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**Continuation-in-part of application Ser. No. 696,595, Jan. 9, 1968, now abandoned.**

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## [54] FLAT POWER-DISTRIBUTION CABLE

15 Claims, 6 Drawing Figs.

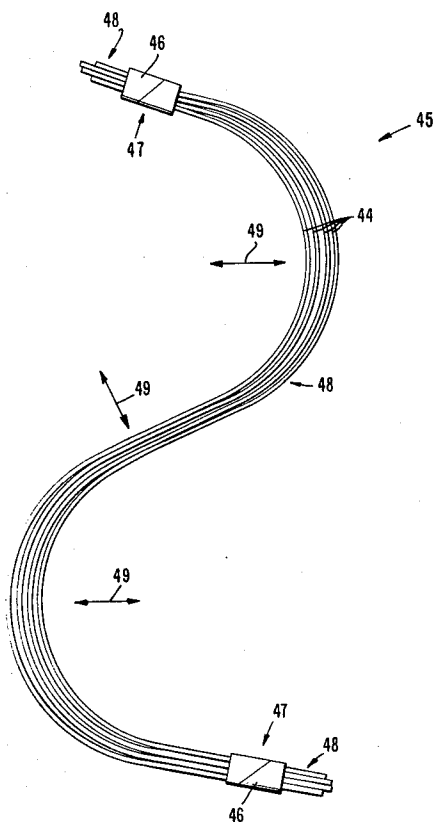
[52] U.S. Cl..... 174/117,  
 174/113  
 [51] Int. Cl..... H01b 7/08  
 [50] Field of Search..... 174/113,  
 117, 117.11, 117.1, 112 (Inquired)

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**ABSTRACT:** A flat cable for distributing electrical power between hingeable or demountable pieces of electrical apparatus is made up of thin, flat conductors nonrigidly mounted one on top of the other. The nonrigid mounting of the conductors relative to each other permits one to slip or slide relative to the other and thereby improve flexure of the cable and also increase the number of flexures the cable can be cycled through before it fails. Nonrigid mounting can be achieved by several different configurations. First, each flat conductor can be provided with its separate insulating layer and then the two insulated conductors may be held one over the other loosely so that they may slide or slip relative to each other. Second, a flat insulating cable may have a partition across its width so that one flat conductor may be placed in one partitioned section and the other flat conductor may be placed under the other conductor in the second partitioned section. Third, separately insulated conductors may be taped together at spaced locations so as to allow each conductor to slide within its own insulation and to allow relative movement of the conductors between the spaced locations.



