March 27, 1962 R. L. TURNER, JR 3,027,417

EXTENSIBLE ELECTRIC CABLE

Filed June 29, 1959 2 Sheets-Sheet 1

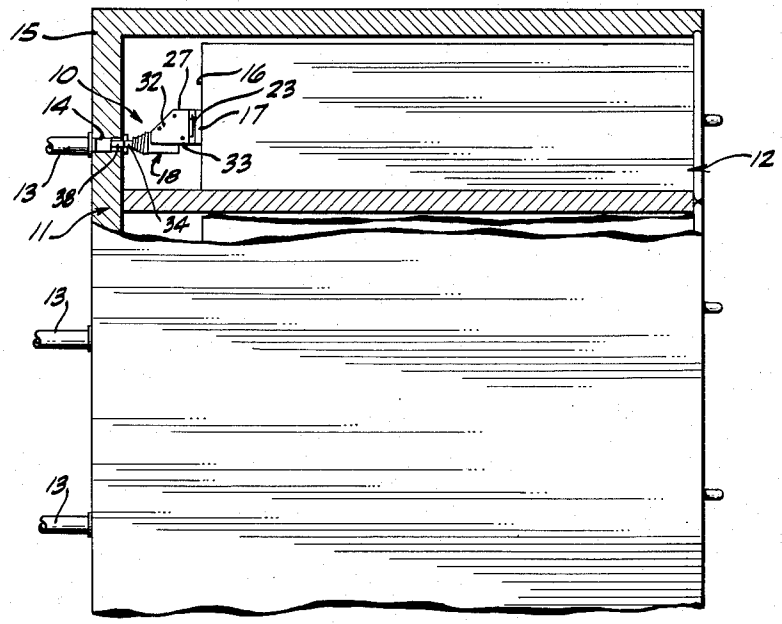


FIG. 1.

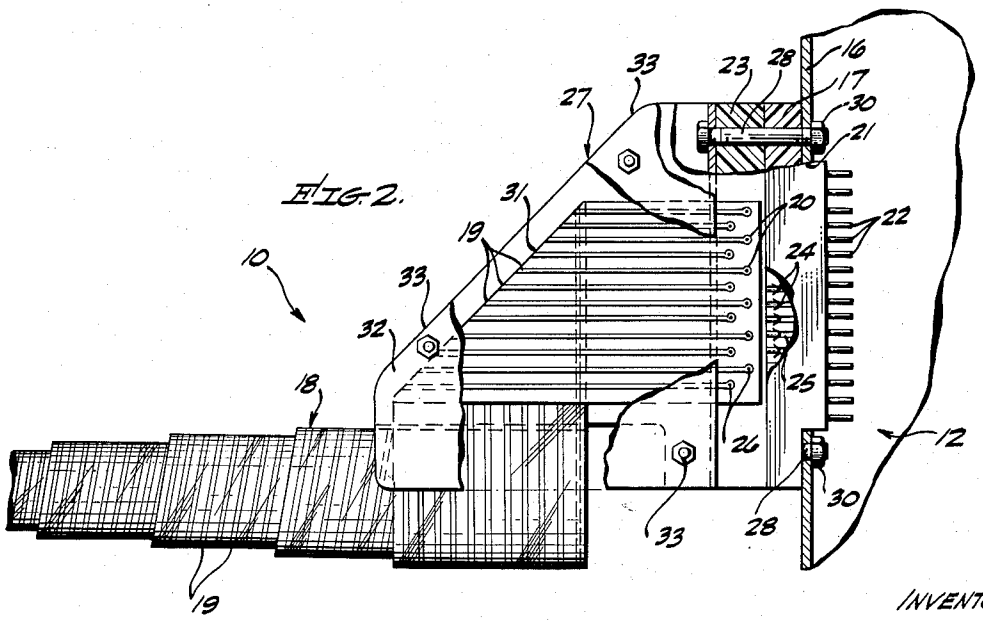


FIG. 2.

