

Ribbon Cable Connector Assembly

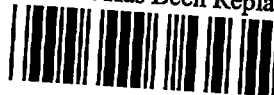
10 The invention relates to a ribbon cable connector assembly for connecting an electrical ribbon cable to a connector by means of which the ribbon cable may be connected e.g. to conductive tracks of a circuit board.

15 Such ribbon cables comprise a series of electrical conductors embedded in an insulating material in juxtaposed manner. The conductors may be round conductors of circular cross-section and/or flat conductors of
20 rectangular cross-section.

The connector housing has a cable insertion opening for pluggably receiving a ribbon cable end. Terminating in the cable insertion opening are conductor
25 contact receiving cavities for receipt of conductor contacts projecting into the cable insertion opening, for establishing contact with the individual ribbon cable conductors. The conductor contacts are in electrical connection with terminal contacts which are
30 electrically connectable e.g. to conductive tracks of a circuit board by soldering.

For rendering possible electrical contact between the ribbon cable conductors and the conductor contacts of
35 the connector, the ribbon cable conductors are exposed

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on a ribbon cable end on a broad side of the ribbon cable by stripping the insulating material up to the ribbon cable conductors. The conductor contacts have contact portions with contact springs engaging the exposed ribbon cable conductors when the ribbon cable end is introduced into the cable insertion opening of the connector.

By stripping the insulating material at the ribbon cable end for the purpose of exposing the ribbon cable conductors, the ribbon cable end loses in flexural strength. This aggravates on the one hand the process of inserting the ribbon cable end into the cable insertion opening of the connector and on the other hand is opposed to establishing in unproblematic manner an electrical contact between the exposed ribbon cable conductors and the contact springs of the conductor contacts. For overcoming this problem, that broad side of the ribbon cable end where the ribbon cable conductors have not been exposed, i.e. where no insulating material has been removed, preferably has a reinforcing layer applied thereto, preferably in the form of a reinforcing film. The latter enhances the flexural strength of the ribbon cable end that has been reduced by insulation stripping. This is why a material of relatively high inherent flexural strength is used for the reinforcing film.

However, despite the use of the reinforcing film there are problems left with this type of connector assembly:

Such a ribbon cable has a film construction with a thickness of e.g. 0.4 mm only. The connectors commonly employed at present for connection of ribbon cables have a small constructional height of approx. 10 mm.

From the beginning of the cable insertion opening to the spring contacts of the conductor contacts, a lateral guiding effect for the thin ribbon cable is thus present across a short distance of about 6 mm only. Furthermore, there is the fact that the presently employed connectors display considerable manufacturing tolerances for connection of such ribbon cables. The result hereof is that the ribbon cable end has to be inserted into the cable insertion opening of the connector with only a slight guiding depth and insecure lateral guiding effect. There is thus a high risk that the ribbon cable end will be introduced into the connector obliquely or even with bends. Due to the narrow spacing pattern between the ribbon cable conductors and, accordingly, of the conductor contacts in the connector, this may easily result in that ribbon cable conductors will not be contacted properly or not at all with the associated contacts or even may be contacted with wrong conductor contacts.

This problem is particularly prominent in case of shielded flat conductor ribbon cables which have a shielding foil disposed above an insulating material layer on each broad side of the cable and in which a flat conductor disposed at one longitudinal edge of the cable is in contact with both shielding foils. The shielding foils thus abut this flat conductor without insulating material being disposed therebetween. Due to the fact that the insulating material is missing in this longitudinal edge portion of the flat conductor ribbon cable, this longitudinal edge portion is particularly instable.

The force with which the contact spring arms of the conductor contacts engage the ribbon cable conductors is only low in view of the very small size of the con-

ductor contacts. Thus, it cannot be excluded that the ribbon cable conductors are detached from the conductor contacts even when the tensile force applied to the ribbon cable is not extraordinarily high.

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There are applications in which it is desirable to ensure a particularly high reliability of the connection between ribbon cable end and connector.

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An improvement is provided by a ribbon cable connector assembly as described in German Patent Application P 195 12 788.9 that was filed earlier but is post-published. This ribbon cable connector assembly comprises a locking member which is either formed integrally with the connector housing or is adapted to be latchingly engaged with the latter. In the region of the ribbon cable end, a longitudinal outside of the ribbon cable has a rib-shaped locking projection disposed thereon which lockingly cooperates with a locking shoulder provided on a resilient locking arm of the locking member connected to or formed integrally with the connector housing. When the ribbon cable end has been inserted to a sufficient depth into the locking member, the locking shoulder engages over the locking projection disposed on the ribbon cable end, whereby the ribbon cable end is secured against withdrawal from the connector housing unless the locking shoulder is released from its locked engagement with the locking shoulder by pivoting of the locking arm against the resilient bias thereof.

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Due to the locking member that is provided in addition to the conventional connector, one obtains a longer cable insertion opening and thus a relatively large length across which the ribbon cable end is guided in the cable insertion opening.

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This already filed ribbon cable connector assembly has proved to be quite successful. However, it is occasionally desired to reduce the expenditure created by the need of attaching the rib-like locking projection to the ribbon cable end.

Ribbon cables often have an electrical shield in the form of shielding foils located between an insulating material surrounding the ribbon cable conductors and an insulating material jacket of the ribbon cable. For establishing contact between the cable shield and an electrical shield of the connector and/or a ground conductor of a circuit board to which the connector is connected, one makes use of an additional wire by means of which a connection is established between the ribbon cable shield and the connector shield and/or the ground conductor of the circuit board. This construction is not capable of achieving a shielding quality as desired for superior applications.

The present invention makes available a ribbon cable connector device as well as a connector assembly comprising such a connector device and a ribbon cable, by means of which it is possible, with little expenditure with respect to an alteration of the ribbon cable to be connected, to achieve not only good retention of the ribbon cable in the connector device, but also unproblematic shielding contact that fulfils high quality demands.

The features of the ribbon cable connector device according to the invention are indicated in claim 1. Advantageous developments are gatherable from claims 2 to 24. Suitable ribbon cables are indicated in claims 25 to 28. Claim 29 is directed to a connector assembly



comprising a connector device according to the invention and a ribbon cable of the type claimed.

