

- [54] **MULTI-CONTACT ELECTRICAL CONNECTOR FOR FLAT CABLE**
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- [58] Field of Search. 339/17 F, 75 M, 176 MF, 59 M, 339/75 MP, 60 M, 103 R, 103 M, 107, 148 R, 192 R, 191 M, 196 M, 205 R, 206 R, 206 P, 207 R, 208 R, 212 R, 99 R

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Primary Examiner—Marvin A. Champion

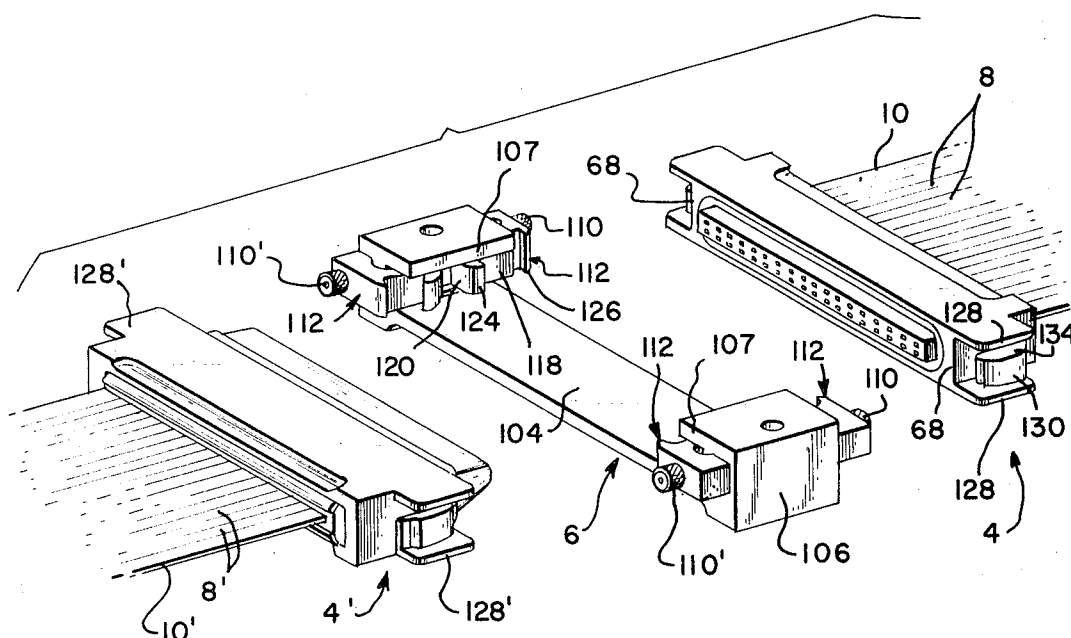
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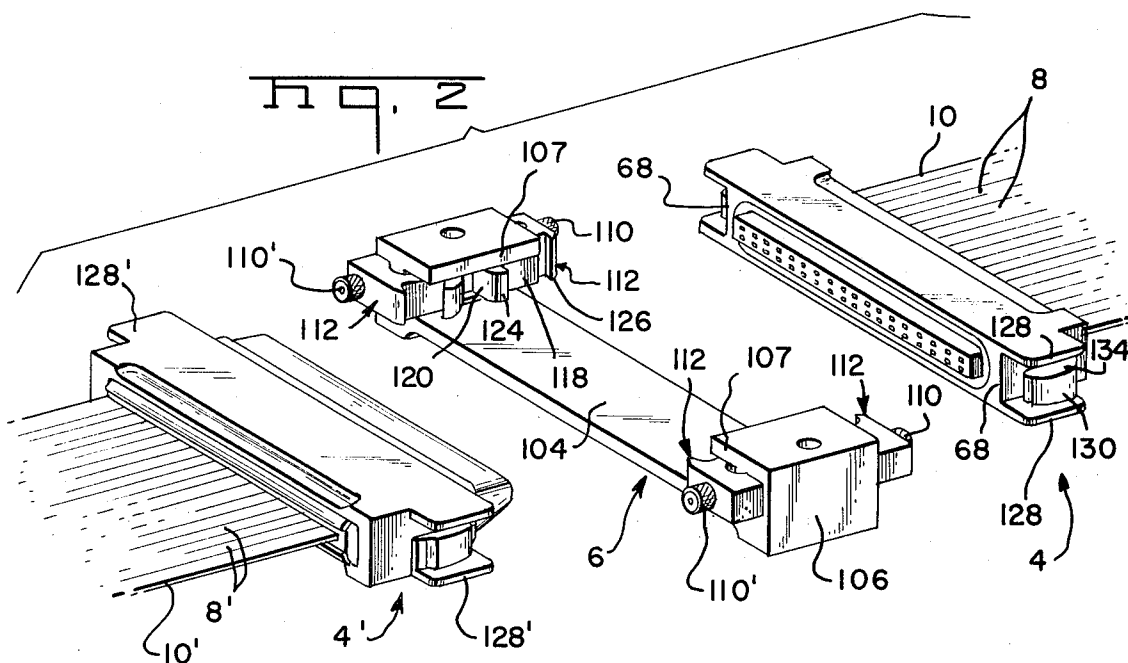
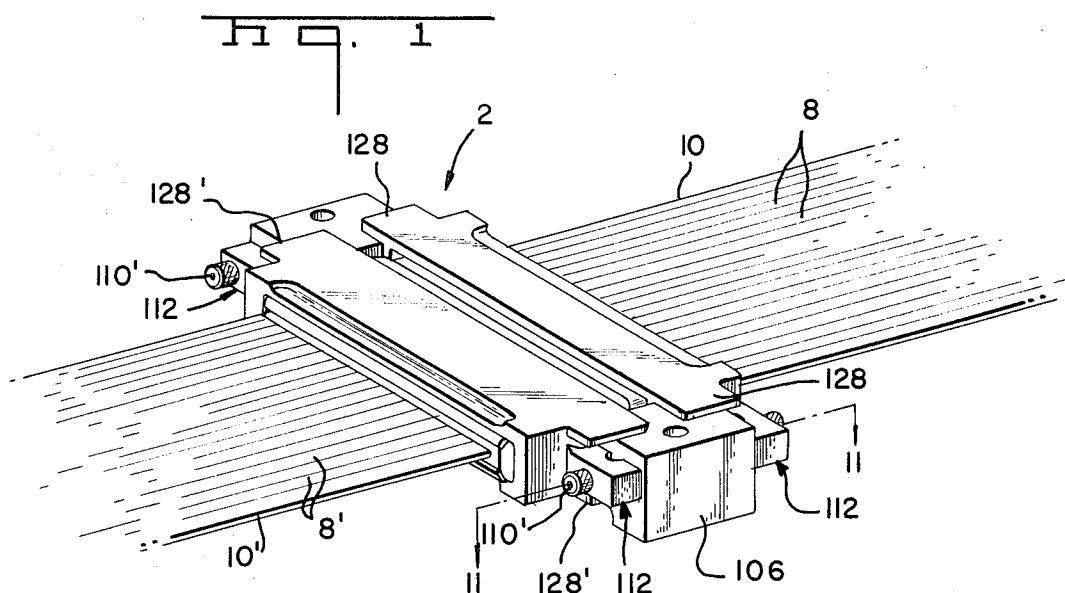
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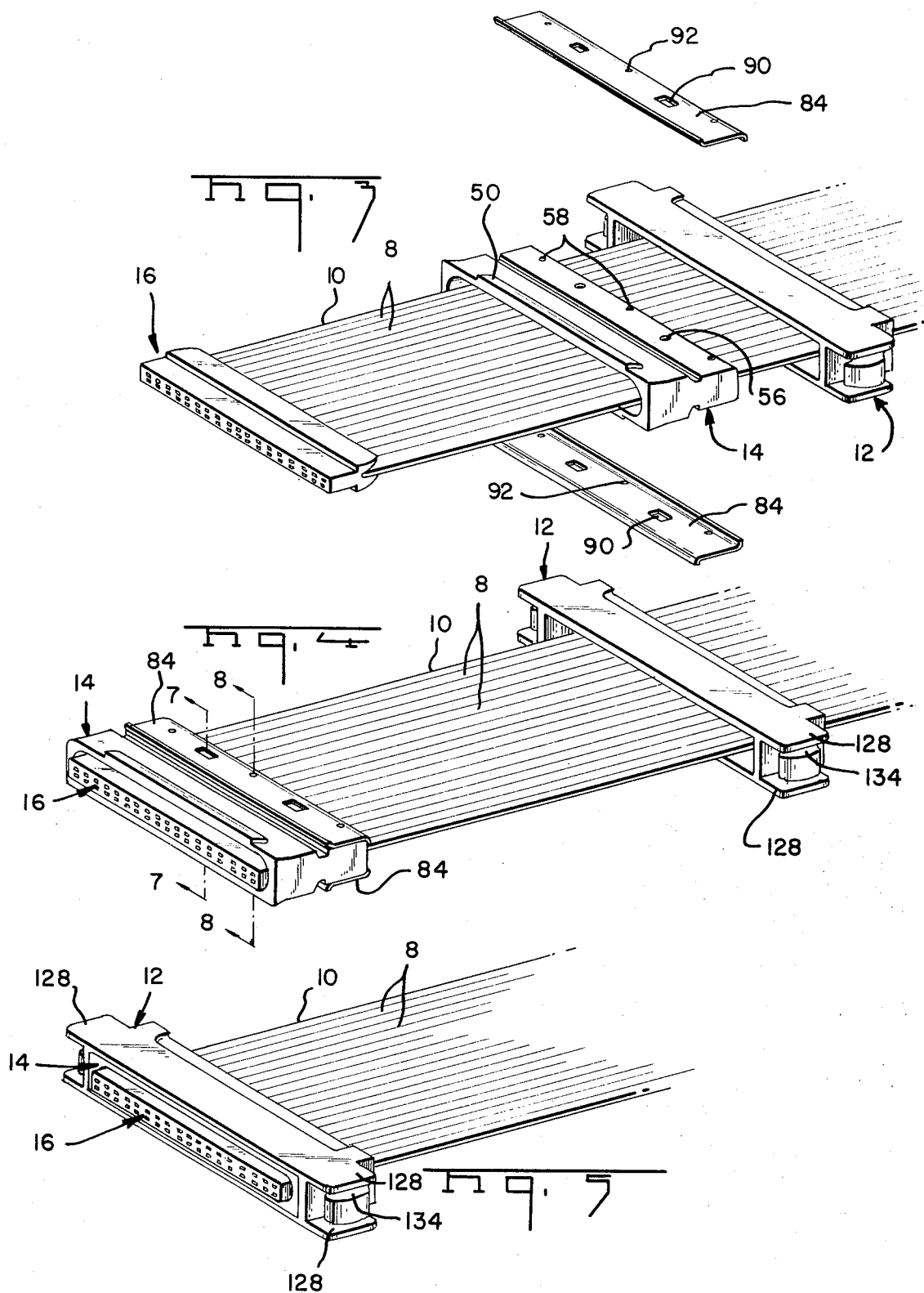
[57] **ABSTRACT**

