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METHOD FOR THREADING WIRES THROUGH INSULATION

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This invention relates to the protecting or insulating of wires and relates more particularly to a method for running or threading wires through flexible tubes of plastic, rubber, etc.

In the aircraft industry it is the practice to provide flexible sheaths or tubes of plastic for the bundles or so-called harnesses of electrical wires. It has always been a tedious, time-consuming, and, therefore, expensive operation to thread the wire bundles through the plastic tubing. In many cases the bundles contain a large number of individual wires of considerable length, say, from 30 to 50 feet long. In order to facilitate the handling of the wires they have been tied together at spaced points throughout their length by cords or string, this tying operation requiring considerable time and patience. A string or cord is then run or blown through the plastic tubing by entering the string in one end of the tubing and then blowing air under pressure through the tubing to blow the string on through. This necessitates handling and straightening of the tubing and often the string becomes tangled or caught in the tubing so that additional time is required to free it and work it on through the tubing. After the cord or string has been threaded through the tubing, it is tied to a plain wire and this wire is laboriously threaded or worked through the tubing. The wire is then attached to the end of the harness or bundle of electrical wires and is employed to assist in pulling or threading the bundle through the tubing. The bundle closely fits the flexible tubing and two or three men are needed to laboriously work the bundle through the plastic tubing. In practice, many man hours are expended in slowly working or threading the bundle through the flexible plastic tubing.

It is a general object of the invention to provide a practical expeditious method for threading or running bundles of wires through flexible tubing by means of which one person may readily run or thread a bundle of wires through a long tubing in a matter of minutes. In actual operations, one man by employing the method of the invention may readily thread a bundle of wires through a flexible plastic tubing in about five minutes, whereas two and perhaps three men would require from 1 to 2 hours to run the same bundle of wires through the same tubing by the customary or standard method.

Another object of the invention is to provide a method of this character that completely eliminates many of the operations required in the methods heretofore employed. In accordance with the present invention there is no need to tie the bundle or harness of wires at spaced points as was the practice heretofore and there is no necessity for blowing or threading a string through the tubing or in pulling a plain wire through the tubing preparatory to entering the bundle into the tubing. The complete elimination of these previously required operations as well as the greatly simplified actual threading or training of the tubing over the bundle makes the method of the invention simpler and much more rapid than the earlier methods.

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Another object of the invention is to provide a method of the kind named that may be performed in full by only one person. In practice, one man may, without undue effort, and without special skill, easily and quickly run or train the plastic tubing over the wire bundle regardless of its length.

Another object of the invention is to provide a method of this character employing a simple, practical and inexpensive apparatus. The equipment or apparatus is simple to manufacture and convenient to use in employing the inventive method.

A further object of the invention is to provide a method of this character that is adapted to handle flexible tubing of various sizes and types.

Other objectives and features will become apparent from the following detailed description of a typical apparatus of the invention and the method of the invention, throughout which description reference will be made to the accompanying drawings, wherein:

Figure 1 is a plan view of the apparatus with the rollers appearing in horizontal cross section and showing the clutch thimble inserted in the end of the tubing and the rod attached to the end of the wire bundle;

Figure 2 is an enlarged more or less schematic horizontal sectional view illustrating the tubing engaged between the rollers and started over the end of the wire bundle;

Figure 3 is a view similar to Figure 2 illustrating the act of elongating or stretching a portion of the tubing with the thimble cooperating with the rollers to clutch the tubing;

Figure 4 is a view similar to Figure 3 showing the clutch-thimble released and the tension removed from the tubing so that a portion thereof has moved onto the wire bundle;

Figure 5 is a view similar to Figure 3 showing the clutch-thimble again cooperating with the rollers to clutch or grip the tubing for further elongation of a portion thereof;

Figure 6 is an enlarged plan view showing the rod secured to the end of the wire bundle and illustrating the clutch-thimble in longitudinal cross section; and

Figure 7 is an enlarged front elevation of the rollers showing the tubing and rod in vertical cross section.

