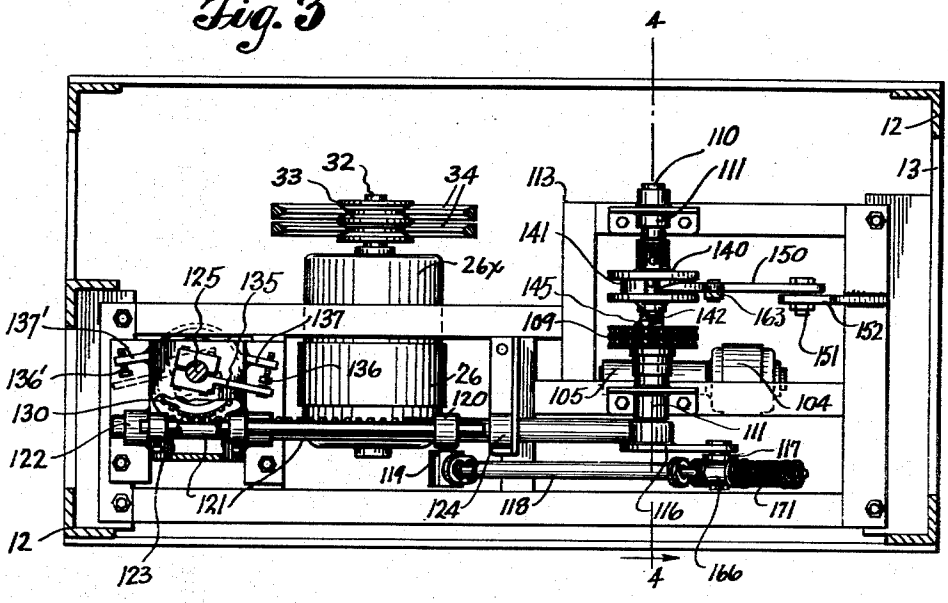
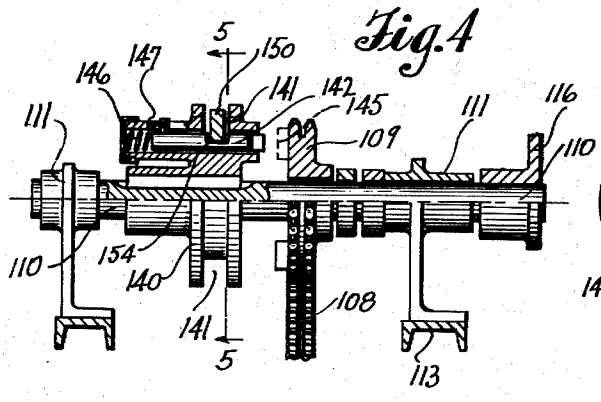


Fig. 4



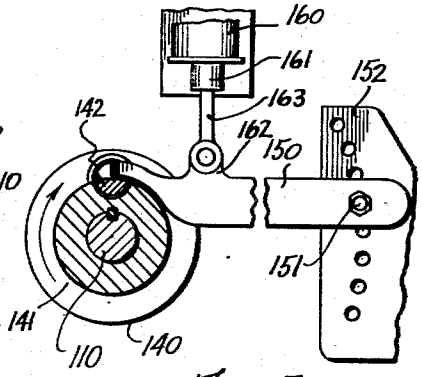
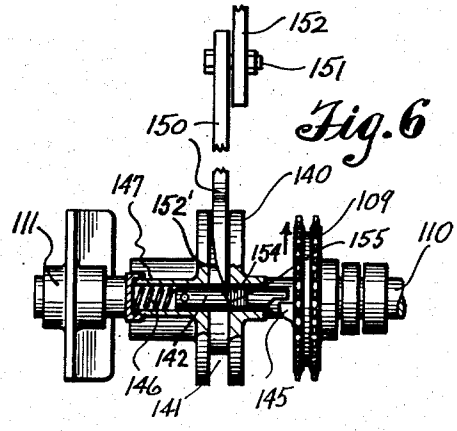


Fig. 5

Fig. 6



INVENTOR.
ALBERT E. CRANSTON, Sr.
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Cook & Robinson
ATTORNEYS

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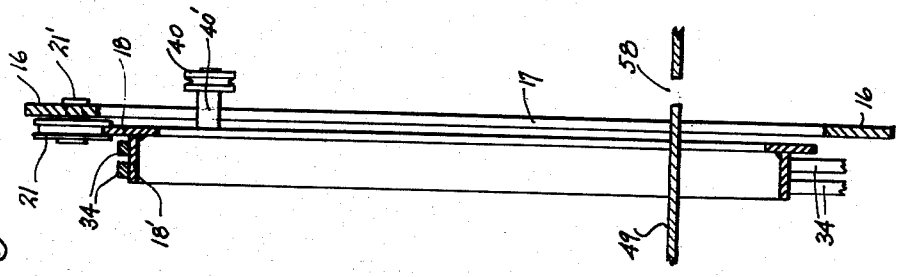


Fig. 8

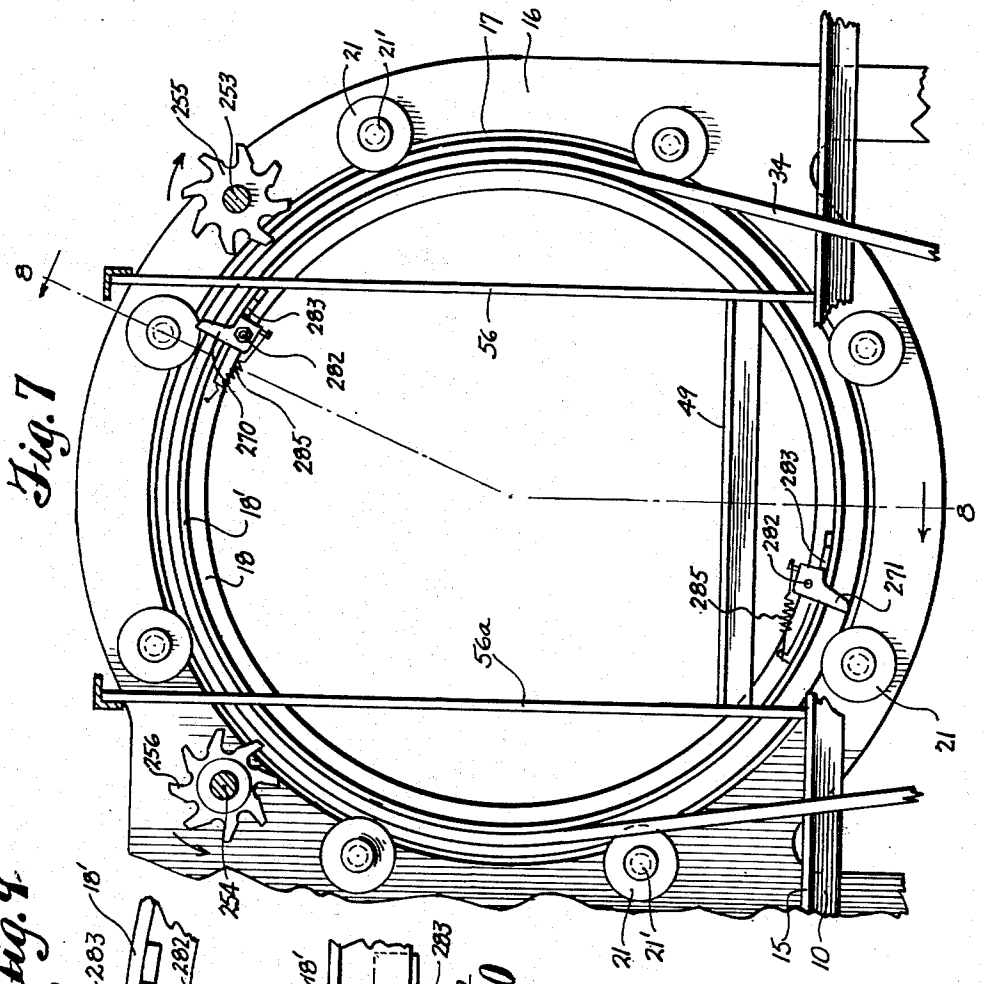


Fig. 7

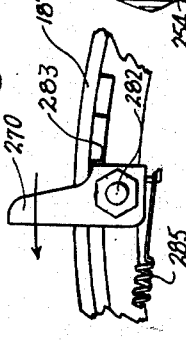


Fig. 9

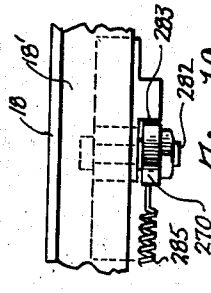


Fig. 10

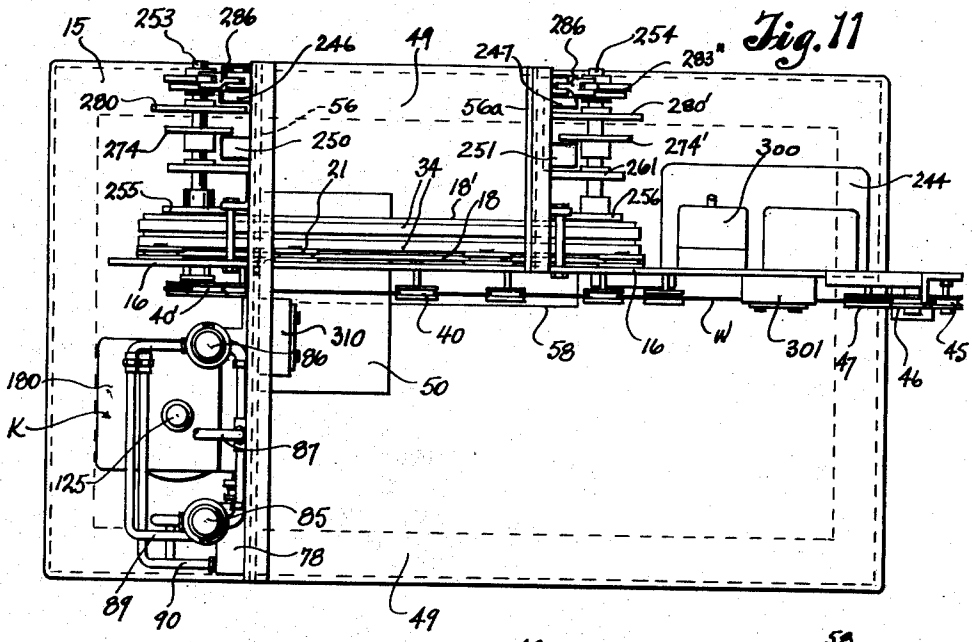
INVENTOR.
ALBERT E. CRANSTON, SR.
BY
Cook & Robinson
ATTORNEYS

