

April 15, 1969

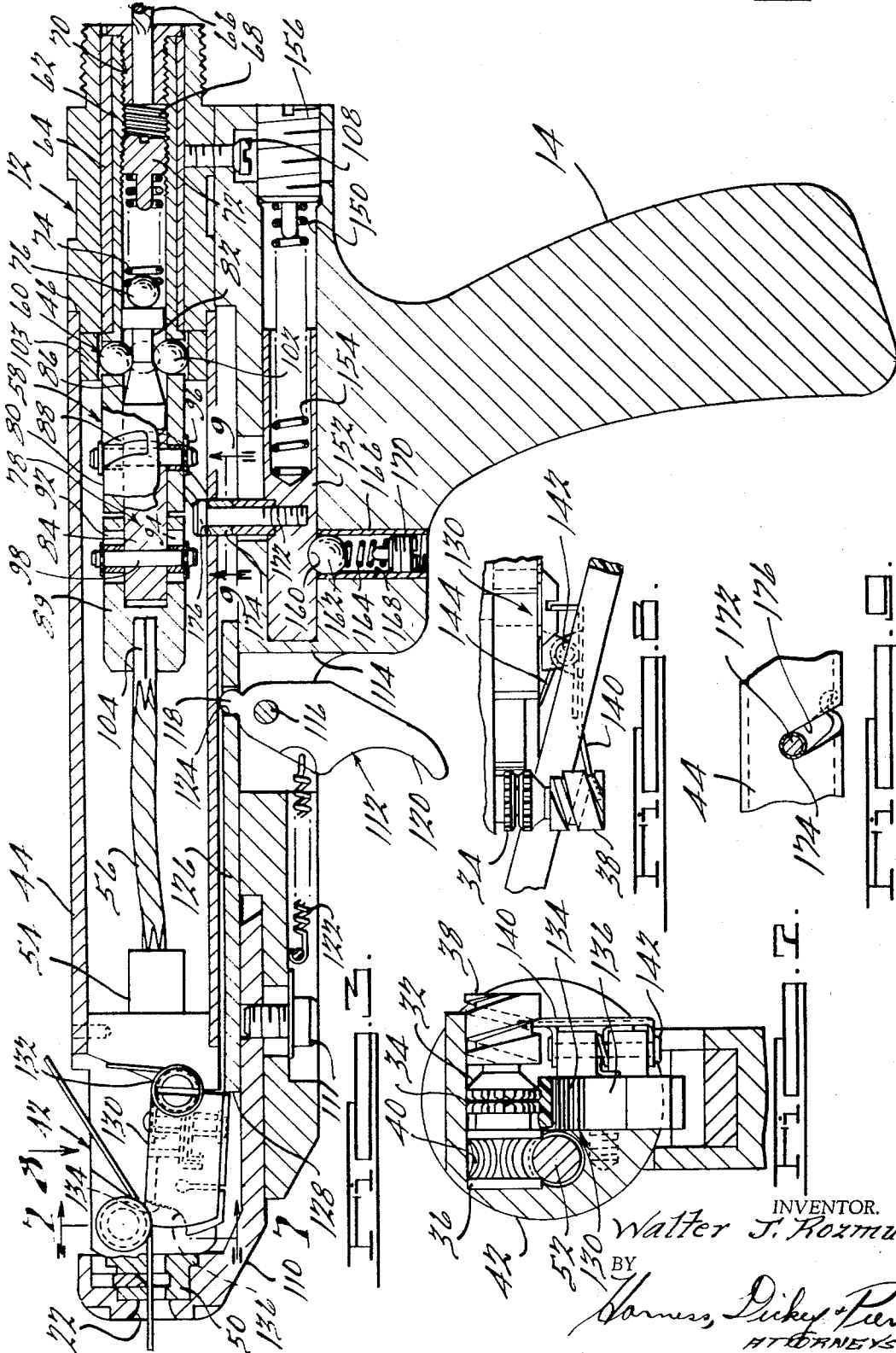
W. J. ROZMUS

3,438,406

STRAP TENSIONING AND LOCKING TOOL

Filed Oct. 13, 1966

Sheet 2 of 3