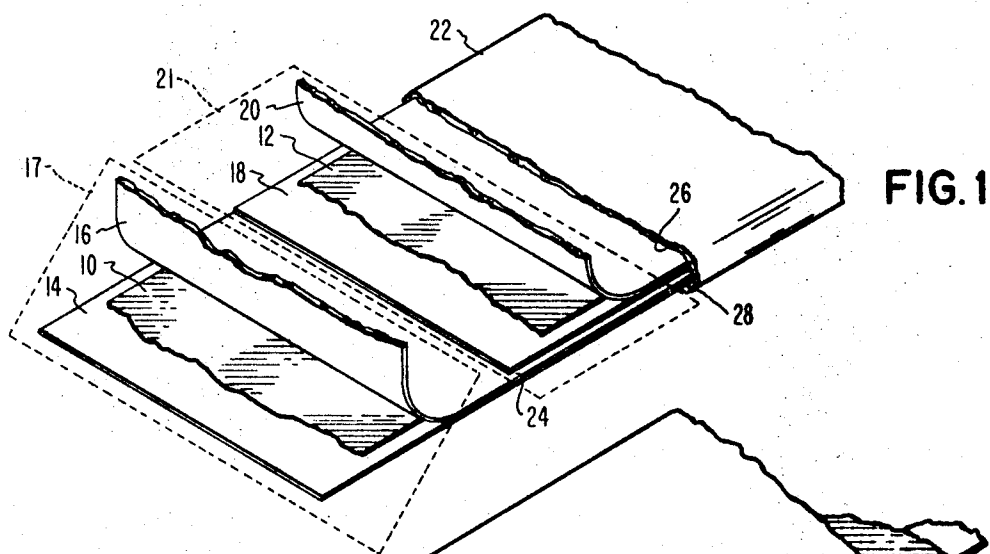


FIG. 1

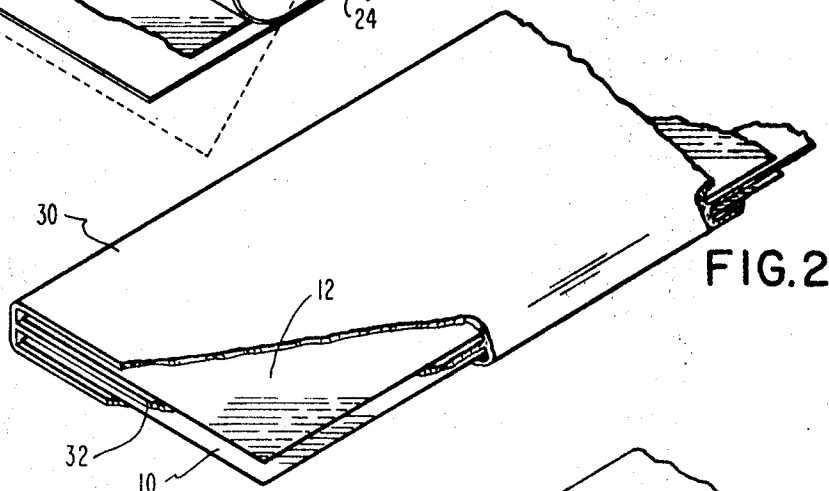


FIG. 2

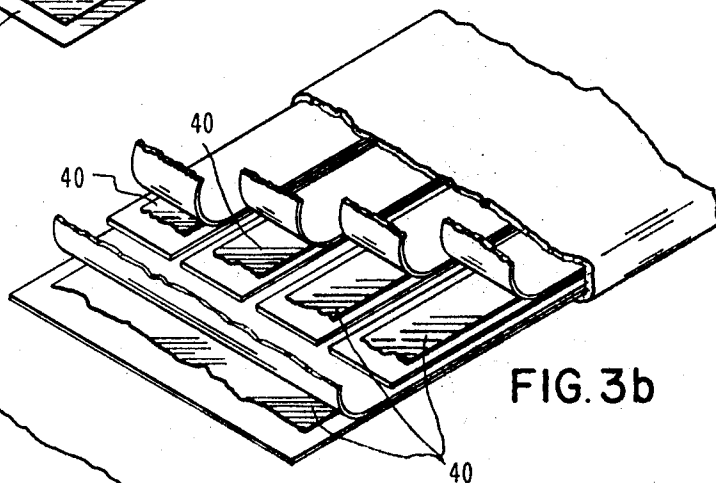


FIG. 3b

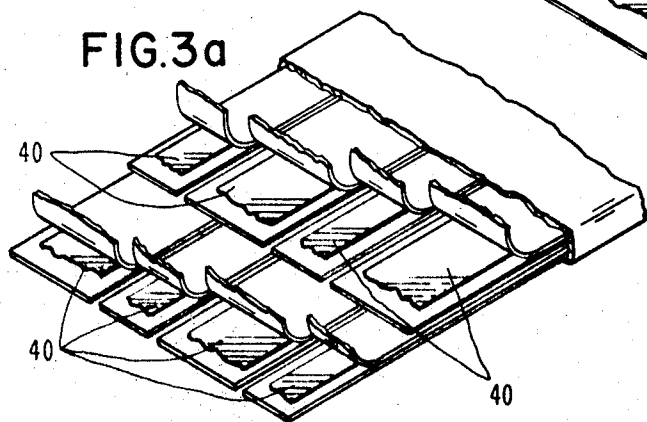
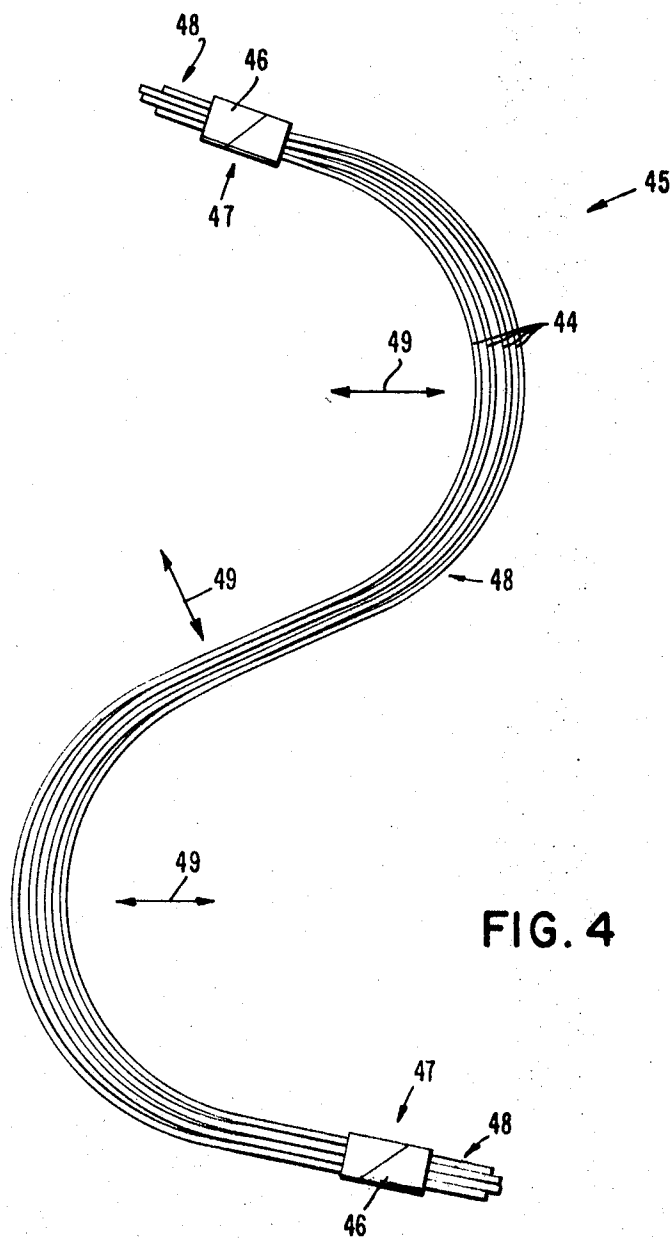
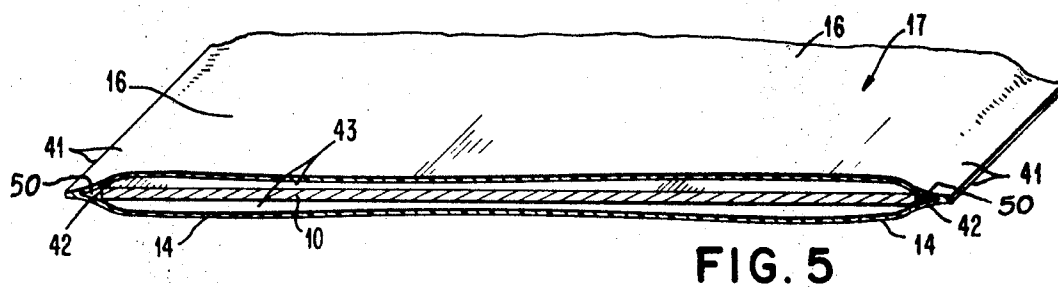


FIG. 3a

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## FLAT POWER-DISTRIBUTION CABLE

## CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a continuation-in-part of copending and now abandoned Ser. No. 695,595, filed Jan. 9, 1968 by Donald F. Colglazier and assigned to the assignee of the present application.

## Background of the Invention

This invention relates to power cables and more particularly to flat cables as commonly used in distributing power to electronic systems.

The broad concept of a flat power cable is quite old; however to date, all of these flat power cables have been susceptible to damage when they were bent sharply. Bending of these cables would cause conductors to pull through the insulation and short out to each other or to a chassis around which the cables were bent. Also if the cable successfully survived one flexure, reflexing the cable to a new position would cause the cable to fail by shorting out or by metal fatigue.

Some of the prior art cable designs are simply two flat conductors mounted rigidly in the same insulating medium. Another flat cable design is where multiple conductors are placed in the same flat cable by having a flat conductor at the bottom of the cable and multiple wire conductors placed immediately over the flat conductor with all of these conductors being bonded to the same insulating material to make up the cable. In either of these two types of cables if a sharp flexure occurs, the metal conductor on the outside of the flexure will have to stretch more than the other inner conductor to make the bend. This additional stretch puts additional tension in the outer conductor tending to pull it through insulation towards the inner conductor.

If the prior art cables happen to survive the initial flexure without shorting, their insulating material will usually be so damaged that to straighten the cable and form another flexure will almost certainly cause the cables to either short to the chassis around which they are being bent or to short one to the other.

The problem is how to prevent a conductor in a flat cable from being pulled through the insulation to another conductor in a flat cable when the cable is bent or flexed sharply around a corner.

