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ELECTRICAL CONNECTORS

5 This invention relates to a connection device that provides any form of electrical connection between two discrete electrical cables or alternatively an electrical cable terminated by a plug and electrically insulated wires. It has application, for example, in data or telecommunications where a computer terminal
10 or telephone instrument is connected by a lead with an appropriate plug to a jack provided in a wall panel. The jack requires connection to data or telephone cables on the opposite side of the wall panel.

15 Arrangements are known in which a jack is provided on a wall panel the jack being connected by way of a printed circuit board to terminal elements which can be connected to the telephone wires. Such arrangements are not easily assembled nor are they
20 easily changed when faulty.

An improvement over this type of arrangement is described in GB-A-2242080. This connector has a moulded housing with a cavity for receiving the plug,

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5 a first set of connecting elements which can receive insulated wire and make electrical contact with the electrically conductive core and a second set of contacts which are connected to the first set and extend from the first set to the cavity such that they can come into electrical contact with contacts carried by the plug. The second set of contacts for part of their extent are located in longitudinal closely spaced relationship.

10

In data communication systems connectors of this type operate satisfactorily at low or moderate data rates. As data rates increase however the system connectors exhibit an impedance imbalance which limits the performance of the system. This impedance imbalance is usually measured as near end crosstalk between recognised pairs. Attempts have been made to alleviate this problem by screening or by reduction in the size of the contact elements. These approaches are not entirely satisfactory and the present invention is concerned with an alternative solutions.

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The present solution arises partly from a careful analysis of the origin of crosstalk in a connector of a type described in GB-A-2242080. Our analysis in which the pairs of contacts are considered as forming a bridge network shows that the major source of crosstalk arises from capacitative imbalance between the pairs.

The following simple mathematical model indentifies the problem to be solved. A connector of the type described in GB-A-2242080 is an 8 wire/4 pair connector. There exist several recognised wiring/pair configurations for this connector, but for simplification and clarification only one of these will be considered in the following analysis.

It is usual to number the contacts on the connector from 1 to 8. The recognised wiring/pair configurations are defined as follows:

Wires/Contacts	Recognised pair configuration
1 & 2	Pair 2
3 & 6	Pair 3

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5 & 4 Pair 1

7 & 8 Pair 4

5 The equivalent circuit for say pairs 1 & 3 is shown in
Figure 2 of the drawings. In this Figure C_1 is the
capacitance between contacts 3 and 5, C_2 is the
capacitance between contacts 3 and 4, C_3 the
capacitance between contacts 5 and 6, and C_4 the
capacitance between contacts 6 and 4. R_1 is the line
10 impedance.

15 This equivalent circuit needs to be considered as it
relates to both the connector and its mating plug,
which is shown schematically in Figure 3 of the
drawings. For simplicity this Figure shows
schematically just the plug and connector. In the
arrangement the 8 plug contacts are shown at 120 and
make contact with the connecting elements 93 in a
socket of the connector shown at 50. The elements 93
20 extend along parallel paths to IDC contacts 80.

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Considering Figure 3 and the bridge of Figure 2 it will be appreciated that if one assumes C_1 is unity then

5 $C_1 = 1$

$C_2 = 2$

$C_3 = 2$

$C_4 = 1$

10 For no crosstalk there must be no current flow through R. For this to happen the bridge must be balanced, that is to say

15 $\frac{C_1}{C_2} = \frac{C_3}{C_4}$

However for the capacitance values given above the relationship in fact gives

20 $\frac{1}{2} = \frac{2}{1}$



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Clearly the bridge is unbalanced and this leads to crosstalk. A similar situation exists in connection with pairs 2 and 3 and also between pairs 3 and 4, although the capacitive imbalance is not so significant for these pair configurations with this connector.

As a result of this analysis we have discovered two ways of minimising crosstalk.

10

The first is to configure the contacts of a connector of the type referred to above in such a way that the capacitive imbalance is reduced.

15 The second is to provide elements in association with said contacts which provide a controlled capacitance such as to reduce said imbalance. Any other function which the element has will be secondary to this prime function.

20

In both of the above examples the contact arrangements can be organised to balance not only the inherent capacitive imbalance of the said connector, but also

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to compensate for the inherent capacitive imbalance of
any associated appropriate plug.

5 The said contact arrangements can also be organised
to compensate for any capacitive imbalance effects
introduced by the wiring practices associated with the
connector or the plug.

10 The invention will be described from now by way of
example only with particular reference to the
accompanying drawings.

In the drawings:

15 Figure 1 is an exploded view of a connector
described in GB-A-2242080;

20 Figure 2 is an equivalent circuit diagram for
two contact pairs of the connector of
Figure 1;

Figure 3 is a schematic view of the
interconnecting arrangement provided by
the connector of Figure 1;

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Figure 4 is a perspective view illustrating a connector in accordance with the present invention,

5 Figure 5 is a schematic view of an interconnecting arrangement provided by a connector in accordance with the present invention;

10 Figure 6 is a view similar to figure 2 of an alternative form of connector in accordance with the present invention, and

15 Figure 7 shows a modified form of lead frame which uses controlled capacitance to balance the connector.

20 Figure 1 shows a connector which is described in detail in GB-A-2242080. In brief it comprises a moulded housing having a moulded upper body part 10 and a lower moulded body part 11. The body parts when connected together define a cavity 50 into which can be located a plug such as that formed on the end of a

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5 cable extending from a telephone instrument or a
terminal of the type used in computing equipment. The
housing includes a first set of contact elements 80
which extend upwardly and terminate in slots which can
10 receive insulated wire in such a way that the walls of
the slots cut the insulation and thereby make contact
with the electrically connected core. The contacts 80
are connected to a second set of contacts which
include elongate strips 93 which extend along grooves
26 formed in the moulded upper body part and which in
the assembled body terminate in the cavity 50 in such
a way that they can contact electrical contacts
carried by the plug. It will be seen that the strips
93 extend in longitudinally closely spaced, parallel
15 relationship from the contact elements 80 to the
cavity 50.

20 Our analysis of this arrangement has revealed that
this type of configuration has an inherent
capacitative imbalance which gives unacceptable
crosstalk levels at high data rates.

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One embodiment of the present invention which alleviates this problem is that illustrated in Figure 4 of the drawings. It will be seen from Figure 4 that the connector is of the same general form as that shown in Figure 1 and that the strips 93 are configured so that they do not lie in parallel paths but are configured to extend along more tortuous paths from the cavity 50 to the connecting elements 80. Additionally the contact positions are re-arranged from their convention positions.

The effect of this arrangement can be best understood by considering the schematic of Figure 5 of the drawings in conjunction with the existing arrangement of Figure 3 and the bridge arrangement of Figure 2. The analysis of Figure 3 showed that the bridge arrangement was unbalanced. We have found that this imbalance can be overcome by carefully positioning the connecting elements 93 to compensate for the inherent capacitive imbalance of the plug and connecting wire. Figure 5 shows one possible arrangement whereby re-arranging the contact positions and their physical relationship to each other makes it possible to reduce the capacitive imbalance.



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In the arrangement of Figure 5 this is achieved by increasing C_1 and C_4 (see discussion relating to Figure 2 above) and by positioning the contact elements 3 and 5 closer together and also the contact elements 4 and 6 closer together. The net effect of this re-arrangement is to lead to a balancing of the capacitance so that, for example with reference to Figure 2

$$\frac{C_1}{C_2} = \frac{C_3}{C_4}$$

It is also possible to decrease C_2 and C_3 by positioning contact elements 3 and 4 further apart and contact elements 5 and 6 further apart. Similarly the electrical performance of the other pair of configurations can be improved in a similar manner. Hence the connector shown in figure 2 of the drawings is capable of meeting the requirements for high data rate communication systems.



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An alternative arrangement of the present invention is shown in figure 6 of the drawings. The male housing part, indicated generally at 100 in Figure 1, is not shown in Figure 6, though it will be understood that it will slide into groove 30 and snap into window 16 as in the first arrangement. In the arrangement of figure 2 of the drawings the order in which the contact 80 are connected to the strips 193 is maintained the same as that for GB-A-2242080.

Figure 7 shows a modified form of the leadframe (90/92 Figure 1). Electrically connected to this leadframe is a second contact element. The second contact element could be either a flexible printed circuit board or a metallic element where the element is insulated with a high dielectric material. This high dielectric material is positioned on the contact element in specific areas to provide controlled capacitance to the other contact positions to balance out the inherent capacitive imbalance.





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CLAIMS:

1. A connector for providing a connection between two electrical cables each of which includes a plurality of conductive wires, said connector including means enabling contact to be established with the wires of each of the cables and a plurality of conductive elements extending between the contact enabling means, said conductive elements being so arranged and configured so as to minimise capacitive imbalance between the pairs of contacts.

2. A connector according to claim 1, wherein the capacitive imbalance is minimised by appropriately configuring the path along which the conductive elements extend.

3. A connector according to claim 1 or claim 2, wherein the capacitive imbalance is minimised by selection of the interconnection arrangement of the contacts of the contact enabling means by the connecting elements.

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4. A connector according to any preceding claim, wherein at least one of the contact enabling means is a socket for receiving a plug on the end of a cable.

5

5. A connector according to any preceding claim, wherein at least one of the contact enabling means is a plurality of insulation displacement type contacts.

10

6. A connector according to any preceding claim, wherein the connector is of the general type described in GB-A-2242080.

15

7. A connector for providing a connection between two electrical cables, each of which includes a plurality of conductive wires, said connector including means enabling contact to be established with the wires of each of the cables and a plurality of conductive elements extending between the contact enabling means, and wherein an element or elements is provided in association with one or more of the contacts of the contact enabling means to provide a

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controlled capacitance such as to minimise capacitive
imbalance between pairs of contacts.

8. A connector for providing a connection
5 between two electrical cables substantially as
hereinbefore described with reference to and as shown
in the accompanying drawings.