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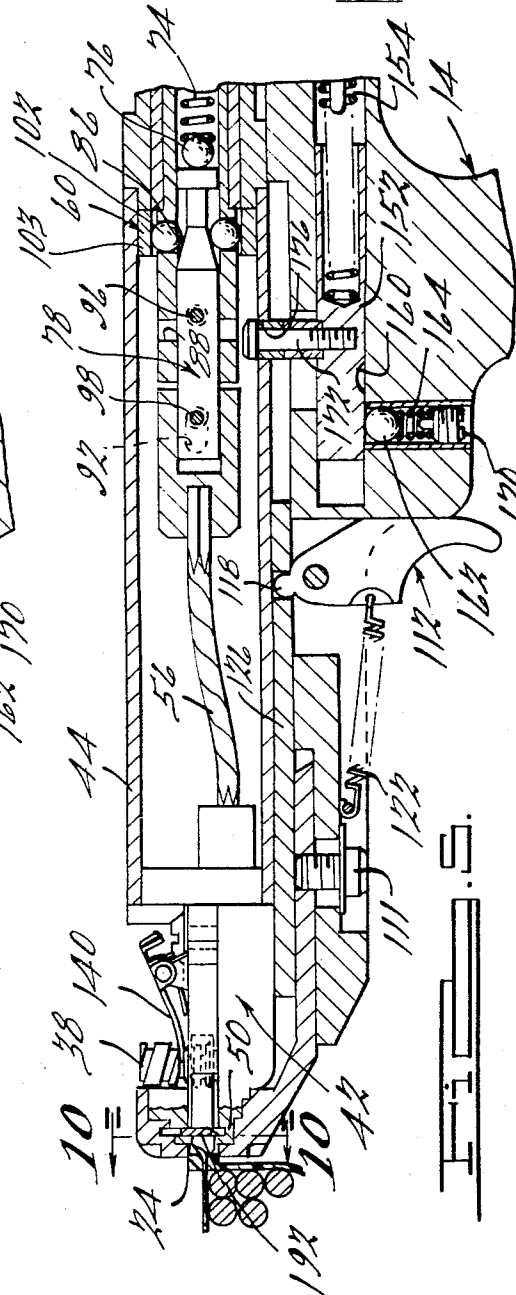
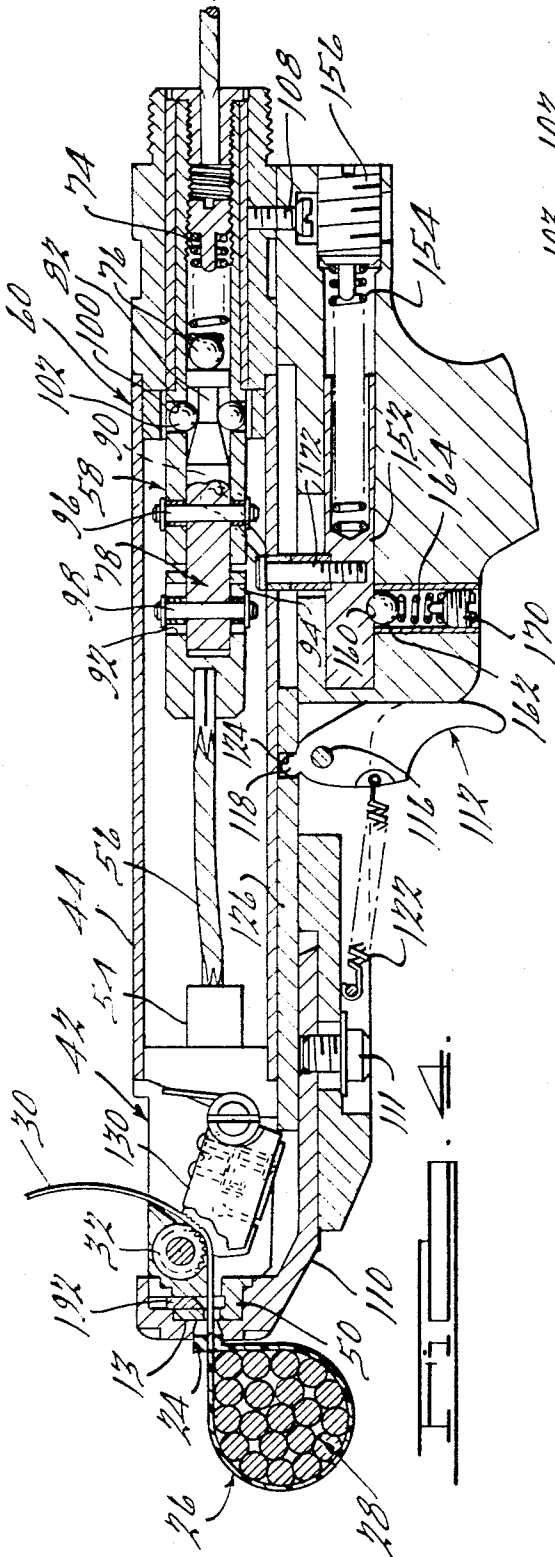
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Sheet 3 of 3