5 Due to the locking of the ribbon cable by means of a lock spring means, efficient securing against inadvertent withdrawal of the ribbon cable from the connector is provided. When the latter is a shielded ribbon cable, it is merely necessary to punch a recess into the insulating material jacket of the ribbon
10 cable at the ribbon cable end, which is preferably done during cable manufacture, and when an electrically conductive lock spring means is employed, a strain-relief locking effect of the ribbon cable in the connector device and an efficient and high-quality
15 shielding contact with the cable shield are obtained at the same time.

The overall height of the connector housing and the lock spring housing are preferably selected such that
20 the ribbon cable end is guided over a relatively large length in the cable mating opening constituted by the cable through-opening of the lock spring housing and the cable insertion opening of the connector housing, before contact of the ribbon cable conductors with the
25 conductor contacts of the connector takes place. This prevents lateral pivoting of the ribbon cable end which may result in erroneous contacting between the ribbon cable conductors and the conductor contacts.

30 Due to the fact that it is no longer necessary to effect the shielding contact via additional wires and it is possible to effect such contact via the lock spring means whose lock portion may be in direct electrical contact with the exposed cable shield over a
35 relatively large area of contact, shielding contact is

not only established in very safe manner, but can be effected also with a very low transition resistance.

5 It is possible to form the connector housing integrally with the lock spring housing. As the part constituting the lock spring housing is located above the connector housing part, an overall height is created such that a sufficient insertion depth is achieved for the ribbon cable end to ensure sufficiently safe lateral guiding of the ribbon cable end. By correspondingly designing in particular the constructional height of the lock spring housing part, it is possible to achieve an arbitrary cable insertion depth and thus an arbitrary lateral guiding effect of the ribbon cable end.

10 If it is desired, for any reason whatsoever, to employ the conventional connectors which do not only display large manufacturing tolerances but also have a low constructional height and thus a low insertion depth for the ribbon cable end, with a correspondingly low protection against oblique insertion or tilting of the ribbon cable, an embodiment of the invention provides the use of the lock spring housing as an additional housing comprising on the one hand a cable through-opening for the ribbon cable end and on the other hand an introduction opening for slidably introducing the conventional connector housing to such a position that the ribbon cable end may reach the cable insertion opening of the connector housing through said cable through-opening of the additional housing.

15 In that case, the additional housing is provided with the lock spring means. By way of the constructional height of this additional housing, it is possible to produce the desired insertion depth for the ribbon

cable, which renders possible sufficient safety against tilting or oblique insertion of the ribbon cable end into the insertion opening of the connector. The introduction opening of the additional housing advantageously is provided with latching spring arms latchingly engaging behind the connector housing introduced into the introduction opening when said housing has been slid into the introduction opening to a sufficient depth.

The lock spring means preferably is designed and positioned such that it develops a free-running effect. This means, it presents only little resistance to the process of inserting the ribbon cable into the connector device, whereas it presents high resistance to the process of withdrawing the ribbon cable from the connector device. This is preferably achieved in that the lock spring means or at least its lock portion engaging the cable is directed obliquely downwardly towards the connector housing. The lock portion is designed to allow unproblematic sliding past of the ribbon cable during insertion of the latter into the connector device, whereas it exerts a locking restraining effect during withdrawal of the ribbon cable from the connector device. The ribbon cable end thus may be inserted into the connector device with almost no resistance of the lock spring means, but may be withdrawn again from the locking device with high force expenditure only.

The lock portion of the lock spring means may engage the ribbon cable end either frictionally or positively. In case of a frictional locking effect, the lock portion simply presses by spring bias against the outside of the ribbon cable. In this case, the lock portion pressing against the ribbon cable is pre-



ferably provided with restraining ribs. This embodiment is used preferably when the ribbon cable has no shielding conductor or when no contacting of the shield is necessary. The lock portion then presses
5 against the insulating material jacket of the ribbon cable which need not be modified with this embodiment.

Positive locking, in which the lock portion engages in a recess provided in the insulating material jacket of
10 the ribbon cable, is preferably employed when the ribbon cable has a shielding foil with which electrical contact is to be established via the lock spring means. In this embodiment, it is merely necessary to
15 punch out a portion from the insulating material jacket of the ribbon cable in order to expose on the one hand the shielding foil for contacting and to provide on the other hand the prerequisite for positive engagement of the lock portion.

20 When the connector is surrounded by a shielding housing shielding the same, the latter may constitute at the same time the lock spring housing, and the lock spring means may be formed integrally with this shielding housing, for example it may be cut free and
25 bent out from a sidewall of the shielding housing.

The lock spring means preferably is designed and supported such that, in the rest condition, it lockingly engages a ribbon cable inserted into the connector
30 device, while however it may be released against its spring force from the engagement with the ribbon cable either manually or by means of a tool, for example a screwdriver, whereafter the ribbon cable can be pulled out from the connector device without any
35 problem.

Further advantageous embodiments and developments of the invention are indicated in the claims.

5 The invention will now be elucidated in more detail by way of embodiments with reference to the drawings wherein:

10 Fig. 1 shows a first embodiment of a ribbon cable connector device according to the invention, comprising a separate lock spring housing in which a conventional connector may be latchingly received;

15 Fig. 2 shows a connector device according to Fig. 1 with two lock spring means that may be used alternatively;

20 Figs. 3 to 5 show cross-sectional views of three different ribbon cable configurations along a sectional line extending perpendicularly to the longitudinal direction of extension of the particular ribbon cable;

25 Fig. 6 shows another embodiment of a lock spring means according to the invention;

30 Fig. 7 shows a partial view of the embodiment of lock spring means and lock spring housing depicted in Fig. 1;

Fig. 8 shows a cross-sectional view of a connector assembly according to the invention;

35 Fig. 9 shows a detail of the connector assembly depicted in Fig. 8;

Fig. 10 shows a schematic side view of the connector assembly depicted in Fig. 8;

5 Fig. 11 shows a side view of the connector assembly depicted in Fig. 10 along with a circuit board;

10 Fig. 12 shows an embodiment of a connector assembly according to the invention comprising a shielding housing;

15 Fig. 13 shows a schematic view, not to scale, of a ribbon cable end having flat conductors exposed on one side;

20 Fig. 14 shows a schematic view of a conventional connector prior to insertion of connector terminal legs into soldering holes of a circuit board;

25 Fig. 15 shows a schematic view of a further embodiment of a ribbon cable with a cover, which is suitable for the invention;

30 Fig. 16 shows a schematic cross-sectional side view, not to scale, of the embodiment depicted in Fig. 15;

35 Fig. 17 shows an example of a cover usable in the embodiment according to Figs. 15 and 16;

 Fig. 18 shows a lock spring usable for the embodiment of Figs. 15 to 18; and

 Fig. 19 shows a schematic view of a further embodiment of a ribbon cable that is suitable for the

invention and usable with the lock spring depicted in Fig. 18.