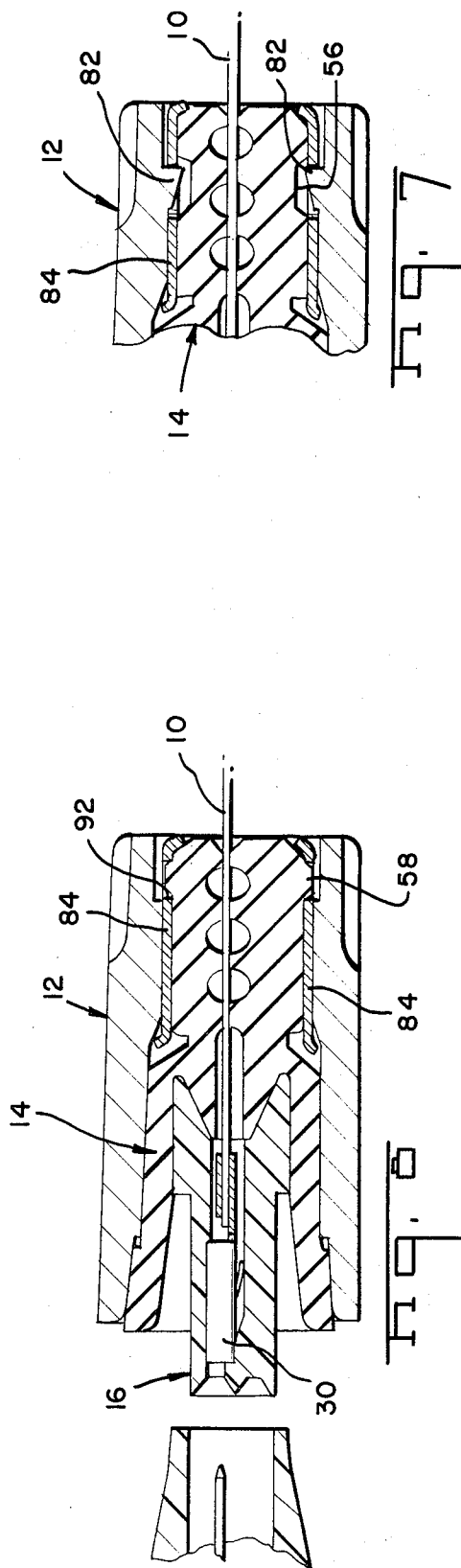
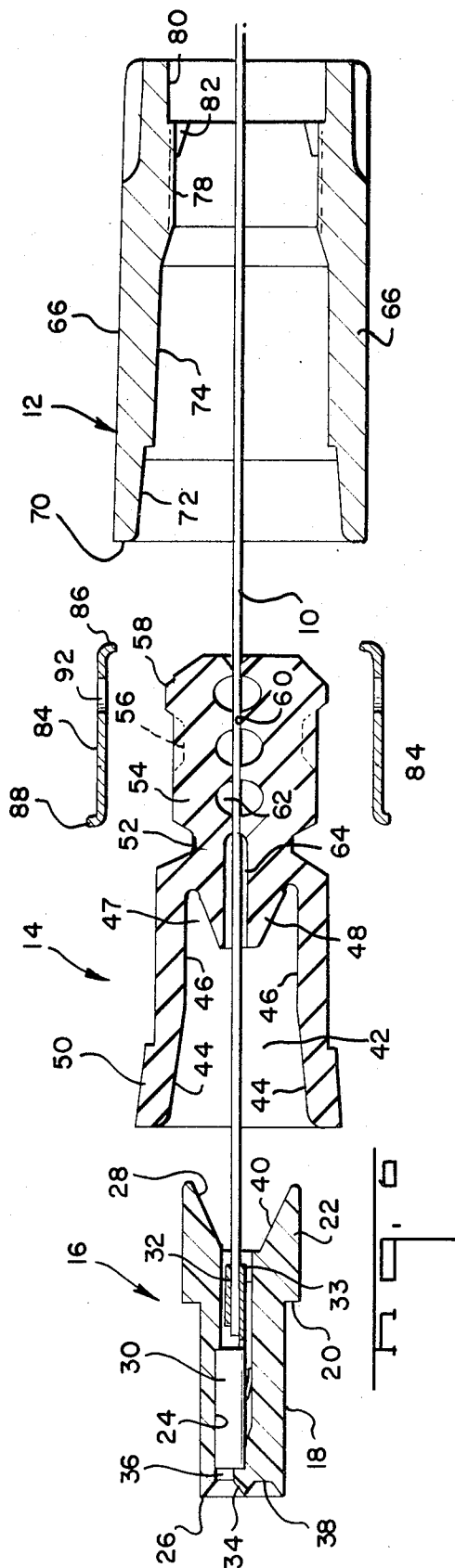
Multi-contact electrical connector for flat cable comprises two matable connector parts. Each connector part is made up of an outer metallic shell, a central insert containing contact terminals, and a sealing gland surrounding the insert and disposed against the internal walls of the shell. The cable to which the terminals are attached extends through the rearward end of the sealing gland and into the insert, and is clamped by the sealing gland at the rearward end of the connector part.

