This invention relates to electrical cable connection devices and more particularly to electrical connectors for fully insulated flat flexible cables wherein the cable insulation need not be removed prior to connection.

Flat cables are presently used in the electronic art as a convenient means for lightweight, space-saving wiring of apparatus. They commonly comprise ribbons or patterns of conductive copper bonded between or molded into flat flexible strips of insulating material such as silicone rubber or the various forms of polyester and polyvinyl plastics.

It has been found in use that due to the diminutive dimensions and delicate nature of the ribbon conductors employed, making connections to conductors from which the insulation has been removed is a tedious, uncertain, and generally difficult undertaking. When the initial difficulty of removing the insulation from these conductors is further taken into consideration, the desirability of a connector which accepts cable in fully insulated form becomes eminently apparent.

Accordingly it is an object of this invention to provide a simple and reliable electrical connector adapted for use with fully insulated flat cables.

A further object is the provision of a flat cable connector which may be assembled to a cable without the use of tools or other external devices.

A still further object is the provision of a connector which may facilitate connection to any or all of the conductors of a flat cable at any point along the cable axis.

And yet another object is the provision of a connector wherein positive pressure contact is established and maintained automatically subsequent to insertion of a cable and removal of the inserting force.

The above objects and advantages are achieved in the connector of this invention by means of a housing having a channel dimensioned to dimensionally receive a flat cable, and a flexible strip contact element having a sharpened end portion resiliently biased against a broad side wall of the channel. The end portion is angularly disposed within the channel to permit axial movement of the cable in one direction between the edge and the channel wall and to oppose motion in the opposite direction, whereby forcible movement of the cable in the opposite direction causes the sharpened end of the contact to penetrate the cable insulation to contact the underlying cable conductor. The exact nature and operation of these and other elements constituting embodiments of this invention, as well as further objects, features, and advantages thereof, will be made more apparent by reference to the following description taken in connection with the accompanying drawings, wherein:

FIGURE 1 is a pictorial view of one form of an assembled connector showing a portion of flat cable in position for insertion therein;

FIGURE 2 is a partially exploded pictorial view of a two contact connector such as shown in FIGURE 1 with one contact element removed for clarity;

FIGURE 3 is a side sectional view taken along line 3-3 of FIGURE 1;

FIGURE 4 is a side sectional view of an embodiment of this invention particularly adapted for connection at points intermediate the ends of a flat cable;

FIGURE 5 is a side sectional view of an embodiment of this invention in the form of a flat cable splice connector, showing one cable connected thereto;

FIGURE 6 is a plan view of an embodiment particularly adapted for use with flat cables having a plurality of closely spaced conductors;

FIGURE 7 is a front section view taken along line 7-7 of FIGURE 6.

In FIGURE 1, the end of a typical strip of flat cable having two ribbon conductors is shown in position for insertion into the rectangular opening 12 of a connector 14 formed in accordance with this invention. The opening is dimensioned to telescopically receive the substantially rectangularly cross-sectional cable 10 in fixed longitudinal alignment.

As shown in FIGURE 2 the connector 14 consists of two mating parts 20 and 22 separably fastened together by machine screws such as 21 which pass through part 22 and engage threaded bores 24 in part 20. Part 22 is provided with a cable receiving channel, indicated generally at 30, which is defined in part by opposed side walls 32 and by planar, preferably flat, cable supporting surface 36. When the parts 20, 22 are assembled as in FIGURE 1, raised lip section 34 on part 20 is disposed in channel 30 and spaced from surface 36 to form rectangular opening 12 at the front or cable receiving end of the connector. Part 22 is further provided with grooves such as 26 to receive contact elements such as 28 in fixed axial alignment relative to the channel 30. Fitting the screws 21 fastens part 20 and 22 together and clamps contacts 28 therebetween to form a solid unitary structure.