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1

3,438,406

STRAP TENSIONING AND LOCKING TOOL

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21 Claims

ABSTRACT OF THE DISCLOSURE

A power operated strap tensioning tool in which a serrated roller is continuously driven in rotation. By pulling a trigger the end of the strap to be tensioned is biased against this roller so that the roller will grip it and tighten it. When a predetermined tensional loading is applied to the strap a spring will yield so that the power used to drive the roller is employed to produce rotation of a strap supporting member to impart a permanent twist to the tensioned end of the strap and thereby lock the strap in the tensioned position.

This invention relates to a tool for applying a tensioned strap around a bundle of wires, or the like, and more particularly to a power tool that will upon the occurrence of a predetermined tension in the strap, twist the strap and thereafter cut it on the side of the twist remote from the bundle of wires or the like to provide a permanent tie for the bundle of wires or the like.

In accordance with the present invention, there is provided a power operated tool for tensioning a strap about a bundle of wires which may take the form of a group of electrical insulated conductors that are arranged generally parallel to one another. This grouping of wires is commonplace in various structures, such as, automobiles, airplanes and other vehicles in which a plurality of electrical circuits must be operated at a place remote from circuit-actuating means. These wires are commonly grouped together in a parallel fashion and are carried by the structure in which they are mounted by various fastening means that attach them to the structure in which they are mounted. It is desirable in these circumstances, to provide some means for tying the parallel wires together to form a simulated cable member that may be readily handled and threaded through a structure in which the conductors are used.

The present invention provides a tool for tying these parallel extending wires or conductors together to form a simulated cable. The tool is power operated and comprises a first jaw means for restraining movement of one end of a strap which has been positioned about a plurality of conductors and a second jaw means for gripping the other end of the strap which has been positioned through an aperture in the first end. Means are coupled to the second jaw means for driving the second jaw means to tension the strap, and means are provided responsive to a predetermined tension in the strap for twisting the portion of the strap held by the second jaw means to impart a permanent twist to the strap. Means are also provided for shearing or cutting the portion of the strap on the opposite side of the permanent twist from the end portion thereof which has the above-mentioned aperture positioned therein upon the continued twisting of strap.

An object of the present invention is the provision of

2

a novel power-operated tool for tensioning and securing a strap about a parallel group of conductors, wires or the like.

Another object of the invention is the provision of a power operated tool that will automatically tension a strap positioned about a group of conductors, wires or the like, twist the strap upon a predetermined tension existing in the strap and thereafter shear the strap in a position remote from the twist with respect to the bundle of wires so that the strap is permanently secured in a tensioned condition about the bundle of conductors, wires or the like.

Another object of the invention is the provision of a power-operated tool which will tension a strap positioned about a parallel group of conductors, wires or the like and will thereafter impart a permanent twist in response to a predetermined tension in the strap to thereby permanently place the strap in a tension condition about the group of conductors, wires or the like.

