ABSTRACT

A tool for fastening a length of thermoplastic resin coated lacing tape around a cable is characterized by means for twisting together the lacing tape ends, heating means for fusing the twisted ends, and means for severing the cable securing tape loop from the supply. Preferably the tool is pistol-shaped and houses a motor which rotates a tubular drive shaft having a twisting member at the muzzle end. The heating and severing means are contained in jaws retracted in the tool barrel and connected to a carrier threadingly engaging a drive screw on the drive shaft exterior. Lacing tape supplied through the shaft is looped around the cable and the free end attached to the twisting member. Rotation of the drive shaft simultaneously twists the tape securely against the cable and extends the jaws into fusing and severing contact with the tape twisted ends. Counter-rotation retracts the jaws in readiness for the next lacing operation. Alternatively, the jaws may be solenoid actuated.

11 Claims, 4 Drawing Figures
BACKGROUND OF THE INVENTION

1. Field of the Invention
The present invention relates to a harness cable lacing tool for twisting and heat fusing the ends of a length of lacing tape looped around a wire bundle.

2. Description of the Prior Art
It is common in the assembly of electronic equipment or the installation of electrical wiring to employ harness cables comprising wire bundles bound with lacing tape.

Harness cables typically are laced by hand using tape supplied from a spool. The installer loops the tape around the cable, forms a simple knot to secure the wires, runs a length of tape along the cable to the next tie-point, and repeats the process. Generally the tape is not severed at each tie, rather an extended cable run is harnessed with a continuous length of lacing tape.

Lacing of such harness cables is tedious and time consuming. However, attempts at automation have met with difficulty. One problem results because most cables include groups of wires which branch into the cable at different locations. This manifold configuration means that certain cable sections will contain fewer or more wires than other sections, so that the diameter is not uniform throughout the entire run. A cable lacing tool must compensate for such diameter differences.

One prior art approach involves the use of individual adjustable ties, each comprising a length of nylon or polypropylene having a special gripping head at one end. The tie is looped around the cable, the tail slipped through the head and pulled tight. Differences in cable diameter are compensated for. Pistol-type tools are available to install such ties. A disadvantage is that such ties are relatively expensive compared with lacing tape, and different length ties are necessary for different wire bundle diameters.

Accordingly, an object of the present invention is to provide a tool for automating the use of lacing tape in forming harness cables. The tool uses lacing tape continuously supplied from a source, and forms secure cable fastening loops regardless of wire bundle diameter.

SUMMARY OF INVENTION
These and other objectives are achieved by providing a pistol-type harness cable lacing tool having in the barrel a tubular shaft containing a double notched twisting member at the muzzle end. A heater and knife members are contained in jaws normally retracted in the barrel. Lacing tape having a thermoplastic coating is supplied through the shaft and through one of the twisting member notches. The tape is looped around the wire bundle and the free end attached to the other notch. A motor rotates the drive shaft to twist the tape securely against the cable. Simultaneously the jaws are positioned into contact with the tape, where the heating element melts the coating to fuse the twisted ends. The knife severs the cable-securing loop from the tape supply. The jaws may be driven by a carrier cooperating with an external drive screw on the drive shaft, or may be actuated by other means such as a solenoid.

BRIEF DESCRIPTION OF THE DRAWINGS
A detailed description of the invention will be made with reference to the accompanying drawings wherein like numerals designate corresponding elements in the several figures.

FIG. 1 pictorially illustrates use of the inventive lacing tool for assembling a harness cable.

FIG. 2 is a side view, partly broken away, of the inventive harness cable lacing tool with the jaws retracted.

FIG. 3 is a muzzle end view of the lacing tool of FIG. 2.

FIG. 4 is a longitudinal sectional view of an alternative lacing tool embodiment employing solenoid jaw actuation, and shown with the jaws extended into fusing and cutting engagement with the lacing tape twisted ends.

DESCRIPTION OF THE PREFERRED EMBODIMENTS
The following detailed description is of the best presently contemplated modes of carrying out the invention. This description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention since the scope of the invention best is defined by the appended claims.

Structural and operational characteristics attributed to forms of the invention first described also shall be attributed to forms later described, unless such characteristics obviously are inapplicable or unless specific exception is made.

Referring to FIG. 1, the inventive lacing tool 10 is useful in the assembly of a harness cable 11 wherein plural wires 12 are bundled together by cable-securing lacing tape loops 13. To form each loop 13, a length of thermoplastic resin coated lacing tape 14 from a supply spool 15 is pulled from the tool muzzle end 10a and looped around the wires 12. The tape free end 14a is inserted into a twisting member 16, described below.