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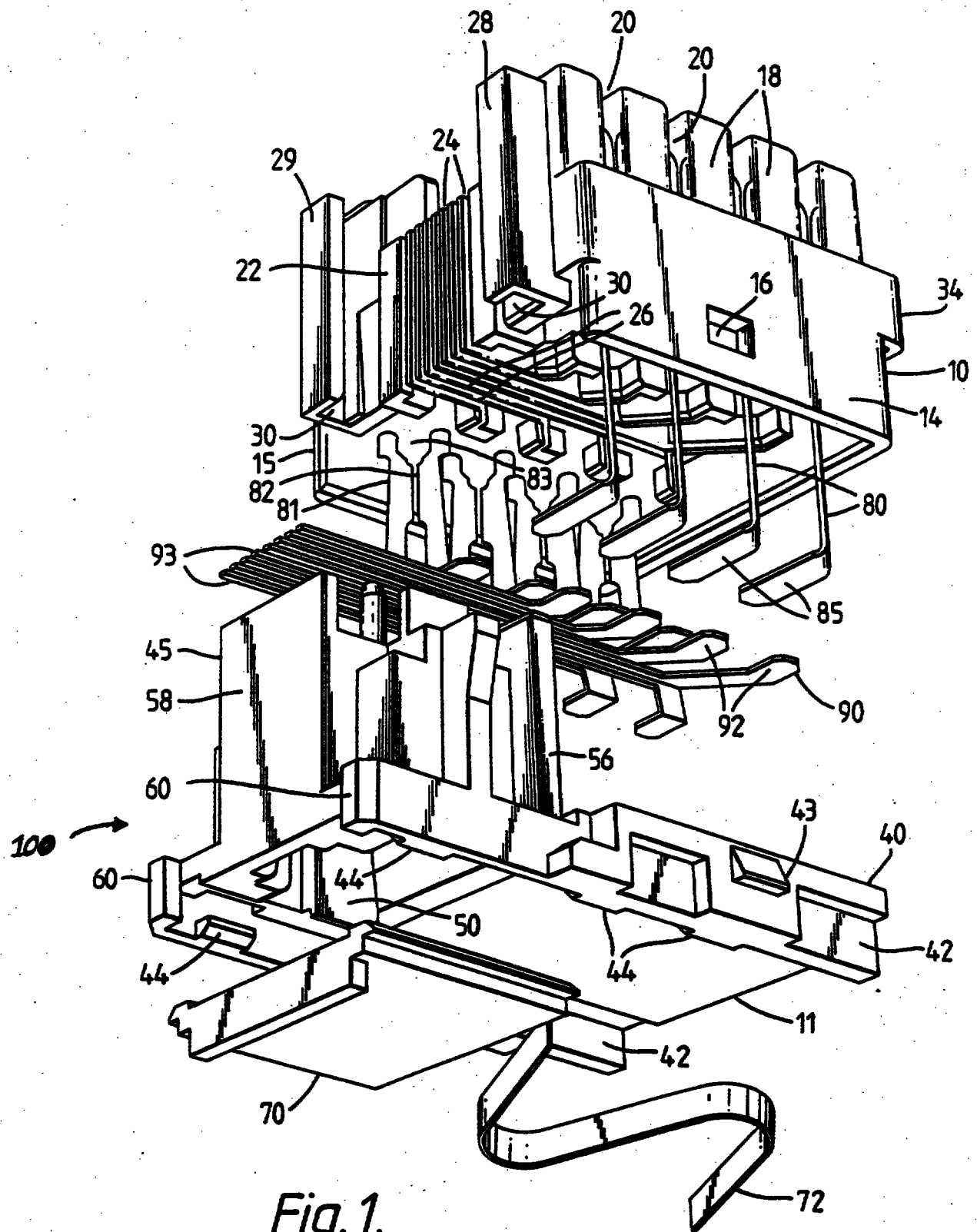


Fig. 1.

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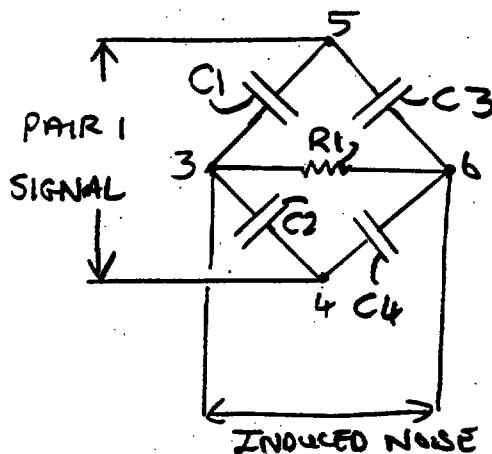


FIGURE 2

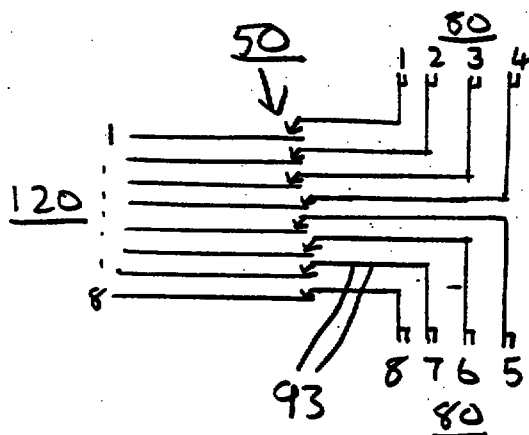


FIGURE 3

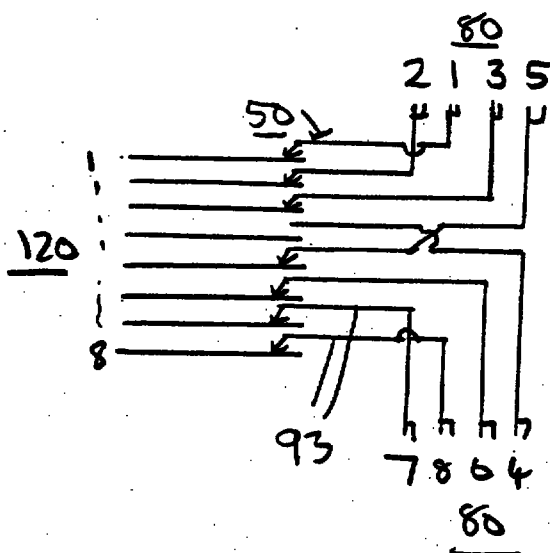


FIGURE 5



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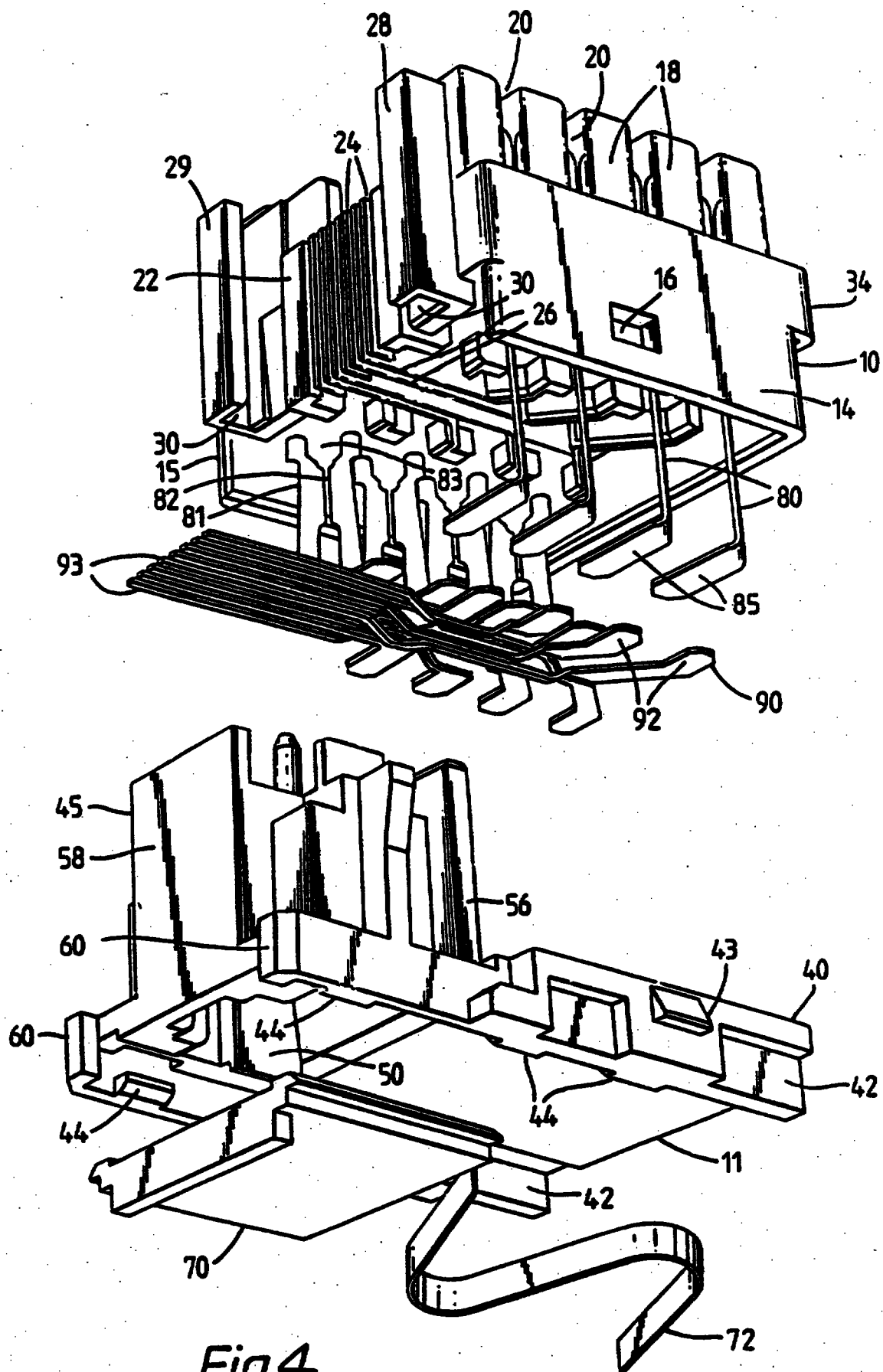


Fig.4.

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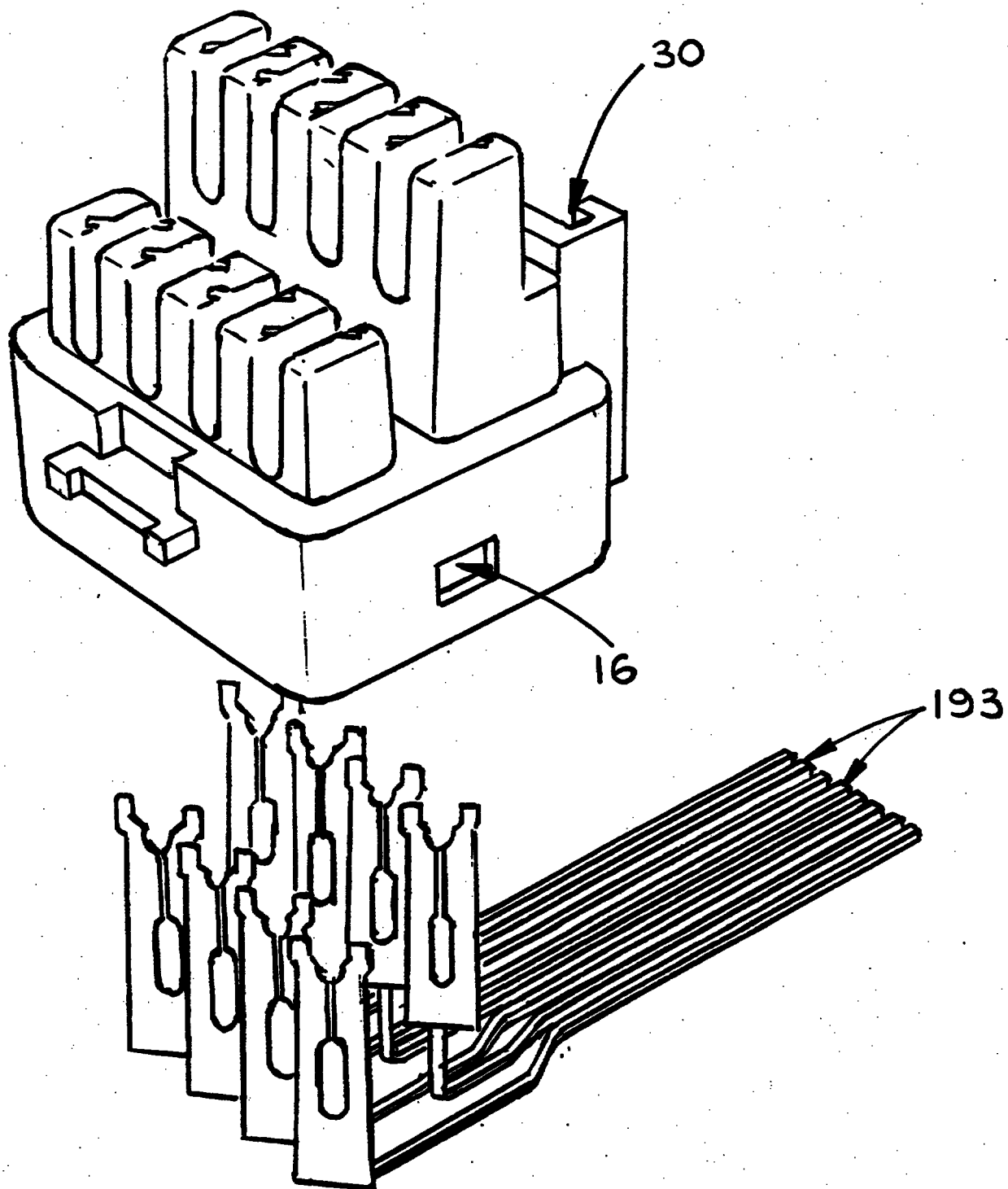