Other objects and attendant advantages of the present invention may be more readily realized as the attached drawings are considered in connection with the specification in which:

FIGURE 1 is a top plan view of the power-operated tool of the present invention;

FIG. 2 is a front elevational view of the power operated tool of the present invention;

FIG. 3 is a longitudinal sectional view taken along the lines 3—3 of FIG. 1;

FIG. 4 is a partial longitudinal sectional view similar to that of FIG. 3 and showing the power-operated tool in one phase of its operation;

FIG. 5 is a partial longitudinal sectional view similar to that of FIG. 3 and showing the power-operated tool in another phase of its operation;

FIG. 6 is a partial sectional view taken along the lines 6—6 of FIG. 1;

FIG. 7 is a sectional view taken along the lines 7—7 of FIG. 3;

FIG. 8 is a view taken in the direction of the arrow of FIG. 3;

FIG. 9 is a view taken along the lines 9—9 of FIG. 3;

FIG. 10 is a sectional view taken along the lines 10—10 of FIG. 5;

FIG. 11 is a sectional view taken along the lines 11—11 of FIG. 1; and

FIG. 12 is a view similar to FIG. 11, but showing the power-operated tool in a different phase of its operation.

Referring now to the drawings, the power-operated tool 10 of the present invention is shown generally in FIGS. 1 and 2 and it comprises a housing 11 having a generally cylindrical rear housing portion 12, a front housing portion 13 and a handle 14. The end 16 of the front housing portion 13 of the power tool has a longitudinally extending slot 18 positioned in an end wall 20. An oblong depression 22 is positioned around the slot 18 for the reception of an enlarged end portion 24 of a strap 26 positioned around a group of parallel extending wires, conductors or the like, generally designated by the numeral 28, as can best be seen by reference to FIG. 4. The other end 30 of the strap is positioned through an aperture in the enlarged end portion 24 and thence into a position to be engaged by a serrated roller 32, as will be described subsequently.

As can best be seen by reference to FIG. 7, the serrated roller 32 has a groove 34 extending circumferen-

3

tially thereof, and it is integrally formed with a gear 36 and a helically grooved guide 38. The gear 36 is rotatably positioned in a bore 40 of a support member 42 and the support member 42 is affixed to a longitudinally extending cylinder or barrel 44 by any suitable fastening means. The support member 42 and the cylinder 44 are rotatably supported in the housing 11 for rotation about an axis passing through the center of the cylinder 44 by means of an annular groove 46 positioned in the rear housing portion 12 which rotatably receives the end of the cylinder remote from the support member 42 and by a bore positioned in the end of the front housing portion 13 that receives a reduced cylindrical portion 50 formed on the support member 42.

Referring now to FIG. 6, the gear 36 is driven by a worm 52 rotatably supported in the support member 42 along an axis parallel to the axis of the cylinder 44 and perpendicular to the axis of the gear. This worm 52 has an enlarged extension 54 connected to a flexible drive cable 56, and the flexible drive cable is also attached to a driving means 58 that includes a clutch 60 (see FIG. 3). This drive means includes a cylindrical drive sleeve 62 rotatably supported in the rear housing portion 12 by means of a radial bearing 64. The driven cylindrical sleeve 62 is attached to a drive cable 66 by means of a threaded enlarged end 68 that is threaded into an internal bore 70 in the sleeve and that engages an adjustable plug 72 that is also threaded in the threaded bore 70. This adjustable plug 72 engages one end of a helical spring 74, the other end of which engages a ball 76 for forcing the ball into engagement with the end of a plunger 78 mounted in an internal bore in an extension 80 of the drive sleeve 62. This plunger 78 has a reduced portion 82 connected to its main body 84 by a conical ramp 86.

The extension 80 of the drive sleeve 62 has helical grooves 88 and 90 positioned therein, and a differential housing 89 positioned over the end of the main body portion 84 of the plunger 78 has a pair of opposed longitudinal grooves 92 and 94 positioned therein. The helical grooves 88 and 90 are positioned in opposed relationship and receive the ends of a pin 96, while the grooves 92 and 94 that are also positioned in opposed relationship receive the ends of a pin 98. Each of the pins 96 and 98 pass through and is affixed to the main body portion 84 of the plunger 78.

The drive sleeve 62 has a plurality of apertures designated by the numeral 100 and each of them receives a ball 102. The balls 102 together with the reduced portion 82, the conical portion 86 of the plunger 84, and an outer clutch ring 103 attached to the cylinder 44 form the clutch device 60, as will be explained subsequently.

The handle 14 of the power-operated tool 10 is attached to the rear housing portion 12 by a suitable fastening means, for example, machine screws, one of which is shown at 108 and to the front housing portion 13 by other suitable fastening means, for example, by means of machine bolts, one of which is shown at 111.