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BUNDLE BINDING MACHINE

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Fig. 11



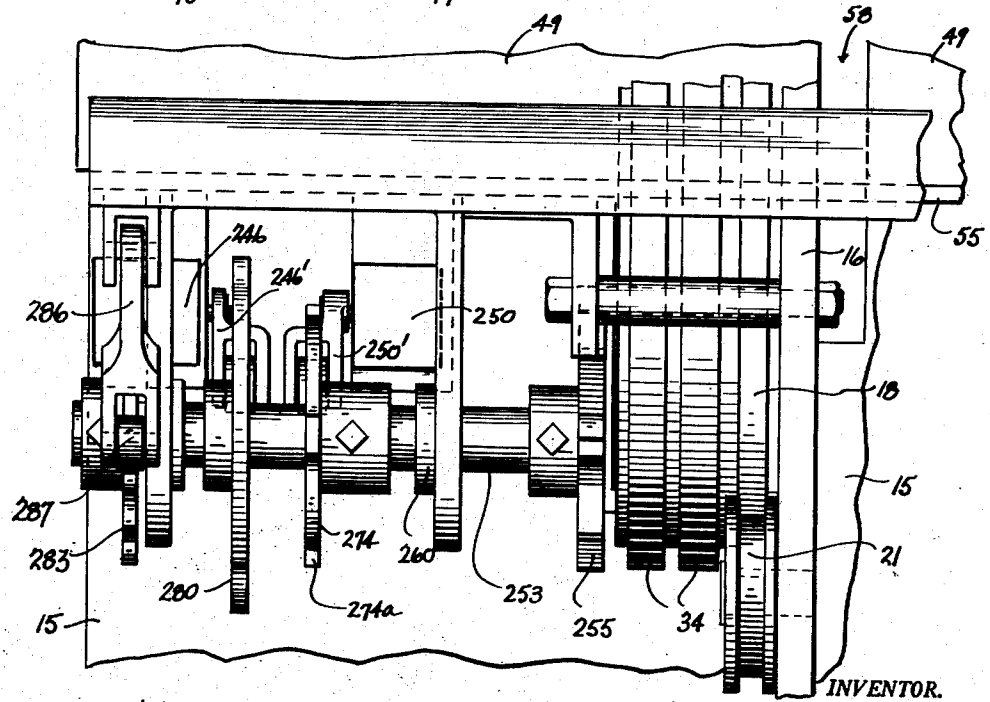


Fig. 12

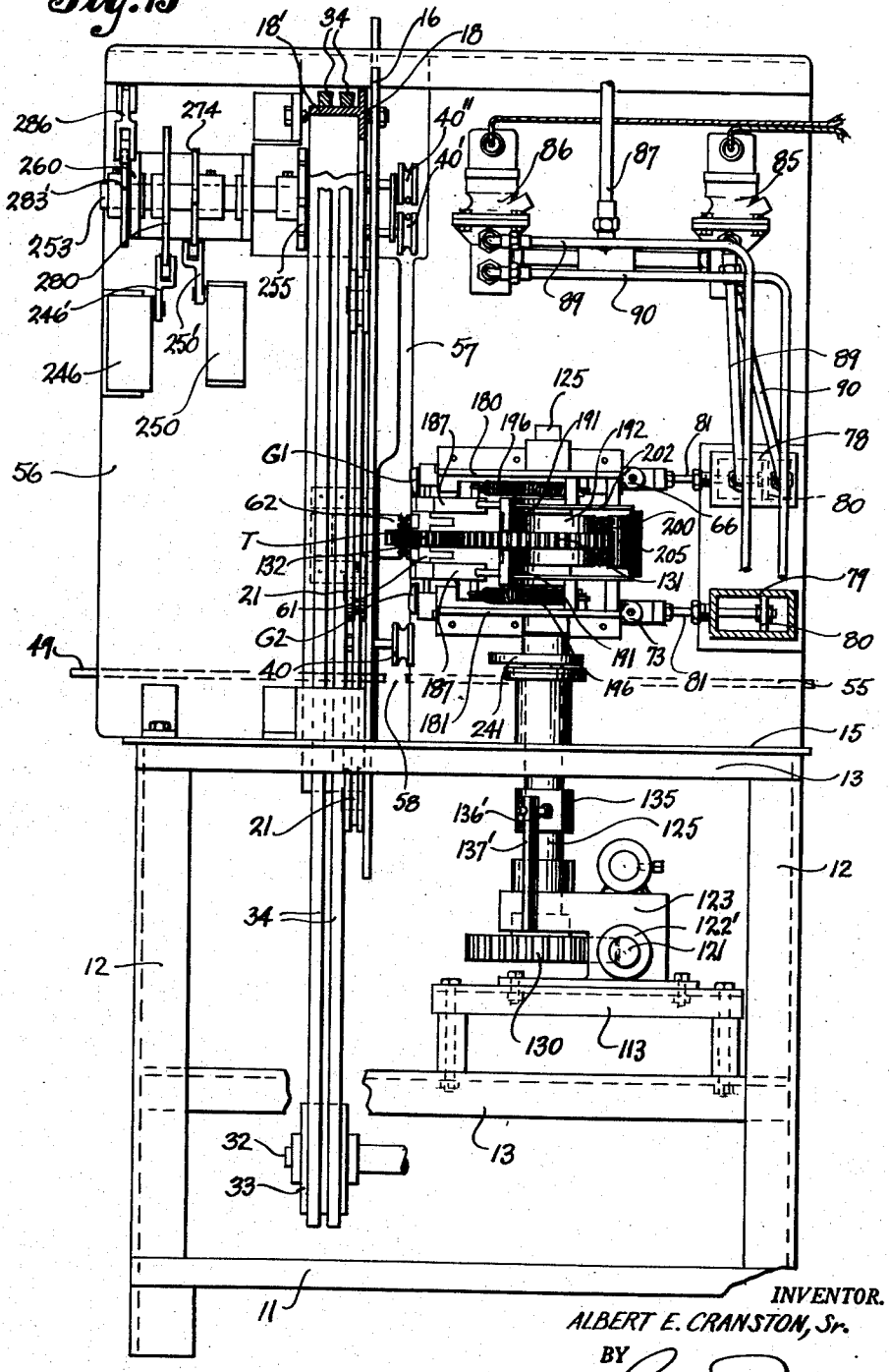
INVENTOR.
ALBERT E. CRANSTON, Sr.
BY
Cook & Robinson
ATTORNEYS

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Fig. 13



INVENTOR.
ALBERT E. CRANSTON, Sr.
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Cook & Robinson
ATTORNEYS

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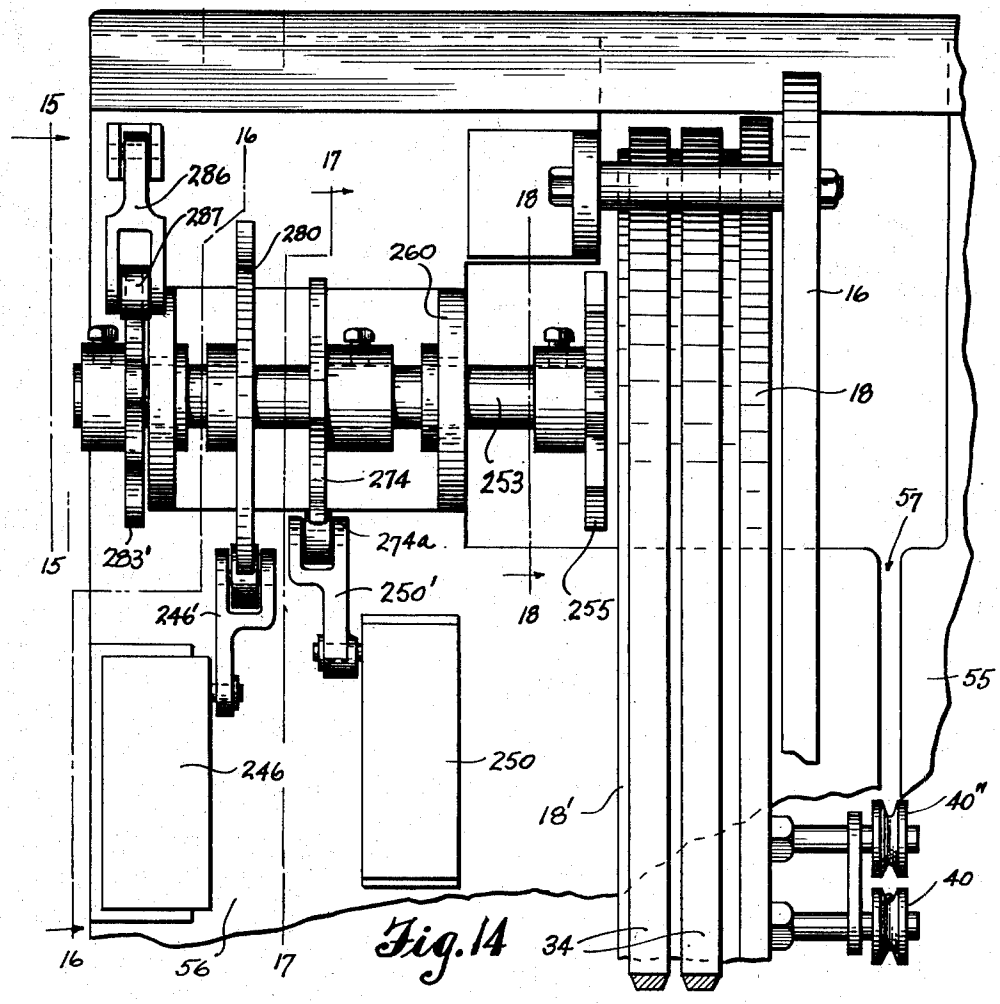


Fig. 14

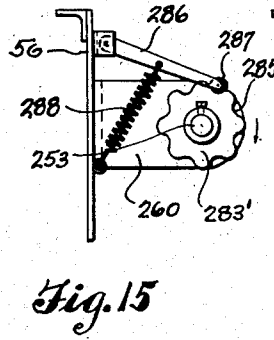


Fig. 15

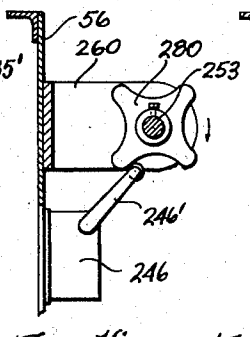


Fig. 16

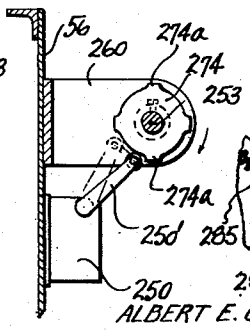


Fig. 17

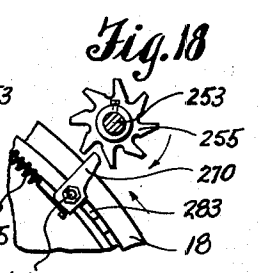


Fig. 18

INVENTOR.
ALBERT E. CRANSTON, SR.
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Fig. 19

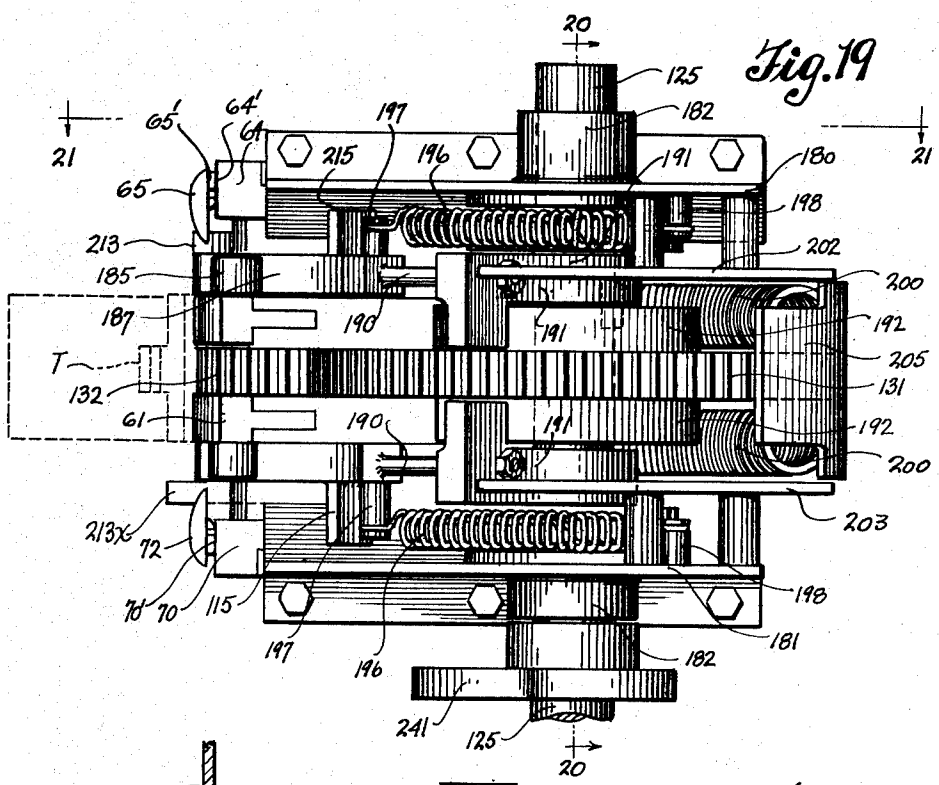
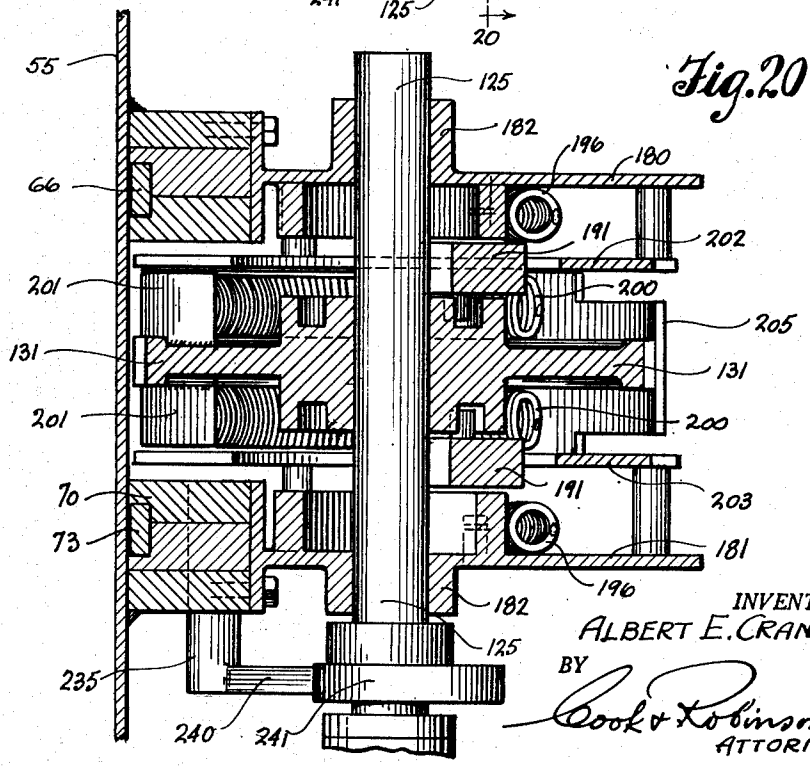


Fig. 20



INVENTOR.
ALBERT E. CRANSTON, SR.
BY
Cook & Robinson
ATTORNEYS

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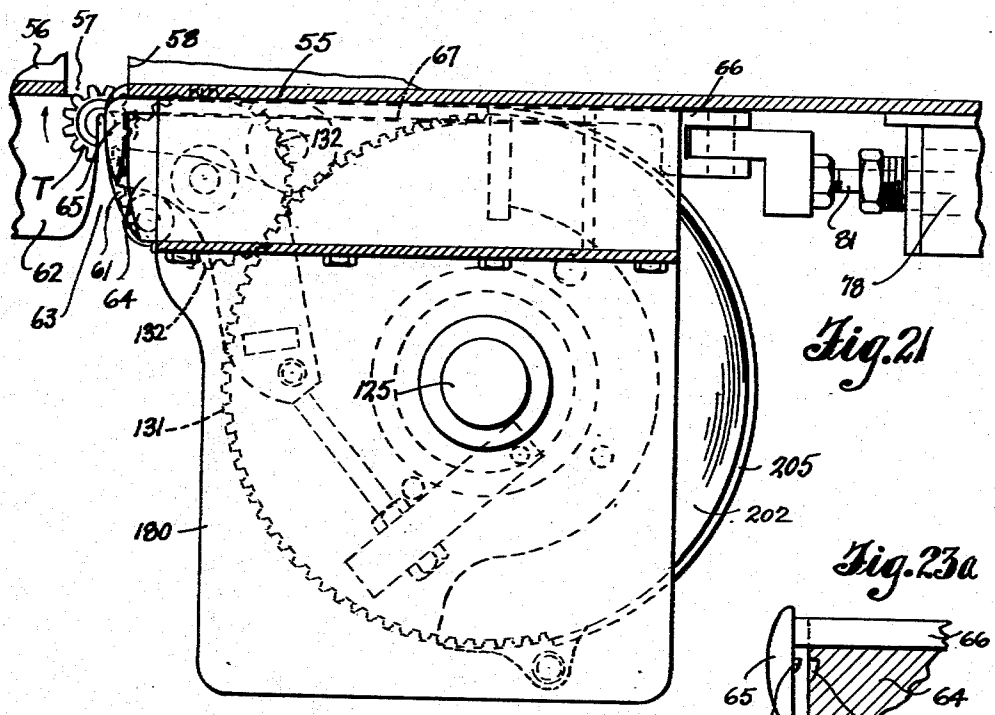