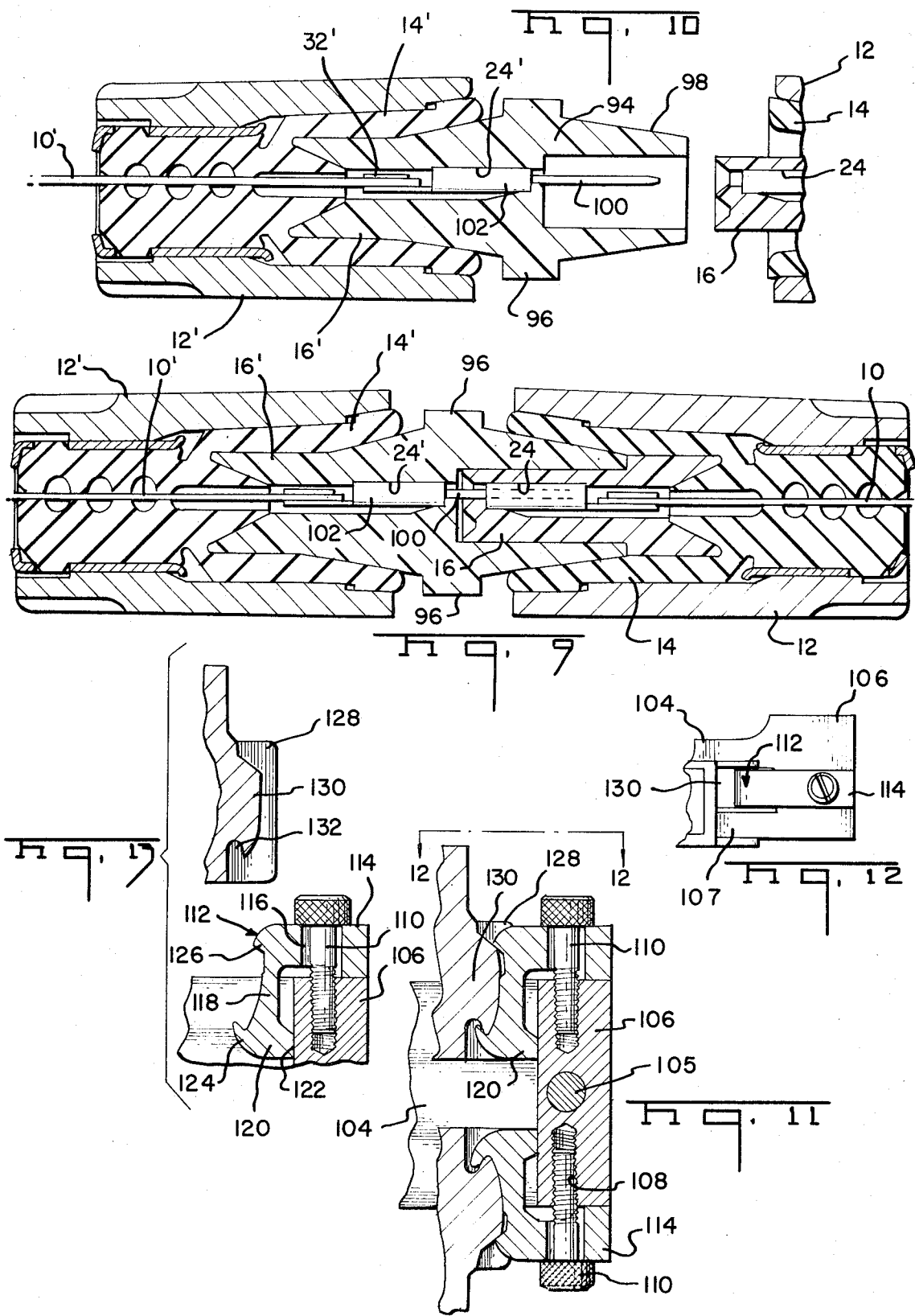
9 Claims, 13 Drawing Figures











MULTI-CONTACT ELECTRICAL CONNECTOR FOR FLAT CABLE

BACKGROUND OF THE INVENTION

This invention relates to multi-contact electrical connectors particularly, but not exclusively, intended for use with flexible flat cables. The term flexible flat cables is generally understood to denote a cable comprising a plurality of parallel ribbon-like conductors laminated between sheets of suitable plastic film such as Mylar (polyethyleneterephthalate).