A trigger 112 is pivotally positioned in a space 114 in the handle 14 by means of a pin 116, and it has a knob 118 positioned thereon opposite the pivot pin 116 from the end 120 that is adapted to be operated by the tool operator. This trigger 112 is biased into the position shown by means of a helical spring 122, as can be seen most readily by reference to FIG. 3. The knob 118 is suitably positioned in an aperture 124 in a slidable actuating member 126 that has an end 128 in engagement with a spring-urged pawl 130 that is spring-urged into the position shown in FIG. 3 by a coiled spring 132. The pawl 130 has a serrated portion 134 and a cylindrical or curved portion 136 positioned on the end thereof adjacent the serrated roller 32. The pawl 130 carries a strap positioner 140 by means of a pin 142 and it is biased into the position shown in FIG. 8 by means of spring 144.

The handle 14 has an elongated bore 150 positioned

4

therein that is generally parallel to the cylinder 44 and the axis of the drive means 58. This elongated bore has a cylindrical plunger 152 positioned therein spring-urged by a helical return spring 154 into the position shown in FIG. 3. The compressive forces on the spring 154 may be adjusted by means of an adjusting screw 156 positioned in the end of the bore 150. The plunger 152 has an indentation 160 for the reception of a ball 162 that is urged into position by a spring 164. The spring 164 is positioned together with the ball 162 in a sleeve 166 that in return is received in a bore 168 in the handle 14. The compressive force on the spring 164 may be adjusted by an adjusting screw 170. The plunger 152 carries a pin 172 having a roller 174 positioned thereon that is received in a helical groove 176 positioned in the cylinder 44, as can best be seen by reference to FIG. 9.

Referring now to FIGS. 10-12, the reduced cylindrical portion 50 of the rotatable support member 42 has a radially extending slot 190 positioned therein that is aligned with the slot 18 in the end 16 of the front housing portion 13 when the tool is in its unactuated position as shown in FIGS. 2 and 3 and 11. A shearing knife 192 is pivotally mounted on the reduced portion 50 of the rotatable support member 42 adjacent slot 190 by means of a pin 194.

During the operation of the power-operated tool of the present invention, the strap 26 is positioned around a group of parallel extending conductors, wires or the like 28 and the end 30 which is substantially rectangular in cross section, is positioned through a complementary rectangular slot in the head 24 of the strap 26. The end 30 is then positioned in the tool through the slots 18 and 190 and this positioning is best shown in FIGS. 3 and 11. The end of the strap 30 will come into engagement with the serrated roller 32 and this may be accomplished readily, if there is any misalignment, by means of the strap positioner shown in FIG. 8 upon the actuation of the trigger 112 from its position shown in FIG. 3 to its position shown in FIG. 4.

The actuation of the trigger 112 will move the slidable actuating member 126 to the left so that the end thereof will raise the pawl 130 on which the strap adjuster 140 is positioned into the position shown in FIG. 4. This permits the end of the strap adjuster 140 to come into engagement with the helical groove positioned in the cylindrical guide 38.

A suitable power means drives the drive cable 66 thereby driving the interconnecting cable 56 through the drive mechanism 58. As viewed from the end of the tool 10 having the drive cable 66, the direction of rotation of the drive cable 66 is clockwise. By way of amplification, the clockwise rotation of the cable 66 is transmitted to the drive sleeve 62 by the enlarged end 68. This rotation is transmitted to the plunger 78, more particularly, the main body portion 84 thereof, by means of the pin 96 which is urged into the ends of helical grooves 88 and 90 by the spring 74 acting on the plunger 78 through ball 76. The rotation is then transmitted to the interconnecting cable 56 via pin 98 positioned in engagement with the differential housing 89 through the sides of the longitudinal slots 92 and 94. The rotation of the interconnecting cable 56 will in turn rotate the worm 52 thereby rotating the gear 36, the serrated roller 34 and the cylindrical guide member 38. If there is any misalignment of the end 30 of the strap 26, the strap adjuster 140 will move inwardly toward the serrated roller 32 in a direction parallel to the axis of the helical grooved guide 36 since the end of the strap adjuster 140 has been positioned in the helical grooves when the pawl 130 was raised by actuation of the trigger 112. This action will move the end of the strap or tie, as shown in FIG. 8, into the proper position where it can be engaged by the serrated roller 32. The serrated portion 134 of the pawl 130 will engage the strap so that the serrated roller 32 will properly grip the strap end 30 and this motion will continue

to rotate the pawl 130 in a counterclockwise direction, as viewed in FIGS. 3 and 4, to the position where the smooth curved portion 136 will come into engagement with the strap and hold it in engagement with the serrated roller 32. This smooth portion permits the strap to slide over it as the serrated roller 32 begins to tension the strap or tie 26.