Fig. 13 shows in a schematic view, not to scale, a ribbon cable end 11 having flat conductors 13 embedded on all sides in insulating material. This is achieved e.g. by films of insulating material applied to both sides of the juxtaposed flat conductors 13. The insulating material may be, for example, expanded polytetrafluoroethylene (ePTFE), polyester or other plastics materials. From an end portion 17 of ribbon cable end 11 insulating material has been removed to such an extent that the flat conductors 13 are exposed on one side and thus are accessible for being contacted electrically. On the rear side of ribbon cable end 11, on which the flat conductors 13 are still covered by insulating material 15, the insulating material 15 has a reinforcing film 19 applied thereto consisting e.g. of polyester. The latter serves on the one hand for increasing again the flexural strength of the ribbon cable end that has been reduced by stripping flat conductors 13, and on the other hand for bringing the ribbon cable end to the dimensions of the plug contacts. Without such a reinforcing film 19, the ribbon cable end 11 having e.g. a width of 15 mm and a thickness of 0.4 mm may become so unstable by the removal of insulating material for the purpose of exposing the flat conductors 13 that it could be handled only poorly for insertion into the connector housing.

The presentation of three flat conductors 13 has been selected for the drawings merely in arbitrary manner. Such ribbon cables generally have a considerably larger number than three flat conductors.

Fig. 14 illustrates a conventional connector 21 for pluggably receiving the ribbon cable end 11 shown in Fig. 13, as well as a circuit board 23 having soldering holes 25 serving for receipt and soldering of terminal legs 27 of connector 21. On the side remote from terminal legs 27, connector 21 is provided with a cable insertion opening 29. The latter has such dimensions that ribbon cable end 11 is adapted to be inserted into cable insertion opening 29.

Projecting into cable insertion opening 29 in Fig. 14 are conductor contacts, not visible, of connector 21 by means of which an electrical connection can be established between ribbon cable conductors 13 of ribbon cable end 11 inserted into cable insertion opening 29 and conductive tracks of circuit board 23.

A pluggable connection between a ribbon cable end according to Fig. 13 and a connector 21 according to Fig. 14 is known per se.

Such known connectors 21 have a constructional height of e.g. 10 mm and an insertion depth for the ribbon cable end 11 of e.g. about 6 mm only. Thus, upon insertion into cable insertion opening 29, ribbon cable end 11 is guided over a very short length only so that there is a high risk that ribbon cable end 11 will be inserted into cable insertion opening 29 obliquely, which may result in erroneous contacting between flat conductors 13 and conductor contacts, not shown, disposed in connector 21.

Fig. 1 shows an embodiment of the invention in which ribbon cable end 11 is inserted into cable insertion opening 29 of a conventional connector 21, however not directly, but upon passage of a cable through-opening

31 of an additional housing 33 constituting a lock
spring housing having a lock spring 35 disposed
therein. This embodiment of the invention is advan-
tageous when, for whatever reason, the conventional
5 connector 21 is to be employed while the advantages
according to the invention should be realized never-
theless, namely a good lateral guiding effect of
ribbon cable end 11 during insertion thereof, safe
retention thereof in the inserted position as well as
10 easy and safe shield contacting of a ribbon cable
shield.

If it is not desired to use the conventional connector
21, connector housing and lock spring housing may be
15 formed integrally, and the conductor contacts may be
disposed in the lower portion and the lock spring in
the upper portion.

In the embodiment shown in Fig. 1, additional housing
20 33 has at the lower end thereof an introduction
opening 37 into which connector 21 can be introduced.
Introduction opening 37 is open at its lower end in
order not to collide with terminal legs 27 of con-
connector 21. At the lower end of introduction opening
25 37, holding ribs 39 extend from the sidewalls of in-
troduction opening 37 laterally towards each other,
preventing withdrawal of the engaged additional casing
33 from connector 21. The sidewalls of introduction
opening 37 are each provided with a latching spring
30 arm 41 cut free from the corresponding sidewall. Each
latching spring arm 41 has at the free end thereof a
latching hook 43 with a latching shoulder 45 and an
inclined ramp 47. Upon introduction of connector 21
into introduction opening 37, latching spring arms 41
35 are resiliently deflected when connector 21 reaches
the inclined ramp 47. When connector 21 has been slid

into introduction opening 37 to a sufficient extent, latching spring arms 41 resile, with latching shoulders 45 thereof engaging behind connector 21 and thus retaining the same within introduction opening 37.

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Additional housing 33 may also be connected in different manner to connector 21, for example by adhesive bonding.

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Introduction opening 37 and latching spring arms 41, in relation to the dimensions of connector 21, are dimensioned such that, when connector 21 is latched in introduction opening 37, cable introduction opening 29 thereof is aligned with cable through-opening 31 of additional housing 33. In this manner ribbon cable end 11 may be introduced through cable through-opening 31 of additional housing 33 into cable insertion opening 29 of connector 21 while being guided by said cable through-opening 31. Safety with respect to correct alignment of flat conductors 13 with respect to the conductor contacts (not shown) in connector 21 and securing of ribbon cable end 11 against inadvertent withdrawal from cable insertion opening 29 is afforded by additional housing 23 in cooperation with lock spring 35. The advantages attainable with the invention are thus realized as well when a conventional connector 21 is used for establishing the connection.

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The additional housing 33 even provides the possibility of giving the safety achieved by the invention later on to connectors 21 which are already soldered on a circuit board 23, by subsequently applying additional housing 33 to soldered connector 21 and by then inserting ribbon cable end 11 provided with lock spring 35 through cable through-opening 31 of additio-

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nal housing 33 into cable insertion opening 29 of already soldered connector 21.