Flexible flat cable is being used to an increasing extent for harnessing operations wherever a high density of wiring is required such as in aircraft and computer harnesses. For several reasons, it is not practical to use conventional multi-contact electrical connectors for flat conductor cable. For example, conventional multi-contact electrical connectors comprise an insulating body having a plurality of separate cavities extending therethrough, each of which is adapted to receive a terminal on the end of a conductor. The terminals are thus individually inserted into the cavities when the harness is being manufactured. In the case of a flexible flat cable, however, the individual conductors are contained in a single body of insulation and all of the terminals lie in a single plane, the plane of the cable. All of the terminals must therefore be inserted into the connector simultaneously. A mass insertion operation of this type cannot be carried out where the individual cavities in the connector are separated from each other and are intended to receive only a single terminal and conductor. Conventional multi-contact connectors are unsuitable for flat flexible cables for other reasons which will become apparent from a reading of the following specification.

It is an object of the invention to provide an improved multi-contact electrical connector assembly. It is a further object to provide a multi-contact connector assembly particularly intended for flexible flat cable. A further object is to provide a connector which can be used with flat cable or with other types of conductors. A still further object is to provide a connector which is sealed and which can be assembled or disassembled without the aid of specialized tools. A further object is to provide an improved arrangement for securing connector parts to each other.

These and other objects of the invention are achieved in a preferred embodiment thereof which is briefly described in the foregoing abstract, which is described in detail below, and which is shown in accompanying drawings in which:

FIG. 1 is a perspective view of a preferred form of electrical connector assembly in accordance with the invention.

FIG. 2 is a perspective view showing the parts of the assembly of FIG. 1 exploded from each other.

FIG. 3 is an exploded view of the socket part of the electrical connector assembly of FIG. 1.

FIG. 4 is a view similar to FIG. 3 but showing the sealing gland and clamping plates assembled to the insert housing.

FIG. 5 is a perspective view of the assembled socket part of the connector assembly.

FIG. 6 is a sectional side view of the socket part with the parts exploded from each other illustrating the manner in which the socket is assembled.

FIGS. 7 and 8 are views taken along the lines 7—7 and 8—8 of FIG. 4.

FIG. 9 is a sectional sideview of a connector plug and a connector socket in accordance with the invention in engagement with each other.

FIG. 10 is a sectional sideview of a connector plug section in accordance with the invention.

FIG. 11 is a sectional plan view illustrating clamping means for clamping the connector plug and the connector socket to a mounting frame.

FIG. 12 is a fragmentary view taken along the line 12—12 of FIG. 11.

FIG. 13 is a fragmentary view similar to FIG. 11 but showing the connector socket disengaged from the mounting bracket.

Referring first to FIGS. 1 and 2, a connector assembly 2 in accordance with the invention comprises a socket part 4 and a plug part 4' which are adapted to be coupled to each other by means of a mounting bracket or frame 6. The plug and socket each contain contact terminals, described below, which are crimped onto the conductors 8, 8' of flexible flat cables 10, 10'. The connector part 4 is herein denominated as the socket part for the reason that it contains electrical contact sockets as described below. The part 4' contains contact pins and for this reason is denominated as the plug. The flexible flat cables, as noted above, may be of the conventional type comprising a plurality of parallel spaced-apart ribbon-like conductors laminated between sheets of suitable plastic film.

The connector plug 4' and the connector socket 4 are similar to each other in many respects so that a description of one part will, in a large measure, suffice for a description of both. Accordingly, only the socket part 4 of the connector assembly will be described in detail and the structural differences between the socket and the plug 4' will be pointed out subsequently. The same reference numerals, differentiated by prime marks, denote corresponding structural parts of the plug and socket.

As best shown in FIGS. 3-6, the socket part 4 comprises an outer metallic shell 12, a resilient sealing gland 14, and an insert housing 16 which is of relatively firm insulating material such as a hard plastic (e.g., hard nylon or diallyl phthalate). The insert housing is generally rectangular in transverse cross section and comprises a forward section 18 and a somewhat enlarged rearward section 22 which is separated from the forward section by a forwardly facing shoulder 20. A plurality of contact receiving cavities 24 extend through the insert housing from the rearward face 28 thereof to the mating face 26. Each of these cavities contains an electrical contact socket terminal 30 which may be of the type disclosed in my co-pending application Ser. No. 105,208 filed on even date herewith. The terminals are crimped unto the individual conductors 8 of the cable 10 by crimped connections as shown at 32 which are advantageously of the type shown in the U.S. Pat. to Huffnagle No. 3,395,381.

Each of the contact receiving cavities communicates with the mating face 26 of the insert housing through a restricted opening 36 which flares outwardly as indicated at 34 towards the mating face to assist in guiding contact pins, described below, into the sockets 30. It will be apparent from FIG. 6 that these openings 36

are above the center line of the insert housing as viewed in FIG. 6. Shallow recesses 38, having bevelled sides 34 are provided below the openings. These recesses prevent damage to contact pins in the plug part 4' in the event that an attempt is made to engage the socket with the plug when the parts are improperly oriented. If such improper engagement is attempted, the contact pins will enter the recesses and the sides of the recesses will support the pins against lateral movement so that the pins will not be bent out of alignment.