Fig. 21

Fig. 23a

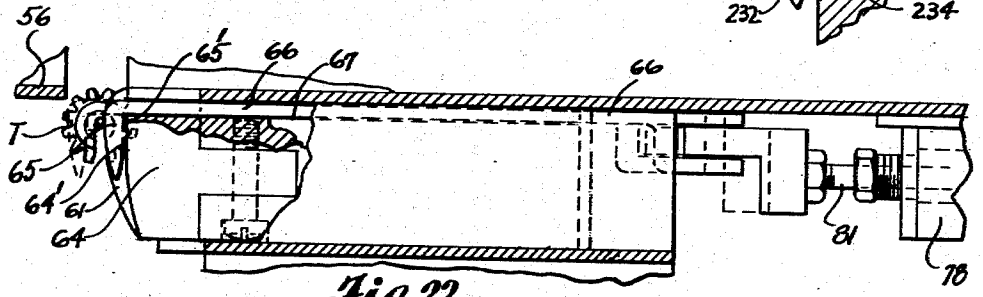


Fig. 22

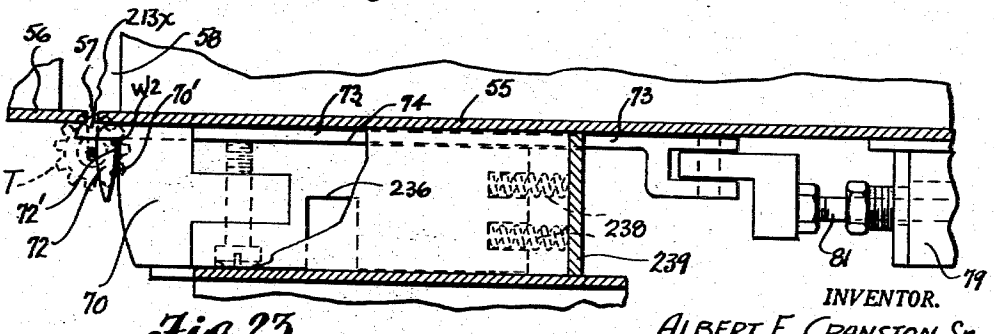


Fig. 23

INVENTOR.
ALBERT E. CRANSTON, Sr.
BY
Cook & Robinson
ATTORNEYS

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Fig. 24

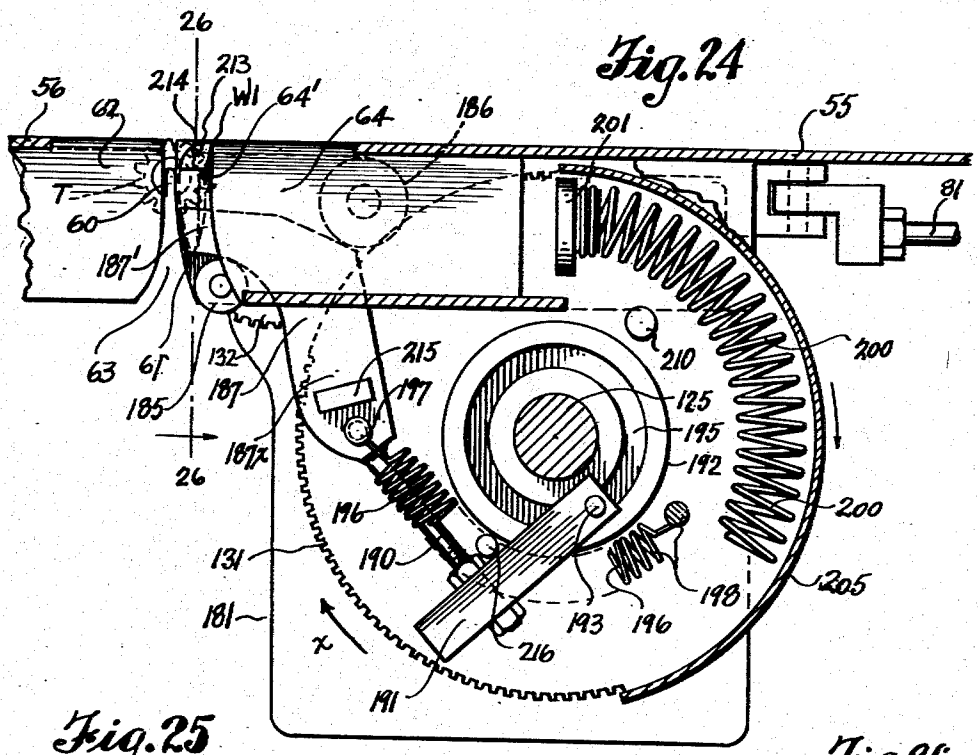


Fig. 25

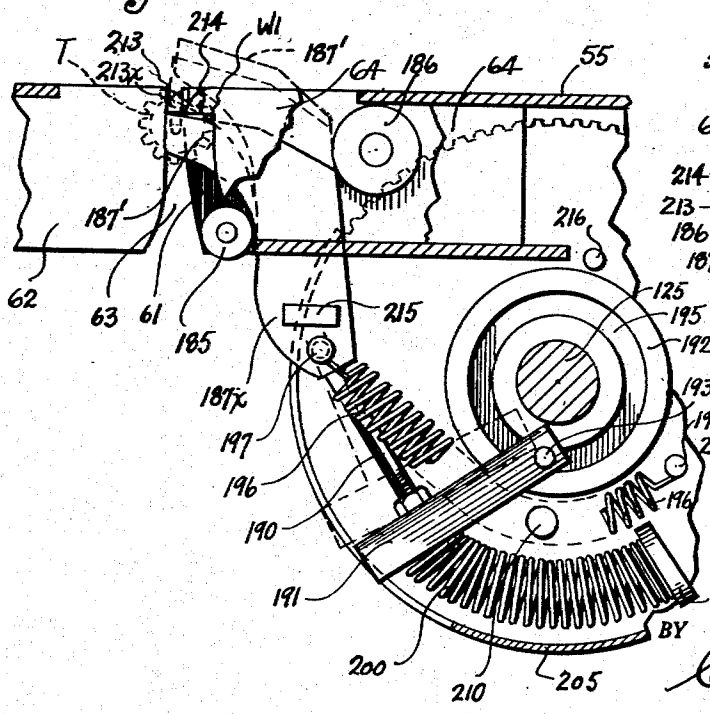
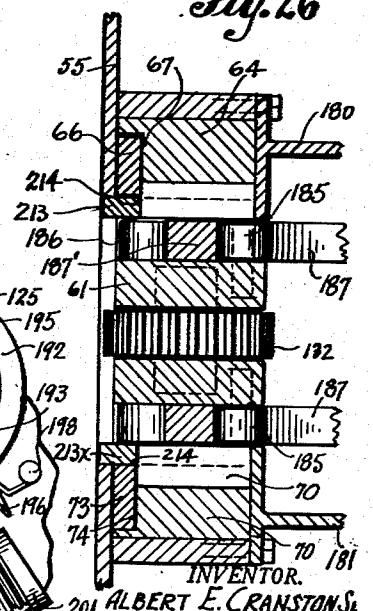


Fig. 26



INVENTOR.
ALBERT E. CRANSTON, SR.
BY
Cook & Robinson
ATTORNEYS

Aug. 24, 1954 A. E. CRANSTON, SR 2,687,082

BUNDLE BINDING MACHINE

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Fig. 27

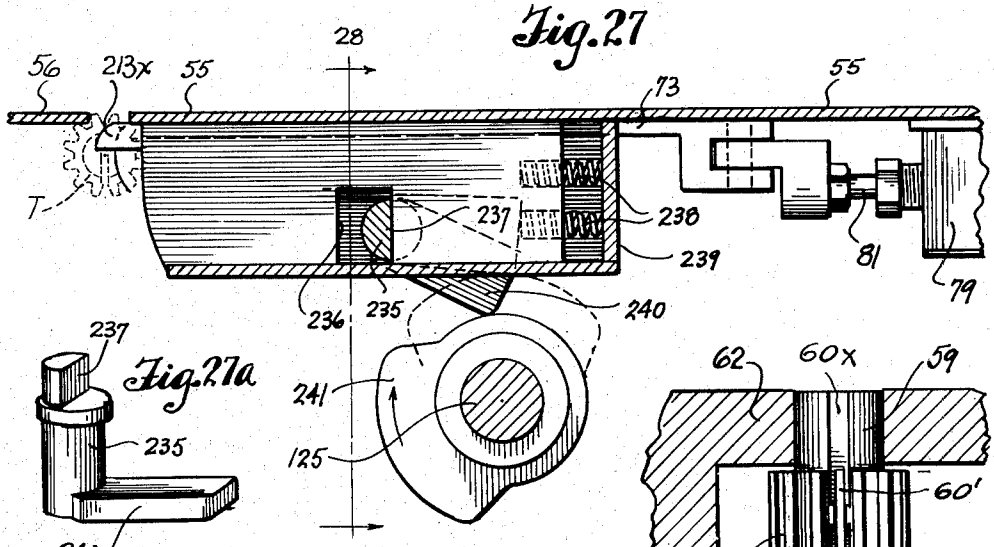


Fig. 27a

Fig. 28

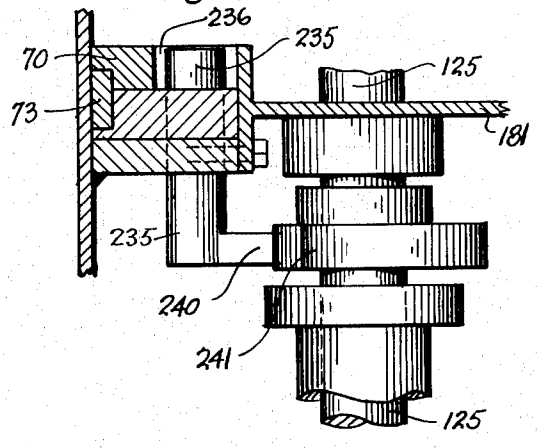


Fig. 29

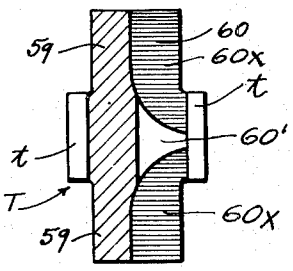


Fig. 30

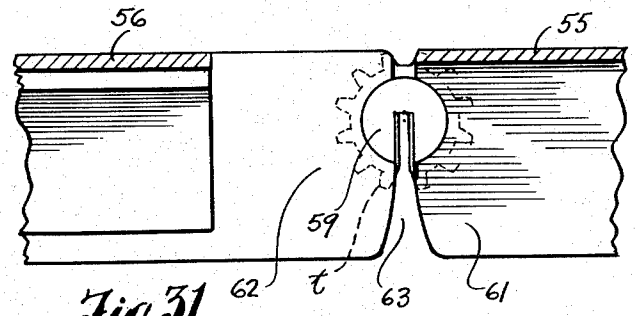


Fig. 31

INVENTOR.
ALBERT E. CRANSTON, Sr.
BY
Cook & Robinson
ATTORNEYS

Aug. 24, 1954 A. E. CRANSTON, SR 2,687,082

BUNDLE BINDING MACHINE

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Fig. 32

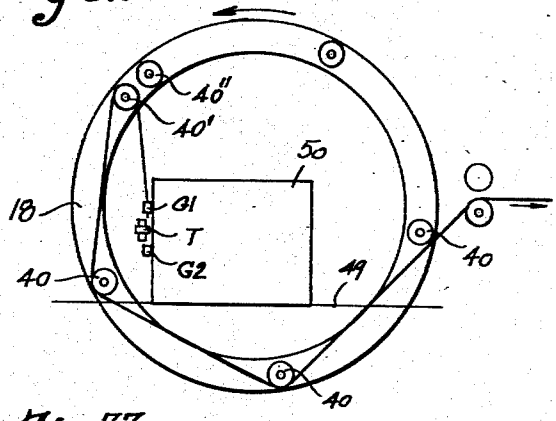


Fig. 33

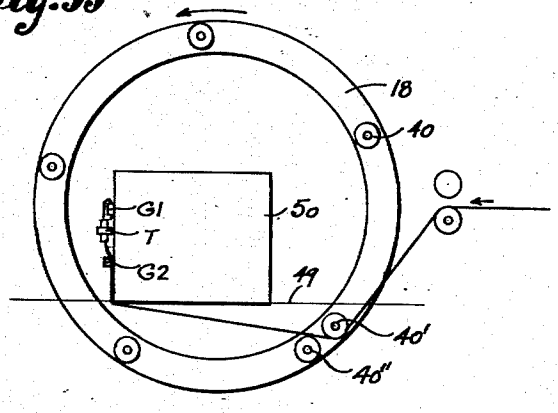


Fig. 34

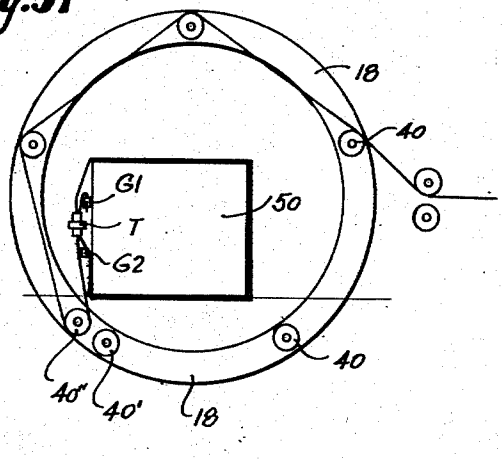


Fig. 35

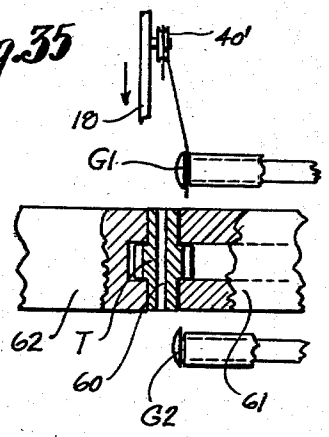


Fig. 36

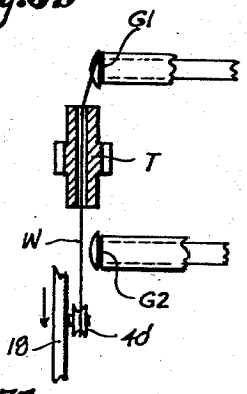
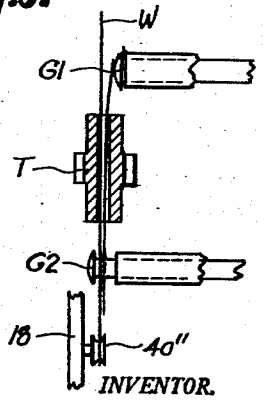