Cables in accordance with the invention find primary applications in connection with electrical apparatus constructed from a number of swingable, hingeable or demountable sections, wherein various supply and bias voltages must be routed to some or all sections at high current levels. More specifically, most large-scale computers and similar devices have a stationary "main frame" containing central power supplies, and a number of "gates" hinged therefrom so as to swing outwardly for servicing and inspection. Each gate, commonly 3 feet square or larger, contains many thousands of individual circuits mounted on cards or boards attached to the gate. It is therefore not unusual for even a single gate to require supply currents on the order of 30 to 100 amperes or more. At the same time such cables must be capable of sustaining repeated flexures over bending diameters as small as one to four inches. Prior attempts to meet these twin requirements have employed large, round stranded wires, parallel smaller stranded wires arranged in a flat configuration, and single flat conductors of the relatively thick bus bar variety. None of these attempts, however, has provided an adequate solution, and the lack of such a solution is today a major impediment to the fabrication of easily serviceable large-scale computers and other equipment.

It is therefore an object of this invention to produce a new flat cable which has great flexibility and can be cycled through multiple flexures without destroying its electrical integrity.

It is a further object of the invention to produce a flat power cable which may be flexed around sharp corners and wherein the outer conductor of the bend will not be pulled through the insulation to short against the inner conductor of the bend.

## SUMMARY OF THE INVENTION

In accordance with the invention the above objects are accomplished by nonrigidly mounting the conductors in the flat cable so that the conductors are free to slide or slip relative to each other. In one embodiment of the invention, two flat conductors are insulated separately with their own slidable insulating layers and the resulting insulated conductors and then placed in a loose casing with one insulated conductor laying on top of the other insulated conductor. The insulated conductors are held loosely in position over each other by an outer casing. Each insulated conductor can slide relative to the other conductor and can also slide relative to the outer casing. In an alternative embodiment, the separately insulated conductors are fastened together by spaced tapes or bands which, while preventing substantial relative movement between the insulators at the taped locations, still permit each conductor to slide within its own insulator, and further permit the conductors to move toward or away from each other between the taped locations. In a further embodiment, the individual flat conductors do not have a layer of insulation bonded around them but instead are mounted in an insulated cable or casing which is partitioned. The partition lies horizontally across the width of the cable so that the partition separates the two flat conductors. Each conductor is held loosely in its partitioned section of the casing so that the conductors can slide along the length of the casing relative to each other and to the casing.

The great advantage of the invention is that it is very flexible and even after many flexures the conductors will not pull through the insulation or fail in fatigue. The conductors do not pull through the insulation because they are slidable mounted in the cable, and therefore the stretch or stress built up in a conductor when the cable is bent around a corner is evenly distributed along the length of the conductor since the entire conductor can stretch to make the bend.

Stated another way, in the prior art where conductors were rigidly tied to insulating material and to each other, the stresses built up upon a conductor at a corner were restricted to a small length of the conductor. Great force built up tending to pull the conductor through the insulation. In the subject invention because the conductor is slidably mounted relative to the other conductor the stress is evenly distributed over a great length of conductor; therefore, forces causing the conductor to be pulled through the insulation are greatly reduced.

The provision of interior slip planes between each individual conductor and its associated insulative covering is especially to be noted. That is, each individual conductor may move relative to its immediately adjacent insulating layers, even if the insulation of one conductor is rigidly mounted to the insulation of another conductor. This aspect of the invention not only leads to ease the manufacture of such cables, but also enhances its stress-relieving properties, since the stress is relieved at many more points, and since the stress on the insulating layers is not permitted to add to the stress on their associated conductors in any significant manner. This method of stress relief has been completely unappreciated by the prior-art flat cables of which applicant is aware.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention as illustrated in the accompanying drawings.

## BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 shows a flat power cable implemented by separately insulating each flat conductor.

FIG. 2 shows a flat power cable implemented by placing two flat conductors in separate partitions of an insulated casing.

FIGS. 3a and 3b show multiple conductor embodiments of the invention utilizing conductors which are each insulated as in FIG. 1.

FIG. 4 illustrates, in a flexed condition, a multiple-conductor cable employing tapes at spaced locations.

FIG. 5 is a perspective view, partly in cross section, of an individual conductor assembly for use with the embodiments of FIGS. 1, 3a, 3b and 4.

### DESCRIPTION

Referring now to FIG. 1, two flat conductors 10 and 12 are surrounded by insulating material. Flat conductor 10 has bonded to it a lower insulating layer 14 and upper insulating layer 16. A flat insulated conductor can be formed by laying the flat conductor 10 on a layer of insulating material 14 and then overlaying the assembly with another layer of insulating material 16 and heat bonding the assembly. Conductor 12 is similarly insulated by insulating layers 18 and 20. The entire assembly of conductors 10 and 12 with their insulating layers is contained in a flexible casing 22. The function of the casing is to keep one insulated conductor positioned over the other conductor. The casing could be replaced by any mounting device which would keep the insulated conductors properly positioned without rigidly holding them.