The head 24 of the strap 26 is then positioned in engagement with the oval or oblong indentation 122 in the end 16 of front housing portion 13 thereby preventing the head 24 from rotating during subsequent twisting and cutting operations.

As strap 26 begins to be tightly drawn around the parallel extending conductors or wires 28, the turning force necessary to turn the serrated roller 32, the gear 36 and the worm 52 will increase thereby increasing the rotary force that must be present to drive these three components at the interconnecting cable 56 and at the differential housing 89. When the strap 26 begins to be tensioned around the parallel extending conductors or wires 28, it can be appreciated that the rate of rotation of the serrated roller 32, the gear 36, the worm 52, the interconnecting cable 56 and the differential housing 89 will be substantially reduced. The driving cable 66, however, will continue to be rotated in a clockwise direction as the tool is viewed from the end where this cable is connected. This continued rotation will cause the inner plunger member 78 to be rotated in a counterclockwise direction as viewed from the end of the tool to which the cable 66 is attached relative to the extension 80 of the drive sleeve 62. This action is permitted by the cooperation of the helical grooves 88 and 90 positioned in the extension 80 and the pin 96 affixed to the main body portion 84 of the plunger 78. This action forces the plunger 78 to the right as viewed in FIG. 3 into the position shown in FIG. 5 and the pin 98 attached to the main body portion 84 of the plunger 78 is permitted to slide longitudinally with respect to the axis of the plunger 78 through the slots 92 and 94 positioned in the differential housing 89.

The movement of the plunger 78 to the right against the bias of the spring 74 causes the conical ramp surface 86 to force the balls 102 of the clutch 60 radially outwardly into engagement with the clutch member 103 attached to the rotatable cylinder or barrel 44 thereby applying a rotating force on the cylinder or barrel which tends to rotate it clockwise as viewed from the end of the tool having the driving cable 66.

It will be remembered, however, that the pin 172 supported by the movable plunger 152 mounted in the bore 150 in the handle 14 has rollers 174 mounted thereon that are in engagement with the walls of a helical groove 176 positioned in the rotatable cylinder. This pin in cooperation with the helical groove 176 as positioned in FIG. 9, will prevent rotation of the rotatable cylinder 44 until sufficient force has been applied to it to overcome the force of the spring 164 that urges the ball 162 into engagement with the indented portion 160 of the plunger 152. As stated previously, the compressive force of the spring 164 on the ball 162 may be varied by the adjustment of the adjusting screw 170. When the force of this spring 164 is overcome, however, by sufficient force being applied to the plunger 152 along a line parallel to its axis through the pin 172 and the edge of the helical groove 176, the ball 162 will move downwardly, as viewed in FIG. 3. This permits the force being applied on the rotatable cylinder 44 to move the plunger 152 to the right, as viewed in FIG. 3, into the position as viewed in FIG. 5 through the action of the helical groove 176 and the pin 172 as the cylinder 44 rotates.

It should be understood that the ball 162 when forced into the indented portion 160 of the plunger 152 by the spring 164 prevents rotation of the cylinder 44 due to the friction between the pawl 130 and the strap 26 until sufficient force has been applied to overcome the com-

pressive strength of the spring 164. This force will be supplied as soon as the clutch 60 becomes engaged by the above-described action upon a predetermined tension existing in the strap 26.

The rotation of the cylinder 44 will rotate the rotatable support member 42 from the position shown in FIGS. 1 and 3 into the position shown in FIG. 5, thereby imparting a twist in the end 30 of the strap 26 at the point shown in FIG. 5. As shown in the drawings, the direction is counterclockwise, as viewed in FIGS. 10 through 12 and clockwise as viewed from the end of the tool that has the driving cable 66, and the angle is approximately 90°, but any other suitable angle could be employed.