Fig 6

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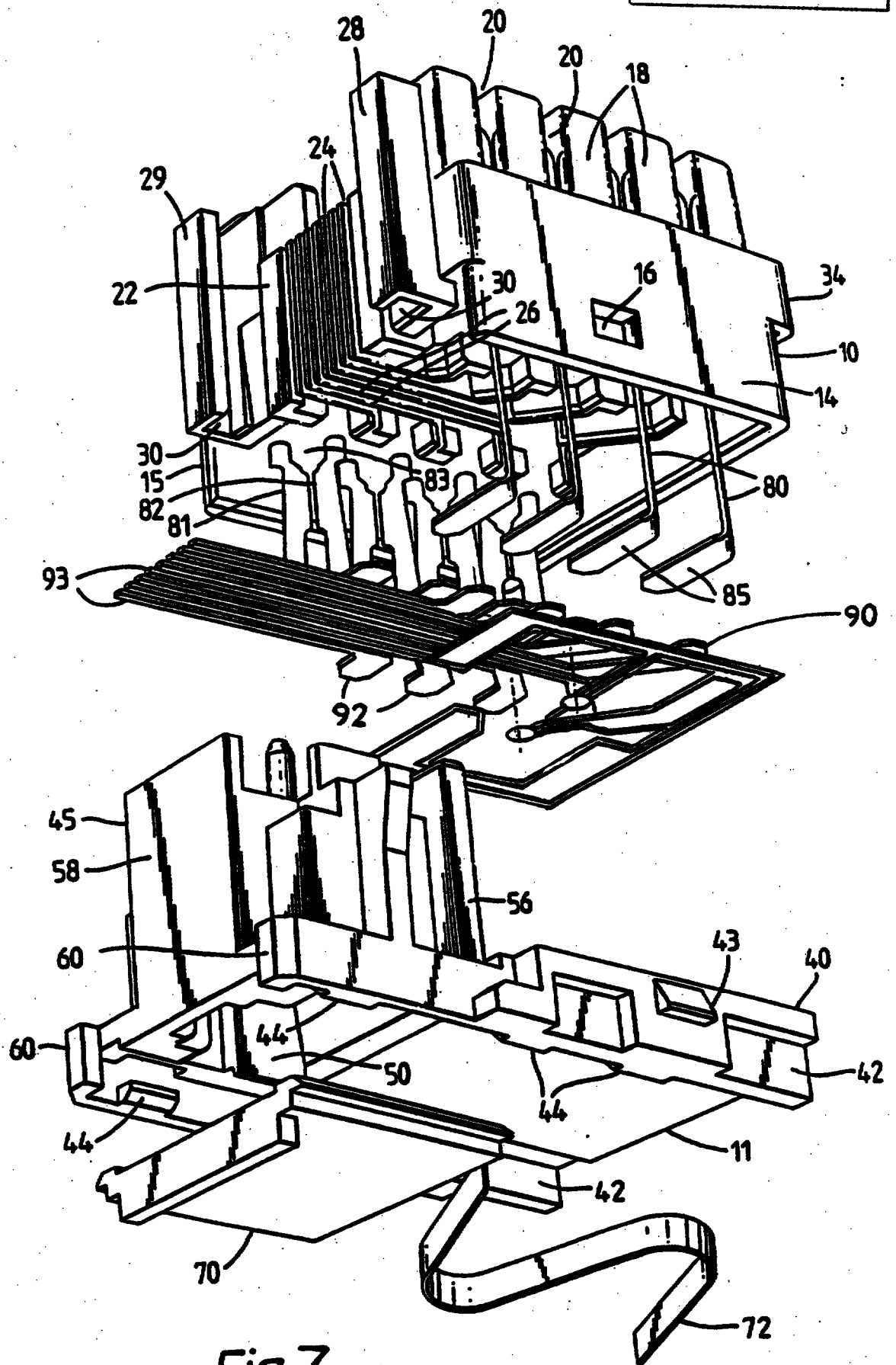


Fig.7.

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ELECTRICAL PLUG CONNECTOR

The invention relates to a plug connector for the telecommunication and data technique, according to the preamble of claim 1.

A plug connector of the type referred to hereinbefore is known in the art from EP 0,445,376 A1. Said plug connector includes a housing with a receiving chamber for the plug, a first set of contacts in insulation displacement technology, and a second set of contacts (RJ contacts) connected with said first set, made of elongated contact strips inserted into grooves of the upper housing portion and guided closely to each other and parallelly right into the receiving chamber, whereinto the plug (RJ plug) can be inserted. The parallelly disposed contact strips are guided over long ways and at small distances to each other, which results in that between the contact tracks, a capacitance effect is generated, leading to poorer values of crosstalk attenuation.

In US 5,186,847, an electrical plug connector for applications in the field of high-frequencies is described, also having parallel contact tracks being each bent-off and disposed relative to each other such that they in part cross each other. By this measure, a reduction of the values of crosstalk attenuation is achieved, without, however, guaranteeing the required values for voice or data transmission over transmission paths with 100 megabits/s or in the frequency region of about 100 MHz, resp.

It is therefore the object of the invention to improve an electrical plug connector of the type referred to hereinbefore such that its electrical parameters are substantially improved and satisfy the requirements for the transmission of high data rates.

The solution of this object is achieved by the characterizing features of claim 1. By providing this embodiment, the capacitive



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imbalance between the contact arrangements is considerably minimized.

Further advantageous embodiments of the invention are defined in the further subclaims.

In the following, the invention will be described in more detail, with reference to an embodiment represented in the drawings. There are:

Fig. 1 a plug connector as known in the art from EP 0,445,376 A1, in an exploded view,

Fig. 2 the equivalent circuit for two contact pairs of the plug connector according to Fig. 1,

Fig. 3 the diagrammatical representation of the line connections in the plug connector according to Fig. 1,

Fig. 4 a perspective view of the plug connector according to the invention in an exploded view,

Fig. 5 the diagrammatical representation of the line connections in the plug connector according to Fig. 4,

Fig. 6 a perspective view of the second embodiment of the plug connector according to the invention according to Fig. 4 in an exploded view,

Fig. 7 a perspective view of the third embodiment of the plug connector according to the invention according to Fig. 4 in an exploded view, and

Fig. 8 the bottom view of another configuration of the connection elements according to the present invention.

The plug connector known in the art from EP 0,445,376, according to Fig. 1, comprises a moulded housing having an upper portion 10 and a lower portion 11. The upper portion 10 has opposed, substantially rectangular side walls 14, 15, each provided with a through-opening 16 for latching wedge-type projections 43 of the lower portion 11 in. On the upper side of the upper portion 10, close to each side wall 14, 15, extend two rows of column-type extensions 18 forming clamping elements, between which slots 20 are formed receiving - as will be described below - electrically conductive connection elements 80 with integrally formed, angled, flat



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foot sections 85. The front-side end wall 22 of the upper portion 10 is provided with a row of parallel grooves 24, being in connection with similar grooves 26 formed in the lower wall of the upper portion 10. Each of the grooves 26 extends up to closely to the lower part of a slot 20 defined by the column-type extensions 18. The front-side end wall 22 comprises, further, opposed, moulded-in and angled, flange-type side portions 28, 29, forming each a channel 30. At the opposed front side, the upper portion 10 is provided with integrated hooks 34 forming clamping elements for electrical conductors.

The lower portion 11 is provided with a substantially flat end section 40 having opposed side walls 42, the outside surfaces of which are provided with wedge-type projections 43. On the inner side of each side wall 42 are provided inwardly directed flanges 44. The front end portion 45 of the lower portion 11 includes a moulded-in part defining a hollow space 50 for receiving a plug, such as a plug disposed at the tail of a cord coming from a telephone set or a computer terminal. Close to the first end section 40, approximately in the centre of the lower portion 11, oppositely disposed, upright columns 56 are formed. The lower portion 11 comprises, on its front, a plane wall 58 uprightly extending in a height of approximately the height of the columns 56. The other end of the wall 58 terminates at projecting portions 60 of each of the side walls 42. The lower portion may receive a closure cover 70 being disposed between the opposed side walls 42 and held in position by the flanges 44. The closure cover may be displaced between a position, wherein it blocks access to the hollow space 50, and a position, wherein the hollow space 50 is open. A spring 72 is attached at the closure cover 70, in order to pre-tension it towards the closed position.

The set of eight electrical connection elements 80 extend into the slots 20 in the upper portion 10 formed by the column-type extensions 18. Each of said connection elements 80 is provided with an insulation displacement contact element 81 having a fork-type shape and defining a relatively narrow contact slot 82 terminating in a wide insertion section 83. The arrangement is

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adapted such that, when inserting an electrically insulated conductor into the insertion section 83, and when pressing said conductor into the narrow contact slot 82, the insulation of the conductor will automatically be cut-in, so that a contact between the central core of the conductor and the material of the connection element 80 will be established. The insulation displacement contact elements 81 are substantially flat and are disposed at an angle of approximately 45° to a line through the column-type extensions 18, i.e. at 45° to the plane of each slot 20. Each connection element 80 is, further, provided with a foot section 85, being integrally formed with the insulation displacement contact elements 81.

A second set of connection elements 90 comprise a row of eight contact tongues 92 being welded each to a foot section 85. An elongated contact strip 93 extends from each contact tongue 92. The contact strips 93 are adapted such that they extend in parallel to each other. The contact strips 93 terminate as RJ contacts in a receiving portion for the RJ plugs of terminals not shown in detail.