The significant fact of the construction of the cable and the essence of this embodiment of the invention is that the insulated conductor assembly 17 and the insulated conductor assembly 21 are not rigidly mounted to each other or to the casing 22. In particular, the casing 22 has sufficient inner dimensions to allow for a slip plane 24 between the insulated conductor assemblies 17 and 21 and also for a slip plane 26 above the assembly 21 and some space 28 below the assembly 17. As a result, the conductive assemblies 17 and 21 are free to slide along the length of the cable relative to each other and relative to the casing 22. As previously pointed out by having the conductors slidably mounted, the cable assembly may be flexed about sharp bends without the conductors pulling through the insulating and shorting out.

FIG. 5 depicts, in greatly exaggerated size but approximately correct relative proportions, a preferred form of conductor assembly 17 of FIG. 1. Conductor assembly 21 (as well as corresponding assemblies shown in FIGS. 3a and 3b) is preferably of a similar construction.

The lengthwise or longitudinal conductor 10 is shown in FIG. 5 as a metallic strip having a substantially rectangular cross section and a width-to-thickness ratio, or aspect ratio, which is extremely high in comparison to previous flat conductors used for power-distribution purposes. A broad optimum for low-voltage distribution systems, for instance, has been found to lie in the neighborhood of a 1000 mil by 10 mil cross section, i.e., an aspect ratio of 100:1. Minimum width is constrained to be at least about 500 mils for adequate current-handling capability; maximum width is limited, primarily by the space available in associated electrical equipment, to about 3000 mils. Current-handling capability and mechanical strength dictate that the conductor thickness be above approximately 5 mils. Maximum thickness is fairly sharply limited by metal fatigue and flexibility to about 30 mils. More specifically, it has been found that the present aluminum alloys are entirely unsatisfactory at a 50-mil thickness, which is a very small thickness in the power-distribution arts. Even a 20-mil thickness dimension has been found to have perceptibly inferior fatigue resistance as compared to the 10-mil optimum. Therefore, it is preferable to increase current ratings by employing parallel, individually insulated conductors of 10-mil to 20-mil dimensions rather than by increasing the thickness much beyond 20 mils.

The above thicknesses are for commercially pure 1100 aluminum according to ASTM Standard B211-68, which combines favorable electrical and structural properties in relation to present-day cost and availability. Although other metals or alloys may become preferable in terms of the above trade-offs, it is considered doubtful that thicknesses much more than 30 mils would be useful in the present invention. Within the above limits, the aspect ratio of the conductor should be greater than about 25:1 to ensure that the conductor lies flat without twisting or turning sufficiently to rupture the insula-

tive covering or to change the orientation of the cable conductors relative to each other. On the maximum side, the aspect ratio should be restricted to less than approximately 300:1 in order to prevent curling of the conductor in a transverse (width) direction within its insulative covering.

The insulative layers 14 and 16 are shown in FIG. 5 as thin, flat, pliable strips having edge regions 41 extending outwardly in a transverse direction beyond the edges 42 of conductive strip 10. Since strips 14 and 16 are wider than conductor 10, regions 41 of insulator 14 will directly underlie corresponding regions 41 of insulator 16. Corresponding edge regions 41 may then be bonded to each other in one of a number of simple, conventional and inexpensive manufacturing techniques. If, for example, strips 14 and 16 are made of a thermoplastic such as polyethylene or Mylar (a trademark of E. I. duPont de Nemours & Co. for a polyester film), a sandwich comprising strips 10, 14 and 16 may be fed from continuous rolls past heated rollers (not shown) for edge-bonding. Strips 14 and 16 will adhere only to each other and not to the conductive strip 10. The aforementioned high aspect ratio of conductor 10 and the pliability of strips 14 and 16 then combine to provide an insulative casing which establishes slip planes 43 between the surfaces of conductor 10 and the interior surfaces of strips 14 and 16, so as to allow lengthwise or longitudinal relative movement therebetween. The proximity of edge regions 41 to the conductor edges 42, however, prevents any substantial transverse or lateral movement of the encased conductor. The apparently contradictory requirements of lengthwise mobility and transverse restriction disappear almost entirely for the high conductor aspect ratios noted hereinabove. FIG. 5 depicts, for example, the loose fit between conductor and insulators in the direction perpendicular to both the longitudinal and transverse directions. This effect proceeds from the fact that the change in length of strip 14 or 16 to achieve a given vertical separation from conductor 10 becomes considerably less for a high aspect ratio. In addition, this large width-to-thickness ratio greatly decreases the angles between strips 14 and 16 adjacent the bonded regions 41. Thus only a portion of edges 42 actually bear against strips 14 and 16, and the relative stiffness of conductor 10 causes it to act as a wedge attempting to separate the strips. Thus, the above configuration produces a pair of triangular or wedge-shaped interior spaces 50 enclosed by the conductor edges 42 and the strips 14 and 16. Since the angles between strips 14 and 16 are small, the angles between each strip and the edges 42 are relatively large.