Fig. 37



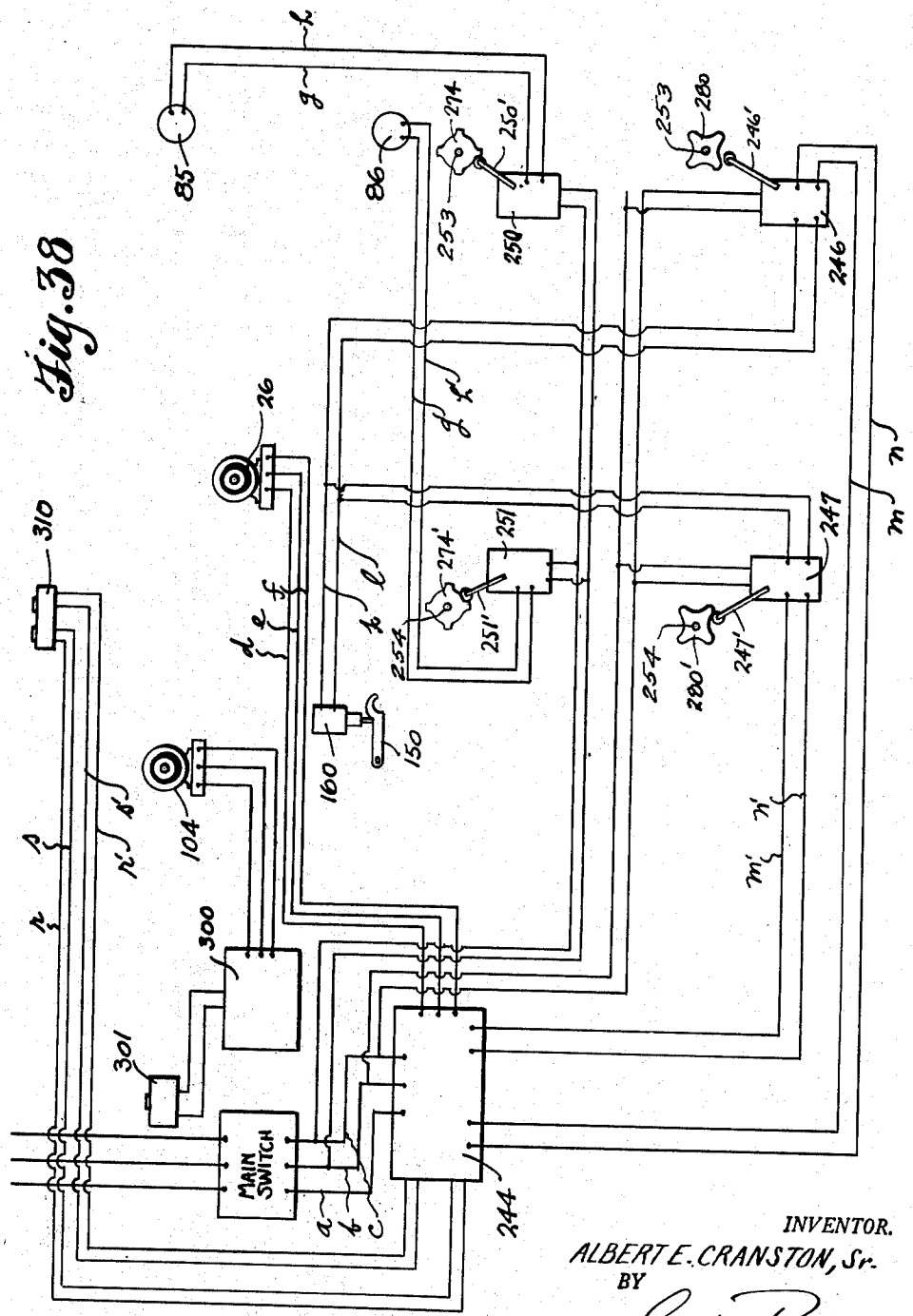
INVENTOR.
ALBERT E. CRANSTON, Sr.
BY
Cook & Robinson
ATTORNEYS

Aug. 24, 1954 A. E. CRANSTON, SR 2,687,082

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Fig. 38



INVENTOR.
ALBERT E. CRANSTON, Sr.
BY
Cook & Robinson
ATTORNEYS

Patented Aug. 24, 1954

2,687,082

UNITED STATES PATENT OFFICE

2,687,082

BUNDLE BINDING MACHINE

Albert E. Cranston, Sr., Oak Grove, Oreg.

Application July 19, 1948, Serial No. 39,568

40 Claims. (Cl. 100—28)

1

This invention relates to improvements in bundle binding machines of those kinds that operate to draw a strand of wire from a continuous supply and to lay a band thereof about a bundle, under tension and in a manner whereby opposite end portions of the band are brought into overlapped relationship within a twister gear which operates to twist the overlapped ends together in a flat knot to secure the band.

More specifically, this invention has to do with improvements in binding machines of the character above stated wherein the wire strand laying means comprises a reversible, rotatably driven ring, within which the bundle is located for binding, and on which ring, wire guiding sheaves are mounted for drawing wire from a supply and progressively laying a band thereof about the bundle, under tension, as the ring rotates. The invention relates especially to the type of machine wherein the direction of rotation of the ring is automatically reversed for each successive binding operation.

Explanatory to the present invention, it will here be stated that one of the present day, well known types of machines of the reversible ring type is that disclosed in United States Letters Patent No. 1,875,260, issued August 30, 1932, to G. D. Parker. In the machine of that patent, a one direction, electric motor is the prime mover for all the operating parts, and the band laying means comprises an externally toothed ring gear that is driven by the motor, through a rather intricate system of gears and clutches which operate in combination with automatic devices for reversing the direction of rotation of the ring gear upon completion of each binding operation.

Another machine of the reversible ring type is disclosed in United States Letters Patent No. 2,124,770, issued to Charles E. Evans on July 26, 1938, designed to bind bundles with rope. The machine therein shown is driven by a one-way electric motor and, like the above Parker machine is operated through a rather intricate system of gears, brakes and clutches.

It has been one of the main objects of this invention to provide a bundle binding machine of a fully automatic type, utilizing a reversible wire training ring, and having the same general mode of operation as the machines of the Parker or Evans patents above noted, for laying a band of wire, under tension, about a bundle; but in which said ring is directly driven by a reversible electric motor instead of a one-way motor, that in turn is controlled by a reversing switch operated through use of devices applied directly to the

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reversible ring. A further principal object is to provide a machine wherein operating parts are reduced to a minimum and weight of the machine materially reduced below that of present day machines which do the same work.

Other important objects are to provide a rotary carrier type of binding machine in which the operations of the band grippers and the knotter mechanism are also controlled and coordinated by the movement of the rotary carrier to perform a sequence of binding operations, to provide a novel form and arrangement of control members for actuation by the carrier, to provide a novel form of gripper operating mechanism, to provide a novel independent driving arrangement for the knotter mechanism, and to provide an improved knotter mechanism comprising a novel twister gear and novel wire gripping, cutting and ejector devices for disengaging the twisted knot and the band from the twister gear slot.

Still further objects of the invention reside in details of construction of various parts embodied in the machine, in the combination and relationship of parts and their mode of operation as will hereinafter be fully described.

In accomplishing the above mentioned and other objects of the invention, I have provided the improved apparatus described in the following specification with reference to a preferred embodiment of the apparatus shown in the accompanying drawings. It is to be understood, however, that the drawings are intended merely to illustrate the principles of the invention, as various changes may be made in the construction and arrangement of parts, and certain parts may be used without others, all such modifications within the scope of the appended claims being included in the invention.

In the drawings:

Figure 1 is a front elevation view of the present binding machine showing the receiving side of the machine;

Figure 1*a* is an enlarged fragmentary view showing the yieldable lost motion connection between the crank arm and pitman for driving the knotter mechanism;

Figure 2 is a rear elevation view of the machine showing the discharge side and control devices actuated by the band laying ring;

Figure 3 is a plan view of the independent drive for the knotter mechanism taken on the line 3—3 of Figure 1;

Figure 4 is a view, partly in elevation and partly in section, on the line 4—4 of Figure 3;

Figure 5 is a view taken on the line 5—5 of Figure 4;

Figure 6 is a plan view of the clutch mechanism shown in Figure 4, with certain parts broken away;

Figure 7 is an elevation of the upper portion of the machine frame as seen from the discharge side, showing the location of the wire training ring therein and the pawls as applied to the ring for the actuation of devices which time the operation of various parts and effect the automatic reversing of the ring for successive binding operations;

Figure 8 is a vertical section taken substantially on line 8—8 of Figure 7;

Figure 9 is a front view of one of the switch actuating pawls;

Figure 10 is a top view of the pawl as shown in Figure 9;

Figure 11 is a top, or plan view of the machine;

Figure 12 is an enlarged, plan or top view of one set of controls to be operated by a pawl on the ring in one direction of rotation of the ring;

Figure 13 is the left elevation of the machine, with reference to Figure 1, showing the knotter mechanism and control devices at that end;

Figure 14 is an enlarged, elevational view of control devices and switches at that end of the machine shown in Figure 13;

Figures 15, 16, 17 and 18 are vertical sections at reduced scale, on the lines 15—15, 16—16, 17—17 and 18—18, respectively, in Figure 14;

Figure 19 is an enlarged elevation of the knotter, gripper and wire cutter mechanisms as seen from that side of the machine shown in Figure 13;

Figure 20 is a vertical section on line 20—20 in Figure 19;

Figure 21 is a top view of the knotter mechanism showing the gear train for driving the twister gear;

Figures 22 and 23 show in plan view the stationary and movable parts of the grippers G–1 and G–2, respectively;

Figure 23*a* is a detail of gripper jaws;

Figure 24 is a horizontal section on line 24—24 in Figure 19;

Figure 25 is a detail showing the cutter shoe as advanced from the position of Figure 24 to wire cutting position, and in dotted lines as advanced to ejecting position;

Figure 26 is a vertical section on line 26—26 in Figure 24;

Figure 27 is a horizontal sectional detail on line 27—27 in Figure 19, showing the retracting means for the band support;

Figure 27*a* is a perspective view of the cutter shifting cam shaft;

Figure 28 is a cross section on line 28—28 in Figure 27;

Figure 29 is an elevation of the twister gear as applied to its supports;

Figure 30 is a section of the twister gear on line 30—30 in Figure 29;

Figure 31 is an upper end view of the twister gear as mounted by blocks which form a mouth to the gear slot;

Figures 32—33 and 34 are diagrammatic views, illustrating the relationship of twister gear and grippers to a bundle and progressively illustrating the training of a wire strand about a bundle by the ring in turning in counter-clockwise direction;

Figures 35, 36 and 37 show the position of the grippers relative to the twister gear when the band laying ring is in the positions of Figures 34—35—36, respectively; and

Figure 38 is a wiring diagram of the electrical control system.

General description

Briefly described, the present machine comprises a table-like frame structure across which the bundles, or boxes, to be bound may be advanced to and supported in position for binding. A wire training ring is supported in a vertical plane, transversely of the direction of and encircling the bundle passage, and is rotatably driven by a belt that is applied directly thereabout. At one side of the bundle passage, and operatively supported from stationary, bundle guide plates defining that side wall of the passage, are the wire holding and knotter mechanisms, including two vertically spaced grippers designed, respectively, to hold and receive the opposite end portions of a wire band as laid by the ring about a bundle. Between the grippers is a slotted twister gear that receives the overlapped end portions of the band, as laid about the bundle by the ring, for twisting them together.

Mounted on the ring, at one side, are guide sheaves whereby, with the rotation of the ring in either direction, the wire strand, as held at one end in one of the grippers, may be drawn from a source of wire supply, trained under tension about the bundle, and its opposite end portions laid in overlapped relationship in the slot of the twister gear preparatory to their being twisted together.

The band laying ring, which is reversed in direction of rotation for successive binding operations, is driven through a direct belt connection with a reversible electric motor and the reversing of the motor for successive binding cycles is automatically effected under control of a reversing switch that, in turn, is controlled by means comprising two limit switches mounted adjacent the ring and actuated by devices carried on the ring itself, to stop the motor at the end of each bundle binding cycle. Also, the actions of the grippers are timed directly from the band laying ring. The knotter mechanism, wire cutters and ejector devices are herein associated as a unit and are operated by a separate motor through a clutch device that is timed in operation from the wire laying ring.

Each binding cycle is started by the manual closing of a switch to energize the reversible motor and is completed with the functional operations of the knotter, wire cutters and ejectors.