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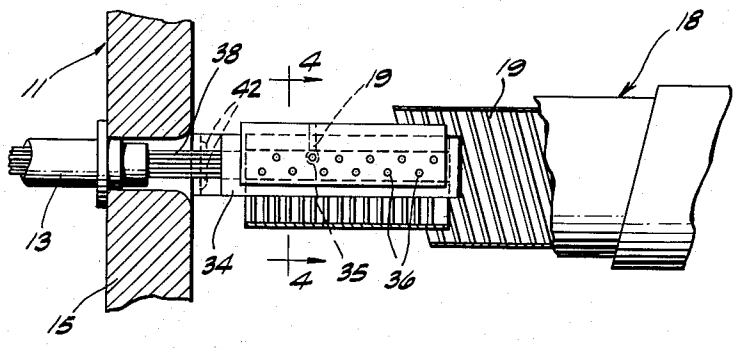


FIG. 3.

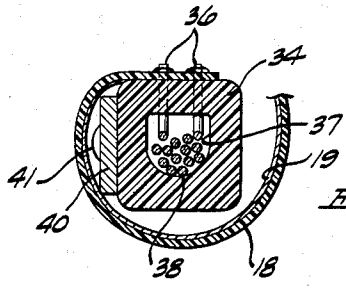


FIG. 4.

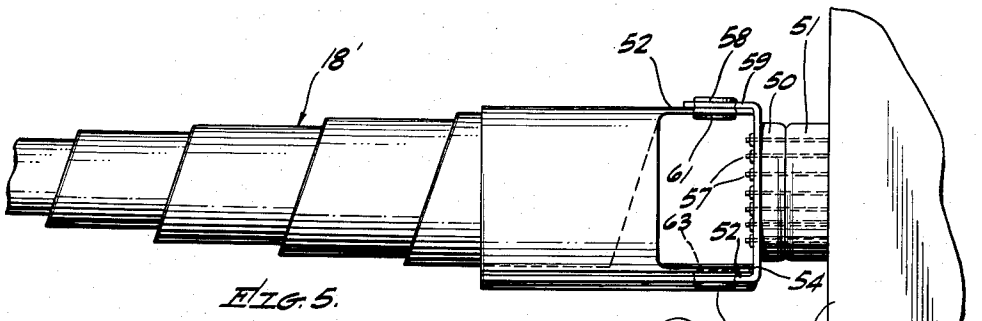


FIG. 5.

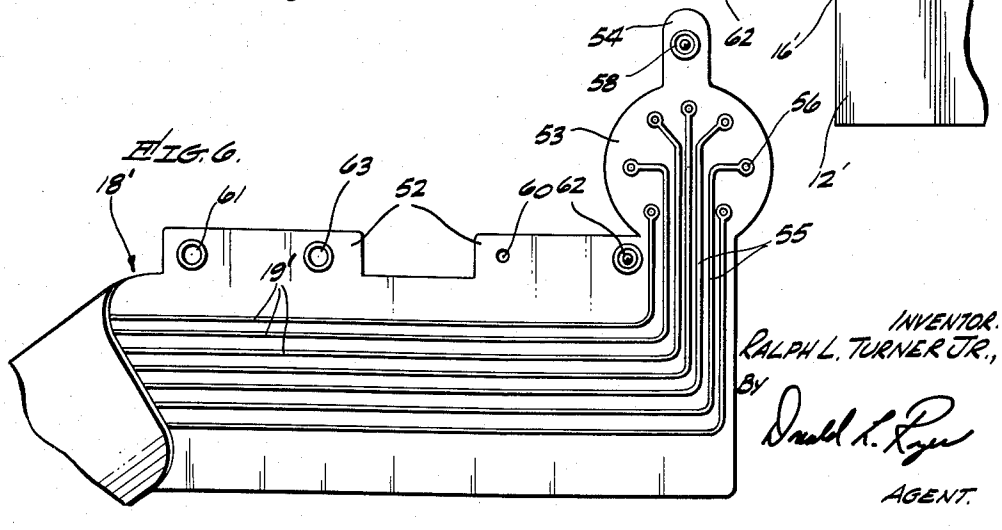


FIG. 6.

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EXTENSIBLE ELECTRIC CABLE

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2 Claims. (Cl. 174—69)

The present invention relates generally to a cable assembly for providing electrical interconnection between relatively movable objects and relates more particularly to a flexible ribbon cable arrangement having one or more longitudinally disposed conductors bonded thereto, the ribbon being spirally disposed, whereby to provide flexibility and resilient retraction thereof.