The apparatus of the invention includes a pair of rollers 10 and 11 supported in spaced parallel relation. The rollers 10 and 11 are rotatable on shafts or pins 12, which are secured at their lower ends to a base 13. Washers 14 are provided at the opposite ends of the rollers 10 and 11 and a removable retaining plate 15 overlies the upper washers, being normally held in place by heads 16 on the pins 12 which may be in the nature of bolts threaded into the base 13, see Figure 7. The rollers 10 and 11 are spaced apart leaving a gap or space 9 therebetween to receive the flexible plastic tubing 15, as will be later described in more detail. A third roller 16 may be rotatably mounted at a side of the roller 10 in spaced relation thereto to leave a gap 17, somewhat smaller than the gap 9, to receive smaller plastic tubing, not shown. The roller 16 may be supported on a pin or bolt 12 in the same manner as the rollers 10 and 11. Upon loosening and removing the pins or bolts 12 the rollers 10, 11 and 16 may be replaced by rollers of other sizes to provide spaces 9 and 17 for receiving plastic tubing 15 of different sizes, as may be required. The base 13 may be bolted, or otherwise secured, on a work bench or other suitable support as the conditions of use dictate. In the simple case illustrated, the base 13 is clamped in a vise 18 which, in turn, is secured on a work bench, or the like.

The apparatus further includes a wire or rod 20 and a spool or thimble 21 freely movable on the rod. The rod 20 is of moderate length, say one or two feet long, more

or less, and may be fairly rigid. One end of the rod 20 is secured to an end of the bundle 22 of wires. The rod 20 may be connected or secured to the wire bundle 22 in any selected or appropriate manner. In the drawings I have shown a lug 23 swedged, soldered, or otherwise secured on an end of the wire bundle 22 and the rod 20 is in turn attached to this lug. The thimble 21 is an elongate, generally cylindrical, part of steel, or the like, having a central longitudinal opening 24 slidably or freely passing the rod. A nut 22 is threaded on the free end of the rod 20 to prevent loss or displacement of the thimble. As shown in Figure 1, the wire or rod 20 is passed through the gap 9, between the rollers 10 and 11, with the wire bundle 22 at what will be considered the outer side or front of the rollers 10 and 11, and the thimble 21 is engaged on the rod at the inner or rear side of the rollers. The end 26 of the thimble 21 facing the rollers 10 and 11 is abrupt or flat with suitably rounded edges while the opposite or rear end of the thimble is tapered to facilitate entrance of the thimble into the tubing 15. The thimble 21 loosely but positively connected with the bundle 22 cooperates with the rollers 10 and 11 to form a clutch for gripping and holding the tubing 15 as the tubing is stretched or elongated during the method described below. The diameter of the thimble 21 is such that the tubing 15 may freely slide over the thimble. It will be observed that the apparatus above described is simple, compact, and inexpensive to manufacture.

In addition to the apparatus described above, an air supply pipe or hose 30, carrying a valve 31, may be used to inflate the flexible tubing 15 when the same is being trained over the wire bundle 22, particularly in cases where the bundle is long and where the tubing 15 is to tightly engage about the wire bundle. The manually operable valve 31 has a nozzle or nipple 32 for entering the end of the tubing 15 most remote from the rollers 10 and 11 and a clamp 33, or the like, may releasably or temporarily clamp the tubing onto the nipple.