Depression of a trigger switch 17 starts rotation of the member 16 so as to twist together the lacing tape ends 14a, 14b extending from the cable 11. Simultaneously a pair of jaws 18 (FIG. 2) are extended from the muzzle end 10a into contact with the twisted tape ends 14a, 14b. The jaws 18 contain heating elements 19 which melt the thermoplastic coating to fuse together the twisted tape ends. Knife edges 20 on the jaws 18 sever the tape loop 13a from the lacing tape 14 supplied through the tool 10. Upon release of the trigger switch 17 the jaws 18 retract, completing formation of a cable-securing loop 13.

Operation of the tool 10 is independent of the bundle 12 diameter. Hence the same tool 10 may be used to form the relatively large diameter loops 13 (FIG. 1), the intermediate size loops 13a and the small loops 13b securing different portions of the harness cable 11.

Referring to FIGS. 2 and 3, the lacing tool 10 is seen to include a pistol-shaped housing 23 including a grip or handle 24 supporting the trigger switch 17 and a barrel 23a terminating at the muzzle end 10a. Extending through the barrel 23a is a tubular drive shaft 24 fastened at the rear end 24a to a drive motor 25. The drive shaft forward end 24b is connected by a slip clutch 26 to the twisting member 16. The twisting member 16 comprises a double-notched disc 16a closing the muz-
Lacing cable 14 from the spool 15 extends through the shaft 24, the clutch 26, the tube 16b and a first notch 16a near the periphery of the disc 16a. After being looped around the wire bundle 12, the lacing tape free end 14a is inserted in another peripheral notch 16d situated in the disc 16a diametrically opposite the notch 16c.

When the switch 17 is depressed, the motor 25 rotates to drive the shaft 24, the clutch 26 and the twisting member 16 in one direction. This rotation of the member 16 twists together the lacing tape ends 14a, 14b. When these ends have been twisted into tight contact with the wire bundle 12, the resultant drag on the twisting member 16 causes the clutch 26 to slip. The twisting member 16 ceases to turn, while continued rotation of the motor 25 and the shaft 24 drives the jaws 18 into contact with the twisted tape ends 14a, 14b.

In the embodiment of FIGS. 2 and 3, the jaws 18 are connected by pivots 28 to a carrier 29. The carrier 29 has a threaded central aperture 29a which engages a drive screw 24c on the exterior of the drive shaft 24. Thus rotation of the motor 25 in one direction causes the carrier 29 to translate axially of the drive shaft 24 toward the muzzle end 10a. During such translation the cammed outer surfaces 18a of the jaws 18 ride against radially inwardly tapered portions 23b of the barrel 23a interior. This cooperation causes the jaw forward ends 18b into contact with the twisted lacing tape ends 14a, 14b as shown in phantom in FIG. 2.

Provided in the jaw ends 18a are the heating elements 19. These elements 19 may comprise electrical resistance heaters supplied with current via wires (not shown) extending through the housing 23. The elements 19 preferably are heated to a temperature sufficient to melt the thermoplastic coating of the lacing tape 14, but insufficient to melt the tape itself. Thus for lacing tape 14 comprising nylon coated with a thermoplastic vinyl, a heating element 19 temperature on the order of 225°F. is typical. At this temperature the vinyl will soften sufficiently to flow and fuse the twisted ends 14a, 14b. However, the temperature is not sufficient to melt the nylon portion of the tape 14.

The jaw ends 18a also include knife edges 20 which sever the lacing tape end 14b from the continuous line of lacing tape 14 supplied from the spool 15.

Counter-rotation of the motor 25 retracts the jaws 18 upon completion of the fusing and severing operations. Such counter-rotation may be initiated by release of the switch 17 and terminated automatically when the jaws reach the fully retracted position shown in solid in FIG. 2. Alternatively, the switch 17 may have a "retraction" position, or the retraction cycle may start automatically after the jaw ends 18a have been in contact with the twisted tape ends for a preselected duration of time.

As evident in FIG. 3, the carrier 29 is provided with a pair of laterally extending guides 29b of generally T-shaped cross-section. The guides 29b ride within respective C-shaped channels 23c extending longitudinally along the inside of the barrel 23a. The guides 29b and channels 23c cooperate to prevent rotation of the carrier 29 as the jaws 18 are extended and retracted.