The prior art plug connector is to be considered as a 8-wire/4-pair plug connector, including contacts 1 to 8 and which can be represented in the following configuration (Figs. 1 to 3):

Wires/contacts	Pair configuration
1 and 2	pair 2
3 and 6	pair 3
5 and 4	pair 1
7 and 8	pair 4

The eight plug contacts at position 120 in Fig. 3 are the RJ contacts and establish contact with the contact strips 93 in a plug present in the hollow space 50. The contact strips 93 extend in parallel to each other up to the connection elements 80 adapted as insulation displacement contact elements 81.





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An analysis of this arrangement shows that the contact pairs can be regarded as a bridge circuit. The respective equivalent circuit, e.g. for the pairs 1 and 3, is shown in Fig. 2. Therein are:

- C1 the capacity between RJ contacts 3 and 5,
- C2 the capacity between RJ contacts 3 and 4,
- C3 the capacity between RJ contacts 5 and 6,
- C4 the capacity between RJ contacts 6 and 4,
- R1 the line impedance.

When the capacity C1 between RJ contacts 3 and 5 (Fig. 3) is defined as 1, then the capacities C2 and C3 are each of the amount 2, and the capacity C4 is also of the amount 1 (Fig. 2).

For avoiding crosstalk, no current must flow through resistor R1, i.e. the bridge according to the figure has to be balanced. This, in turn, requires fulfillment of the condition

$$\frac{C1}{C2} = \frac{C3}{C4}$$

If, however, the bridge comprises, as shown in the example, capacity values C1 and C4 of the amount 1, and capacity values C2 and C3 of the amount 2, then it is distinctly imbalanced. This situation exists between pairs 1 and 3 as well as between pairs 2 and 3 and 3 and 4. The main reason for crosstalk is the capacitive imbalance between the pairs.

Crosstalk can be minimized, when the RJ contacts of a plug connector are adapted such that the capacitive imbalance is reduced, or elements are brought into connection with the contacts, which provide a controlled capacity and reduce thus the imbalance. The RJ contact arrangements can be organized such that not only the internal capacitive imbalance, but also the internal capacitive imbalance of each assigned, suitable plug is compensated.

The plug connector according to the invention shown in Fig. 4 corresponds, in its construction, to the housing of the plug connector according to Fig. 1 formed of an upper portion 10 and of a



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lower portion 11. The contact strips 93 are adapted, however, such that they do not extend in parallel to each other, on part of their path, but are disposed in multiply angled paths from the hollow space 50 to the connection elements 80 or to the contact tongues 92, resp. The contact tongues 92 are disposed in one plane. From the plane of the contact tongues, the contact strips 93 are in part multiply angled, in the area of the contact tongues 92, towards bottom and top and also towards left or right, and in part cross each other. The RJ contact 1, e.g., is connected over its contact strip 93.1 with the contact tongue 92.2, the RJ contact 2 is connected over its contact strip 93.2 with the contact tongue 92.1, the RJ contact 3 is connected over its contact strip 93.3 with the contact tongue 92.3, the RJ contact 4 is connected over its contact strip 93.4 with the contact tongue 92.5, the RJ contact 5 is connected over its contact strip 93.5 with the contact tongue 92.4, the RJ contact 6 is connected over its contact strip 93.6 with the contact tongue 92.6, the RJ contact 7 is connected over its contact strip 93.7 with the contact tongue 92.8, and the RJ contact 8 is connected over its contact strip 93.8 with the contact tongue 92.7.

In Fig. 5, in a diagrammatical representation, is shown that by such arrangement of the contact strips 93, now the capacity C1 between the RJ contacts 3 and 5 and the capacity between the RJ contacts 6 and 4 is increased, since the RJ contacts are closer together. Thereby, a compensation of the capacities is achieved. Such compensation can also be achieved by a reduction of capacities C2 and C3, by positioning the RJ contact elements 3 and 4 farer away from each other. The electrical parameters of the remaining configuration pairs can also be affected.

A second embodiment of the present invention is shown in Fig. 6. Therein, the housing is not shown. The contact strips 93 are angled in a different manner, and are then guided in parallel to each other.

Fig. 7 shows an third embodiment of the connection elements 90, 92 according to Fig. 4. To these connection elements 90, 92 is electrically connected a second contact element 95. Said second contact element 95 can either be a printed circuit board or a

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metal element, such element being insulated with a high-dielectrical material. Such high-dielectrical material is positioned in certain regions on the contact element 95, in order to provide a controlled capacity to the remaining contact positions and to compensate the internal capacitive imbalance.

In Fig. 8, another embodiment of the connection between the contact tongues 92 and the contact strips 93 is shown. In this embodiment, the contact strips 93 are in part crossing each other in the area of the connection to the contact tongues 92. The contact strip 93.1 is guided to the contact tongue 92.2 and crosses the contact strip 93.2 being guided to the contact tongue 92.1. The contact strip 93.3 is guided to the contact tongue 92.3 without crossing. The contact strip 93.4 is connected with the contact tongue 92.5 and crosses the connection between the contact strip 93.5 and the contact tongue 92.4. The contact strip 93.6 is connected with the contact tongue 92.6. The contact strip 93.6 is guided to the contact tongue 92.8 and is crossed by the connection between the contact strip 93.8 and the contact tongue 92.7. The contact strips 93 and the contact tongues 92 are disposed in the plug connector area in guide webs 57 of the lower housing portion 11. The guide webs 57 have interruptions 59 in the crossing area of the contact strips 93. The contact strips 93 and the contact tongues 92 are disposed in two planes at the crossing positions only, but are generally in one plane. The in part crossing contact strips 93 guided in guide webs 57 of plastic effect a reduction of the mutual capacitive influences.

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PATENT CLAIMS

1. An electrical plug connector for the telecommunication and data technique, comprising RJ contacts disposed in a housing and insulation displacement contacts and contact strips connecting the latter, characterized by that the contact strips (93) are multiply and differently angled between the RJ contacts (1 to 8) and the insulation displacement contacts (81), and are, at least in the contact tongue area (92), in part not guided in one plane parallelly to each other.

2. An electrical plug connector for the telecommunication and data technique, comprising RJ contacts disposed in a housing and insulation displacement contacts and contact strips connecting the latter, characterized by that between the contact strips (93), means for affecting the capacity are disposed.

3. An electrical plug connector according to claim 1, characterized by that the contact strips (93) are embedded and guided in guide webs (57).

4. An electrical plug connector according to claims 1 and 3, characterized by that the contact strips (93) are partly crossing each other, in the crossing area of the contact strips (93) the guide webs (57) having interruptions (59).

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ELECTRICAL PLUG CONNECTOR

ABSTRACT

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The invention relates to a plug connector for the telecommunication and data technique, comprising RJ contacts disposed in a housing and insulation displacement contacts and contact strips connecting the latter. The object of the present invention, namely to improve an electrical plug connector of the type referred to hereinbefore such that its electrical parameters are substantially improved and satisfy the requirements for the transmission of high data rates, is achieved by that the contact strips are multiply and differently angled between the RJ contacts and the insulation displacement contacts, and are, at least in the contact tongue area, in part not guided in one plane parallelly to each other.

FIGURE 4

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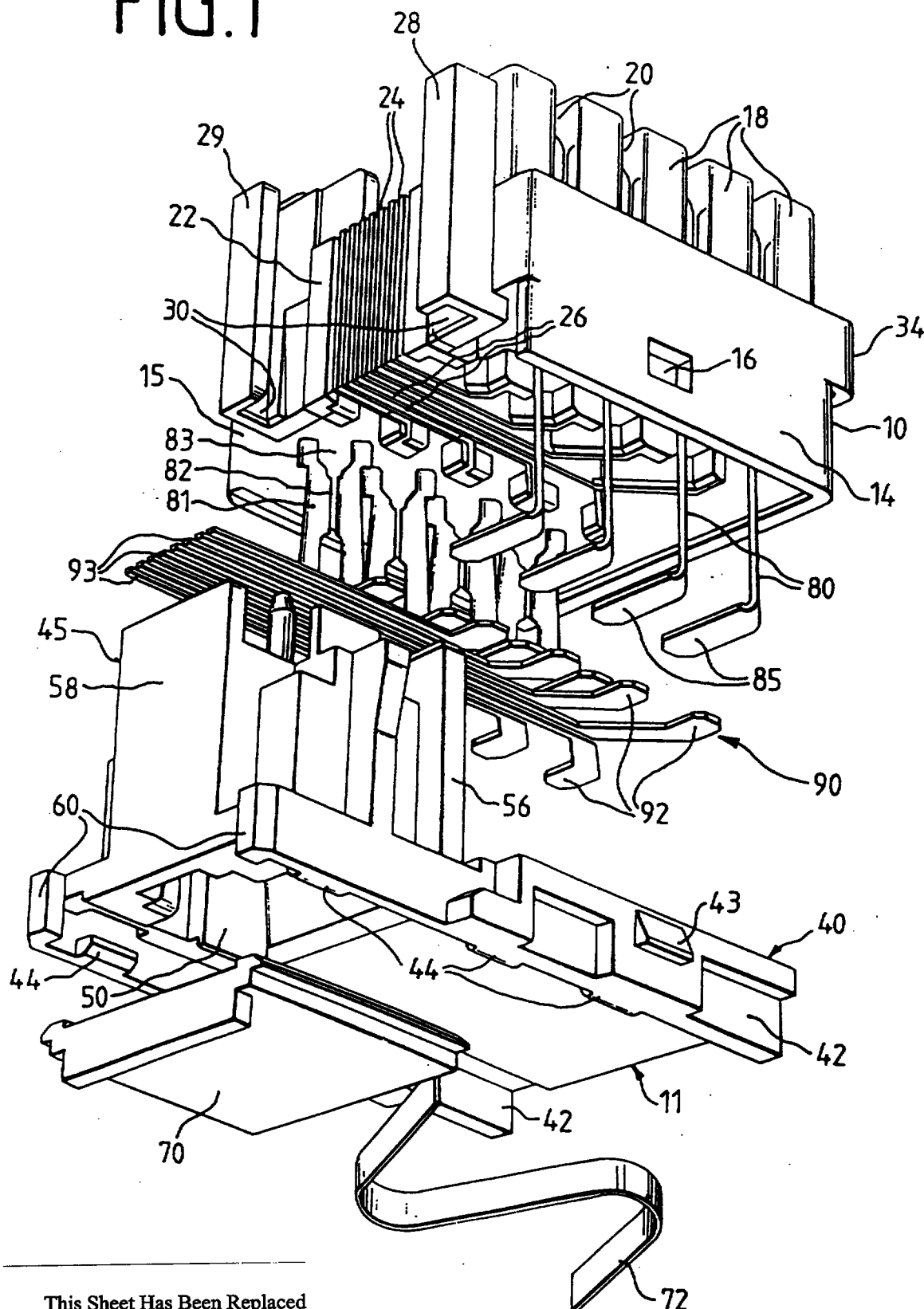
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FIG.2