The band laying ring

Referring more in detail to the drawings, the operating parts of the present machine are mounted in and upon a main frame structure of rectangular, table-like form, having longitudinal top rails 10 and longitudinal bottom rails 11 at opposite sides, fixed to four corner posts or legs 12. The legs 12 are rigidly joined across the ends of the frame by cross rails 13. Overlying a part of the top of the frame is a cover plate 15. All parts of the frame are welded together or otherwise joined in such manner as to provide a rigid and substantial structure.

Rigidly secured in the main frame, in its longitudinal direction and extending substantially above the cover plate 15, is a rigid and substantially vertical plate 16. Formed in this plate is a circular opening 17 of substantial diameter,

and disposed concentrically of this opening is the wire or band laying ring 18 within which the bundle, or box, is received for binding, as shown in Figure 1.

The ring 18 is rotatably supported concentrically of the plate opening 17 by means of a plurality of spaced wheels 21, rotatably mounted on studs 21' that are fixed in the plate 16, as shown in Figures 7 and 8; each wheel being formed with a circumferential groove in which the inner peripheral edge portion of the ring is received for guided, rotatable support of the ring. The ring 18, as observed particularly in Figures 7 and 8, is a flat, annular member, with a cylindrical flange 18' fixed concentrically thereto at one side to serve as a drive wheel about which driving belts are extended, as presently explained.

Hingedly mounted within the lower part of the main frame, as observed in Figures 1 and 2, is a platform 25 on which the reversible, electric motor 26, for driving the ring 18, is mounted. The platform 25 is hingedly supported at one end by a horizontal cross shaft 27 that is mounted at its ends in brackets 28 secured to frame members; the other end of the platform being unsupported from the frame. The motor drive shaft 32 is equipped, substantially directly below the ring 18 with a belt pulley wheel 33 over which a pair of V-belts 34 for driving the ring 18 extend; these belts being extended about the ring flange 18', as shown in Figures 2 and 13, and are kept taut by reason of the suspended weight of the motor.

The motor 26 operates through a suitable gear reduction, indicated at 26*x* in Figure 3, to drive the shaft 32 and belt pulley wheel 33, for the direct driving of the ring 18 in opposite directions, as presently explained, and through its above described belt connection with the motor, the ring may be rotated at a speed that is satisfactory for the present binding operations.

Mounted on the ring 18, on that side shown in Figure 1, are wire guiding and band laying sheaves 40, each of which is freely revoluble on a mounting stud 41 fixed in the ring; each sheave having a circumferential groove in which the wire strand, as payed out over the sheaves, will be guided.

These sheaves 40 are mounted on the ring 18 in the relationship which will be understood best by reference to Figures 1 and 32, and their arrangement on the ring is such that they will carry the strand of wire, as led from the supply, about a bundle located within the ring, with clearance in either direction of rotation of the ring.

As shown best in Figures 32 to 34, there are two rather closely associated sheaves, designated at 40' and 40'', on the ring, from between which the wire strand is payed out from the ring to one or the other of the two grippers G1 and G2, presently described, which holds the end of the wire for a binding operation. The other sheaves 40 are located on the ring at suitable intervals to properly carry the strand in its application about a bundle in either direction of rotation of the ring.

In threading the machine for use, the end of the wire strand, designated at W, is drawn off from the source of supply of wire, passed through a suitable tension means 45 as shown in Figure 1, there extended downwardly and about a weighted slack take-up sheave 46, thence drawn upwardly and over a guide sheave 47 fixed on the plate 16, and from this is extended over wire guide sheaves 40 on the ring 18, as presently explained, and at its end is held in one or the other of the paired grippers, G1 or G2, depending on the direction of rotation of the ring 18 for the next binding operation.

In Figures 1 and 2, I have shown a bundle, designated by numeral 50, as placed within the ring for binding. To insure the proper positioning and holding of the bundle for binding, guide plates 55 and 56 are fixed vertically and in alignment on the frame structure and in a plane perpendicular to the plane of plate 16, to define one side wall of the bundle passageway through the ring. The opposite side of the passageway is defined by a plate 56*a*, as noted in Figures 1, 2 and 11. The bottom of the passageway is formed by a horizontal plate 49 extended between the opposite side plates 56—56*a*, and overlying a part of the frame structure as seen in Figure 11.

It is illustrated clearly in Figure 13, that the adjacent, vertical edges of plates 55 and 56 are spaced apart, thus providing a vertical slot 57 between them for the passage of the ring 18 and the laying of the wire band about the bundle by the ring. Likewise, a slot 58, aligned with passage 57, is provided in the bottom plate 49 for the passage of the wire band as laid by the ring about the under side of the bundle 50. The bundle, as disposed in the machine for binding, as shown in Figure 11, should have one side disposed closely against the plates 55 and 56 and across the passage 57.

The knotter mechanism

The knot twister gear, which is herein designated in its entirety by reference character T, is located closely adjacent that side of the bundle which is placed against the plates 55 and 56, with axis vertical and in the plane of the band as laid by the ring about the bundle. At this location it is inside of the circumference of the ring, as will be understood best by reference to Figures 32 to 34. As shown best in Figures 29 to 31, the twister gear T comprises the toothed body portion *t*, from the opposite ends of which coaxial mounting hub portions 59—59 extend. The slot of the gear is designated by numeral 60 and it extends through the gear and to the full length of its hub portions and inwardly to the axial line of the gear.

Mounting of the twister gear is by means of bearing blocks 61 and 62, fixed to the plates 55 and 56 at the outside of the bundle passage and at opposite sides of the passage 57, as has been shown in Figures 29 and 31, and rotatably containing the hub portions of the gear between them. As seen in Figure 31, the adjacent end surfaces of the gear mounting blocks are spaced apart and at the wire receiving side are shaped to provide an outwardly flared mouth 63, leading to the gear slot, for better guiding the wire band thereinto.

A feature of the twister gear construction is illustrated in Figures 29 and 30, wherein it is shown that the gear slot 60 is of special design, being characterized by having a relatively narrow slotted portion 60' midway of the opposite ends of the gear in which overlapped end portions of the wire band are received, one upon the other; this portion of the slot being of a width substantially of the diameter of the wire so that the contained portions of the wire will be held securely for the knot twisting operation. At opposite ends of this slotted portion 60' of narrow

width, are wider portions 60x leading through to the ends of the hub portions of the gear and of such increased width that overlapped portions of the wire contained therein may wind one upon the other in the twisting operation therein. The bottom surfaces of these wider portions of the slot, as they approach the slotted portion 60', are curved laterally and gradually toward each other and come almost together at the entrance to the slot as is best shown in Figure 30.

The particular advantage in this manner of forming the twister gear slot resides in the fact that there is no tendency of the twisted portions of the knot as formed to hang up on the shoulders at opposite ends of the narrow portion of the slot such as is experienced in the usual types of twister gears where these shoulders are formed in planes perpendicular to the gear axis.

Attention is directed to Figures 35—36—37, for a better understanding of the relationship of the twister gear T to the two grippers which are herein designated diagrammatically and in general by reference characters G1 and G2.

The grippers, together with the wire cutters and twister gear driving mechanism, are mounted as a unit within a housing that is fixed on the plate 55 at the outside of the bundle passage, as best shown in Figures 1 and 2, where the unit is designated in its entirety by reference character K. In Figures 19 and 20, the unit is shown more in detail. The two grippers G1 and G2 are substantially alike in construction, each comprising a stationary jaw and a jaw that is adapted to be moved from and toward the stationary jaw.

In Figure 22, the parts comprised by the upper gripper G1 are shown. The fixed jaw comprises a metal block 64, formed at one end with a gripping surface 64'. The movable jaw comprises a jaw member 65 with flat gripping surface 65' in opposed relationship to surface 64'; the jaw 65 being fixed on or formed at the end of a horizontal bar 66 that is slidably contained in a housing guideway 67 (see Figure 26) for such reciprocal movement as required for moving the jaw 65 toward or away from the jaw 64. The jaw 65 has a rounded outer surface, and it will be understood by reference to Figure 21, that when the movable jaw is in its closed position, it is then disposed outside of the plane of travel of the wire as laid by the ring gear about the bundle. However, when the jaw is open, it assumes the dotted line position in Figure 22, within the plane of travel of the wire, and will receive the wire therein when laid in the twister gear by the ring.

The gripper G2, shown in Figure 23, likewise comprises a jaw block 70 with flat gripping surface 70' at one end, and there is a movable jaw 72 with gripping surface 72' in opposed relationship to surface 70'; this latter jaw being fixed to the end of a horizontal slide bar 73 that is held in a guideway 74 for horizontal reciprocal action. The two slide bars, 66 and 73, are vertically spaced and substantially coextensive. Their functional operations are effected by means which will now be described, with reference to their showing in Figure 13.

Mounted on the supporting plate 55, horizontally aligned with the slide bars 66 and 73, respectively, are air cylinders 78 and 79, containing pistons 80 that are connected, respectively, by their piston rods 81 to the outer ends of the slide bars, to provide that the bars may be reciprocally actuated, incident to application of air under pressure to the cylinders, as presently described, to open and close the grippers.

The air cylinders, 78 and 79, are controlled, respectively, by solenoid valves 85 and 86, mounted on the plate 55 as seen in Figure 13. Each valve has a pipe connection with a source of supply of compressed air indicated by pipe 87, and also has pipe connections 89 and 90 extended therefrom to the inner and outer ends, respectively, of the corresponding air cylinder. Admission of air to the outer end of an air cylinder actuates its piston therein to shift the movable jaw of the corresponding gripper to open position, as for receiving or releasing a wire. Likewise, admission of air to the inner end of the cylinder causes the gripper jaw to be moved to closed position, as for holding a wire. The valve member of each of these solenoid valves which controls admission of air to the pipes 89 and 90 will be normally held in one position by air pressure from line 87, and it will be moved to its other position upon energization of the valve solenoid which is connected thereto.

The functional operations of the grippers G1 and G2, respectively, are controlled by the solenoid valves 85 and 86. These valves are adapted to be individually energized and deenergized through control switches 250 and 251 mounted on the plates 56—56a at opposite sides of the bundle passageway, as noted in Figure 11, and connected in electric circuit as in Figure 38. These switches are actuated between "on" and "off" positions by means presently described operating under control of the ring 18.

Knotter drive mechanism

The twister gear operating mechanism, the wire cutters and knot ejectors designated as the unit K are operated by a motor which is independent of the ring driving motor 26 but which operates through a clutch that is timed also by movements of the ring 18. This latter motor, the clutch and parts associated directly therewith, will now be described with reference more particularly to Figures 2 to 6.

Disposed within the lower portion of the main frame structure, is a hingedly mounted platform 102 on which an electric motor 104 is mounted. This motor operates through a reduction gear mechanism 105 to drive a shaft 106 on which paired sprocket wheels 107 are fixed. Chain belts 108 operate about the sprocket wheels 107 and about sprocket wheels 109 that are revolubly mounted on a crank shaft 110. The crank shaft is revolubly supported at its ends in bearings 111—111 on a horizontal frame 113 which is fixed in the main frame as seen in Figures 1 and 3. A crank arm 116 is fixed on one end of the shaft 110, and this is pivotally connected as at 117, to one end of a pitman, designated generally at 118 in Figure 3, which has its other end pivotally connected, as at 119, to a reciprocally movable cross head 120 fixed to a rack bar 121. The rack bar 121 is supported at one end for reciprocal movement in guide bearings 122 and 122' formed with a casting 123 that is rigidly mounted on the left hand end of frame 113 as seen in Figure 1. At its other end, the rack bar is reciprocally contained in a bearing 124 mounted on the frame 113.

A vertical shaft 125 for driving the knotter mechanism has its lower end portion revolubly mounted in the casting 123, as noted in Figures 1 and 13, and at its lower end has a gear wheel 130 keyed thereto in operative mesh with the teeth of rack bar 121 as seen in Figure 3.

Fixed on the upper end portion of shaft 125,

as shown in Figures 13, 19 and 20, is a gear wheel 131 which is a part of the mechanism K and which as seen in Figure 21 meshes with a revolubly mounted idler gear wheel 132, which is in operative mesh with the twister gear T. The normal position of the twister gear is that which faces its longitudinal slot away from the bundle. Reciprocal action of the rack bar 121 in one direction causes the twister gear to rotate from its normal starting position, through three and one-half turns, to twist together the end portions of a wire band that have been placed therein, to form a flat knot, then after the ends of the band at the outside of the knot have been cut and the band ejected from the gear slot, the reciprocal travel of the rack bar in the other directions returns the twister gear through three and one-half turns, to starting position. The extent of turning of the twister gear in each direction is dependent upon the extent of turning of shaft 125 in opposite directions. This turning, which in the present machine is about 150°, is accurately limited in order to properly position the slot of the twister gear for receiving the wire and discharging the band. This limiting of the arc of turning of shaft 125 is effected by a stop arm 135, fixed to the shaft 125 just above casting 123, and extended radially therefrom, as shown in Figure 3, for engaging at the opposite ends of a definite arc of travel, with stop bolts 136 and 136' that are adjustably mounted in brackets 137 and 137' fixed to opposite sides of the frame 123 and extended upwardly therefrom.

The clutch mechanism which controls the driving and stopping of the crank shaft 110, as shown in Figures 3 to 6, comprises the dual sprocket wheel 109 which is continuously driven by the motor 104 through chain belts 108. The wheel 109 is revolubly mounted on the crank shaft 110 adjacent a wheel 140 that is keyed on the shaft 110 to serve as its driving member. The wheel 140 is formed with a circumferential groove 141 and a clutch locking bolt 142 is slidably mounted in the wheel, parallel with its axis, to extend transversely through the base of the groove 141 and beyond the face of the wheel, as in Figure 6, to such extent that it may be engaged in driving contact with one of a plurality of lugs 145 formed on the adjacent face of sprocket wheel 109. A coiled spring 146 is contained in the bolt guide bearing 147 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 150 is pivoted at its outer end by a bolt 151 on a bracket 152 fixed in the frame 113. The other end of the lever rides in the wheel groove 141, see Figure 5, and at this end has a beveled side surface 152', as seen in Figure 6. It is also shown in Figure 6 that the bolt is formed on its outer side with a cross channel 154 with an angularly sloping side surface 155. With the rotation of wheel 140 that engages the beveled end surface 152 of the lever with the bolt surface 155, the bolt will be retracted against the pressure of spring 146 and thus disengaged at its outer end from the sprocket wheel lug to stop the driving of shaft 110.