In carrying out the method of the invention the relatively short wire or rod 20 is secured to an end of the wire bundle 22, for example by means of the lug 23. In this connection it may be observed that the terminal or lug 23 serves to connect the ends of the several wires constituting the bundle 22 and this is the only mutual attachment or connection of the wires necessary preparatory to training the plastic tubing 15 over the wires. It is unnecessary to wrap or tie the bundle 15 at spaced points throughout its length as in the earlier methods. The wire or rod 22 is passed through the gap 9 between the rollers 10 and 11 and the spool or thimble 21 is arranged on the rear portion of the rod, being loosely retained thereon by the nut 25. The end portion of the flexible tube 15 is then manually threaded over the thimble 21. Figure 1 shows the tubing 15 being slid or passed over the thimble 21. When this has been done the tubing 15 is passed through the gap 9 between the rollers 10 and 11 and its end is manually trained or worked over the lug 23 and onto the end portion of the wire bundle 22. A sufficient length of the plastic or rubber tubing 15 is manually worked over or onto the wires of the bundle 22 to be conveniently grasped by the hands of the operator so that he may grip the tubing to hold and pull the bundle 22 through the medium of the tubing. At this time, that is prior to pulling on the wire bundle, the thimble 21 is free of and at the rear of the rollers 10 and 11. Figure 2 of the drawings illustrates the parts in the position and condition just described. It will be observed from this figure and from Figure 7 that the narrow gap 9 between the rollers 10 and 11 constricts and flattens the flexible sheath or tubing 15, the soft flexible tubing readily conforming to the surfaces of the rollers where it enters the gap.

With the parts in the positions of Figure 2, the workman grasps the tubing 15 at the bundle 22 to prevent rearward or retrograde movement of the tubing relative to the bundle. This gripping or retention of the tubing 15 is in-

dictated in the drawings by the arrow X. The workman then pulls outwardly on the tubing 15 and wire bundle 22 as indicated by the arrow Y in Figure 3. This may be done by the hand grasping the tubing at X and by the other hand engaging and pulling on the tubing 15 between the bundle 22 and the rollers 10 and 11. The outward pull on the bundle 22 and flexible tubing 15 first moves a portion of the flexible tubing through the gap 9 and brings the thimble 21 to a position such as shown in Figure 3 where it grips or pinches the walls of the tubing 15 against the rolls 10 and 11. Accordingly continued outward tension or pull applied to the tubing 15 in front of the rollers 10 and 11 stretches or elongates this region or portion of the tubing. The tubing 15 is constructed of vinylite plastic or other plastic material or composition having considerable elongation under tension and possessing elasticity so as to return to approximately its original length when the tension is relieved. In practice the tubing 15 is usually a transparent or partially transparent vinylite material and is illustrated as such in the drawings. It is to be understood that the tubing 15 may be constructed of other flexible elastomeric materials such as rubber, synthetic rubber compositions, etc. In Figure 3, the arrows X indicate the grip maintained by the workman to hold the tubing 15 against retrograde movement, as above described, while the outward tension is applied and maintained and the arrow Y represents the outward pull and elongation or advancement of the tubing 15, the tubing being held or clutched at the rollers 10 and 11 by the thimble 21 so that the portion of the tubing ahead of the rollers is stretched and advanced. In addition to merely elongating the tubing 15 in front of the rollers 10 and 11, this portion of the tubing is worked or advanced forwardly over the wire bundle 22. This is done by the two hands of the workman, care being taken to prevent retrograde movement or elastic return of the tubing toward the rollers 10 and 11. The portion of the tubing 15 ahead of the rollers 10 and 11 and advanced onto the wire bundle 22 is preferably stretched or elongated to approximately the extent of its ability and commensurate with the strength of the workman.

The next step or operation of the method is the freeing or releasing of the roller and thimble clutch 10-11-21, to permit the elastic property or tendency of the tubing 15 to return to its original length to further advance the tubing over the wire bundle 22. In the drawings the characters A, B and C indicate points on the tubing that are originally equally spaced therealong, these points being illustrated merely to assist in explaining the method and invention. By comparing Figures 2 and 3, it will be seen that the forward or outward working and elongating of the tubing 15, as described above, has moved the point A from a position between the rollers 10 and 11 and the lug 23 to a position beyond or ahead of the lug. The abovementioned release of the clutch 10-11-21 is effected by relieving the forward pull or tension on the bundle 22 and tubing 15 and allowing a limited retrograde movement of the bundle and tubing as a unit while maintaining the grip at the region X to prevent the tubing from returning back toward the rollers relative to the bundle 22. The action just described may move the lug 23 toward the rollers 10 and 11 to a position such as shown in Figure 4 and, of course, frees the thimble 21 so that the tubing 15 is no longer clutched or gripped at the rolls. As a consequence of this release of the tubing 15, the tension or energy stored in the elongated elastomeric tubing 15 causes the tubing to return to its original length. This restoration of the tubing 15 to its original or approximately original length results in bodily forward movement of a substantial portion of the tubing through the gap 9 to in front of the rolls 10 and 11. This motion of the tubing 15 is represented by the arrow Z in Figure 4. While this is taking place, the workman holds or manipulates the tubing 15 that is already on the wire bundle 22 in such a manner that the tubing is moved for-