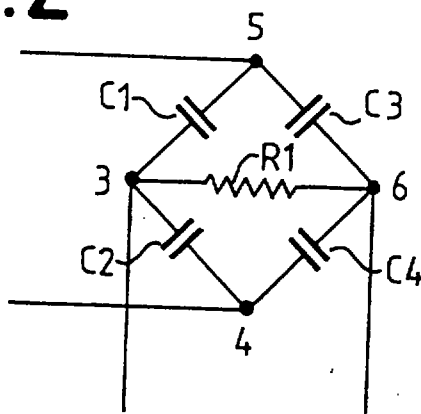
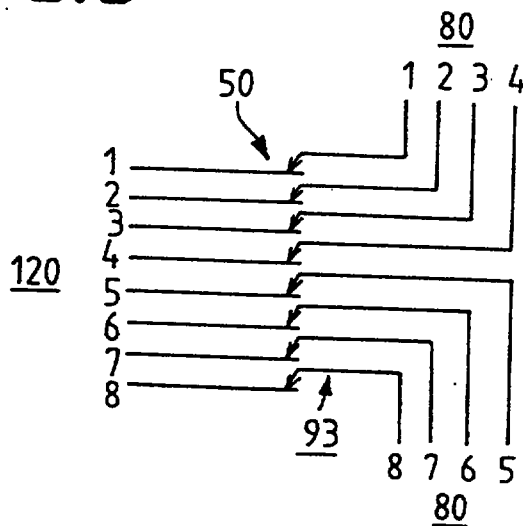


FIG.3



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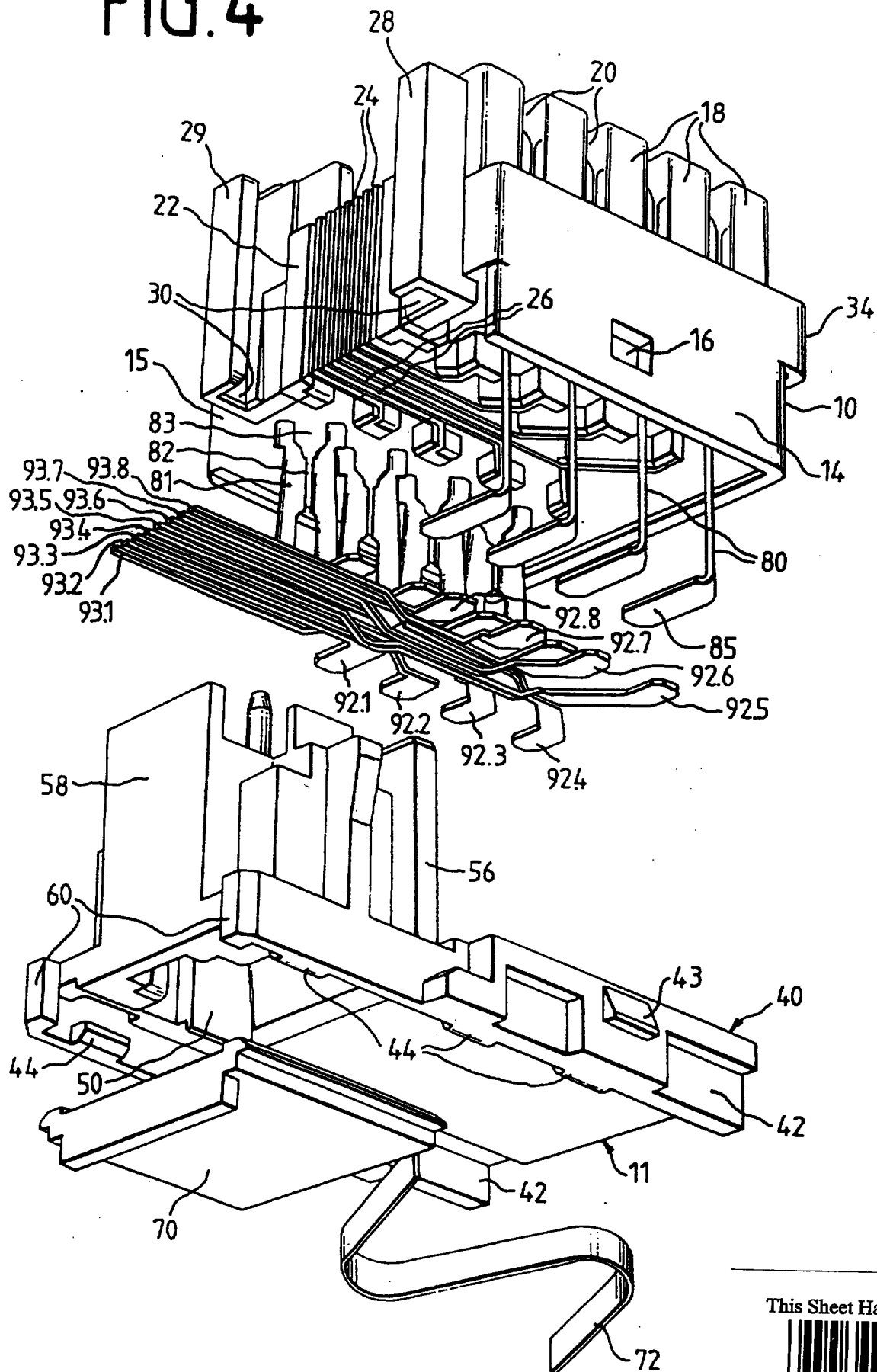
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FIG. 4



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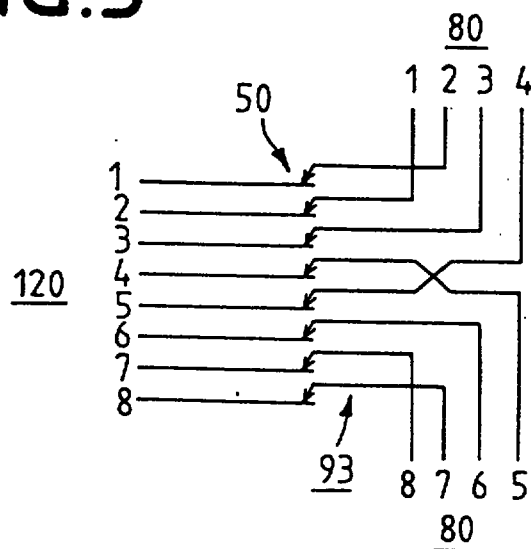
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FIG.5



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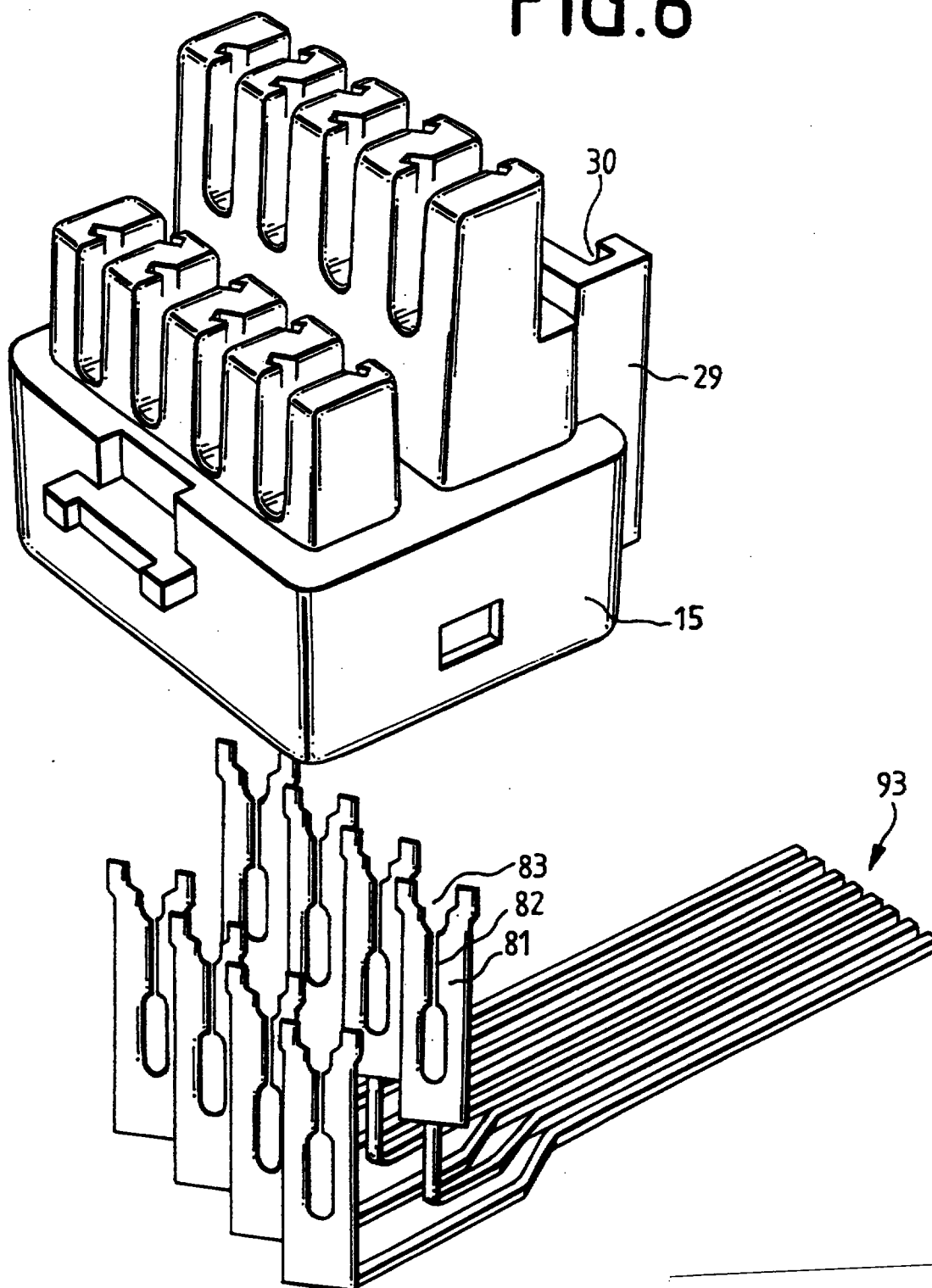
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FIG.6