A solenoid 160 is mounted on plate 16 directly above the lever 150, and the solenoid core 161 is connected to a lug 162 on lever 150 by a link 163. To engage the clutch for a cycle of operations, the solenoid is momentarily energized by means presently described, thus causing the lever 150 to be momentarily lifted from the clutch wheel 140 and the bolt 142 released. Spring 146 then pushes the bolt outwardly, causing it to effect a driving connection between the continuously driven sprocket wheels 109 and wheel 140, thus to drive the crank shaft 110. The lever 150 immediately drops back into the wheel groove 141 and effects disengagement of the clutch bolt from the sprocket, and thus stops the crank shaft upon its making one complete rotation.

It is to be understood that after a wire has been applied about a bundle by the ring, the ends of the band are held secure in the grippers G1 and G2, located adjacent upper and lower ends of the twister gear, while the knot is twisted. Thus it becomes necessary that the wire strand be cut at points between the twisted knot and grippers in order to release the bundle for removal from the machine. The cutting of the wire and ejection of the knot from the slot of the twister gear is herein effected immediately upon completion of the twisting operation and while the gear slot faces toward the bundle, and before the rack bar starts on its return travel to rotate the twister gear back to its normal or starting position.

It is necessary that there shall be a momentary standstill of the twister gear immediately after the knot has been completed and while the gear slot faces the bundle, that will give time for the wire cutting and ejection operations before the twister gear starts on its reverse rotation. This is accomplished by reason of a yieldable, lost motion movement in the pitman rod connection between the crank shaft arm 116 and the rack bar 121. In Figure 1a it is noted that the crank arm 116 is pivotally connected at 117 with a cross head 166. The cross head has a limited sliding movement on paired, parallel pitman rods 167—167 which comprise a part of pitman connection designated by numeral 118. This movement, in one direction, is limited by the cross head engaging resilient abutments 170 fixed on the rods. It is yieldably limited in the other direction by engaging against coiled springs 171 mounted on the outer ends of the pitman rods. This lost motion in the connection provides that, at the completion of the inward stroke of the rack bar, effected by the cross head 166 acting against the abutments 170, the inertia of moving parts will hold them in that position and the twister gear will remain faced toward the bundle until the cross head 166 on the return swing of the crank arm 116 has moved outwardly on rods 167 and has compressed the springs 171 to a sufficient amount to overcome the inertia and actuate the rack bar in the return direction. This lost motion interval is so timed and established that the wire cutting and ejection of the band from the twister gear slot will take place while the twister gear is standing still and its slot faced toward the bundle.

Wire cutters

The devices for cutting the ends of the wire strand between the knot and grippers G1 and G2 will now be described; reference being directed particularly to Figures 24 and 25 which illustrate the upper gripper G1, but with the understanding that this description applies equally to the devices for cutting the wire between the knot and lower gripper G2.

This particular unit of the mechanism, embodying knotter gears, wire cutters and ejectors, designated by reference K, is contained in a housing comprising two vertically spaced, and horizontally disposed plates 180 and 181, that are fixed rigidly to plate 55 at the out-

side of the bundle passage as seen in Figures 19 and 20.

The knotter drive shaft 125 on which the gear wheel 131 is fixed extends through the plates 180 and 181 and is revolubly contained in bearings 182 formed thereon. Mounted on the top side of the bearing block 61 which serves as a hub containing bearing at one side of the upper end of the twister gear are spaced rollers 185 and 186, between which an angularly formed wire cutter shoe 187 is contained for guided travel. The shoe has a toe portion 187' which, with the shoe in its normal position, as in Figure 24, terminates substantially even with the end of block 61 that forms the near side of the mouth 63 for guiding the wire strand into the gear slot. The shoe also has a leg portion 187x that extends outwardly and mounts a rigidly secured bolt 190 as an extension thereof. At its outer end, the bolt 190 is fixed in the outer end portion of a horizontal bar 191 which, at its inner end overlies the upper hub portion 192 of the gear 131. A stud 193 extends downwardly through the inner end of the bar 191 for guided travel in a groove 195 that is formed in the hub concentrically of the wheel axis.

The cutter shoe is pulled in a direction away from the twister and yieldingly held in the position of Figure 24 by a coiled spring 196 that is attached at one end to a stud 197 fixed in the shoe and at its other end to a stud 198 that is fixed in the plate 180, see Figure 19.

Mounted on the gear wheel 131 at upper and lower sides, are coiled springs 200, each of which is fixedly mounted at one end on a lug 201 formed on the corresponding side of the gear. The other ends of the springs are free; however, these two springs are retained in guideways provided between the opposite faces of the gear and plates 202 and 203 that are fixed in spaced relationship thereto, and closed at the outer side by a cylindrically curved plate 205 that is fixed to the circumferential edge of the gear 131 to extend to upper and lower sides thereof as best shown in Figure 19.

The normal position of the gear 131 and springs 200—200 is as shown in Figure 24, but when this gear is rotated in the direction of arrow x adjacent thereto by the initial reciprocal action of the rack bar 121, the free ends of the coiled springs 200 will be brought into abuting contact with the outer ends of the corresponding bars 191 as in Figure 25, and as the pressure of springs 200 overcomes the tension of springs 196, the shoes 187 will be shifted inwardly toward the twister gear and to the position of Figure 25, against the wires that are to be cut, but with not enough pressure to cut them. However, as the gear 131 continues to rotate, the pressure of the springs 200 is built up and finally studs 210, projecting from the upper and lower sides of the gear wheel 131, will engage with the corresponding bars 191 and cause a positive and final inward movement of the shoes that cuts the wires.

It is to be understood that the primary and secondary end portions of the band that encircles a bundle, and as laid down by the ring in a binding operation and as extended from the grippers G1 and G2 into the twister gear slot, are drawn tightly over shear blades 213 that are mounted by the fixed jaw portions of the grippers. The location of the wire strand that is to be cut is shown in Figure 25 at W1. The wire held in the lower gripper across the lower cutter blade is s[illegible] in Figure 23 at W2. The cutter shoes 187 have sharpened edges at 214. By the clockwise rotation of gear 131 in the knot twisting operation, these edges 214 are brought against the wires for the cutting operation. As soon as the wires are cut, the shoes 187 are released and the force stored up in the compressed springs 200 causes them to be driven forcibly against the band to eject the knot from the gear slot and also to kick the bundle away from the plates 55 and 56. This band ejecting position of the shoes is shown in dotted lines in Figure 25. Lugs 215 on the inner end portions of the shoes will engage the housing to limit the extent of travel of the shoes under force of the springs 200. A positive return of the shoes 187 is insured by reason of studs 216 mounted in upper and lower faces of the gear 131 in position to engage the corresponding bars 191 with the return of gear 131 in counter-clockwise direction to its starting position.

To insure that the end of the wire band will not be pulled from a gripper during this initial part of any wire laying operation, I provide each movable gripper jaw, on its inner face, with a small, inwardly extended boss 232, see Figure 23a, designed to be received in a socket 234 in the face of the stationary jaw. When the movable jaw is open, this boss is entirely clear of the stationary jaw surface, and presents no interference to reception of the wire strand into the base of the gripper mouth. When the movable jaw is closed, the wire will lie back of this boss and with the reversing of the ring for each band laying operation, the end of the wire will be bent back around this stud as a hook that retains the wire secure in the jaw. After the wire has been cut, this hook portion will drop out with the opening of the jaw.

One of the novel features of the present invention resides in the provision of means whereby the unjoined ends of the wire band will be prevented from being drawn laterally from the twister gear slot during the first turn of the gear in a twisting operation. For better understanding of this feature, it may be explained that there is a tendency, due to the fact that the twister gear is somewhat outside of the plane of the near side of the bundle, for the taut band to draw out of the gear slot as the gear makes that first half turn that faces its slot toward the bundle and before the overlapped portions of the band contained in the slot have been twisted together. This tendency of the band to pull out from the gear slot becomes greater if the bundle should not be placed closely up against the plates that define that side of the bundle passage.

The means which I have provided to overcome this possibility of one or both end portions of the band pulling out of the gear slot is illustrated in Figures 27 and 28, wherein it is provided that the block 70 which mounts the lower wire cutter blade thereon is slidably mounted in the gripper slide bar housing for limited retractive movement. The cutter blade 213x, as applied to this lower block, is extended to such length that, except when the block is retracted, the blade will extend just beyond the plane of the band as wrapped about the bundle and just beyond the twister gear slot, and will serve, when so extended, to form a support for the unjoined ends of the band as applied about the bundle and through the slot, that will hold them in the gear slot as the gear first turns toward the bundle.

It is necessary, however, for this blade 213x to be retracted to clear the wire band for release

from the twister gear immediately following the twisting operation, and prior to cutting of the ends of the wire and ejection of the knot from the gear. This is accomplished by retraction of the block 70 to which the blade is attached. To actuate the block to a retracted position, and to hold it there for a limited period during which the gripped end of the wire is cut, the band ejected and the bundle removed from the machine, I mount a cam shaft 235 vertically and rotatably in the guideway housing members for the lower gripper bar as shown in Figure 28. The cam shaft extends at its upper end into a recess 236 in the block 70 and is there provided with a flattened cam surface as shown at 237 in Figure 27*a*. A pair of coiled springs 238 contained in end sockets on block 70 act against the end wall 239 of the housing and against the block to urge it toward its extended position as shown in Figure 27. By rotation of the cam shaft from the position shown in Figure 27 in a counter-clockwise direction, an end edge of the flat surface 237 acting against a wall of recess 236 will shift the block away from the twister gear. This shifting is sufficient to shift blade 213*x* in the clear of the wire band as wrapped about the bundle, but not clear of that end of the band W2 as extended from the knot to the lower gripper. Thus, with the actuation of the lower cutter shoe 187, this end of the wire will be cut to release the bundle for removal from the machine.

To rotate the cam shaft 235, and thus to effect the shifting of the blade carrying block 70, I provide the said cam shaft, at its lower end, with a radially extending lever arm 240, and on the twister gear driving shaft 125 I provide a cam 241 as shown in Figures 19, 20 and 27. With the rotative action of the shaft 125 that takes place during the knot twisting operation, the cam 241 acts against the lever arm 240 and effects that rotation of cam shaft 235 that results in the retractive movement of the block, thus to shift the blade 213*x* out of the way of the band for its ejection from the gear slot. With the return movement of the shaft 125 toward starting position, the cam 241 disengages arm 240 and the parts resume the normal position as in Figure 27 under the pressure of springs 238.

It will be understood that with the retraction of the block 70, the movable gripper jaw associated with the block moves therewith, due to the pressure against its controlling piston, and does not release hold on its end of the wire band.

Control mechanism

The reversing of the driving motor 26, to reverse the direction of rotation of the ring 18 for successive binding operations, is accomplished through use of a conventional reversing switch designated at 244 in Figure 38 and shown in Figure 2 as mounted on plate 16. This is used in conjunction with two limit switches, 246 and 247 mounted on the plates 56 and 56*a* at opposite sides of the bundle passageway, and which operate, respectively, to stop the machine upon completion of binding cycles in opposite directions. Also, the solenoid valves 85 and 86 which, respectively, control the operations of the grippers G1 and G2, have the control switches 250 and 251, previously mentioned; these switches also being mounted on the plates 56 and 56*a*. Circuit connections for the switches are shown in Figure 38.

The functional operation of the switches 246, 247, 250 and 251 are timed and controlled by devices mounted on shafts 253 and 254, the locations of which, with respect to opposite sides of the bundle passage and ring, are shown in Figures 2, 7 and 11. Shafts 253 and 254 are independent of each other and are revolubly mounted by bearing brackets 260 and 261 that are fixed on the vertical plates 56 and 56*a*. Shaft 253 has devices thereon for timing the sequence of the binding operations that take place in one direction of rotation of ring 18, while shaft 254 has like devices thereon which time the sequence of operations in the other direction of rotation. Means for actuation of shafts 253 and 254 will now be described, particularly with reference to Figures 7 to 10.

Fixed on the inner end portions of shafts 253 and 254, respectively, and adjacent the ring 18, are ratchet wheels 255 and 256. Each ratchet wheel has eight teeth; those of one wheel facing opposite those of the other. These ratchet wheels are designed to be rotatably advanced, respectively, by pawls 270 and 271 that are pivotally mounted on the ring 18 as best shown in Figure 7.

Pawl 270 actuates the shaft 253 by contact with a tooth of ratchet wheel 255 when the ring rotates in one certain direction. Pawl 271, likewise, actuates shaft 254 by contact with a tooth of ratchet wheel 256 when the ring rotates in the other direction. Each time either ratchet wheel is operatively engaged by its actuating pawl, in passing, the shaft which mounts the ratchet is rotated through a forty-five degree interval and, as will presently be explained, each wheel is twice operatively engaged by its pawl in each binding cycle by reason of the ring 18 making more than one complete turn.

The ratchet actuating pawls 270 and 271 are angularly spaced on the ring 18 about 170°, as noted in Figure 7, and each pawl is pivotally mounted on the ring by a pivot bolt 282, and engages against a stop 283 to limit its turning in one direction, and a spring 285 is fixed thereto and to the ring to yieldingly hold the pawl extended to a position at which, in rotation of the wheel in one direction, it will be caused in passing the corresponding ratchet wheel to engage a tooth thereof and advance the wheel one interval, that is, one-eighth turn. When the ring rotates in a reverse direction, this pawl pivots on its bolt and merely rides over the ratchet wheel and avoids turning it in the reverse direction.