In contemporary electronic unit packaging apparatus, it has become common practice to dispose such apparatus in drawers or other types of movable chassis that are in turn carried by or mounted in a suitable cabinet. Electrical or electronic devices thus packaged in the console structure provided by the drawer and cabinet arrangement may then be serviced or inspected without the necessity for complete disassembly of the cabinet or difficult removal of the chassis. In structures of this type, however, problems have been encountered relative to the necessity for providing electrical current or other electrical connections to the movable element. This has previously been accomplished by use of wire harnesses or cable structures of sufficient length to permit removal of the drawer. When the drawer is in a closed position, these cables must necessarily be stored in large areas to the rear of the drawer and protected against damage by other drawers of the console. Cables of this type are necessarily expensive, are heavy, require a considerable amount of space or necessitate the use of supplemental equipment to prevent the cables from interfering with other portions of the equipment and necessitate considerable force to remove the drawers.

The present invention, therefore, provides a means for enabling flexible electrical interconnection along a plurality of electrical paths between a fixed portion of the cabinet and a rearward portion of a movable drawer or the like. This connection is made by means of a flat flexible ribbon cable having a plurality of conductors formed thereon, bonded thereto and provided with an insulating coating. This ribbon cable is spirally formed and connected to suitable plug connectors carried by the cabinet and drawer respectively. Upon removal or extension of the drawer, the ribbon cable will thus extend telescopically and will thereafter retract, when desired.

While the present cable structure will be described in connection with a drawer and a cabinet, it is to be understood that this arrangement may be employed between any type of movable objects wherein electrical connection is desired therebetween. The particular cable hereof is adapted primarily for linear displacement and, while only a single such cable will be described, it is to be understood that a plurality of such cable arrangements may be disposed laterally across a rear portion of a drawer without departing from the spirit and scope hereof.

It is therefore one important object of the present invention to provide a linear displacement electrical cable arrangement.

It is another object of the invention to provide an electrical cable comprising a spirally wound ribbon cable including means for securing ends thereof to portions of relatively movable objects.

A further object of the invention is to provide an electrical cable having a plurality of conductors thereon and arranged in a spiral manner to permit linear displacement thereof together with low resistance extension and resilient self retraction.

Still another object of the invention is to provide a ribbon cable disposed in a spiral manner and telescopically extensible to form an electrical interconnecting structure which occupies a minimum amount of space.

A still further important object of the invention is to provide a linear displacement electrical cable that is simple in construction, reliable and efficient in use, effective in operation and relatively inexpensive in manufacture.

Other and further important objects of the invention will become apparent from the disclosures in the following detailed specification, appended claims and accompanying drawings, wherein:

FIGURE 1 is a fragmentary sectional view of a portion of a cabinet and drawer arrangement showing the present linear displacement electrical cable in a retracted position;

FIG. 2 is an enlarged fragmentary view, partially in section, showing the present electrical cable in an extended position together with means for attaching one end thereof to a plug connector;

FIG. 3 is a fragmentary sectional view showing a manner of attaching another end of the cable to a fixed structure;

FIG. 4 is a fragmentary sectional view, taken substantially as indicated by line 4—4, FIG. 3;

FIG. 5 is a longitudinal elevational view showing a fragmentary portion of another form of the invention, and

FIG. 6 is a plan view showing the ribbon cable employed in the form of the invention of FIG. 5 and disposed in an opened out position.

With reference to the drawings, and with reference primarily to FIG. 1, the present linear displacement electrical cable is shown as indicated generally at **10**. The cable **10** is shown in conjunction with a cabinet **11** having a plurality of drawers **12**. The drawers **12** are adapted to contain suitable electrical or electronic equipment and may be withdrawn from the cabinet **11** for service or repair to this equipment. A plurality of electrical harness cables **13** extend into the cabinet **11** and through suitable openings **14** in a rear wall **15** thereof. A rear wall **16** of the drawer **12** is adapted to carry a plug **17**.

In practice, the electrical cable unit **10** may be used in multiples thereof and spaced either laterally or vertically across the rear wall **16** of the drawers **12**. Also, the use of the linear displacement cables **10** is not to be limited to drawer and cabinet structures but may be employed with any relatively movable objects between which it is desired to maintain electrical interconnection.