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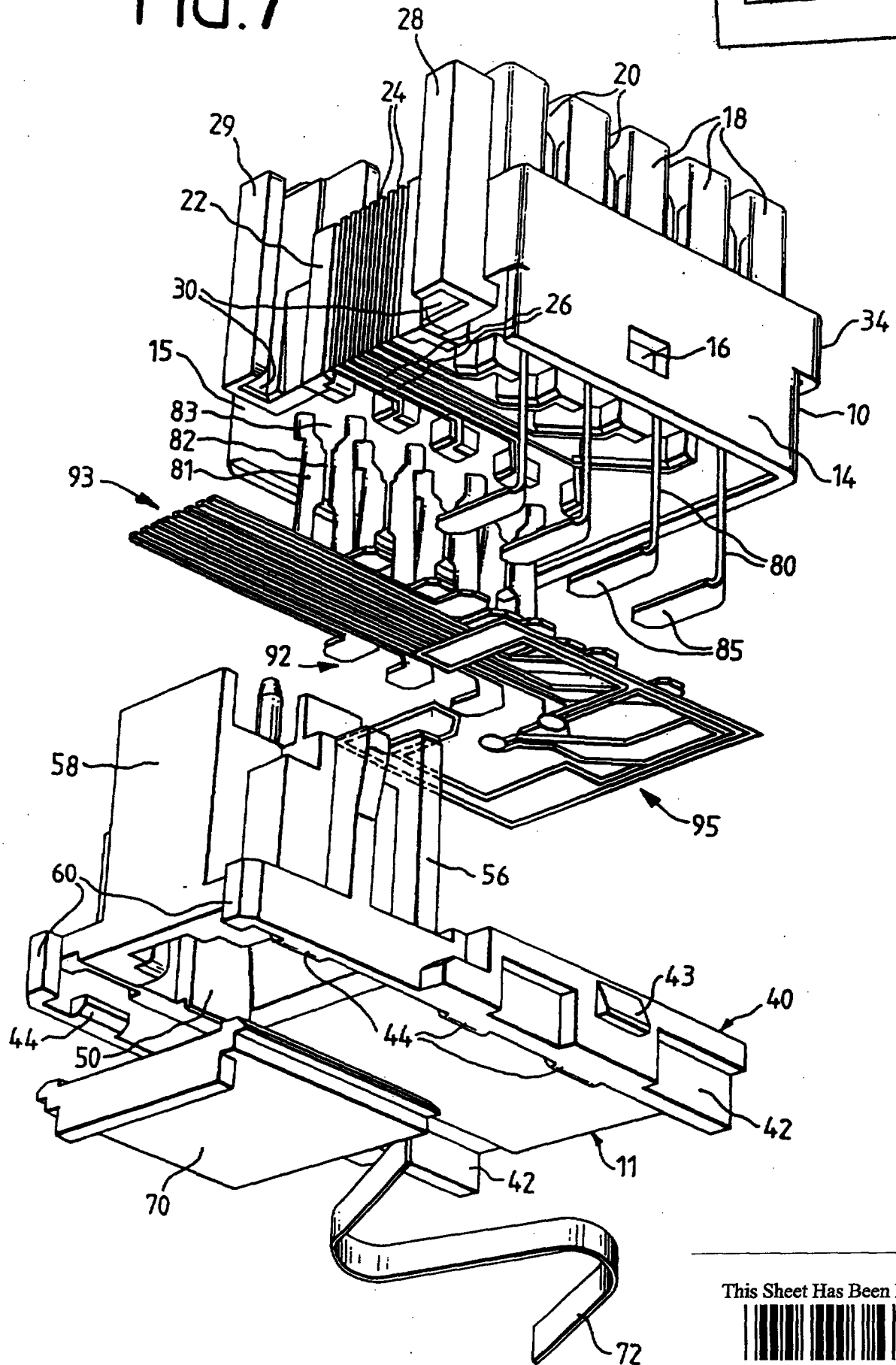


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FIG. 7



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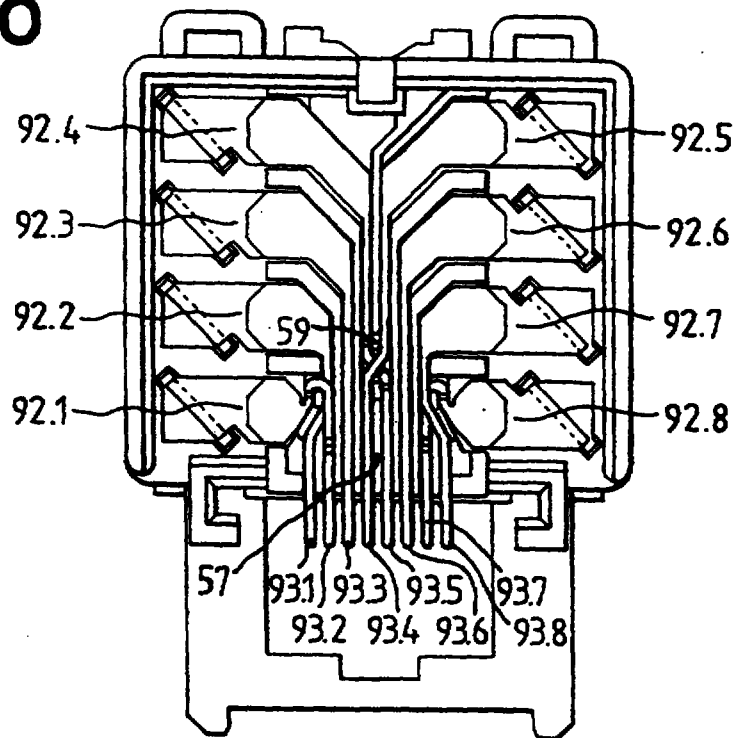


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FIG.8



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5 This invention relates to a connection device that provides any form of electrical connection between two discrete electrical cables or alternatively an electrical cable terminated by a plug and electrically insulated wires. It has application, for example, in data or telecommunications where a computer terminal
10 or telephone instrument is connected by a lead with an appropriate plug to a jack provided in a wall panel. The jack requires connection to data or telephone cables on the opposite side of the wall panel.

15 Arrangements are known in which a jack is provided on a wall panel the jack being connected by way of a printed circuit board to terminal elements which can be connected to the telephone wires. Such arrangements are not easily assembled nor are they
20 easily changed when faulty.

An improvement over this type of arrangement is described in GB-A-2242080. This connector has a moulded housing with a cavity for receiving the plug,

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5 a first set of connecting elements which can receive insulated wire and make electrical contact with the electrically conductive core and a second set of contacts which are connected to the first set and extend from the first set to the cavity such that they can come into electrical contact with contacts carried by the plug. The second set of contacts for part of their extent are located in longitudinal closely spaced relationship.

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In data communication systems connectors of this type operate satisfactorily at low or moderate data rates. As data rates increase however the system connectors exhibit an impedance imbalance which limits the performance of the system. This impedance imbalance is usually measured as near end crosstalk between recognised pairs. Attempts have been made to alleviate this problem by screening or by reduction in the size of the contact elements. These approaches are not entirely satisfactory and the present invention is concerned with an alternative solutions.

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The present solution arises partly from a careful analysis of the origin of crosstalk in a connector of a type described in GB-A-2242080. Our analysis in which the pairs of contacts are considered as forming a bridge network shows that the major source of crosstalk arises from capacitative imbalance between the pairs.

The following simple mathematical model indentifies the problem to be solved. A connector of the type described in GB-A-2242080 is an 8 wire/4 pair connector. There exist several recognised wiring/pair configurations for this connector, but for simplification and clarification only one of these will be considered in the following analysis.

It is usual to number the contacts on the connector from 1 to 8. The recognised wiring/pair configurations are defined as follows:

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Wires/Contacts	Recognised pair configuration
1 & 2	Pair 2
3 & 6	Pair 3

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5 & 4 Pair 1

7 & 8 Pair 4

The equivalent circuit for say pairs 1 & 3 is shown in
5 Figure 2 of the drawings. In this Figure C_1 is the
capacitance between contacts 3 and 5, C_2 is the
capacitance between contacts 3 and 4, C_3 the
capacitance between contacts 5 and 6, and C_4 the
capacitance between contacts 6 and 4. R_1 is the line
10 impedance.

This equivalent circuit needs to be considered as it
relates to both the connector and its mating plug,
which is shown schematically in Figure 3 of the
15 drawings. For simplicity this Figure shows
schematically just the plug and connector. In the
arrangement the 8 plug contacts are shown at 120 and
make contact with the connecting elements 93 in a
socket of the connector shown at 50. The elements 93
20 extend along parallel paths to IDC contacts 80.

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Considering Figure 3 and the bridge of Figure 2 it will be appreciated that if one assumes C_1 is unity then

$$5 \quad C_1 = 1$$

$$C_2 = 2$$

$$C_3 = 2$$

$$C_4 = 1$$

10 For no crosstalk there must be no current flow through R. For this to happen the bridge must be balanced, that is to say

$$\frac{C_1}{C_2} = \frac{C_3}{C_4}$$

$$15 \quad C_2 = C_4$$

However for the capacitance values given above the relationship in fact gives

$$20 \quad \frac{1}{2} = \frac{2}{1}$$

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Clearly the bridge is unbalanced and this leads to crosstalk. A similar situation exists in connection with pairs 2 and 3 and also between pairs 3 and 4, although the capacitive imbalance is not so
5 significant for these pair configurations with this connector.

The present invention is concerned with an electrical plug connector in which the problem of capacitive
10 imbalance is alleviated.

According to the present invention there is provided a connector for providing a connection between two electrical cables each of which includes a plurality of
15 conductive wires, said connector including means enabling contact to be established with the wires of each of the cables and a plurality of conductive elements extending between the contact enabling means, said conductive elements being so arranged and
20 configured so as to minimise capacitive imbalance between the pairs of contacts.

The invention will be described from now by way of example only with particular reference to the
25 accompanying drawings.

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In the drawings:

Figure 1 is an exploded view of a connector described in GB-A-2242080;

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Figure 2 is an equivalent circuit diagram for two contact pairs of the connector of Figure 1;

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Figure 3 is a schematic view of the interconnecting arrangement provided by the connector of Figure 1;

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- Figure 4 is a perspective view illustrating a connector in accordance with the present invention,
- 5 Figure 5 is a schematic view of an interconnecting arrangement provided by a connector in accordance with the present invention;
- 10 Figure 6 is a view similar to figure 2 of an alternative form of connector in accordance with the present invention, and
- 15 Figure 7 shows a modified form of lead frame which uses controlled capacitance to balance the connector.

20 Figure 1 shows a connector which is described in detail in GB-A-2242080. In brief it comprises a moulded housing having a moulded upper body part 10 and a lower moulded body part 11. The body parts when connected together define a cavity 50 into which can be located a plug such as that formed on the end of a

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cable extending from a telephone instrument or a terminal of the type used in computing equipment. The housing includes a first set of contact elements 80 which extend upwardly and terminate in slots which can receive insulated wire in such a way that the walls of the slots cut the insulation and thereby make contact with the electrically connected core. The contacts 80 are connected to a second set of contacts which include elongate strips 93 which extend along grooves 26 formed in the moulded upper body part and which in the assembled body terminate in the cavity 50 in such a way that they can contact electrical contacts carried by the plug. It will be seen that the strips 93 extend in longitudinally closely spaced, parallel relationship from the contact elements 80 to the cavity 50.

Our analysis of this arrangement has revealed that this type of configuration has an inherent capacitative imbalance which gives unacceptable crosstalk levels at high data rates.

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One embodiment of the present invention which alleviates this problem is that illustrated in Figure 4 of the drawings. It will be seen from Figure 4 that the connector is of the same general form as that shown in Figure 1 and that the strips 93 are configured so that they do not lie in parallel paths but are configured to extend along more tortuous paths from the cavity 50 to the connecting elements 80. Additionally the contact positions are re-arranged from their convention positions.