Contact 28 is formed of a strip of resilient conductive material such as, for example, full hard Beryllium Copper, having an end or leg portion 30 bent at an acute angle thereto, the free end of the leg portion extending to and bearing against cable support surface 36. The free end of leg portion 30 is formed, in the embodiments shown, to a pointed chisel edge 40 adapted to penetrate the insulation of a flat cable at an angle to the flat surface thereof; a substantially pointed chisel edge having a slightly rounded apex has been found to be preferable for this application, but well known alternative such as straight knife edges or chisel edges or simple pointed ends may also be embodied in a connector constructed in accordance with this invention. Contact 28 may be provided with any convenient means such as notched tab 42 either within or external to the connector 14, to facilitate connection thereto of external electrical conductors.

As shown in FIGURE 3 cable receiving channel 30 extends inwardly from opening 12 into the connector between lip 34 and surface 36. Rear wall 44 of channel 30 provides a stop which limits the extent of axial engagement of the cable 10 within the connector, and assures that connection is made within a fixed distance from the cable end.

The elements of the connector embodiment shown in FIGURE 4 correspond in all respects to those of FIGURE 3 with the exception of rear wall 44 which, in this embodiment, is provided with inclined edge 46 and in-
cludes added channel 31. Channel 31 is coaxial with and equal in cross-sectional dimension to opening 12, and penetrates cable conductors thereby so that the contact may be established at any point intermediate the cable ends. Inclined edge 46 serves to guide the cable into channel 31 after it has passed through channel 39 and beneath sharpened edge 40.

The splice connector of FIGURE 5 is equivalent to two of the connectors of FIGURE 3, joined back-to-back about line A—A. The numbered and lettered elements correspond in function to the identically numbered elements of FIGURES 1 to 3. The primed elements at the right of line A—A correspond to the identical but mirror image elements to the left of the line.

The operation of each of these connector embodiments is essentially identical. In use, a cable is inserted through the opening 12 along the channel 30, and is axially pressed against the forward side of contact end portion 38 until the end flanges at bend 39, moving sharpened edge 49 inwardly into the channel and away from opening 14 and surface 36; the cable end thus passes beyond contact end portion 38 and slides inwardly into the channel between edge 40 and surface 36. Side walls 32 engage the longitudinal edges of the cable 10 to fix the transverse position of the cable within the channel 30, so as to position the cable conductors 16 and 18 directly beneath the contact sharpened edges 49. The transverse spacing of the contacts relative to one another is accordingly made to correspond to the relative spacing of the conductors within the cable. Subsequent to insertion, end portion 38 is disposed at an angle to the surface of the cable 10 and is resiliently biased thereagainst by bend 39; an outward pull on the cable at this point forces it back against the edge 40 and causes the edge to angularly penetrate the underlying cable insulation. As shown in FIGURE 5, a typical flat cable 10 appears in cross-section as a conductive layer 16 sandwiched between two layers of insulating material 17. Subsequent to entering the upper insulating layer, sharpened edge portion 40 next engages conductive layer 16 to establish electrical contact therewith. Pressing edge 40 against conductor 16 initially deforms the conductor without substantially puncturing it and forms a surface area contact between the upper surface of the conductor and the forward side of contact portion 38. As the conductor deforms around edge 40 it forms a blunting shield which tends to prevent penetration of lower insulating layer 17. The angular relationship of portion 38 and conductor 16 minimizes the normal puncturing force exerted by edge 40 and facilitates blunting and shielding process. An angular relationship between 30° and 70° has been found to be preferable for this purpose. In practice, the maximum outward pull which can be manually applied to a cable without undue exertion, in a connector built in accordance with this specification and drawings, will be sufficient to assure adequate contact without substantial puncturing as described. In connectors adapted for connection only at an end of a cable, such as in the embodiments shown in FIGURES 3, 5 and 6, side walls 32 may be made to converge inwardly from opening 12 as illustrated in FIGURE 2 to produce increasing transverse compressive pressure on a cable 10 being inserted into the channel 30. This compressive force produced during insertion is stored in the slightly resilient and compressible insulation 17 commonly used in commercial flat cable. After removal of the insertion force, the compressed insulation tends to expand between the outwardly diverging side walls 32 to urge the cable out of the channel 30 and against sharpened edge 40. Urning the cable outwardly in this manner facilitates penetration of the cable 10 by contact 28 and assures continued contact-cable engagement.