5 Before the mechanism of the lock spring means will be elucidated in more detail, the ribbon cable configurations shall be elucidated by way of Figs. 3 to 5, which are suitable for connection to the connector device according to the invention. Figs. 3 to 5 each show in a highly schematic perspective sectional view,
10 not to scale, the construction of the respective ribbon cable. Figs. 3 and 4 show ribbon cable structures with shielding foils, whereas Fig. 5 shows a ribbon cable construction without shielding foil.

15 A first ribbon cable configuration 49 shown in Fig. 3 contains four flat conductors 13 embedded in insulating material 15. The presentation with four flat conductors 13 is just of arbitrary nature. In practical application, the ribbon cable may have a considerably higher number of flat conductors. The in Fig.
20 3 upper longitudinal outside of ribbon cable configuration 49 is constituted by an upper insulating material jacket 51, while the in Fig. 3 lower longitudinal outside of ribbon cable configuration 49 is constituted by a lower insulating material jacket 53.
25 Between insulating material 15 and upper insulating material jacket 51, there is an upper shielding foil 55 in Fig. 3, whereas a lower shielding foil 57 is located between insulating material 15 and lower insulating material jacket 53. While the two shielding
30 foils 55 and 57 are separated from the three right-hand - as seen in Fig. 3 - flat conductors 13 by insulating material, the two shielding foils 55 and 57 are in contact with the left-hand flat conductor 13 in
35 Fig. 3. The two shielding foils 55 and 57 are thus

electrically connected to each other via flat conductor 13 on the left-hand side in Fig. 3.

5 One of the two insulating material jackets 51 and 53, in Fig. 3 the upper insulating material jacket, has a locking recess 59 punched thereinto, in which upper shielding foil 55 is exposed. The purpose of locking recess 59 shall be elucidated hereinafter in conjunction with the more detailed description of the
10 lock spring means.

A second ribbon cable configuration 61 shown in Fig. 4 is partly identical with the first ribbon cable configuration 49 shown in Fig. 3. Deviations are present
15 in so far as in the second ribbon cable configuration 61 both shielding foils 55 and 57 are electrically isolated across their entire width both from all flat conductors 13 and from each other. For being able to establish electrical contact to both shielding foils
20 55 and 57, each of the two insulating material jackets 51 and 53 has a locking recess, namely an (in Fig. 3) upper locking recess 63 and a lower locking recess 65, respectively.

25 The third ribbon cable configuration 67 illustrated in Fig. 5 shows an unshielded ribbon cable comprising only flat conductors 13 and insulating material 15 in which the latter are embedded. Due to the fact that this ribbon cable configuration 67 is not provided
30 with shielding foils to which electrical contact would have to be made, this ribbon cable configuration can be employed for a lock spring means acting in frictional manner only, so that no locking recess is necessary. If a positive locking effect is to be established
35 between this ribbon cable configuration 67 and the lock spring means, it is possible to provide in

the insulating material 15 of ribbon cable configuration 67 an upper locking recess 63 and/or a lower locking recess 65, outlined in Fig. 5 in broken lines.

5 In the following, the construction and the operation of the embodiments of the ribbon cable connector devices according to the invention, as shown in the drawings, shall be elucidated in more detail.

10 In the embodiment shown in Fig. 1, additional housing 33 serving as lock spring housing has a lock spring 35 in the form of a flat spring disposed therein. The latter is supported at the upper end in Fig. 1 so as to be pivotable about a pivot axis 69 extending
15 parallel to the transverse direction of additional housing 33, and it has an approximately plate-shaped lock portion 71 extending obliquely downwardly from the region of pivot axis 69 towards introduction opening 37 of additional housing 33. In the region of
20 its free lower end, lock spring 35 is provided with a latching tongue 73 cut free from the plate-shaped body of lock spring 35 and bent outwardly from this portion of lock spring 35 on the side of lock spring 35 remote from introduction opening 37.

25 Fig. 2 shows an embodiment of additional casing 33 in which alternatively either a lock spring 35 or a lock spring 35' may be employed. Lock spring 35 corresponds to the lock spring shown in Fig. 1 and is designed
30 mainly for positive engagement in a locking recess 59, 63 of one of the ribbon cable configurations 49, 61 and 67, respectively, shown in Figs. 3 to 5. Lock spring 35' is designed mainly for positive engagement on a longitudinal outside of a ribbon cable that need
35 not have a locking recess, like ribbon cable configuration 67 shown in Fig. 5. A lock portion 71' of

lock spring 35' is provided with restraining ribs 77 for enhancing the frictional engagement on the longitudinal outside of the ribbon cable. Lock spring 35' is formed in its pivot axis with pivot axis stubs 79' adapted to be latched into pivot axis holes 81 of additional housing 33 that are open on one side.

In particular when lock spring 35 is used for electrically contacting an exposed ribbon cable foil shield 55 or 57, it consists of metal or an electrical conductive material in order to effect electrical contact with foil shield 55 or 57, respectively. When lock spring 35' is to be used for frictionally engaging not a shield foil, but the insulating material 15 of ribbon cable configuration 67 or one of insulating material jackets 51 or 53, lock spring 35' may consist of elastic plastics material.

The pivotal support of lock spring 35 within additional housing 33 shall be elucidated in more detail by way of Fig. 7. Additional housing 33 serving as lock spring housing is open on its top side 83 on the cable insertion side as well as at the upper end of its rear wall 85. The insides of two transverse sidewalls 87 of additional housing are provided with one supporting post 89 each, which are located near rear wall 85 and have a supporting shoulder 91 which is offset downwardly from upper side 83 by a certain distance. Each one of said supporting shoulders 91 has one of two convex supporting arcs 93 supported thereon, which are formed on both sides of lock portion 71 of lock spring 35. The convex bulge of each supporting arc 93, which is directed towards lock portion 71, is pivotally supported on one of the two supporting shoulders 91 and on the wall portion 95 of the associated supporting post 89 located above supporting shoulder 91.