The effect of this arrangement can be best understood by considering the schematic of Figure 5 of the drawings in conjunction with the existing arrangement of Figure 3 and the bridge arrangement of Figure 2. The analysis of Figure 3 showed that the bridge arrangement was unbalanced. We have found that this imbalance can be overcome by carefully positioning the connecting elements 93 to compensate for the inherent capacitive imbalance of the plug and connecting wire. Figure 5 shows one possible arrangement whereby re-arranging the contact positions and their physical relationship to each other makes it possible to reduce the capacitive imbalance.

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In the arrangement of Figure 5 this is achieved by increasing C_1 and C_4 (see discussion relating to Figure 2 above) and by positioning the contact elements 3 and 5 closer together and also the contact elements 4 and 6 closer together. The net effect of this re-arrangement is to lead to a balancing of the capacitance so that, for example with reference to Figure 2

$$\begin{aligned} \underline{C_1} &= \underline{C_3} \\ C_2 &: C_4 \end{aligned}$$

It is also possible to decrease C_2 and C_3 by positioning contact elements 3 and 4 further apart and contact elements 5 and 6 further apart. Similarly the electrical performance of the other pair of configurations can be improved in a similar manner. Hence the connector shown in figure 2 of the drawings is capable of meeting the requirements for high data rate communication systems.

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An alternative arrangement of the present invention is shown in figure 6 of the drawings. The male housing part, indicated generally at 100 in Figure 1, is not shown in Figure 6, though it will be understood that it will slide into groove 30 and snap into window 16 as in the first arrangement. In the arrangement of figure 2 of the drawings the order in which the contact 80 are connected to the strips 193 is maintained the same as that for GB-A-2242080.

Figure 7 shows a modified form of the leadframe (90/92 Figure 1). Electrically connected to this leadframe is a second contact element. The second contact element could be either a flexible printed circuit board or a metallic element where the element is insulated with a high dielectric material. This high dielectric material is positioned on the contact element in specific areas to provide controlled capacitive to the other contact positions to balance out the inherent capacitive imbalance.

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CLAIMS:

1. An electrical plug connector for telecommunication and data transfer applications, comprising:

5 a housing having a housing upper portion with a first side wall, a second side wall, a front-side end wall and a lower wall;

insulation displacement contacts positioned in said housing, including a first set of insulation displacement
10 contacts disposed along said first side wall of said housing and a second set of insulation displacement contacts disposed along said second side wall of said housing;

contact strips having a contact tongue area
15 connected to said insulation displacement contacts, said contact strips terminating in RJ contacts for connection to an RJ type plug; and

crosstalk reduction means for reducing crosstalk between said contact strips, said crosstalk reduction
20 means being provided along said contact strip adjacent to said contact tongue area, between said first set of insulation displacement contacts and said second set of insulation displacement contacts, said contact strips extending in parallel form adjacent to said contact area
25 to contact strip ends.



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2. An electrical plug connector according to claim 1,
wherein the crosstalk reduction means is provided by the
contact strips being multiply and differently angled and
being, at least in a contact tongue area, in part not
5 guided in one plane parallel to each other.

3. An electric plug connector according to claim 1 or
2, characterised in that the contact strips are embedded
and guided in guide webs.

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4. An electrical plug connector according to claim 3,
characterised in that the contact strips partly cross
each other, and that the guide webs have interruptions
in the area at which the contact strips partly cross.

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5. A connector for providing a connection between two
electrical cables substantially as hereinbefore described
with reference to and as shown in the accompanying
drawings.



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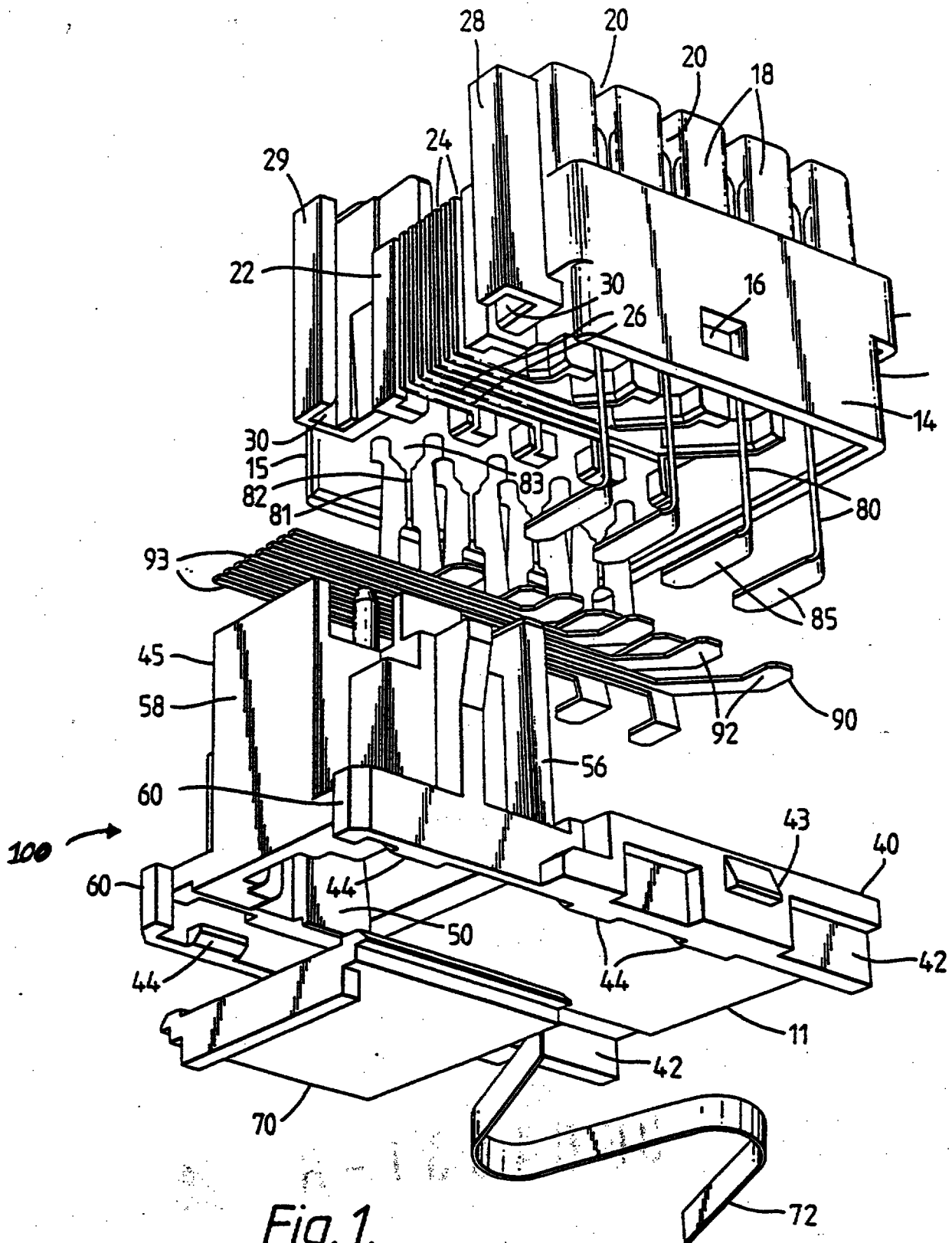


Fig. 1.

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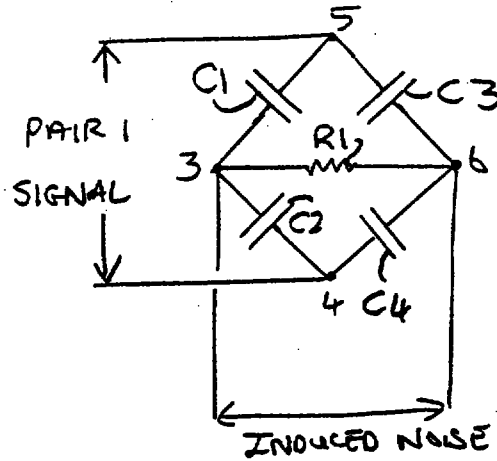