The rear of the tool 10 is configured to receive the lacing tape supply spool 15. To this end, the housing 23 includes a spool chamber 23d having spaced, coaxial spindles 30, 30a which receive the hollow shaft of the spool 15. One of the spindles 30a is spring loaded to facilitate spool replacement.

In the alternative embodiment of FIG. 3, the lacing gun 10 has a rotary twisting mechanism 16 like that of the gun 10. However, the jaws 18 are extended and retracted by a pair of solenoids 33 actuated when the lacing tape ends 14a, 14b have been twisted tightly against the wire bundle 12. The solenoids 33 may be energized by the switch 17, or by a switch (not shown) which closes when rotation of the member 16 stops and the clutch 26 is "slipping." Alternatively, the clutch 26 may be eliminated and the twisting member 16 driven directly by a small motor 34. Electrical control circuitry 35 may sense the change in motor 34 current coincident to the increased drag occurring when the lacing tape ends 14a, 14b are twisted tightly against the bundle 12. In response to such current change, the circuitry may turn off the motor 34 and energize the solenoids 33 to extend the jaws 18. A single solenoid may be used in place of the two shown.

Intending to claim all novel, useful and unobvious features shown or described, the applicant:

1. A harness cable lacing tool for securing a length of lacing tape around a wire bundle, comprising: a housing, a drive motor in said housing, a tubular drive shaft extending through to one end of said housing and having at said one end a twisting member, a source of lacing tape, said tape extending through said shaft and said twisting member, a part of said twisting member receiving the free end of said tape after looping around said bundle, said drive motor rotating said shaft and member to twist together the ends of said tape loop, a heating element, and means for positioning said heating element against said tape to fuse said twisted ends.

2. A cable lacing tool according to claim 1 wherein said lacing tape comprises a line of first material having one melting temperature, said line being covered with a thermoplastic resin having a second, lower melting temperature, said heating element heating said lacing tape to a temperature intermediate said first and second temperatures to melt said resin but not said line.

3. A cable lacing tool according to claim 1 further comprising means for terminating said twisting when said lacing tape is twisted securely against said cable while continuing to position said heating element.

4. A cable lacing tool according to claim 3 wherein said means for terminating comprises a slip clutch connecting said drive shaft and said twisting member.

5. A cable lacing tool according to claim 1 wherein said twisting member comprises a disc across said shaft one end, said disc having a first notch through which extends said lacing tape from said source, and a second notch receiving said tape free end.

6. A cable lacing tool according to claim 1 wherein said housing is pistol-shaped and including a trigger-positioned switch for controlling operation of said motor.

7. A cable lacing tool according to claim 1 wherein said drive shaft includes an external drive screw, wherein said heating element is contained in a pair of jaws, and wherein said means for positioning comprises
5 a carrier cooperatively engaging said drive screw to extend said jaws forwardly of said housing and into heat providing contact with said lacing tape twisted ends as said shaft is rotated in a first direction, and to retract said jaws when said shaft is rotated in the opposite direction.

8. A cable lacing tool according to claim 7 wherein said jaws also include knife means for cutting said lacing tape twisted ends from the tape supplied through said shaft.

9. A cable lacing tool according to claim 7 further comprising:

guide means in said housing to prevent rotation of said carrier as said jaws are positioned, and means for mounting a spool of lacing tape and for guiding tape from said spool into said tubular drive shaft.

10. A cable lacing tool according to claim 1 wherein said heating element is jaw mounted, and wherein said means for positioning comprises a solenoid for extending said jaw into operative engagement with said twisted ends.

11. A hand held tool for securing a thermoplastic coated lacing tape around a wire bundle, comprising:

a grip-shaped housing, means for twisting together the ends of a length of said tape extending around said bundle, said twisting means being contained substantially within said housing and including a rotatable member engaging said ends and drive means for rotating said member, a pair of jaws retractable into said housing, said jaws containing heating means for applying heat to said lacing tape to fuse said twisted ends and a cutter for severing said fused ends from a tape supply line, and extension/retraction means for extending said jaws into operative engagement with said heating element positioned against said twisted ends to fuse them together and with said cutter in severing relationship with said tap, and for retracting said jaws back into said housing subsequent to fusing and severing of the tape.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,821,058 Dated June 28, 1974

Inventor(s) ALAN R. MILLER

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the designation of Assignee, change "EDN Corporation" to --EON Corporation--.

Signed and sealed this 17th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR. C. MARSHALL DANN
Attesting Officer Commissioner of Patents