In the embodiment of lock spring 35 shown in Figs. 1 and 2, lock portion 71 thereof is cut free from the plate of lock spring 35. The plate remainders 97 left
5 on both sides of lock portion 71 after such cutting free each project into a space between rear wall 85 and associated supporting post 89. At its upper end in Fig. 2, lock spring 35 has an upper edge 101 bent away from lock portion 71. Lock spring 35' has a corresponding upper edge 101'.
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At the lower edge in Fig. 2, lock spring 35 is provided with two spaced apart projections 103 that may be inserted into correspondingly shaped circuit board
15 holes and electrically connected therein to ground conductors.

Lock spring 35 is intended for establishing contact with upper shielding foil 55 or lower shielding foil
20 57, depending on the rotational position in which the ribbon cable is introduced into cable through-opening 31. Lock spring 35 thus is suitable in particular for shielding foil contact with ribbon cable configuration 49 shown in Fig. 3. When employing ribbon cable configuration 61 shown in Fig. 4, electrical contact is
25 established both with upper shielding foil 55 and with lower shielding foil 57. For establishing such bilateral contact, a lock spring 105 may be used as shown in Fig. 6. The latter has the same construction as the lock spring shown in Fig. 2, as regards lock portion
30 71, supporting arcs 93, plate remainders 97, latching tongue 73, upper edge 101, and projections 103. In addition to lock spring 35 shown in Fig. 2, lock spring 105 shown in Fig. 6 comprises an angle web 107
35 projecting at right angles from the right-hand plate remainder 97 in Fig. 6 and having an additional lock

portion 111 at its bent free end 109. When a ribbon cable having the ribbon cable configuration 61 shown in Fig. 4 is introduced into cable through-opening 31 of additional housing 33, it is passed between oblique lock portions 71 and 111 aligned substantially parallel with each other, until it has reached its final inserted position in which flat conductors 13, exposed as shown in Fig. 13, have come into mating contact with the conductor contacts of connector 21. Additional lock portion 111 could also be directed obliquely towards lock portion 71. This would provide stronger retention of the ribbon cable, but would render release of the ribbon cable from the locked condition more difficult.

Also when a ribbon cable configuration is present in which only one shielding foil or even no shielding foil needs to be contacted, lock spring 105 of Fig. 6 may be advantageous as well. For, in that case lock spring 105 itself provides a well definable passage gap between lock portions 71 and 111 for the ribbon cable so that particularly good retention of the ribbon cable is possible when lock spring 105 is employed.

The positioning and mode of operation of lock spring 35 can be seen particularly good from Figs. 8 and 9. It is expressly pointed out that these figures are of very schematic nature and not necessarily to scale.

In the sectional view of Fig. 8, connector 21 is shown in the position in which it is inserted into insertion opening 37 of additional housing 33. The sectional view shows conductor contacts 113 with soldering legs 27 soldered in soldering holes 25 of a circuit board 23. Inserted into cable through-opening 31 of additio-

nal housing 33 and cable insertion opening 29 of connector 21 is a ribbon cable end 11 at the, in Fig. 8, lower end of which flat conductors 13 are exposed on at least one side, as shown in Fig. 13, so that they are electrically contacted by at least one conductor contact of conductor contact pair 113. Flat conductors 13 usually are exposed on only one side as shown in Fig. 13, so that only one conductor contact 113 of the opposing conductor contact pair establishes electrical contact with the respective flat conductor 13, whereas the other conductor contact 113 of the related conductor contact pair exerts only a counterpressure. In the representation shown in Fig. 8, ribbon cable 11 is provided on its side directed towards lock spring 35 with a reinforcing film 19 whose upper end 115 forms an engagement shoulder for the free end of lock portion 71. When the ribbon cable has shielding foils which are to be contacted electrically by means of lock spring 35, the insulating material jacket 55 or 57 directed towards lock spring 35 is provided with a locking recess 59, 63 or 65, such that the free end of lock portion 71 can establish electrical contact with this shielding foil. Lock spring 35 in this case is made of metal or another conductive material and at least one of the projections 103 is electrically connected to a ground conductor of circuit board 23. In this manner, the shielding foil is electrically connected to the ground conductor of circuit board 23 via lock spring 35.

The plate part of lock spring 35 located laterally of and below lock portion 71 is disposed between supporting post 89 and rear wall 85 of additional housing 33, with such little movement play between supporting post 89 and rear wall 85 that lock spring 85 is held by means of latching tongue 73 in a complementary

latching shoulder 74 of rear wall 85, and lock spring 35 thus is kept latched in additional housing 33. As can be seen best in Fig. 9, a front edge 117 of supporting shoulder 91 constitutes an abutment site for the lower end 119 of supporting arc 93 of lock spring 35. The centre of curvature of supporting arc 93 then constitutes the pivot axis 69 of lock spring 35. In the rest condition of lock spring 35, the lock part 71 thereof is biased towards the ribbon cable, such that locking of the free end of lock portion 71 with the ribbon cable is effected by way of positive engagement.

Lock spring 35 with its lock portion 71 constitutes a free-running mechanism such that lock portion 71, upon insertion of the ribbon cable into cable through-opening 31, is resiliently deflected and does not impede introduction of the ribbon cable, whereas when withdrawal of the ribbon cable from the cable through-opening 31 is attempted, locking is effected between lock portion 71 and the shoulder constituted by the upper reinforcing film end 115 and/or the confine of locking recess 59, 63 or 65. If the locked condition between ribbon cable and lock portion 71 is to be released, one either presses, with a finger or a tool, in the direction of arrow A shown in Fig. 8 against the upper edge 101 of lock spring 35, thereby pivoting lock portion 71 about pivot axis 89, such that the locked condition between lock portion 71 and ribbon cable is released. Release of the locked condition between ribbon cable and lock portion 71 of lock spring 35 may also be effected by moving the upper edge 101 of lock spring 35 in the direction of arrow B in Fig. 8 away from the ribbon cable to such an extent that lock portion 71 is disengaged from the ribbon cable. The ribbon cable may then be easily withdrawn

from cable insertion opening 29 and cable through-opening 31.

5 Similar representations as in Fig. 8 are shown in the side views of Figs. 10 and 11: in Fig. 10 without and in Fig. 11 with circuit board 23. In the embodiments shown in Figs. 10 and 11, insulating material 15 at the lower ribbon cable end, where flat conductors 13 are exposed, is not cut off but is bent upwardly in
10 the form of a folded portion 121 and there acts as an abutment on the inside of a front wall 123 of additional housing 121. Folded portion 121 enhances safe positioning of the ribbon cable for safe engagement between lock portion 71 and locking recess 59, 63 or
15 65 and possibly upper reinforcing foil end 115.