The rearward face 28 of the insert housing has inclined surfaces 40 which extend toward the row of contact receiving cavities 24. The forward portions of the individual cavities are separated from each other by relatively thin wall sections. The contact terminals 30 on the end of the cable can be inserted into the cavities and the end of the cable is received by slot 33 which extends inwardly from the rearward face 28 of the insert housing. Further details of the housing 16 and the cavities 24 are disclosed in my above-identified copending application Ser. No. 105,208.

The sealing gland 14 is preferably of resilient insulating material such as a silicone rubber and has a recess 42 extending inwardly from its lefthand end, as viewed in FIG. 6, for the reception of the insert housing 16. The sidewalls of the sealing gland adjacent to the lefthand end thereof are inclined convergently as indicated at 44 and merge with parallel sidewall portions 46. A central boss 48 extends outwardly from the inner end of the recess 42 for the full width of the gland and is adapted to enter the insert housing between the inclined sidewalls 40 as shown in FIG. 8. The upper and lower sides of the sealing gland are recessed at 52 and the righthand portion of the gland comprises a relatively massive block of material which has recesses 56 and bosses 58 on its upper and lower surfaces. A thin slot 60 extends through this portion of the sealing gland and into the central boss 48 for the accommodation of the cable. As shown in FIG. 6, recesses 62 are provided on each side of this slot as is conventional in sealing glands of this type. Slot 60 is somewhat enlarged in the vicinity of boss 48 as shown at 64 to permit limited movement of the end of the cable without disturbance to the seal.

The outer metallic shell 12, which may be of diecast aluminum, is a hollow rectangular member having upper and lower walls 66, and end walls 68. The internal surfaces of the shell extend rightwardly, as viewed in FIG. 6, from the mating side 70 convergently as shown in 72. Intermediate the ends of the shell, the surfaces are substantially parallel or very slightly convergent as shown at 74 and this intermediate section merges through a short relatively steeply inclined section 76 with a rearward section 78 having substantially parallel sidewalls. The opening extending through the shell is slightly enlarged at the righthand end of the shell as shown at 80 and inwardly directed bosses or teeth 82 are provided adjacent to the enlarged opening.

In order to securely clamp the sealing gland in the shell, it is preferable to employ a pair of clamping plates 84 which are disposed against the upper and lower surfaces of the sealing gland at the righthand end thereof. These plates are also desirable in that they serve to stabilize the rubbery sealing gland 14 during assembly of the connector and thereby reduce the risk of damage to the sealing gland when the connector is

disassembled. As is apparent from FIG. 3, these clamping plates comprise simple flat plates having upwardly and downwardly directed lips 86,88 extending along their edges, and enlarged openings 90 for the reception of the teeth 82. Additional openings 58 are provided in these plates to receive the bosses 58.

When a connector socket 4 is being assembled to the terminated end of the cable 10, the end portion of the cable having the terminals thereon is first passed from right to left, as viewed in FIG. 6, through the shell 12 and then through the slot 60 in the sealing gland 14. This can be accomplished by stretching the sealing gland to a width sufficient to permit passage of the terminals. Thereafter, the terminals are inserted en masse into the cavities 24 in the insert housing 16. The gland is then moved leftwardly, as viewed in FIG. 6, over the insert housing 16 until the righthand end of the insert housing is disposed in the generally triangular recesses 47 on each side of the boss 48. Thereafter, the clamping plates are positioned on the sealing gland and the shell member 12 is moved leftwardly over the gland until the plates 84 are disposed against the surfaces 78' on the righthand end of the shell member. When the parts are in their final positions, the teeth or detents 82 on the internal surface portions 78 of the shell 12 will extend through the openings 90 of the plates and into the recesses 56 in the sealing gland. The bosses 58 on the sealing gland will extend into the smaller circular openings 92 of the clamping plates as shown in FIG. 8. The bosses 58 locate the plates 84 with respect to the sealing gland and the detents or teeth 82 locate the plates with respect to the shell and restrain the plates against movement in the assembled connector part. This arrangement thus locates the sealing gland and retains it in the shell.

As previously pointed out, the plug part of the connector assembly 4' is similar in many respects to the socket part 4 so that a detailed description of the former part is not necessary. The shell 12', the plates 84', and the sealing gland 14' are identical to the corresponding parts in the socket part 4. The terminals secured to the conductors 8' of the cable 10' comprise contact pins 100 which are adapted to enter the contact sockets 30 in the socket part 4. These pins are integral with, and extend from, formed body portions 102 which have leftwardly (as viewed in FIG. 10) extending crimped portions 32' by means of which the terminals are secured to the conductor. The contact cavities 24' in the insert housing 16' are adapted to receive the body portions 102 of the terminals and have a suitable retention means for retaining the contact terminals in the cavity.

The insert housing 16' differs from the insert housing 16 in that the former housing projects for a substantial distance beyond the righthand end, as viewed in FIG. 10, of the shell member 12'. Immediately adjacent to the face of the shell, the insert housing 16' has a laterally extending collar 96 which protects the ends of the sealing glands 14, 14' against damage when the connector parts are mated. Extending from collar 96, there is provided a hood portion 98 in the form of a wall which surrounds, and projects beyond, the ends of the contact pins 100. The external surface of this hood is tapered as shown in FIG. 10 so that it is adapted to enter the space between the forward portion 18 of the

insert housing 16 and the internal wall portions 44 of the sealing gland 14 in the socket member 4.