The continuing rotation of the rotatable support member 42 brings the shearing knife 192 shown in FIG. 11, into play and it will come into abutment with a shoulder formed in the front housing portion 13, as shown in FIG. 12, thereby applying a rotating force on the shearing knife 192 that rotates it with respect to the rotatable support member 42 and moves its cutting edge through the end 30 of the strap or tie 26.

It can be appreciated therefore that the twisting and cutting of the strap 26 occurs when the clutch mechanism 60 is actuated against the bias of spring 74 when a predetermined tension level occurs in the strap 26 and that this level may be set by the adjustment of adjusting plug 72.

As shown in the drawings, the strap 26 is constructed of a plastic material that will take a permanent set as the twisting operation occurs so that when the end 30 is cut by the shearing knife 192, the twist will remain. The strap 26 therefore will be under a permanent tension around the parallel extending conductors or wires 28. The end 30 with the twist in it cannot therefore move back through the horizontal slot in the head 24. The continued rotation of the gear 36 and serrated roller 32 as the end 30 of the strap is severed will short the severed end of the strap out of the tool.

When the forces in the drive mechanism 58 are released by the severing of the end 30 of the strap or tie 26 by the shearing knife 192, the spring 74 will force the plunger to the left from the position shown in FIG. 5 to the position shown in FIG. 3 thereby disengaging the clutch 60. The return spring 154 that is in engagement with the plunger 152 will move the plunger to the left from its position shown in FIG. 5 to the positions shown in FIGS. 3 and 4. The pin 172 with its rollers 174 positioned in the helical groove 176 in the rotatable cylinder 44 will therefore rotate the cylinder 44 and the rotatable support member 42 back into the position shown in FIGS. 3 and 4. The operator will then release the trigger 112 and the tool will then be in position to perform another tying operation.

It should be noted that the twisting and cutting operations on the strap 26 occur automatically upon a predetermined tension occurring in the strap and that this predetermined tension may be set by the adjustment of the adjusting screw 72 that adjusts the force applied by the spring 74 against the plunger 78.

The present invention thus provides a compact, efficient and easily operated power tool for placing a strap around a group of parallel extending wires, conductors or the like in which the strap will be automatically twisted and thereafter cut when a predetermined tension is present in the strap. This twisting and cutting operation leaves the strap under this predetermined tension around the parallel extending group of wires, conductors or the like, to bind them together in the form of a simulated cable.

Although a preferred embodiment of the invention has been illustrated and described in detail, it should be understood that various modifications and additions may be made thereto without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. A power operated tool for tensioning a strap comprising means for restraining movement of one end of the strap, rotary means for gripping the strap in a location spaced from said one end, manually operable means for biasing a strap into engagement with said second mentioned means, power operated means coupled to said second mentioned means and driving said second mentioned means in rotation for tensioning the strap, and means responsive to a predetermined tension in the strap for twisting the portion of the strap held by said second mentioned means to impart a permanent twist in said strap.

2. The combination of claim 1 includes a shearing means operatively coupled to one of said first or second mentioned means for shearing the portion of the strap on the opposite side of the permanent twist from said first mentioned means as said last mentioned means continues to twist the strap.

3. The combination of claim 1 including means operatively coupled to said second mentioned means and said last mentioned means for rotating said second mentioned means through a substantial angle upon the occurrence of the predetermined tension in the strap.

4. The combination of claim 3 in which said second mentioned means comprises a serrated roller mounted in said power operated tool on a rotatable axis substantially perpendicular to the motion of the strap as it is tensioned.

5. The combination of claim 4 in which said serrated roller is supported in a rotatable support means rotatably supported in said power-operated tool about an axis substantially perpendicular to the axis of said roller.

6. The combination of claim 5 in which said power-operated means comprises a drive means positioned in said rotatable support means, said drive means including a clutch having means operable upon a predetermined tension in the strap for engaging the clutch with said rotatable support means thereby rotating said rotatable support member and said serrated roller through said substantial angle.

7. The combination of claim 6 in which a spring urged means carried by said power tool engages said rotatable support means for preventing said clutch means from rotating said rotatable support means prior to the time when said predetermined tension is present in said strap.