Fig. 12 shows an embodiment in which the arrangement of connector 21, additional housing 33, lock spring 35 and ribbon cable end 11 is accommodated in a shielding
20 housing of electrical conductive material. The latter is connected by means of lower projections 127 to ground conductors (not shown) of a circuit board 23, either by soldering or by a solder-free clamping connection as shown in portion 129 of the circuit board.
25 Shielding housing 125 is provided with an additional lock spring 131 that may be cut free and bent outwardly from a sidewall of shielding housing 125. Lock spring 35, which is visible only in part in Fig. 12, may be used for contacting one shielding foil 55 or
30 57, respectively, while additional lock spring 131 may take over contacting of the other shielding foil 57 or 55, respectively, of ribbon cable configuration 61 of Fig. 4.

35 If a ribbon cable configuration of the type of Fig. 4 is used, having two shielding foils 55, 57 that are

not electrically connected to each other via a flat conductor 13, it is recommendable to establish contact with both shielding foils 55, 57 by means of an electrically conductive lock spring, e.g. by means of the two lock portions 71 and 111 of lock spring 105 shown in Fig. 6 or by means of the two lock springs 35 and 131 shown in Fig. 12. For, if electrical contact were established with only one of the two shielding foils by means of a lock spring as shown in Fig. 8 in case of such a ribbon cable configuration, an additional wire as before would still be necessary for establishing electrical contact with the other shielding foil.

It has already been mentioned that ribbon cables of the type considered hereinbefore are very thin and have a thickness of e.g. about 0,4 mm only. This means that shielding foils 55, 57 necessarily are also very thin and may break especially upon engagement of lock portion 71. This risk is counteracted by the embodiments of the invention shown in Figs. 15 to 19.

In the embodiment shown in Fig. 15, when ribbon cable configuration 49 shown in Fig. 3 is used, locking recess 59 is protected, and when ribbon cable configuration 61 shown in Fig. 4 is used, upper locking recess 63 and lower locking recess 65 are protected by a reinforcing cover 133. The latter consists of a plastics strip folded around an longitudinal edge of ribbon cable 11, with the two legs 135 and 137 thereof abutting different broad sides of ribbon cable 11 such that they cover locking recesses 49 or 63 and 65, respectively. In the regions located on top of locking recesses 49 or 63 and 65, respectively, legs 135 and 137 are provided with through-openings 139. Engaging through said openings are engagement projections 141

on lock portion 71 of the modification of lock spring 35 shown in Fig. 18 when ribbon cable 11 is in its locked position in lock spring housing 33.

5 In this embodiment, with an appropriate relative dimensioning of through-openings 139 and engagement projections 141, the engagement force of lock portion 71 is taken up in essence by the cover 133 such that shielding foils 55, 57 remain substantially without
10 load and the risk of breakage thereof is greatly decreased.

Differently from the embodiment shown in Fig. 15, it is also possible to make cover 133 of two separate
15 plates, one thereof being disposed on one broad side and the other one being disposed on the opposite broad side of ribbon cable 11. In contrast to the embodiment shown in Figs. 15 and 17, the two legs 135 and 137 are not connected integrally to each other but constitute
20 separate parts.

Fig. 16 very schematically shows a cross-sectional view, not to scale, with a cover 133 either in the one-piece folded form shown in Fig. 15 or in the form
25 with two separate legs 135 and 139.

If ribbon cable 11 is to be reinforced with a reinforcing film 17 as already shown in Figs. 8 and 13, this film may be applied to that leg of cover 133
30 which is located on the side on which flat conductors 13 are not exposed in end portion 17 of ribbon cable 11. Reinforcing film 19 is disposed on the inside of leg 137 facing the ribbon cable. The reinforcing film either may be formed integrally with cover 133 or may
35 be provided as separate reinforcing film adhered to the inside of leg 137. In the latter case, through-

openings 139 of leg 137 are punched through reinforcing film 19.

5 In the embodiments having a cover 133, it is possible, instead of locking recesses 59 or 63 and 65, to expose the corresponding shielding foil or foils over the entire ribbon cable width and cover them with cover 133.

10 By means of cover 133, it is possible to provide both a reinforcing effect for ribbon cable 11 in the portion thereof weakened by locking recesses 59, 63, 65, as well as protection for shielding foils 55, 57.

15 In the embodiment shown in Fig. 19, no reinforcing cover 133 is provided, but the insulating material jacket 51 and/or 53 is provided with through-openings 143 instead of locking recesses 59 or 63 and 65, respectively. In this case, engagement projections 141
20 on lock portion 71 of lock spring 35 shown in Fig. 18 engage directly through engagement openings 143 in the insulating material jacket of ribbon cable 11 so as to reach shielding foil 55 and/or 57. In this case, too, the relative dimensions of through-openings 143 and
25 engagement projections 141 are selected such that the engagement force of lock portion 71 is substantially taken up by the portion of insulating material jacket 51 and/or 53 surrounding through-openings 143.

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Patent Claims

1. A ribbon cable connector device for connection of
5 an electrical ribbon cable (11) having a series of
electrical ribbon cable conductors (13) embedded
in an insulating material (15) in juxtaposed
manner and one side thereof being exposed in the
region of a ribbon cable end,
10 said connector device comprising a connector (21)
having a connector housing of electrically insu-
lating housing material, which has a cable inser-
tion opening (29) for pluggably receiving the
ribbon cable end as well as conductor contact re-
15 ceiving cavities for receipt of conductor contacts
(113) projecting into the cable insertion opening
(29), for establishing electrical contact with the
individual exposed ribbon cable conductors (13),
at least one lock spring means (35; 35'; 105)
20 which is disposed on a lock spring housing (33)
provided on the connector housing (21) and having
a cable through-opening (31) aligned with the
cable insertion opening (29), projects into the
cable through-opening (31) of lock spring housing
25 (33), is biased transversely of the cable passage
direction and has at least one lock portion (71;
71'; 111) which, when the ribbon cable (11) is
inserted into the cable through-opening, engages
with resilient bias at least one longitudinal side
30 of the ribbon cable (11) and retains the cable in
the cable through-opening (33).
2. A connector device according to claim 1,
characterized in that the lock spring housing (33)
35 is formed integrally with the connector housing
(21).