When the connector plug and the connector socket are assembled to each other as shown in FIG. 9, complete sealing of the electrical interface is achieved by virtue of the fact that the rearward portion of each sealing gland 14, 14' is pressed against the surfaces of the cables 10, 10' as noted above. By virtue of this fact, fluids cannot move between the cable and the sealing gland into the contact receiving cavities 24, 24' of insert housing 16, 16'. Sealing at the electrical interface, between the ends of the connector assembly, is achieved by virtue of the fact that the forward portions of the sealing gland 14, are compressed between the surface portions 72, of the shell 12 and the inclined surface 98 of the hood portion 94 of the insert housings 14'. Additionally, the forward portions of the sealing gland 14' in the plug 4' are compressed between the internal surface of the plug shell by the portions of the insert housing 16' which extend leftwardly from the collar 96. The fact that the plug and socket parts are firmly held in engagement with each other by the bracket described below contributes to the effectiveness of the seal between the forward portions of the glands 14, 14' and the shells and insert housings.

In order to secure the socket part 4 to the plug part 4' of the connector assembly, and to prevent accidental uncoupling of the two parts, I provide a mounting bracket or frame 6 comprising a strap member 104 having a width slightly greater than the width of the connector parts and having integral blocks 106, on its ends. Openings 105 as indicated extend through these end blocks to secure the mounting bracket to a panel or other mounting surface. Referring particularly to FIGS. 2 and 11-13, the blocks 106 on the ends of the strap 104 are provided with threaded openings 108, 108' on each side of each block, that is facing the connector parts 4, 4'. Blocks 106 are also provided with inwardly directed flanges 107, 107' on their upper ends which serve as a polarizing means for the connector parts as will be described below. Screws 108 extend through elongated slots 116 in clamping hooks which are carried on these blocks. These clamping hooks 112 have enlarged heads 114 through which the screws extend and shank portions 118 which extend alongside the blocks and towards each other as best shown in FIG. 11. The ends of the shanks 118 have rightwardly (as viewed in FIG. 11) directed heel portions 120 which are adapted to bear against the side of the adjacent block portion 106 as indicated at 122. Barbs 124 extend leftwardly from the inner ends of the shanks and are adapted to engage integral ears on the connector shells as will be described below. Additionally, a lip 126 extends leftwardly as viewed in FIG. 11 from the head portion of each hook member.

The connector shells 12, 12' have at each end thereof laterally extending flanges 128 which constitute extensions of the upper and lower surfaces of the shell members. An integral ear 130 is provided on the side of each shell member which is integral with the sidewalls 68 but which extends only partially upwardly as viewed in FIG. 2 from the flange 128 towards the upper flange so that an upwardly facing shoulder or surface 134 is provided. As best shown in FIG. 11, the contour of the side of each ear 130 is complementary to the side of the

hook members so that each hook member can engage an ear between the barb 124 and the lip 126.

When the connector plug and socket are to be engaged with each other, it is merely necessary to loosen the screws 110, 110' a turn to two so that the hook members are permitted limited universal movement with respect to the blocks 106 on the ends of the strap 104. The plug and socket are then properly oriented relative to the strap member, so that the flange 107 can be received between the upper flanges 128 and the upwardly facing shoulders 134 of ears 130. The plug and socket are then moved between the block sections 106 of this strap so that the ears 130, 130' on the shells 12, 12' of the connector parts will seat on the outside surfaces of the hook members as shown in FIG. 11. Thereafter, it is merely necessary to tighten the screws by turning them one or two revolutions to securely lock the parts to the bracket 6.

The disclosed arrangement of locking the connector parts 4, 4' to the bracket is particularly advantageous by virtue of the fact that only one or two turns of the screws, 110, 110' are required to lock or unlock the connector parts. This effect is achieved by virtue of the fact that the hook members 108 are secured to the block portions 106 of the bracket by the screw and slot arrangement 110, 116 permitting limited universal movement of the hooks with respect to the blocks 106. Also, when the screws are tightened, the head portions of the hooks are firmly clamped against the upper surfaces of the blocks 106 so that the hooks can not rock or slide on the blocks 106 and, therefore, securely hold the connector parts 4, 4' on the bracket.

A bracket as shown at 6 is required where 2 individual connector parts 4, 4' are to be connected to each other. It should be noted that brackets of this type can be stacked when several connector assemblies are mounted adjacent to each other. Under some circumstances, one or the other of the connector parts, preferably the plug 4', may be permanently mounted on a panel or on one wall of a container or black box in which further equipment is mounted. A specific permanent mounting for the plug part of the connector assembly is disclosed in co-pending application Ser. No. 879,451 filed Nov. 24, 1969.