8. The combination of claim 5 including a trigger means carried by said power-operated tool, a pivotally mounted pawl pivotally mounted in said rotatable support member adjacent said serrated roller, and means interconnecting said trigger means and said pivotally mounted pawl for pivoting said pawl upon the actuation of said trigger means, said pawl engaging the strap upon pivotal movement thereof for bringing it into engagement with said serrated roller.

9. The combination of claim 8 including a strap positioning means carried by said pawl, and means rotatable with said serrated roller engaging said strap positioning means when said pivotally mounted pawl is rotated by the actuation of said trigger means said strap positioning means including means for moving said strap into engagement with said serrated roller and said pawl.

10. The combination of claim 2 including means operatively coupled to said second mentioned means and said last mentioned means for rotating said second mentioned means through a substantial angle upon the occurrence of the predetermined tension in the strap.

11. The combination of claim 10 in which said second mentioned means comprises a serrated roller mounted in said power operated tool on a rotatable axis substantially perpendicular to the motion of the strap as it is tensioned.

12. The combination of claim 11 in which said serrated roller is supported in a rotatable support means rotatably supported in said power operated tool about an axis substantially perpendicular to the axis of said roller.

13. The combination of claim 12 in which said power-operated means comprises a drive means positioned in

said rotatable support means, said drive means including a clutch having means operable upon a predetermined tension in the strap for engaging the clutch with said rotatable support means thereby rotating said rotatable support member and said serrated roller through said substantial angle.

14. The combination of claim 13 in which a spring-urged means carried by said power tool engages said rotatable support means for preventing rotation of said rotatable support means prior to the time said clutch is engaged due to said predetermined tension in said strap.

15. The combination of claim 12 including a trigger means carried by said power-operated tool, a pivotally mounted pawl pivotally mounted in said rotatable support member adjacent said serrated roller, and means interconnecting said trigger means and said pivotally mounted pawl for pivoting said pawl upon the actuation of said trigger means, said pawl engaging the strap upon pivotal movement thereof for bringing it into engagement with said serrated roller.

16. The combination of claim 15 including a strap positioning means carried by said pawl, and means rotatable with said serrated roller engaging said strap positioning means when said pivotally mounted pawl is rotated by the actuation of said trigger means, said strap positioning means including means for moving said strap into engagement with said serrated roller and said pawl.

17. In a power-operated tool for tensioning a strap around a plurality of parallel extending wires, conductors or the like, with the strap including an enlarged end having a rectangular aperture positioned therein, and a complementary shaped rectangular main body portion comprising a housing having an end portion, means on said end portion holding said enlarged end of the strap for preventing rotation thereof, a support means rotatably mounted in said housing, a serrated roller rotatably mounted in said rotatable support member about an axis substantially perpendicular to the axis of rotation of said support member, cooperating means mounted in said support member for causing the main body portion of the strap to be brought into engagement with said serrated roller, a drive means mounted in said support member for driving said serrated roller, and means coupled to and operated by said drive means for imparting a rotary force on said support member when the tension in said strap reaches a predetermined level, whereby when said predetermined tension occurs in the strap, said rotatable support member including said serrated roller is rotated about an axis substantially perpendicular to the axis of rotation of said roller and a twist is imparted to the main body portion of the strap.

18. The combination of claim 17 including cutting means carried by said rotatable support member for cutting the main body portion of the strap when the rotatable support means has been rotated through an angle sufficient to impart the twist to the strap.

19. The combination of claim 18 including means carried by said power-operated tool and engaging said rotatable support means for preventing rotation of said rotatable support means prior to the time said predetermined tension occurs in said strap.

20. The combination of claim 18 in which said means coupled to and operated by said drive means for imparting a rotary force on said support member comprises a clutch having clutching members carried by said drive means, and means carried by said drive means for forcing said clutching members into engagement with said rotatable support member when said predetermined tension occurs in the strap.

21. The combination of claim 19 in which said means carried by said power-operated tool and engaging said rotatable support means for preventing rotation of said rotatable support means until said predetermined tension occurs in said strap comprises a spring-urged plunger mounted in said power tool for reciprocal movement in a direction substantially parallel to the axis of rotation

of said support member, a pin carried by said plunger, said rotatable support member having a helical groove for the reception of said pin, and ball detent means positioned in said power tool and engaging said plunger.

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