The edge-bonded regions 41 must, of course, be sufficiently wide to secure an adequate bond and to prevent rupture thereof by the conductor. But again the high aspect ratio of the conductor proves to be an advantage. With no tensile stress being imposed in the vertical direction by the wide, flat surfaces of conductor 10, the bonds need withstand only the slight wedging forces relative motion which is skewed from the lengthwise direction. Since the purpose of lengthwise relative motion is only to relieve compressive and tensile stresses in the assembly 17, the actual amount of the motion is very small in relation to both the length and the width of the assembly, and the maximum possible skew is therefore insignificant. For the 1000-mil by 10-mil conductor described above, e.g., the total width of each strip 14 and 16 may be approximately 1125 mils (i.e., 1½ inches), yielding on edge bond of 30 to 50 mils on each side. That is, the extra width required for the bonded edge regions increases the total width of assembly 17 by only about 10 percent for a conductor aspect ratio of 100:1. The thickness of each insulative strip 14 and 16 may conveniently be approximately 5 mils in this instance, depending for the most part on the magnitude of the voltages to be carried.

The assembly specifically detailed here was designed to carry 5 volts at a current of 60 amperes in free air, derated to 30 amperes when used in a cable such as that shown in FIG. 1. A slightly larger assembly, having a 1000-mil by 12-mil aluminum conductor and 1150-mil by 8.5-mil polyethylene insulating layers, was tested for failure (conductor breakage or in-

sulator rupture) by weighing one end and bending it  $\pm 90^\circ$  over mandrels having various sizes. For mandrel diameters of  $\frac{1}{4}$ ,  $\frac{1}{2}$  and  $1\frac{1}{4}$  inches, the average numbers of complete bending cycles to cause failure were 735, 2000 and 5800, respectively. This assembly was designed for bending diameters in the approximate range of 1 to 4 inches. Under conditions of actual usage, therefore, it is virtually indestructible.

Referring now to FIG. 2 an alternative embodiment of the invention is shown. In this alternative embodiment the flat conductors 10 and 12 are mounted loosely in a conductive casing 30 which has an insulating partition 32 to separate the conductors 10 and 12. The conductors 10 and 12 are loosely mounted in the casing 30 having ample space for each conductor 10 or 12 to slide along the length of the cable in its associated partitioned section. That is, slip planes are established between casing 30 and the conductors 10 and 12. The fact that the conductors 10 and 12 can slide relative to each other and relative to the insulated casing 30 and partition 32 permits the cable assembly of the FIG. 2 to sustain very sharp flexures around a bend without the conductors 10 and 12 pulling through the insulation.

In FIGS. 3a and 3b, multiple conductor cables embodying the invention are shown. Each of the metal conductive strips 40 is surrounded by insulating layers or strips just as described in connection with FIGS. 1 and 5. Each insulated conductor assembly is thus a separate entity which is slidable relative to the other insulated conductive assemblies.

FIG. 4 is a side elevation of a further embodiment according to the present invention. This form of the cable 45 employs a number of flat conductor assemblies 44, each of which is constructed in accordance with the preceding description of representative assembly 17. The assemblies appear in an edge-on aspect in order to illustrate another type of stress-relieving relative motion attainable under the invention. More particularly, the cable of FIG. 1 permits substantial relative motion of conductors 10 and 12 in only one direction perpendicular to the conductor width, namely, in the lengthwise or longitudinal direction of the conductors. Cable 45, on the other hand, additionally allows substantial relative movement in a vertical direction, i.e., in a direction perpendicular both to the length and to the width of its conductors.

Cable 45 comprises a stack of any number of flat conductor assemblies 44 laid one on top of another; for clarity of description, only four such assemblies are shown. Assemblies 44 are restrained by discrete bands or bindings 46 encircling the assemblies in the direction transverse to their length and disposed at spaced locations 47 therealong. Bands 46 may conveniently be strips of insulating adhesive tape adhering to at least the two outer assemblies 44 and fastened upon themselves. For the 1000-mil by 10-mil conductor size referred to above, the tapes may be, e.g., from about  $\frac{1}{2}$  inch to one inch wide, and the spaced locations 47 may be, e.g., from about 3 inches to about 12 inches apart. The only major requirements are that the locations 47 be sufficiently close together to prevent substantial transverse (i.e., perpendicular to the plane of FIG. 4) relative motion between assemblies 44, and that the tapes 46 be wide enough to avoid their cutting into the cable 45 and to avoid the imposition of extremely sharp bends in the cable when it is flexed near the locations 47. In other respects, the width of tapes 46 and the spacing of locations 47 are design choices to be determined from the contemplated cable size and application.