The connector embodiment shown in FIGURES 6 and 7 which is particularly adapted for use with cables having a plurality of closely spaced conductors, is seen to comprise a body 61 and a plurality of contact elements 63 disposed therein, the body being formed of three closely dielectric half sections 60 and 62 shown held together, by way of example only, by means of spring clips 64. Each half section includes a planar cable supporting surface 66, a pair of side walls 68, and a plurality of contact receiving grooves 70 in the supporting surface. Surfaces 66 and side walls 68 cooperate to form a substantially rectangular channel within body 61 for telescopeically receiving a flat cable along its longitudinal axis. Grooves 70 are located in each surface 66 such that, in assembled position the grooves in one surface are substantially opposite the surface portions 72 between grooves in the other surface. Contact elements 63 are essentially similar to those of the other embodiments herein described, having angularly bent end portions 74, bearing sharpened edges 76, and having notched tab ends 78 for connecting external conductors thereto. They may however be of varying lengths and bent at various angles as shown in FIG. 10 URE 7 to provide greater relative separation from cable other and to facilitate the making of external connections. End portions 74 when disposed in grooves 70 extend therefrom and bear against opposite cable supporting surface portions 72. Penetration and contacting of an inserted cable by sharpened edges 76 is accomplished in the identical manner as for the embodiment shown with the embodiments shown in FIGURES 3, 4 and 5.

The invention has thus been described but it is desired to be understood that it is not confined to the particular forms or usages shown and described, the same being merely illustrative, and that the invention may be carried out in other ways without departing from the spirit of the invention; therefore, the right is hereby claimed to employ all equivalent instrumentalities coming within the scope of the appended claims, and by means of which objects of this invention are attained and new results accomplished, as it is obvious that the particular embodiments herein shown and described are only some of the many that can be employed to obtain these objects and accomplish these results.

I claim:

1. A connector for flat flexible cable of the type including a plurality of parallel spaced apart strip conductors within a supporting body of flexible dielectric material, comprising:

   a housing including a front surface and a cavity extending inwardly therefrom for longitudinally receiving a flat flexible cable in fixed position relative to said housing; said cavity including two substantially parallel spaced apart side surfaces for receiving said flat cable therebetween; a plurality of spaced apart grooves parallel to the longitudinal axis of said cable in said supporting surface, the grooves in each said surface being disposed opposite the spaces between grooves in the other said surface; a base surface in each said groove; a plurality of contact elements formed of resilient strip material each disposed in part in contact with the base surface of one of said grooves and in part extending angularly therefrom and inwardly into said cavity; means on said housing for fixing securely thereto a portion of each said contact element disposed in said grooves; each said angularly and inwardly extending contact part having a free end bearing against the cable supporting surface opposite the groove containing said contact, and adapted to flex inwardly and away therefrom; a sharpened edge on each said groove on said outer side wall of the dielectric jacket of a cable inserted into said cavity between said sharpened edge and said cable support surface, in response to movement of said cable in the direction opposite to insertion.

2. A connector according to claim 1 wherein said cavity includes a pair of inwardly converging side walls substantially normal to said cable supporting surfaces
and forming with said surfaces a channel of decreasing transverse dimension for transversely compressing a cable inserted into said cavity to urge said cable outwardly in the direction opposite to the direction of insertion.

References Cited by the Examiner

UNITED STATES PATENTS
2,291,434 7/42 Holloperator et al. 339—97
2,359,541 10/44 Bancroft 339—97

FOREIGN PATENTS
699,856 11/53 Great Britain.

JOSEPH D. SEERS, Primary Examiner.