As shown primarily in FIGS. 2 and 3, the linear displacement electrical cable structure **10** includes an elongated ribbon cable **18** that may be formed from any suitable flexible material such as, for example, that commercially known as nylon or polytetrafluorethylene, sold under the trademark Teflon by E. I. du Pont de Nemours and Co. or the like and has a plurality of conductors **19** formed thereon and bonded thereto as by a process employed in the manufacture of printed circuits and the like. The cable material is non-conductive with the conductors **19** being either embedded therein or covered with a suitable insulating material. The conductors **19** may be made from copper or the like and are permanently secured to the material of the cable. The conductors **19** also have rounded terminal portions **20** through which suitable openings are formed, surface areas of the terminal portions **20** being exposed for a purpose to be hereinafter more fully described.

It is to be noted that the ribbon cable **18** is formed in a spiral manner, whereby to permit telescopic extension thereof. The cable **18** may be preformed into the de-

sired spiral configuration whereby to produce a permanent configuration thereof and establish greater resiliency therein when telescopically extended.

As shown primarily in FIG. 2, the plug **17** is disposed through a suitable opening **21** in the rear wall **16** of the drawer **12**. The plug **17** has suitable protruding connector tabs **22** to which the electrical material in the drawer **12** may be attached. A second plus **23** is positioned in contact with the plug **17** and has suitable pins **24** which mate with connectors **25** in the plug **17**. The pins **24** extend through the plug **23** and outwardly therefrom as at **26**, with the openings in the terminal portions **20** in the conductors **19** being adapted for disposition over the portions **26**. The terminal portions **20** may thereafter be soldered or otherwise fixed to the pin portions **26**. The plugs **17** and **23**, together with an angle bracket **27** are secured to the end wall **16** by means of bolts **28** and nuts **30**.

As shown in FIG. 2, the ribbon cable **18** extends at right angles from the plug **23** and is angularly folded as at **31** for disposition in a direction parallel to a longitudinal portion of the plug **23**. The end of the cable **18** and the fold **31** are positioned on a planar surface of the bracket **27**, there being a cover plate **32** which acts as a clamp member to retain the cable and the folded portion thereof in position and which overlies the planar surface of the bracket **27**. The plate member **32** is secured to the bracket **27** by means of suitable bolts **33**. The cable **18** is thus retained in position and, upon extension thereof, no force is applied to the pins **26**.

As shown primarily in FIG. 3, another end of the cable **18** is secured to a fitting or plug **34**, as by connection of terminal ends **35** of the conductors **19** to pins **36**. The pins **36** extend above a surface of a fitting **34** and into a longitudinal cavity **37** therein. Individual wires **38** from the cable **13** are adapted to extend into the cavity **37** for individual connection with the pins **36**. The fitting **34** is secured to the rear wall **15** of the cabinet **11** as by an angle bracket **40** that is connected to the fitting as by screws **41** and to the rear wall as by suitable attachment members **42**.

It may thus be seen that the flexible ribbon cable **18** is spirally disposed and rigidly connected at each end thereof. Thus, when the drawer **12** or other movable object is displaced from the rear wall **15** of the cabinet **11**, the cable **18** will extend in the manner shown in FIGS. 2 and 3, whereby to permit continued electrical connection of a plurality of conductors between these relatively movable objects. With the conductors **19** being contained in the material of the flexible cable **18** or covered with a suitable insulating material, there is no contact or electrical connection between concentrically overlying conductors. When the drawer or other object is returned to its original position, the flexible ribbon cable **18** will again assume is original configuration as shown in FIG. 1.

As shown in FIGS. 5 and 6, a modified form of the invention includes a ribbon cable **18'** having conductors **19'** thereon. In this form of the invention, the ribbon cable **18'** is adapted for connection with a cylindrical plug **50**, with the plug **50** being adapted to mate with another plug **51** carried by a rear wall **16'** of a drawer **12'**. The cable **18'** has a pair of laterally disposed integral tabs **52** and an integral circular portion **53** from which another tab **54** depends. The conductors **19'** terminate in laterally extending portions **55** and enlarged terminal ends **56** that are arranged in a circular pattern and adapted for connection with pins **57** carried by the plug **50**. The terminal portions **56** may be soldered or otherwise connected to the pins **57**. The tab **54** is fitted with a male snap member **58** that is adapted to extend through an opening **60** in one of the tabs **52** and into a female snap member **61** carried by the other of the tabs **52**. Additionally, a second male snap member **62** is carried by one of the tabs **52** and adapted to mate with a female snap member **63** also carried by the other of the tab members **52**, whereby to retain an end portion of the cable **18'** in the configuration shown in FIG. 5. The modified form of the invention shown in FIGS. 5 and 6 is adapted particularly for use with cable arrangements wherein a reduced number of conductors **19'** are required.