A salient advantage of the invention is that it presents a convenient method of terminating flexible flat cable. The contact terminals 30, 30' can be applied to the cable in accordance with the teachings of U. S. Pats. Nos. 3,395,381 and 3,553,836 which show respectively a suitable crimped connection for crimping terminals to the conductors of flat conductor cables and a machine for forming such connections. After the terminals 30, 30' have been applied to the cable ends, it is merely necessary to carry out the procedural steps described above for assembling the connector plug and socket 4, 4' to the cable ends. As described above, the electrical interface is sealed in the disclosed embodiment and is therefore suitable for use under circumstances where hostile environments are encountered or were for other reasons, a high degree of electrical integrity is required. Unsealed connectors in accordance with the teachings of the invention can be provided where sealing is not required.

It should also be noted that multi-contact electrical connectors in accordance with the invention can be

used with conventional discrete wires or "ribbon cable" (multi-conductor cables comprising individual ground wires bonded to each other in a single plane). The versatility of the invention in this respect is advantageous in that where flexible flat cable is being used in a harnessing system for most of the wiring but where some ribbon cable or some discrete round wire is also being used, it is unnecessary to specify several types of connectors for the several types of conductors.

A connector in accordance with the invention can be assembled or disassembled with very simple tools and individual contact terminals on the ends of the cables can be replaced if necessary by suitable hand crimping tools. The connector assembly is completely serviceable in the field so that repairs can be carried out rapidly and with a minimum of lost time for the equipment with which the connector is being used.

A further significant feature of the invention is that the inserts 16, 16', in which the contact terminals are contained, are permitted to move by a very slight distance or "float" with respect to the connector shell 12, 12'. This float is permitted by virtue of the fact that the inserts are entirely surrounded and held by the resilient sealing glands 14, 14'. This float in the connector inserts is required to permit the two inserts to align themselves with each other when the two connector parts are mated. It should be added that it is impractical to achieve such alignment by mounting the individual terminals in a manner such that they can float individually (as is common practice in conventional connectors) for the reason that the terminals in each connector part all are held attached to a single cable which limits their individual freedom of movement.

What is claimed is:

1. A multi-contact electrical connector comprising:
 - an outer shell of hard material having an opening extending therethrough from its rearward face to its mating face,
 - a sealing gland of soft resilient material in said opening and extending for substantially the full length thereof,
 - an insert housing within, and surrounded by, said sealing gland, said insert housing being proximate to said mating face of said shell and extending partially towards said rearward face,
 - contact terminals in said insert housing, said contact terminals being secured to conductors, said conductors extending rearwardly through said insert housing, through said sealing gland, and exteriorly of said connector,
 - clamping plate means between said sealing gland and said outer shell, said clamping plate means extending transversely across said connector adjacent to said rearward face, and
 - interengaging means effective between said outer shell and said clamping plate means and between said sealing gland and said clamping plate means for maintaining said sealing gland assembled to said outer shell, said insert housing being capable of limited lateral movement within said connector when said connector is engaged with a complementary connector for alignment purposes.
2. A connector as set forth in claim 1 and a complementary connector, said connector and said complementary connector having a generally rectangular cross

section, said complementary connector having a shell, a sealing gland, an insert housing and contact terminals in said insert housing arranged as in said connector, said conductors in said connector and said complementary connector comprising the conductors of flexible flat cables.

3. A connector and a complementary connector as set forth in claim 2, and frame means, said connector and said complementary connector being assembled to said frame means whereby said connector and said complementary connector are maintained in coupled relationship.

4. A connector, a complementary connector, and frame means as set forth in claim 3, said frame means comprising a plate extending transversely with respect to said connector and said complementary connector, said plate having integral blocks at its ends, said connector and said complementary connector being between said blocks, and hook means on said blocks securing said connector and said complementary connector to said frame means.

5. A connector, a complementary connector, and frame means as set forth in claim 4 wherein each of said hook means comprises a head portion clamped against on side of one of said blocks, and a shank extending from said head in engagement with one side of one of said connectors.

6. A connector as set forth in claim 1 and a complementary connector, said complementary connector having a shell, a sealing gland, an insert housing, contact terminals in said insert housing, and clamping plate means as in said connector, forward portions of said insert housing in said connector being spaced from said sealing gland in said connector, and forward portions of said insert housing of said complementary connector extending between said sealing gland and said insert housing of said connector and surrounding forward portions of said insert housing in said connector.

7. A connector and a complementary connector as set forth in claim 6, said connector and said complementary connector being generally rectangular, said outer shells of said connector and said complementary connector being identical, and said sealing glands of said connector and said complementary connector being identical.

8. A connector and a complementary connector as set forth in claim 7, and frame means, said connector and said complementary connector being individually removably secured to said frame means.

9. Securing means on a member which is adapted to receive a multi-contact electrical connector, said member comprising spaced-apart block means adapted to receive said connector therebetween, said securing means comprising:

a pair of hooks, one of said hooks being on each of said block means, each of said hooks having a head portion disposed against its respective block means,

clamping means for each of said hooks for releasably clamping said heads of said hooks against said blocks,

each of said hooks having a shank portion extending alongside its respective block and beside said connector, said shank portion having of each hook being contoured to interfit with one side of said

connector, whereby, upon positioning said connector on said member, engaging said shank portions of said hooks with the sides of said connector, and clamping said heads of said hooks against said blocks, said connector is secured to said member.

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