Bindings 46 may alternatively be made of nonadhesive or even noninsulating material. Where it is desired to affix the cable 45 to a mechanical support, e.g., the restraining function of bindings 46 may be accomplished by a clamp (not shown) or similar means. Even when the bindings 46 adhere to some or all of the assemblies 44, the slip planes 43, described in connection with FIG. 5, still allow longitudinal relative movement among the individual conductors of the assemblies. Such movement may occur both at the spaced locations 47 and at all locations 48 therebetween. In addition, the assemblies 44 have another degree of freedom at the locations 48, as shown

by the arrows 49 in FIG. 4. That is, the restraining means 46, being interrupted along the length of cable 45, permit the individual assemblies 44 and their respectively encased conductors to move relative to each other in a direction which is perpendicular both to their length and to their width.

The cable embodiment shown in FIG. 4 has three salient advantages, for many applications, over the preceding variations having continuous casings. First, the fabrication of the cable is rendered easier and cheaper, especially in that it may be built up in situ to exact specifications, without wastage, from a continuous roll containing a single conductor assembly 44. Second, the provision for relative movement in the direction 49 allows a large number of assemblies 44 to be stacked into a single cable without the introduction of undue stress. This is particularly true when the cable is disposed within its associated equipment (not shown) such that flexure will force the cable into the S-shape illustrated, since this configuration places only insignificant longitudinal stresses upon assemblies 44, so that there is no tendency for the bindings 46 to be sheared or pulled out of shape. As stated earlier, it is generally preferable to increase the current of capacity of cables according to the invention by paralleling conductor assemblies rather than by making the individual assemblies larger in size. Therefore this second advantage increases the current capability of the cable.

In the third place, the interrupted restraining means, and its attendant increase in the number of assemblies in a single cable, allows lateral connections or taps to the cable to be made in a simple manner. In many power-distribution systems, it is necessary that connections to individual conductors of a cable or bus bar be brought out from the side. Conventional practice achieves this end by the use of tabs, as illustrated, e.g., by U.S. Pat. No. 1,999,137. Such tabs, however, must either be initially built into the conductors at specified locations or be mechanically affixed thereto at installation. Either of these alternatives increases the cost of the cable to a significant extent. Moreover, the only practical connections to the tabs are by means of substantially round wires, which decrease flexibility, which tend to break the tabs by pulling and bending them, and which undesirably increase the inductance of the system. The cable 45 of FIG. 4 overcomes these disadvantages by allowing a large number of stress-relieved parallel conductor assemblies such as 44. That is, cable 45 may contain several assemblies 44 each carrying the same supply voltage. A lateral tap may then be made at any location 48 merely by folding one entire assembly out of the cable, in any desired direction, and by connecting it directly to its individual load (not shown). Such folding is made practical in the present invention, of course, by the very high aspect ratio of the individual conductors, as pointed out hereinabove.

It will be appreciated by one skilled in the art that other electrical cable configurations can be designed using multiple flat conductors of various configurations. Also in a two conductor cable the conductors can be insulated from each other by giving only one conductor an insulated coating. An outer casing would position the conductors over each other and insulate the uncoated conductor from conductive metal outside the cable.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

I claim:

1. A cable for distributing electrical power, comprising:
  - a plurality of conductor assemblies extending in a longitudinal direction, each said assembly including a thin flat conductive strip extending in said longitudinal direction, a first pliable insulative strip immediately and nonadheringly overlying said conductive strip and having a plurality of edge regions extending outwardly beyond the edges of said conductive strip in a direction transverse to said longitudinal direction, and a second flat pliable insu-

lative strip immediately and nonadheringly underlying said conductive strip and having a plurality of edge regions bonded only to corresponding ones of said first-named edge regions so as to allow said conductive strip to move in said longitudinal direction relative to each of said insulative strips; and  
restraining means holding said conductor assemblies one on top of another so as to prevent substantial relative movement thereamong in said transverse direction while permitting relative movement thereamong in a direction perpendicular to said transverse direction.