It may thus be seen that the linear displacement electrical cable of this invention provides a reliable, efficient and inexpensive means for enabling a plurality of electrical connections between relatively movable objects and that the spiral configuration thereof provides for retraction and storage of the cable and prevents interference between the cable and any drawers, guides or adjacent elements of an electrical console. Additionally, the present cable may be disconnected from the drawer **12**, if desired, and may be replaced with ease, if necessary.

Having thus described the invention and the present embodiments thereof, it is desired to emphasize the fact that many further modifications may be resorted to in a manner limited only by a just interpretation of the following claims.

I claim:

1. An extensible and rectractable electrical cable for electrically connecting two bodies relatively movable along a substantially linear translatory axis comprising: a section of elongated, wide, thin, flat, flexible ribbon cable, the width of said cable being large compared to the thickness thereof, said cable being loosely coiled upon itself about an axis transverse to the largest dimension of said cable to form a plurality of complete overlapping turns arranged in a spiral, cylindrical configuration, said cable having each of its ends affixed to a different one of said relatively movable bodies, the axis of said coiled cable being substantially parallel to the translatory axis between said bodies, the minimum distance between said relatively movable bodies along said translatory axis being at least greater than the width of said cable, the maximum distance between said relatively movable bodies along said translatory axis being no greater than the combined widths of the overlapping turns of said cable, relative movement of said bodies away from each other along said translatory axis causing relative axial displacement of the turns of said coiled cable to form a partially overlapping, self-supporting spiral configuration, the outer surfaces of said cable having a low coefficient of friction so that little force is necessary to extend and retract said cable, said cable having a plurality of longitudinally disposed, laterally spaced, electrical conductors therein, each of said conductors being provided with enlarged terminal end portions, said end portions being free of insulation, a plug connector having connector pins, said terminal end portions on one end of said conductors being soldered to said pins, a plate clamp secured to said plug connector and disposed in contact with opposite flat sides of said cable, said cable being angularly folded within the confines of said clamp, said plug connector being adapted for connection with elements of one of said movable bodies, and a fitting disposed axially within said coiled cable and adapted for attachment to the other of said movable bodies, said fitting having connection means, said terminal end portions on the other end of said conductors being soldered to said connection means.

2. An extensible and retractable electrical cable for electrically connecting two bodies relatively movable along a substantially linear translatory axis comprising: a section of elongated, wide, thin, flat, flexible ribbon cable, the width of said cable being large compared to the thickness thereof, said cable being loosely coiled upon itself about an axis transverse to the largest dimension of said cable to form a plurality of complete overlapping turns arranged in a spiral, cylindrical configuration, said cable having each of its ends affixed to a different one of said relatively movable bodies, the axis of said coiled cable being substantially parallel to the translatory axis between said bodies, the minimum distance between said

relatively movable bodies along said translatory axis being at least greater than the width of said cable, the maximum distance between said relatively movable bodies along said translatory axis being no greater than the combined widths of the overlapping turns of said cable, relative movement of said bodies away from each other along said translatory axis causing relative axial displacement of the turns of said coiled cable to form a partially overlapping, self-supporting spiral configuration, the outer surfaces of said cable having a low coefficient of friction so that little force is necessary to extend and retract said cable, said cable having a plurality of longitudinally disposed, laterally spaced electrical conductors therein, said conductors having enlarged terminal end portions, said end portions being free of insulation, an annular tab formed integrally on said cable, said conductors extending onto said tab, snap means disposed on said cable for securing said tab in a position normal to the axis of said coiled cable, an annular plug connector having connector pins, said terminal end portions of said conductors on said tab being soldered to said pins, said plug connector

being adapted for connection with elements of one of said bodies, and a fitting disposed axially within said coiled cable and adapted for attachment to the other of said bodies, said fitting having pin connection means, said terminal portions on the end of said cable remote from said tab being soldered to said connection means.

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