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wardly along the bundle but he holds or stops the tubing against any retrograde movement toward the rolls 10 and 11. As will be seen from an inspection and comparison of Figures 3 and 4, the points A, B and C have all advanced, the point A having moved some distance along the wire bundle 22, the point B having moved from behind the rolls 10 and 11 to a position some distance ahead of the rolls, and the point C having advanced toward the rolls. This advancement of the tubing 15 through the rolls 10 and 11 and over the wire bundle 22 caused by the elastomeric return of the tubing, coupled with the action or manipulations of the workman, produces considerable movement of the tubing forwardly along the bundle. In practice, the retrograde movement of the bundle 22 from a position such as shown in Figure 3 to a position such as shown in Figure 4 to effect the release of the clutch 10-11-21, is accompanied by the forward advancement of the tubing 15 over the bundle 22 as represented by the arrow Z so that there is a distinct "illusion" that the bundle of wires is being drawn into the tubing. As already stated, the advancement of the tubing 15 over the bundle 22 as represented by the arrow Z is considerable in extent. This advancement of the tubing 15 is determined in amount by several factors, namely the amount of stretch or elongation of the tubing 15, the length or amount of the tubing 15 that had previously been advanced over the bundle 22 and worked or elongated forwardly and the total length of the tubing from the grip point X to the rolls 10 and 11.

As described above, the tubing 15 and the wire bundle 22 may be related so that the bundle is to tightly fit within the tubing. In such a case, and particularly where the bundle 22 is of considerable length, it is desirable to attach the air pressure supply pipe or hose 30 with the end of the tubing 15, as shown in Figure 1, so that the valve 31 may be operated to admit air under pressure to the tubing. In addition, it is sometimes desirable to introduce a suitable dry lubricant such as powdered soapstone into the tubing 15 prior to initiating the operations. The air under pressure admitted to the tubing 15 serves to inflate the tubing 15 and increase its diameter so that it more readily advances forwardly over the wire bundle 22. In this connection the workman, by proper manipulation of the tubing 15 on the wire bundle 22 and by operation of the valve 31, may control the inflation of the tubing to assure a rapid free working or advancement of the tubing 15 over the wire bundle.

After the tubing 15 has been caused or allowed to advance over the wire bundle 22, as above described and as shown in Figure 4, the workman again applies a pull or tension to the bundle 22 and tubing. This returns the thimble 21 to the position at the rolls 10 and 11 where the tubing 15 is clutched or gripped between the thimble and rolls. The workman while preventing any retrograde movement or return of the tubing 15 pulls on the tubing to elongate the portion thereof ahead of the rolls 10 and 11 and at the same time works the tubing forwardly along the wire bundle 22. This is the same action as above described and serves to move the point B some distance along the wire bundle 22 and to elongate a substantial portion of the elastomeric tubing 15. The workman while preventing any retrograde movement or return of the tubing 15 relative to the bundle 22 releases the forward pull on the assembly in such a manner that the thimble 21 is freed to move to a position such as shown in Figure 4, and again the energy or elasticity stored in the elongated portion of the tubing ahead of the rolls 10 and 11 causes a substantial part or region of the tubing 15 to advance through the gap 9 and to move up over the wire bundle 22. As in the previously described series of operations, the workman at this time manipulates the tubing in such a way that it is free to advance along the wire bundle 22 and yet prevents any retrograde movement or return of the tubing in the direction of the rolls 10 and 11.