Fixed on the shafts 253 and 254 are switch actuator wheels 274 and 274', each of which comprises a circular disk formed with four equally spaced rises 274*a*, as shown in Figure 17. These wheels are designed to control the "on" and "off" positions of the switches 250 and 251. The actuator levers 250' and 251' of these switches engage with the edges of these wheels, and when a lever is resting on a rise of its actuator wheel, the switch that is controlled thereby will be on and the circuit which it controls will be closed.

Also fixed on the shafts 253 and 254 are star wheels 280 and 280', each having four equally spaced radial arms, as shown in Figure 16, that are designed, incident to rotative advance of the wheels by the turning of their mounting shafts, to operatively engage with and actuate the switch levers 246' and 247' of the corresponding limit switches 246 and 247.

Fixed on the shafts 253 and 254, at their outer ends, are indexing wheels 293' and 293'', each formed with eight equally spaced peripheral notches 285'. Pivotally fixed on the adjacent mounting plates 56 or 56*a*, adjacent each indexing wheel, is a lever arm 286 with a roller 287 at its

end adapted to ride on the wheel edge and to seat in its notches. Each lever has a spring 288 attached thereto, under tension, to cause its roller to yieldingly seat in a notch of the indexing wheel, thus to definitely index the advance movements of the shaft 253 or 254.

In the wiring diagram shown in Figure 38, the power input wires lead to a main switch from which connections *a*, *b*, *c* are made with the reversing switch 244 and similar connections made with knotter motor switch 300, which is turned on or off by push button switch 301.

The ring driving motor 26 has connections, *d*, *e*, and *f* with the reversing switch. Solenoid valves 85 and 86 are connected with their respective switches 250 and 251 by wires *g*—*h* and *g'*—*h'*. The knotter clutch solenoid 160 has connections *k* and *l* with limit switches 246 and 247 and these switches also have their connections *m*—*n* and *m'*—*n'* with the reversing switch 244.

Attention is called to the provision in switches 246 and 247 that whenever the switch lever arm 246' or 247' is actuated by the turning of the star wheel 280 or 280' to close a circuit through wires *m*—*n* or *m'*—*n'*, that stops the ring driving motor, a circuit is also momentarily closed through the solenoid 169 to release the clutch lever 150 and cause the knotter mechanism to be set in motion for one cycle of operations.

Operation

Binding operations in one direction or the other are started by a push button switch designated at 310 and having connections *r*—*s* and *r'*—*s'* with the reversing switch. Prior to commencing the binding operation, motor 104 is started by push button switch 301, and left running.

With the understanding that the opening of the grippers G1 and G2 is caused, respectively, by the energizing of solenoid valves 85 and 86, and that they respectivey are controlled by the switches 250 and 251, and that the stopping of the motor 26 when operating in different directions is effected by the opening of limit switches 246 and 247 and that the two switches 246 and 250 are controlled and timed by the action of shaft 253 and parts fixed thereto as influenced by pawl 270, and that switches 247 and 251 are likewise controlled and timed by the action of shaft 254 and parts thereon as influenced by pawl 271, it will then be apparent that if a binding operation starts with the ring 18 in that position seen in Figure 7, with the wire held at its end in gripper G1, as in Figure 32, the first rotatable actuation of shaft 254, by the pawl 271 engaging the ratchet 256 will cause the open switch 251 to be closed by wheel 274' and the solenoid 86 thereby energized, causing the lower gripper G2 to open. This opening of the gripper takes place after the primary end of the wire has been drawn into the twister gear slot and has passed to the inside of the gripper G2 as in Figure 33. Then with the completion of the wrapping operation and the laying of the secondary end of the band in gripper G2 as in Figure 37, the second actuation of shaft 254 by pawl 271 takes place. This causes wheel 274' to open switch 251 to de-energize the solenoid valve 86, thus to cause the gripper G2 to close on the secondary end of the band.

The first rotative action of shaft 254 effected by the above contact of pawl 271 with ratchet 256 causes no change in the switch 247 by wheel 280', but with the second rotative advancement of the shaft, switch lever arm 247' of limit switch 247 is actuated, and the circuit through wires *m'*—*n'* to the reversing switch is opened, thus to stop the ring driving motor and also to momentarily close a circuit through wires *k* and *l* to the knotter clutch control solenoid 160 to set the knotter in operation. The opening of the circuit to the reversing switch not only stops the ring driving motor but also causes a resetting of parts in the reversing switch that will cause the motor 26, when again energized, to operate in a reverse direction; this being a well-known function of reversing switches.

The same mode of operation takes place with the ring 18 turning in the reverse direction, and the primary end of the wire held in gripper G2. With the turning of the ring, the pawl 270 engages ratchet 255 for rotating shaft 253 to cause wheel 274 to actuate switch 250 to open gripper jaw G1 and, with the second actuation of the shaft, to de-energize the solenoid valve 85 to close the gripper G1 and to cause wheels 280 to actuate switch 246 to stop the machine at the completion of that binding cycle.

Cutting of the ends of the wire takes place with the completion of the knot twisting operation and the stopping of the twister gear is automatically effected by release of the driving clutch by the driven shaft.

It will be apparent to persons skilled in the art that the knotter mechanism may be disposed at the bottom of the bundle passage instead of at the side. It will also be apparent that certain features of the apparatus may be employed in a binding machine designed to handle bands of other materials such as rope or paper twine, for bundles where such bands would be suitable.

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 including a bundle support, a slotted twister gear adjacent thereto, a wire gripper adjacent each of the opposite ends of the twister gear and a rotatably mounted ring adapted to lay a wire band, while held at one end in one of said grippers, about the bundle and in the twister gear slot, and to apply it to the other gripper, power applying means for rotating the ring, a separate power applying means for rotating the twister gear, a control means for both of the said powered means, including a rotary shaft, a contact wheel thereon, an actuator member on the ring for engaging the contact wheel to rotatably advance the rotary shaft a definite interval with each passing of the actuator member, and means on the said shaft for actuating the control means to stop the ring after laying a band about a bundle with its ends in the twister gear slot, and to rotate the twister gear to join said ends.

2. In a wire binding machine, a bundle support, a gripper adjacent thereto for holding one end of a wire band, a rotatably mounted ring for laying a wire band under binding tension, while so held, about a bundle on said support, electrically powered means having a friction belt drive on the ring for rotating the ring, a manually set switch for energizing said means to rotate the ring, a switch for de-energizing the powered means to stop the ring, a fixedly positioned actuating means for the latter switch, and an actuator element on the ring disposed to momentarily engage and actuate the said fixedly positioned means at a predetermined angular position in the rotation of the ring after the ring has laid the band about the bundle and placed its ends in overlapped relationship.

3. In a wire binding machine, a bundle support, a gripper for holding one end of a wire band, a slotted twister gear, a rotatably mounted ring for laying a wire band, while so held, about a bundle on said support and in the twister gear slot, electrically powered means for driving the ring, electrically powered means for driving the twister gear, a control switch for each of said powered means, an actuator member common to both switches, and an actuator on the ring for functionally actuating the said actuator member to close one switch to stop the ring after the wire has been laid thereby about the bundle and twice through the gear slot, and to close the other switch to energize the twister gear to twist together the ends of the band therein.

4. In a wire binding machine, a bundle support, a gripper for holding one end of a wire band, a slotted twister gear, a rotatably mounted ring for laying a wire band, while so held, about a bundle on said support and in the twister gear slot, electrically powered means for driving the ring, electrically powered means for driving the twister gear, a control switch for each of said powered means, an actuator member common to both switches, an actuator on the ring for functionally actuating the said actuator member to close one switch to stop the ring after the wire has been laid thereby about the bundle and twice through the gear slot, and to close the other switch to energize the twister gear to twist together the ends of the band therein, and means operable by the twister gear driving means to automatically stop the twister gear after a predetermined amount of rotation.

5. In a wire binding machine, including a bundle support, a gripper for holding one end of a wire band, a slotted twister gear, and a rotatably mounted ring for laying a wire band while so held about a bundle on said support and to lay it in the twister gear slot; electrically energized means for driving the ring, electrically driven means for rotating the twister gear, a manual switch for energizing the first mentioned powered means to rotate the ring, a switch for de-energizing the powered means to stop the ring, a clutch for making or discontinuing the driving connection between the twister gear and its driving means, a switch for engaging the clutch to drive the gear, a switch control means, and an actuator on the ring for actuating the control means to actuate said switches to deenergize the ring driving means after the band has been laid about the bundle and twice in the twister gear, and to engage the clutch for rotating the twister gear.

6. Mechanism as recited in claim 5 including also means operated by the twister gear driving means for the automatic disengaging of the clutch.

7. In a wire binding machine having a bundle support, a slotted twister gear adjacent thereto, wire gripping means at opposite ends of the gear and a rotatably mounted ring operable to lay a wire band, while held at one end in one of said grippers, under tension about a bundle on said support and to place opposite end portions of the band in the twister gear slot and its other end in the other gripper; a reversible electric motor for driving the ring, a reversing switch therefor, an electric motor for driving the twister gear, manually operable switches for starting the ring driving motor, a de-energizing switch for the said motor, a shiftable clutch connection between the twister gear and its driving motor, electrically energized means for setting the clutch, a control switch for said latter means, a switch operating means common to said last mentioned switch and said de-energizing switch, and an actuator for the switch operating means mounted on said ring.

8. In a wire binding machine including a bundle support, a slotted twister gear adjacent thereto, primary and secondary grippers mounted in fixed positions at opposite ends of the gear and having movable jaws for gripping the ends of a band as applied about a bundle with opposite end portions laid in the twister gear slot, and a rotatably mounted ring having driving means for laying a wire band under binding tension, while held at one end in the primary gripper, about a bundle held on said support; individual means for shifting the gripper jaws to open positions in the plane of the wire band to receive the band and to closed positions at one side of the plane of the band to grip the wire band, a driving means for the twister gear, a control member for the ring driving means and the twister gear driving means, and an actuator positioned on the ring to operatively engage and actuate the control member twice during each binding cycle, the first actuation shifting the movable jaw of the secondary gripper to open position and the second actuation stopping the ring at the end of a wrapping operation, energizing the twister gear driving means and shifting the movable jaw of the secondary gripper to closed position.

9. In a wire binding machine including a bundle support, a slotted twister gear adjacent thereto, grippers at opposite ends of the gear adapted to grip and hold the ends of a wire band and a rotatably mounted ring for laying wire bands alternately in opposite directions about a bundle on said support, individual means for coordinating the opening, shifting and closing of the grippers with the turning of the ring, a driving means for the ring, a reversing means therefor, a driving means for the twister gear and separate mechanisms for controlling the operation of parts for different directions of rotation of the ring; each of said mechanisms comprising a rotatably mounted operating shaft, a star wheel on the shaft, oppositely faced pawls pivoted on the ring, one to engage the star wheel of one shaft when the ring rotates clockwise and the other to engage the star wheel of the other shaft when the ring rotates in a counterclockwise direction, and each of said mechanisms being operable to stop the ring at the end of a wrapping operation, to rotate the twister gear and to reverse the driving means for the ring.

10. A mechanism as in claim 9 including also, a wire cutter means at each end of the twister gear, and operable by the twister gear driving means at the end of a twisting operation.

11. In a binding machine of the character described, a rotatably mounted and longitudinally slotted twister gear, a rotary carrier operable to draw a wire strand from a wire supply and to lay it about a bundle and locate opposite end portions thereof in the twister gear slot, means for rotating the twister gear to knot together the end portions of the band contained therein, means for cutting the strand to release the bound bundle from the wire supply; said two last mentioned means having a common operating mechanism including a reciprocally movable bar which moves in one direction to cause formation of the knot and cutting of the wire, and which moves in the opposite direction to reset the twisting and wire cutting elements, a crank

shaft, a crank arm fixed thereto, a pitman connecting the crank arm and reciprocally movable bar, a continuously driven shaft, a one-revolution clutch operable to effect a driving connection between the driven shaft and crank shaft, and means operable by the rotary carrier at the end of a wire laying operation to engage said clutch.

12. In a binding machine of the character described, a rotatably mounted and longitudinally slotted twister gear, a rotary carrier for laying a wire band about a bundle and to place opposite end portions thereof in overlapped relationship in the twister gear slot, means for rotating the twister gear to knot together the contained end portions of the band, said means including a gear train and an actuating rack bar movable in one direction to effect the twisting operation, and movable in the other direction for the resetting of the parts, a crank shaft, a crank arm fixed thereto, and a pitman having connections at its ends with the crank arm and rack bar, one of which connections is yieldable, and means for definitely stopping the movement of the rack bar in that direction which results in a wire twisting operation, with the gear slot turned toward the bundle in a position to discharge the band, said crank arm having an over-run that provides an interval of rest for the twister gear for the discharge of the band therefrom.

13. In a binding machine of the character described, a rotatably mounted and longitudinally slotted twister gear, a carrier operable to draw a wire strand from a wire supply and to lay a band thereof about a bundle with opposite end portions of the band in the gear slot, a driving gear in mesh with the twister gear and rotatable in one direction for rotating the twister gear to join the band ends, and in the other direction to restore the gear to starting position, a wire cutter operable by said driving gear during a twisting operation to cut the wire strand for release of the bound bundle from the wire supply, a reversible driving means for said driving gear including a rack bar, a crank shaft, a crank arm fixed thereto, and a pitman rod connecting the crank arm and rack bar through a yieldable connection, means for definitely limiting the travel of the rack bar at the end of a wire twisting operation to stop the gear with its slot facing the bundle; said crank arm, by reason of its yieldable connection, having an over-run after the rack bar has been stopped at the end of the wire twisting operation, during which the gear is stationary for the displacement of the band from its slot.

14. A combination as recited in claim 13, including also, a continuously driven shaft, a one-rotation clutch providing a driving connection between the said continuously driven shaft and said crank shaft and a means controlled by the turning of said carrier means to set said clutch to cause one rotation of the crank shaft.