3. A connector device according to claim 1,
characterized in that the lock spring housing is
formed as an additional housing (33) designed for
connection with the connector housing (21).
4. A connector device according to claim 3,
characterized in that the additional housing (33)
is adapted to be latchingly engaged with the con-
nector housing (21).
5. A connector device according to any of claims 1 to
4,
characterized in that the lock portion (71; 71';
111) frictionally engages a ribbon cable (11) in-
serted into the cable through-opening (31).
6. A connector device according to any of claims 1 to
4, for connection to a ribbon cable (49; 61; 67)
having an outer insulating material jacket (15;
51; 53),
characterized in that the insulating material
jacket (15; 51; 53) on at least one of its two
broad outsides is provided with at least one
locking recess (59; 63; 65; 143), and in that the
lock portion (71; 71'; 111) of the connector de-
vice is positively engaged with the locking recess
(59; 63; 65; 143) of the insulating material
jacket (15; 51; 53).
7. A connector device according to any of claims 1 to
6,
characterized in that the lock portion (71; 71';
111) of lock spring means (35; 35'), when the
ribbon cable (11) is inserted into cable through-
opening (31), engages a portion of ribbon cable



(11) which, as seen from the ribbon cable end, is located beyond the ribbon cable portion (17) having the exposed ribbon cable conductors (13).

5 8. A connector device according to any of claims 1 to
7, for connection to a ribbon cable (11; 61)
having between the ribbon cable conductors (13)
and each of the two broad outsides of an insu-
lating material jacket (51, 53) one shielding con-
10 ductor (55, 57) each that extends substantially
over the entire ribbon cable width,
characterized in that each broad outside of the
ribbon cable is provided with at least one locking
recess (63, 64; 143) exposing the shielding con-
15 ductor (55, 57),
that the lock spring means (35, 1051) is composed
with electrically conductive material that is
electrically connected to an electrical grounding
means (125) associated with the connector (21),
20 and in that the lock spring means (35; 105; 131)
has at least two lock portions (71, 111) which,
when the ribbon cable (11; 61) is inserted into
the cable through-opening (31), engage in locking
recesses (63, 65; 143) on different broad outsides
25 of the ribbon cable (11; 61) while establishing
electrical contact with the respective shielding
conductor (55, 57) such that an electrical con-
nection is established between each of the two
shielding conductors (55, 57) of the ribbon cable
30 (11; 61) and the grounding means (125).

9. A connector device according to any of claims 1 to
7, for connection to a ribbon cable (11; 49)
having between the ribbon cable conductors (13)
35 and each of the two broad outsides of an insu-
lating material jacket (51, 53) one shielding con-

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ductor (55, 57) each that extends substantially over the entire ribbon cable width, with both shielding conductors (55, 57) being electrically connected to each other via at least one of the ribbon cable conductors (13),

characterized in that one of the two broad sides of the ribbon cable (11; 49) is provided with at least one locking recess (59) exposing the associated shielding conductor (55),

that the lock spring means (35; 131) is composed with electrically conductive material that is electrically connected to an electrical grounding means (125) associated with the connector (21),

that the lock spring means (35; 131) has at least one lock portion (71, 111) which, when the ribbon cable (11; 49) is inserted into the cable through-opening (33), engages in the locking recess (59) of the ribbon cable (49) while establishing electrical contact with the shielding conductor (55) exposed by this locking recess (59), such that an electrical connection is established between each of the two shielding conductors (55, 57) of the ribbon cable (11; 49) and the grounding means (125).

10. A connector device according to claim 8 or 9, characterized in that the grounding means comprises at least one shielding housing (125) of electrically conductive material which surrounds the connector housing, and in that the lock spring means (35, 131) is electrically connected to the shielding housing (125).

11. A connector device according to any of claims 8 to 10,



characterized in that the conductor contacts (113) of connector (21) are electrically connected to conductive tracks of a circuit board (23), that the grounding means comprises at least one ground conductor of the circuit board (23), and in that the lock spring means (35; 105; 131) is electrically connected to the ground conductor.

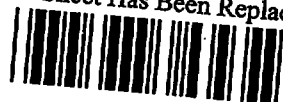
12. A connector assembly according to claim 10 or 11, characterized in that at least part of the lock spring means (131) is disposed on the shielding housing (125).

13. A connector device according to claim 12, characterized in that the part (131) of the lock spring means disposed on the shielding housing (125) is formed integrally with the shielding housing (125).

14. A connector device according to any of claims 1 to 13, characterized in that, from said lock spring means (35; 35'; 195; 131), at least the lock portion (71; 71'; 111) extends obliquely towards the connector housing (21) with a free-running effect with respect to insertion of the ribbon cable (11) into the cable through-opening (33) and with a restraining effect with respect to withdrawal of the ribbon cable end (11) from the cable through-opening (31).

15. A connector device according to any of claims 1 to 14, characterized in that the lock spring means (35; 35'; 105; 131) is pivotable relative to connector housing (21) about a pivot axis (69; 69') ex-

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tending parallel to the transverse direction of a ribbon cable (11) inserted into the cable insertion opening (29) of connector housing (21), that the lock spring means (35; 35'; 105; 131) is supported on the lock spring housing (33) such that, in the pivotal rest position, it is resiliently biased against a ribbon cable inserted into the cable through-opening (31), and in that the lock spring means (35; 35'; 105; 131) is pivotable against its resilient bias such that it is released from the locking engagement with a ribbon cable inserted into the cable through-opening (31).

16. A connector device according to any of claims 1 to 15,
characterized in that the lock spring means (35; 35'; 105; 131) comprises at least one lock spring latching device (73) by means of which it can be latched to a complementary housing latching device of the lock spring housing (33).

17. A connector device according to any of claims 1 to 16,
characterized in that the lock spring means (35; 35') comprises two lock springs, possibly each having its own pivot axis (69; 69'), each of said two lock springs, when the ribbon cable (11) is inserted into the cable insertion opening (29) of connector (21), engaging a different one of the two longitudinal outsides of the ribbon cable (11).