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The above described sequence of operations is repeated until the plastic tubing 15 has been threaded or trained over the entire length of the wire bundle 22. At the completion of the job the wire or rod 20 is disconnected from the wire bundle 22 and of course the lug 23 may be removed from the wires if and when desired. In actual operations employing the method of the invention it is usual to run a plastic tubing over a bundle of wires 50 ft. long in a matter of minutes, say 5 minutes, a single workman being all that is necessary for the entire job, whereas this same job or operation requires at least two and usually three men and takes from 1 to 2 hours when employing the conventional or older method. The manual operations or manipulations of the single workman when performing the method of the invention become semi-automatic and are repetitious so that a plastic tubing of considerable length may be quickly run over a bundle of wires in a short time and with a minimum of physical effort. The apparatus is simple to set up and use, and as noted above may be adapted or constructed to handle plastic tubing of a range of different diameters. In the present method there is no necessity to run or blow string, wires or the like, through the plastic tubing preparatory to training the tubing over the wire bundle as in the earlier methods. In fact, a minimum of time and effort is required to prepare for the actual running of the plastic tubing 15 over the wire bundle 22.

Having described only a typical form of the invention I do not wish to be limited to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art and fall within the scope of the following claims.

I claim:

1. The method of running an elastic tubing over a wire bundle which comprises the steps of (1) starting an end part of the tubing over an end portion of the bundle, (2) axially stretching a region of the tubing ahead of the bundle by applying tension to the same by gripping the tubing at a first point spaced axially ahead of the bundle while manipulating the tubing along the bundle at a second point to tension and axially elongate the tubing between said points, to advance the tubing over the bundle to some extent and to prevent the tubing from moving axially back toward said first point, (3) releasing the grip on the tubing at said first point to cause the axial elastic return of said stretched region of the tubing to axially advance additional tubing over the bundle while manipulating the tubing at said second point to allow such advancement of the tubing and yet prevent retrograde axial movement of the tubing, and (4) successively repeating steps (2) and (3) to progressively advance the tubing over the bundle.

2. The method of training a flexible resilient tubing over a wire bundle which comprises the steps of (1) attaching a rod to an end of the bundle; (2) assembling a thimble on the rod; (3) training the tubing over the thimble and rod, then between a pair of spaced rollers and then onto an end portion of the bundle; (4) manipulating the tubing along the bundle to advance the same longitudinally therealong and to exert a pull on the tubing and bundle which moves the thimble to the rollers to clamp the tubing against the rollers and thus stop further bodily longitudinal movement of the tubing; (5) manipulating the tubing on the bundle to tension and longitudinally elongate the region of the tubing extending between said rollers and the area of manipulating the tubing of the bundle; (6) then relieving said tension by allowing the bundle to move longitudinally toward the rolls to release the clamping engagement of the thimble and rollers so that the longitudinal resilient return of said region of the tubing advances additional tubing longitudinally onto the bundle; (7) and manipulating the tubing on the bundle to allow such additional tubing to move longitudinally along the bundle and to

prevent retrograde longitudinal movement of the tubing relative to the bundle.

3. The method of training a flexible resilient tubing over a wire bundle which comprises the steps of (1) attaching a rod to an end of the bundle; (2) assembling a thimble on the rod; (3) training the tubing over the thimble and rod, then between a pair of spaced rollers and then onto an end portion of the bundle; (4) manipulating the tubing along the bundle to advance the same longitudinally therealong and to exert a longitudinal pull on the tubing and bundle which moves the thimble to the rollers to clamp the tubing against the rollers and thus stop further bodily longitudinal movement of the tubing; (5) manipulating the tubing on the bundle to tension and longitudinally elongate the region of the tubing extending between said rollers and the area of manipulating the tubing on the bundle; (6) then relieving said tension by allowing the bundle to move longitudinally toward the rolls to release the clamping engagement of the thimble and rollers so that the resilient longitudinal return of said region of the tubing longitudinally advances additional tubing onto the bundle; (7) and manipulating the tubing on the bundle to allow such

additional tubing to move along the bundle and to prevent retrograde longitudinal movement of the tubing relative to the bundle and then (8) repeating steps (4), (5), (6) and (7) to progressively advance the tubing over the handle.

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