15. In a wire binding machine, in combination, a longitudinally slotted twister gear mounted in a fixed position in the wrapping plane of the machine, a wire carrier operable to draw a wire strand from a wire supply and lay a band thereof about a bundle and to place opposite end portions of the band in overlapped relationship in the twister gear slot, a driving gear in mesh with the twister gear and operable in one direction of rotation to rotate the gear to twist the band ends together therein, a wire cutting means including a cutter shoe movable toward the bundle and beyond the twister gear, and means on said driving gear arranged to engage and actuate said shoe to cut the wire strand after the overlapped end portions have been joined and eject the strand from the twister gear slot to free the bound bundle from the wire supply.

16. In a wire binding machine, in combination, a longitudinally slotted twister gear mounted in the wrapping plane of the machine, a wire carrier operable to draw a wire strand from a wire supply and lay a band thereof about a bundle and to place opposite end portions of the band in overlapped relationship in the twister gear slot, and a driving gear in mesh with the twister gear and operable through a definite portion of a turn to rotate the twister gear to twist the end portions of the band together therein, said twister gear having a wire discharge position with said slot facing the bundle, a wire cutter including a movable shoe, and means on said driving gear arranged to engage and actuate said shoe toward the bundle to cut the wire strand after the said end portions of the band have been joined to free the bound bundle from the wire supply and eject the band from the twister gear slot.

17. In a wire binding machine, in combination, a longitudinally slotted twister gear mounted in the wrapping plane of the machine, a wire carrier operable to draw a wire strand from a wire supplyl and lay a band thereof about a bundle with opposite end portions of the band in the gear slot, while the slot is faced away from the bundle, a relatively large driving gear for the twister gear, means for turning the said driving gear through a definite arc in one direction to cause said band ends to be twisted together and to face the gear slot toward the bundle for displacement of the band from the gear, then for turning it an equal amount in the reverse direction to reset the parts, a wire cutter means including a stationary cutter element and a coacting movable cutter shoe, and means on said driving gear for actuating the cutter shoe toward the bundle to cut the strand and free the bound bundle from the wire supply and displace the strand from the gear slot.

18. A combination as in claim 17 wherein said cutter shoe actuating means comprises a spring that is placed under compression by the movement of the said driving gear after the shoe has engaged the wire strand, and which spring, upon the severing of the strand by the shoe, expands to impart driving force to the shoe, to cause it to engage and displace the band from the gear slot and to kick the bundle away from the twister gear.

19. A combination as in claim 17 wherein the said means on the said driving gear for actuating the cutter shoe comprises a spring that is placed under compression by the further turning of the said driving gear after the shoe has engaged the wire strand, and which spring, upon the severing of the wire, expands to drive the shoe against the band to displace it from the slot and to kick the bundle away from the twister gear, and an actuator member on the driving gear for a positive actuation of the cutter shoe, after the spring has been placed under compression, to cut the strand.

20. In a wire binding machine of the character described, in combination, a longitudinally slotted twister gear, a support adjacent said gear against which a bundle may be placed for binding, a rotary carrier operable to draw a wire strand from a supply and to lay a band thereof about said bundle with opposite end portions of the band in said gear slot, a relatively large driving gear for the twister gear, rotatable in one direction to rotate the twister gear and to twist the band ends

together therein, and rotatable to like extent in the other direction to reset the parts, a wire cutter comprising a stationary cutter element across which the wire strand will be drawn after twice being laid in the gear slot, and a movable cutter shoe, means for guiding travel of the said shoe in a cutting and ejecting operation, a spring mounted on said driving gear and adapted to engage with the shoe after the twisting operation has been started, to shift the shoe to a cutting position against the wire, a positive actuator element mounted on said driving gear arranged to engage the shoe, after the band ends have been joined, to effect the cutting of the wire, said spring being placed under compression incident to the turning of the driving gear and operable by expansion, upon the band being severed, to eject the band from the gear slot and to kick the bundle away from said support, and means for retracting the shoe with the reverse travel of the said driving gear.

21. In a wire binding machine, the combination with a rotary, longitudinally slotted twister gear, a rotary wire carrier operable to lay a wire band under tension about a bundle and in doing so to lay opposite end portions thereof in the gear slot, and means for rotating the gear to twist together the ends of the band therein; of a wire cutter comprising a movable cutter element normally extending into the plane of the band as laid about the bundle and in the gear slot, to hold the unjoined end portions of the band against displacement from the gear slot incident to the initial turn of the gear in a twisting operation, and across which element the wire is laid by the carrier, a second cutter element adapted to be moved to coact with the first cutter element for cutting the wire as laid thereacross, means for actuating said second element, and means for retracting the first cutter element out of the plane of wrapping and clear of the band, as released from the gear.

22. A combination as recited in claim 21 wherein the first mentioned cutter element is mounted on a movable support and said support is actuated for the retraction of the cutter, by the twister gear driving means.

23. A combination as recited in claim 21 including also a movably mounted support for the first mentioned cutting element, a rock shaft that is rotatable for moving said support for the retraction of the cutter, a rotary shaft for driving the twister gear, and means on said rotary shaft for actuating the said rock shaft.

24. A combination as recited in claim 21 including also a reciprocally movable support for the first mentioned cutter, a spring acting thereagainst to normally position the cutter in its extended position, a rock shaft that is rotatable to effect that movement of the carrier for retraction of the cutter, a lever arm on said shaft, a rotary shaft for actuating the twister gear, and a cam on said rotary shaft for engaging the said lever arm to time the cutter retracting and extending movements of the said carrier in timing with the twisting operations.

25. In a binding machine having a reversible rotary carrier for laying a band under tension in opposite directions about a bundle, means for securing portions of the band together on one side of the bundle, grippers for holding said band in position for said securing means, a first control member arranged for actuation two times in succession by rotation of said carrier in one direction in a binding cycle, a second control member arranged for actuation two times in succession by rotation of said carrier in the opposite direction in a different binding cycle, means on said control members responsive to the first actuation thereof in a cycle to effect operation of one of said grippers, and means on said control members responsive to the second actuation thereof to effect another operation of said operated gripper and operation of said securing means.

26. In a wire binding machine of the type having a slotted twister gear for twisting together overlapped portions of the wire to form a knot, a member movable in opposite directions for turning said twister gear, means for limiting the movement of said member in one direction to stop the twister gear in a wire receiving position, means for limiting the movement of said member in the opposite direction to stop the twister gear in a knot ejecting position, and driving means for said member including a yieldable lost motion device having an overrun beyond the limits of movement allowed by said stops to provide an interval of rest for the twister gear in its knot ejecting position.

27. A binding machine comprising a rotary carrier for laying a band under binding tension about a bundle, an electric motor, a belt on said carrier driven by said motor to rotate the carrier, electrically operated means for securing portions of the band together on one side of the bundle, grippers for engaging said band on opposite sides of said securing means, electrical means for initiating the operations of said grippers, switch means adjacent said carrier for controlling said motor, securing means and grippers, and means on said carrier for actuating said switch means in timed relation with the rotation of said carrier to perform a cycle of binding operations.

28. A binding machine comprising a rotary carrier for laying a band under binding tension about a bundle, an electric motor belted to said carrier, means for securing portions of the band together on one side of the bundle, grippers for engaging said band on opposite sides of said securing means, fluid pressure cylinders for operating said grippers, solenoid valves controlling said cylinders, switch means adjacent said carrier controlling said motor, band securing means, and solenoid valves, and means on said carrier for actuating said switch means in timed relation with the rotation of said carrier to perform a cycle of binding operations.

29. A binding machine comprising a band laying ring, rollers engaging the outer periphery of said ring to support the ring for rotation, an electric motor having a belt drive on said ring to rotate said ring for laying a band under binding tension about a bundle, electrically operated means for securing portions of the band together on one side of the bundle, fluid pressure operated grippers for engaging said band on opposite sides of said securing means, electrically operated means controlling said grippers, switch means adjacent said ring for controlling said motor and electrically operated means, and means on said ring for actuating said switch means in timed relation with the rotation of said ring to perform a cycle of binding operations.

30. A binding machine comprising a reversible rotary carrier for laying a band under binding tension about a bundle, a reversible electric motor having a belt drive on said carrier to rotate the carrier in opposite directions, means for securing portions of said band together on one side of the bundle, grippers for holding said band in position for said securing means, switch means adjacent said carrier for controlling said motor,

securing means and grippers, and means on said carrier for actuating said switch means in timed relation with the rotation of said carrier to perform a cycle of binding operations.

31. A binding machine comprising a rotary carrier for laying a band under binding tension progressively about a bundle, a motor having a belt drive on said carrier, means for securing portions of said band together on one side of said bundle, grippers for holding said band in position for said securing means, a plurality of electric switches for controlling said motor, securing means and grippers, operating means for said switches adjacent said carrier, and means on said carrier for actuating said switch operating means to perform a cycle of binding operations in timed relation with the rotation of said carrier regardless of creep or slippage of the belt.

32. A binding machine comprising a rotary carrier for laying a band under tension about a bundle, a reversible electric motor having a belt drive on said carrier to rotate the carrier in opposite directions in successive band laying operations, means for securing portions of the band together on one side of the bundle, grippers for holding said band in position for said securing means, a first set of switches controlling said motor, securing means and grippers when said carrier rotates in one direction, a second set of switches controlling said motor, securing means and grippers when said carrier rotates in the other direction, and means on said carrier actuating said first set of switches when said carrier rotates in said one direction and actuating said second set of switches when said carrier rotates in said other direction to perform a cycle of binding operations in each of said directions of rotation.

33. A binding machine comprising a rotary carrier for laying a band under tension about a bundle, a reversible electric motor having a belt drive on said carrier to rotate the carrier in opposite directions in successive band laying operations, means for securing portions of the band together on one side of the bundle, grippers for holding said band in position for said securing means, a first set of switch means controlling said motor, securing means and grippers when said carrier rotates in one direction, a second set of switch means controlling said motor, securing means and grippers when said carrier rotates in the other direction, individual operating means for said two sets of switches adjacent said carrier, means on said carrier for actuating one of said switch operating means to operate said first set of switches when said carrier rotates in said one direction, and means on said carrier for actuating the other switch operating means to operate said second set of switches when said carrier rotates in said other direction, to perform a cycle of binding operations in each of said directions of rotation.

34. In a binding machine having a carrier rotatable through an angle exceeding 360° to lay a band about a bundle in each cycle of operation, a motor for driving said carrier, means for securing portions of said band together on one side of said bundle, grippers for holding said band in position for said securing means, means adjacent said carrier for controlling said motor, securing means and grippers, and means on said carrier for actuating said controlling means twice in succession in each cycle of operation at an intermediate point in the rotation of said carrier, the first actuation of said controlling means producing a gripper operation and the second actuation of said controlling means deenergizing said motor, operating said securing means, and producing another gripper operation.

35. In a binding machine having a rotary carrier for laying a band about a bundle; a plurality of operating components comprising driving means for said carrier, means for securing portions of said band together on one side of said bundle, and grippers for holding said band in position for said securing means; control means adjacent said carrier for controlling the operation of said components; and means on said carrier to actuate said control means twice in succession in each cycle of operation at a point removed from the starting point of the carrier, the first and second actuations of said control means effecting different operations of said components at different times in the cycle.

36. A binding machine comprising a rotary carrier for laying a band under tension about a bundle, an electric motor having a belt drive on said carrier to rotate the carrier, means for securing portions of the band together on one side of the bundle, grippers for holding said band in position for said securing means, electric switches controlling said motor, securing means and grippers, operating means for said switches adjacent said carrier, and means on said carrier for actuating said switch operating means twice in each band laying movement of said carrier after the carrier has left its starting position, certain of said switches being operated by the first actuation of said switch operating means and other of said switches being operated by the second actuation of said switch operating means.

37. A wire binding machine having a slotted twister gear mounted in a fixed position in the wrapping plane of the machine, a member movable in opposite directions for turning said twister gear in opposite directions, means for stopping the movement of said twister gear in one direction in a wire receiving position, means for stopping the movement of said twister gear in the opposite direction in a wire discharging position, driving means including a crank arm and pitman for moving said member in said opposite directions, and a yieldable lost motion connection in said driving means having an overrun beyond the limits of movement allowed by said stopping means to provide an interval of rest for said twister gear in its wire discharging position.

38. In a binding machine, a band laying carrier rotatable through an angle exceeding 360° for laying a band about a bundle, an electric motor having a friction belt drive on said rotary carrier, means for securing portions of the band together on one side of the bundle, grippers for holding the band for said securing means, a plurality of switches controlling said motor, securing means and grippers, a common actuator for said switches adjacent said carrier, a member on said carrier engaging said switch actuator twice in a band laying movement, and means on said actuator operating said switches selectively by the first and second engagements of the actuator by said member in a band laying movement of the carrier for performing a cycle of binding operations.

39. In a binding machine having band gripping, securing and cutting means for securing a band under tension about a bundle, a band laying carrier rotatable through an angle exceeding 360° for laying the band around the bundle, an electric motor having a friction belt drive on

said rotary carrier, a plurality of electric switches controlling said motor and the gripping, securing and cutting of said band in a binding cycle, an operating member adjacent said carrier arranged to close and open said switches in predetermined sequence in a cycle of switch movements requiring two actuations of said operating member, and an actuating member on said carrier arranged to actuate said operating member twice in a binding cycle.

40. In a binding machine for securing a band under tension about a bundle, a reversible rotary carrier for laying a band about a bundle in opposite directions in successive binding cycles, a reversible electric motor having a friction belt drive on said rotary carrier, a first set of switch means controlling the functions of the machine for a binding cycle in one direction of rotation of said carrier, a second set of switch means controlling the functions of the machine for a binding cycle in the opposite direction of rotation of said carrier, an operating member adjacent said carrier for said first set of switch means, an operating member adjacent said carrier for said second set of switch means, an actuating member on said carrier operatively engaging one of said operating members in one direction of rotation of the carrier, and an actuating member on said carrier operatively engaging the other operating member in the opposite direction of rotation of the carrier.

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