18. A connector device according to any of claims 1 to 16,

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characterized in that the lock spring means is constituted by one single lock spring (105) having two different lock portions (71, 111), each one thereof engaging a different one of the two longitudinal outsides of the ribbon cable (11) when the ribbon cable (11) is inserted into the cable insertion opening (29) of connector (21).

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19. A connector device according to any of claims 1 to 18,
characterized in that the lock spring (35; 35'; 105) is designed as a flat spring.

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20. A connector device according to any of claims 1 to 19,
characterized in that the lock spring means comprises a flat spring body on which a first one (71) of the two lock portions is formed,
and in that a flat spring web (107) projects from the flat spring body and has, at its end remote from the flat body, the second lock portion (111) disposed thereon,
with the two lock portions (71, 111) engaging opposite longitudinal outsides of the ribbon cable (11) when the ribbon cable (11) is inserted into the cable insertion opening (31).

30

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21. A connector device according to any of claims 3 to 20,
characterized in that the lock spring housing (33), in the region of its longitudinal end remote from the cable through-opening (31), has a connector receiving opening (37) in which connector housing (21) can be accommodated such that the cable insertion opening (29) of the connector

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housing (21) is aligned with the cable through-opening (31) of the additional housing (33).

5 22. A connector device according to claim 21,
 characterized in that on both sides of the con-
 nector receiving opening (37) there is disposed
 one resilient latching spring arm (41) each, which
 each have a latching shoulder (45) at the free
10 latching arm end,
 and in that the latching shoulders (45) of the two
 latching spring arms (41) latchingly engage behind
 the connector housing (21) when the latter is in-
 serted into the additional housing (33) until its
15 cable insertion opening (29) is aligned with the
 cable through-opening (31) of the additional
 housing (33).

20 23. A connector device according to any of claims 1 to
 22, in which the lock spring means (35') is not
 used for establishing electrical contact,
 characterized in that the lock spring means (35')
 is formed integrally with the lock spring housing
 (33) and the lock spring housing or the additional
25 housing (33), respectively, is formed of elastic
 plastics material.

30 24. A connector device according to claim 23,
 characterized in that the spring means (35'), when
 formed integrally with the lock spring housing
 (33), is cut free in the form of a flat spring
 from at least one sidewall of the lock spring
 housing (33).

35 25. A connector device according to any of claims 6 to
 24,

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characterized in that the locking recess (59) or locking recesses (63, 65) in the insulating material jacket (51) or insulating material jackets (51, 53), respectively, is/are provided with a cover (133) reinforcing the ribbon cable (49; 61) in the region of the locking recess(es) (59; 63, 65) and/or protecting the shielding foil (55, 57) exposed by the locking recess (59; 63, 65), that the cover (133), in its portion(s) covering the locking recess(es) (59; 63, 65), is provided with through-openings (139), and that the lock portion (71) of lock spring (35) is provided with engagement projections (141) by means of which the lock portion (71) is adapted to establish electrical contact with the associated shielding foil (55, 57) through said through-openings (139).

26. A connector device according to claim 25, characterized in that the cover (133), on the part located on that flat side of the ribbon cable (49; 61) where the flat conductors (13) are not exposed, is provided with a reinforcing film (19) extending towards the ribbon cable end (17) for increasing the stiffness of the ribbon cable end (17).

27. A ribbon cable for connection to a connector device according to any of claims 6 to 26, characterized in that the ribbon cable (49; 61; 67) has an outer insulating material jacket (51; 53; 15) which on at least one of its two broad outsides is provided with at least one locking recess (59; 63; 65) for positive engagement of at least one lock portion (71; 71'; 111) of the connector device.

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28. A ribbon cable for connection to a connector device according to any of claims 8 or 10 to 26, characterized in that it comprises between the ribbon cable conductors (13) and each of the two broad outsides of an insulating material jacket (31; 53) one shielding conductor (55, 57) each that extends substantially over the entire ribbon cable width, with each broad side of the ribbon cable (11; 49; 61; 67) being provided with at least one locking recess (63, 65; 143) exposing the shielding conductor (55, 57).
29. A ribbon cable (49) for connection to a connector device according to any of claims 9 to 26, characterized in that it comprises between the ribbon cable conductors (13) and each one of the two broad outsides of an insulating material jacket (51, 53) one shielding conductor (55, 57) each that extends substantially across the entire ribbon cable width, with both shielding conductors (55, 57) being electrically connected to each other via at least one ribbon cable conductor (13), and one of the two broad sides of the ribbon cable (49) being provided with at least one locking recess (59; 143) exposing the associated shielding conductor (55).
30. A ribbon cable according to any of claims 27 to 29, characterized in that one broad side of the ribbon cable end (11) is formed with a reinforcing layer (19), for example a reinforcing film (19) adhesively applied to the insulating material (15) or an insulating material jacket (51, 53) of the ribbon cable end (11).

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31. A ribbon cable according to any of claims 28 to 30,
characterized in that on each broad side of the
5 ribbon cable (11) provided with a locking recess (49; 63, 65) there is disposed a cover (133) which covers the locking recess (59; 63, 65), reinforces the ribbon cable in the region of the locking re-
cess (59; 63, 65) and/or protects the shielding
10 foil (55, 57) exposed by the locking recess (59; 63, 65) and which has through-openings (139) for through-engagement of the cover (133) so as to establish electrical contact with the shielding foil (55, 57).
- 15 32. A ribbon cable according to claim 31,
characterized in that the cover (133) comprises two legs (135, 137) integrally connected to each other in a U-shape, one (135) thereof covering a
20 locking recess (63) on one broad side of the ribbon cable (11; 61) and the other one (137) covering a locking recess (65) on the other broad side of the ribbon cable (11; 61).
- 25 33. A ribbon cable according to claim 31 or 32 in conjunction with claim 30,
characterized in that the reinforcing layer (19) is disposed on one of the two legs (135, 137) of the cover (133) in the form of a reinforcing film.
- 30 34. A ribbon cable according to claim 33,
characterized in that the reinforcing film (19) is integrally moulded on one leg (137).

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35. A connector assembly comprising a connector device according to any of claims 1 to 26 and a ribbon cable according to any of claims 27 to 34.

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