FIGURE 2

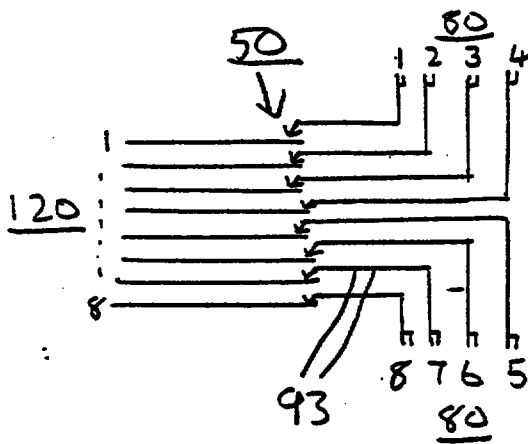


FIGURE 3

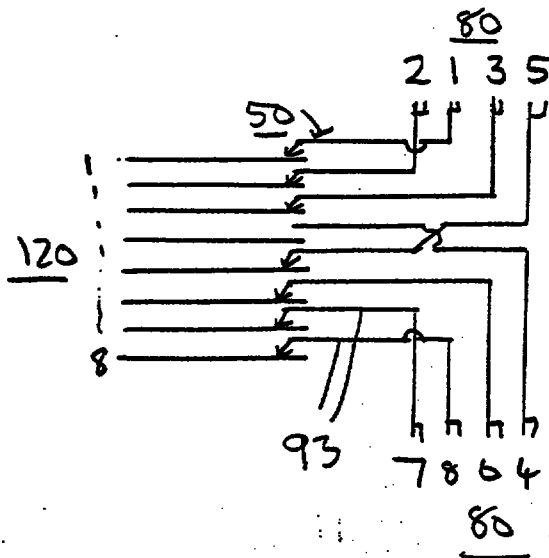


FIGURE 5

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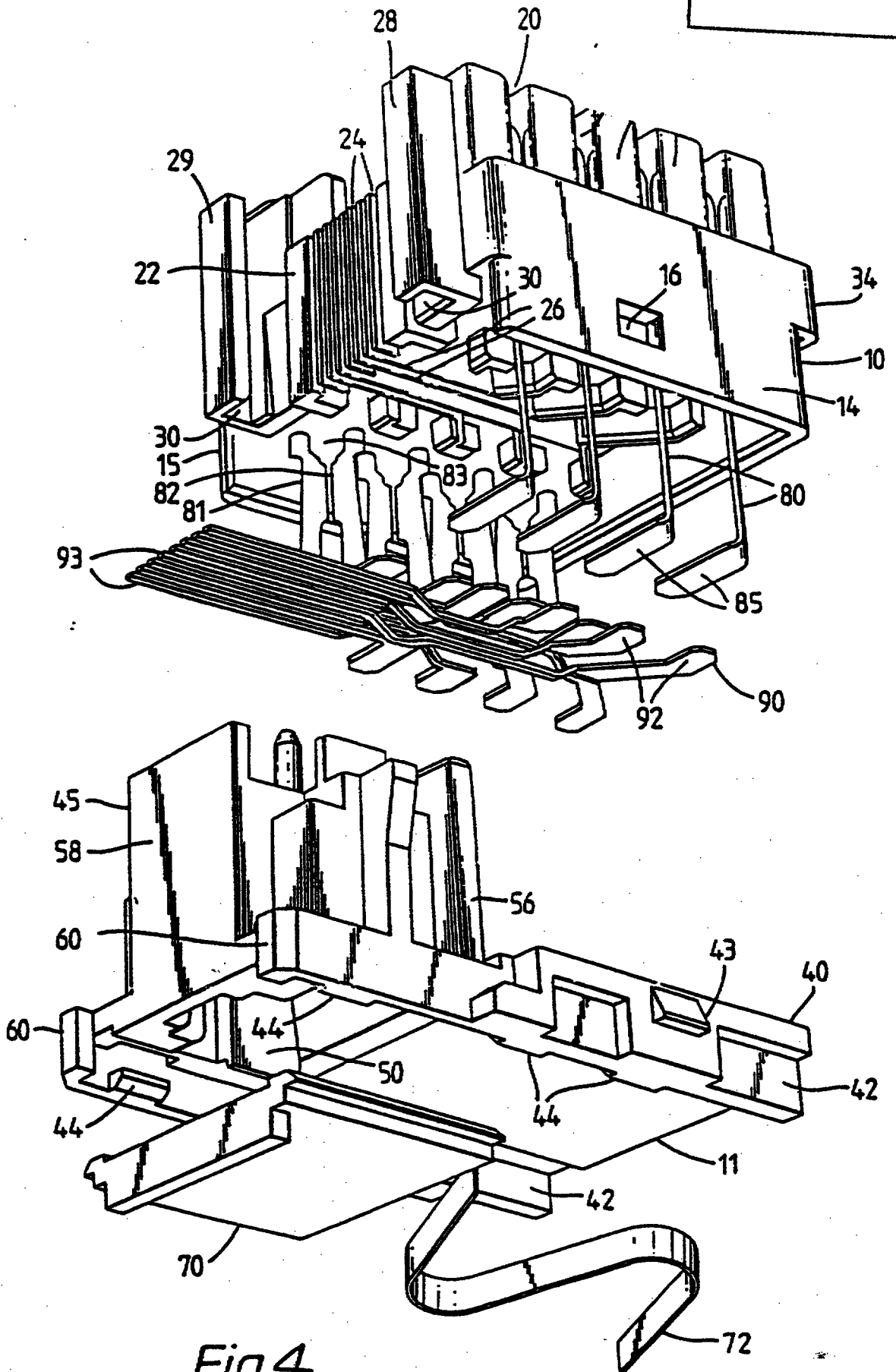


Fig.4.

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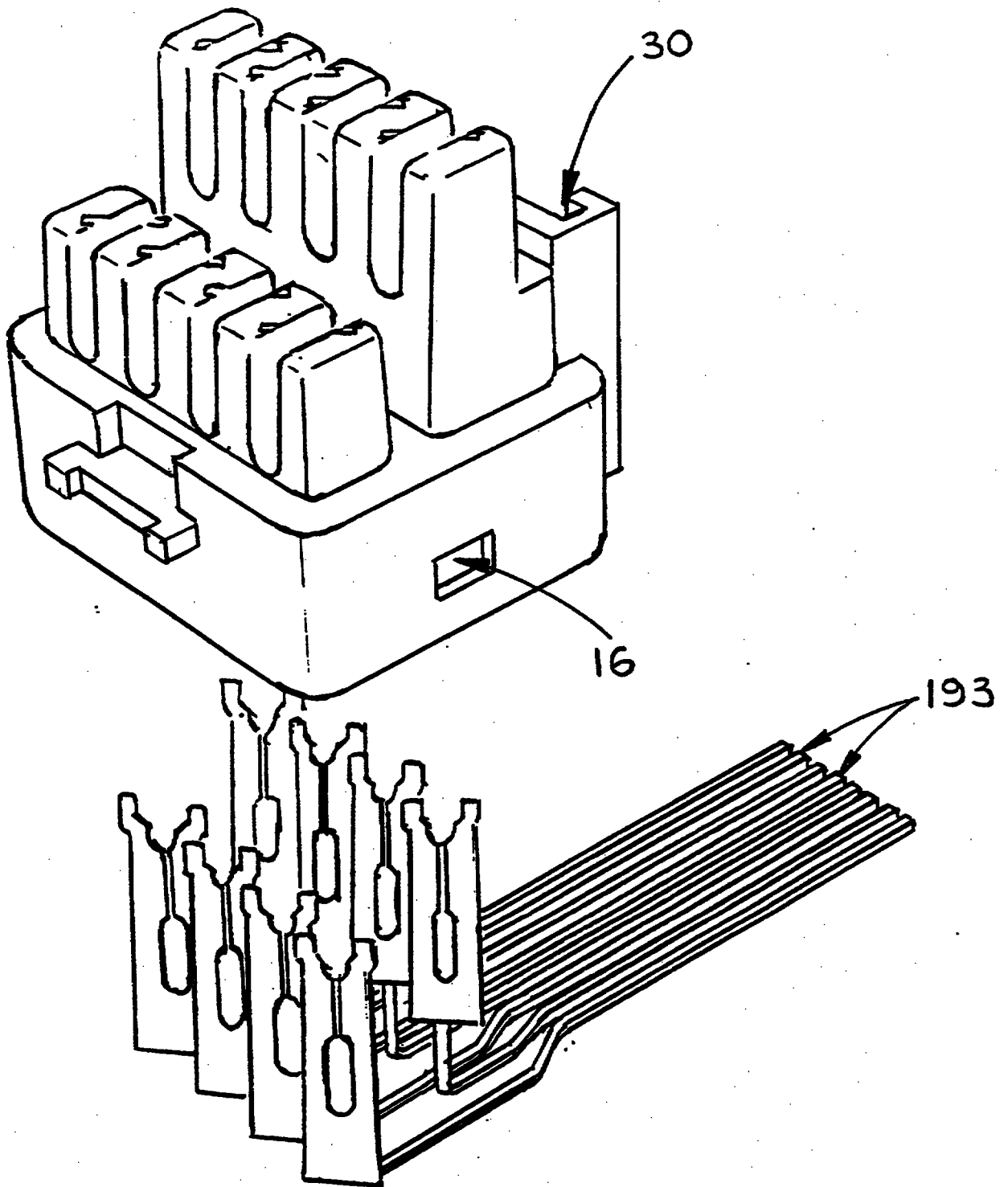


Fig 6

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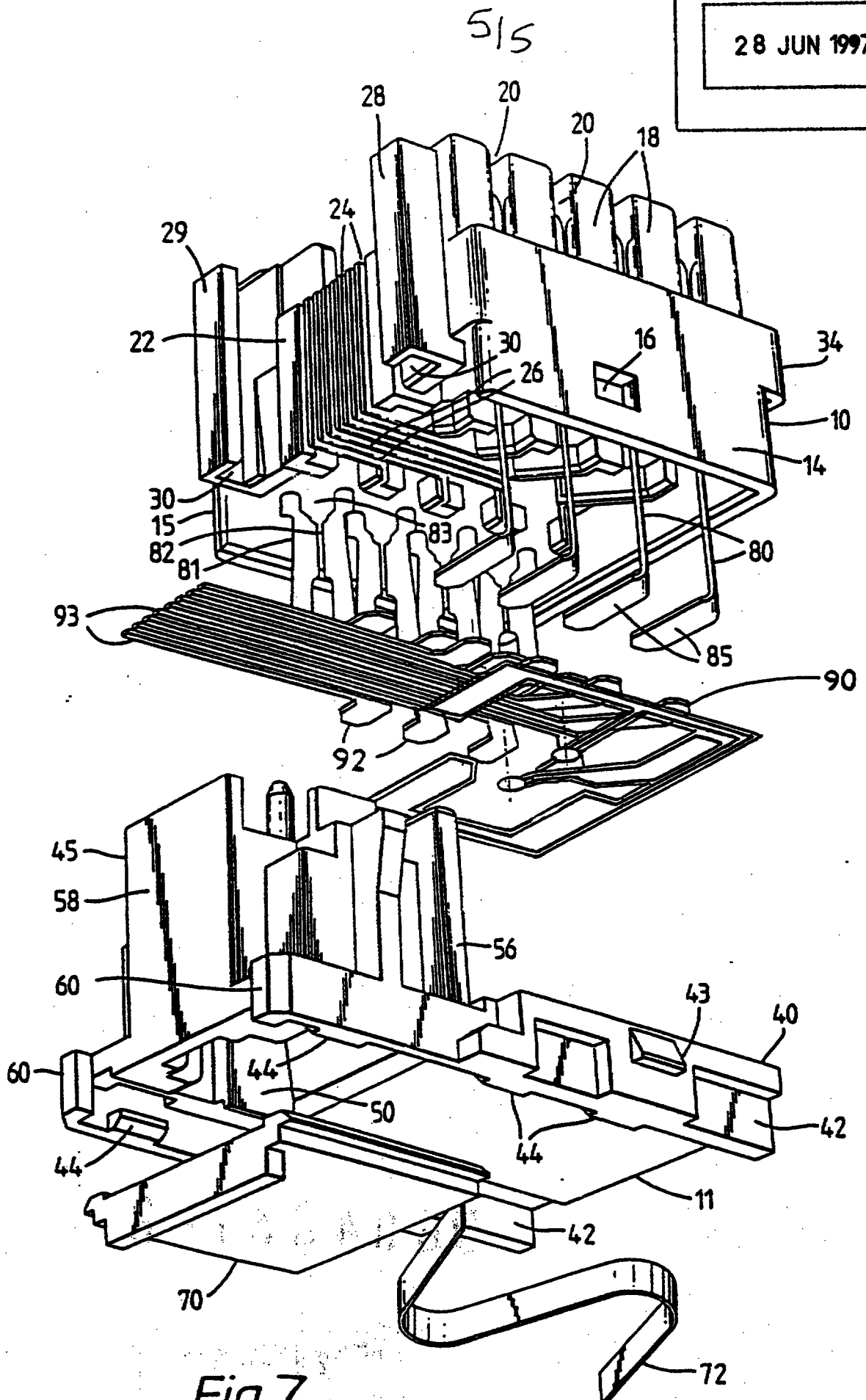


Fig. 7.

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ABSTRACT

The invention relates to a plug connector for the telecommunication and data technique, comprising RJ contacts disposed in a housing and insulation displacement contacts and contact strips connecting the latter. The object of the present invention, namely to improve an electrical plug connector of the type referred to heretofore such that its electrical parameters are substantially improved and satisfy the requirements for the transmission of high data rates, is achieved by that the contact strips are multiply and differently angled between the RJ contacts and the insulation displacement contacts, and are, at least in the contact tongue area, in part not guided in one plane parallelly to each other.

FIGURE 4

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ELECTRICAL CONNECTORS**ABSTRACT**

The invention relates to a plug connector for the telecommunication and data technique, comprising RJ contacts disposed in a housing and insulation displacement contacts and contact strips connecting the latter. The object of the present invention, namely to improve an electrical plug connector of the type referred to hereinbefore such that its electrical parameters are substantially improved and satisfy the requirements for the transmission of high data rates, is achieved by that the contact strips are multiply and differently angled between the RJ contacts and the insulation displacement contacts, and are, at least in the contact tongue area, in part not guided in one plane parallelly to each other.

FIGURE 4