2. A cable according to claim 1 wherein said edge regions of said second insulative strip of each assembly extend outwardly beyond the edges of said conductive strip in said transverse direction, said conductor and said strips of each assembly defining a pair of interior, substantially triangular spaces enclosed by the edges of said conductor and the bonded edge regions of said strips, each said space having one relative small acute angle and two relatively large angles.

3. A cable according to claim 2 wherein said restraining means comprises a plurality of binding means disposed at spaced locations along said longitudinal direction for preventing, at said locations, substantial relative movement among said strips in a direction perpendicular to both said longitudinal and said transverse directions, and for permitting relative movement in said perpendicular direction at other than said locations upon flexure of said cable assembly.

4. A cable according to claim 2 wherein the aspect ratio of each of said conductors is greater than about 25:1.

5. A cable according to claim 4 wherein the thickness of each of said conductors is less than approximately 30 mils.

6. A cable according to claim 5 wherein the thickness of each of said conductors is less than or equal to approximately 12 mils and the width of at least one of said conductors is equal to or greater than approximately 1000 mils.

7. A flat cable for distributing electrical power, comprising: first and second lengthwise electrical conductors, each of said conductors being of a substantially rectangular cross section and having a width substantially exceeding a thickness thereof;

insulating means having a plurality of pliable insulating layers immediately adjacent and slidably encasing each of said conductors so as to permit lengthwise relative motion between said conductors and said layers, each of said layers having a width exceeding the width of said conductors associated therewith, at least two of said layers encasing each conductor being edge-bonded to each other; and means supporting said first conductor on top of said second conductor so as to restrain relative movement therebetween in the direction of said conductor width while permitting relative movement therebetween in a direction perpendicular to said conductor width.

8. A cable according to claim 7 wherein said conductors are slidably encased by said insulating layers, said conductors and said layers defining a plurality of substantially triangular spaces, each said space having one relatively small acute angle and two relatively large angles.

9. A cable according to claim 8 wherein said insulating means comprises a first pair of mutually edge-bonded insulating layers encasing said first conductor and a second pair of mutually edge-bonded insulating layers encasing said second conductor.

10. A cable according to claim 9 wherein said supporting means encircles said conductors and both of said pairs of layers.

11. A cable according to claim 10 wherein said supporting means comprises a lengthwise pliable insulative sheath loosely encasing said layers and said conductors so as to permit lengthwise relative movement between said layers and said sheath.

12. A cable according to claim 10 wherein said supporting means comprises a plurality of spaced insulative binding means, each of said binding means bonded to a plurality of said layers so as to restrict lengthwise relative movement between said layers and said binding means at the locations of said binding means, but so as to permit relative movement between said locations.

13. A cable according to claim 9 further comprising:

a third lengthwise electrical conductor, said third conductor being of a substantially rectangular cross section and having a width substantially exceeding a thickness thereof; a third pair of mutually edge-bonded insulative layers encasing said third conductor; and

wherein said supporting means is constructed and arranged for holding said third conductor beside said first conductor so as to permit relative movement between said second and said third conductors in a direction perpendicular to that of said conductor widths.

14. A cable according to claim 13 further comprising:

a fourth lengthwise electrical conductor, said fourth conductor being of a substantially rectangular cross section and having a width substantially exceeding a thickness thereof;

a fourth pair of mutually edge-bonded insulative layers encasing said third conductor; and

wherein said supporting means is constructed and arranged for holding said fourth conductor beside said second conductor so as to permit relative movement between said third and said fourth conductors in a direction perpendicular to said conductor widths.

15. A cable distributing electrical power, comprising:

a plurality of conductor assemblies extending in a longitudinal direction, each said assembly including a thin flat conductive strip extending in said longitudinal direction, a first pliable insulative strip immediately and nonadheringly overlying said conductive strip and having a plurality of edge regions extending outwardly beyond the edges of said conductive strip in a direction transverse to said longitudinal direction, and a second flat pliable insulative strip immediately and nonadheringly underlying said conductive strip and having a plurality of edge regions extending outwardly beyond the edges of said conductive strip in said transverse direction and bonded to corresponding ones of said first-named edge regions so as to allow said conductive strip to move in said longitudinal direction relative to each of said insulative strips, said conductor and said strips of each assembly defining a pair of interior, substantially triangular spaces enclosed by the edges of said conductor and the bonded edge regions of said strips, each said space having one relatively small acute angle and two relatively large angles; and  
restraining means comprising an insulative casing loosely disposed about said assemblies for holding said conductor assemblies one on top of another so as to permit relative movement thereamong in said longitudinal direction while preventing substantial relative movement thereamong in said transverse direction and in the direction perpendicular to both said longitudinal and said transverse directions.