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CORDLESS ELECTRIC CROSS-CONNECT PANEL WITH IMPROVED MOVABLE CONTACT ASSEMBLY
Original Filed Dec. 8, 1969 13 Sheets-Sheet 1

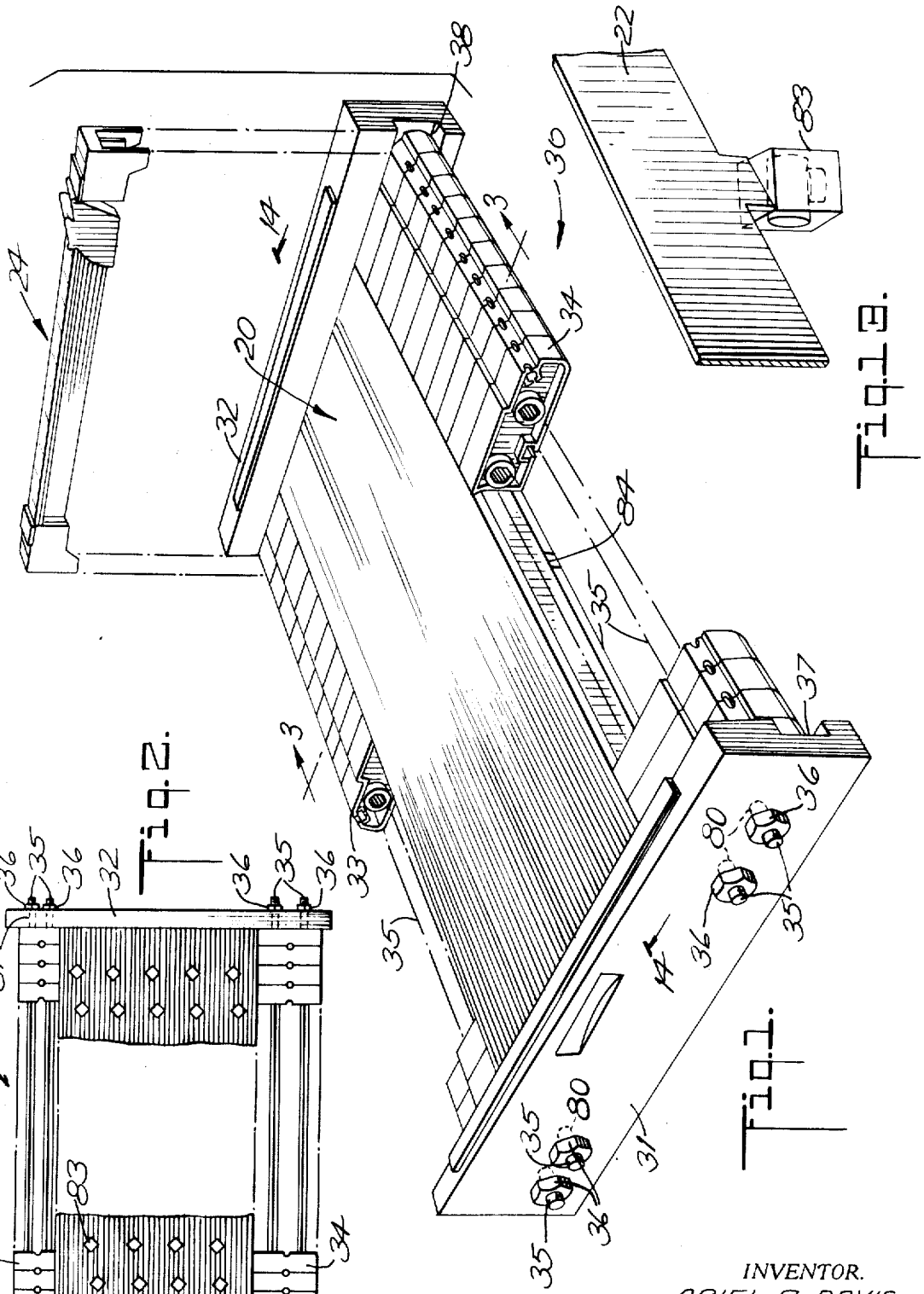


Fig. 1.

Fig. 2.

Fig. 3.

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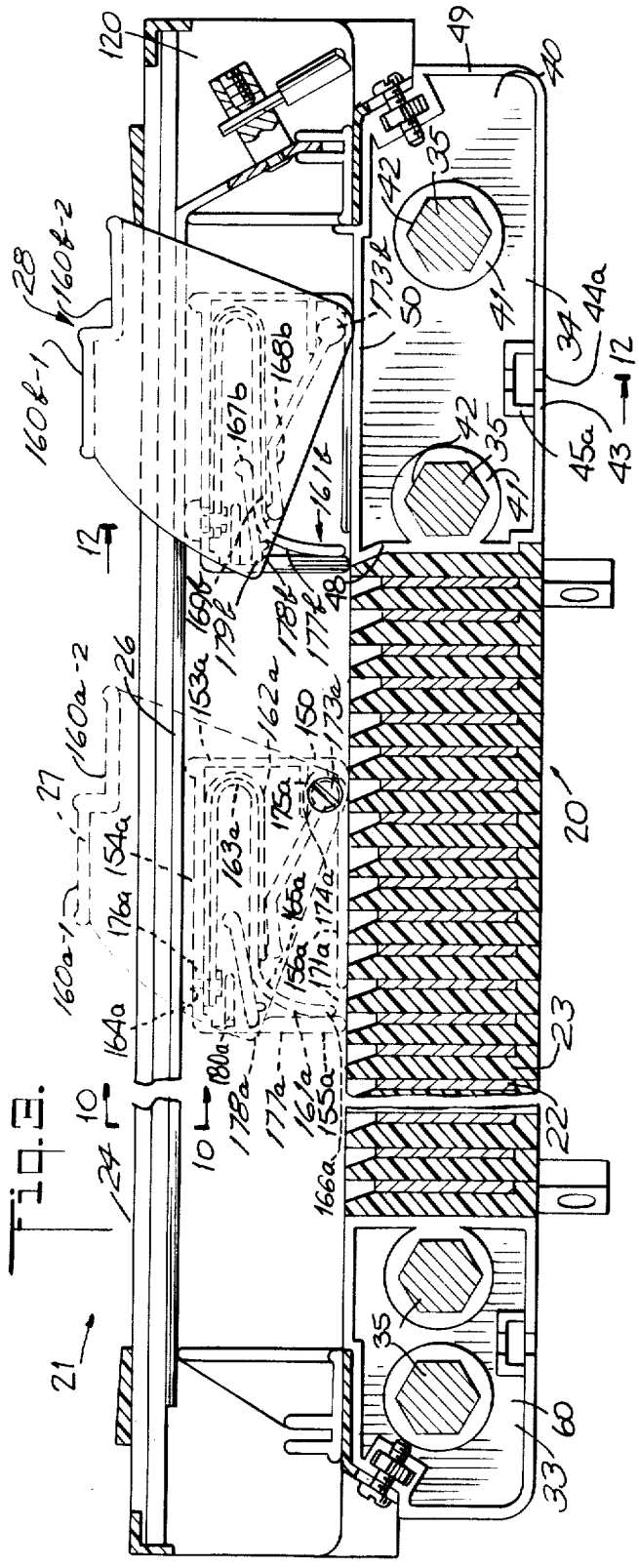


Fig. 3.

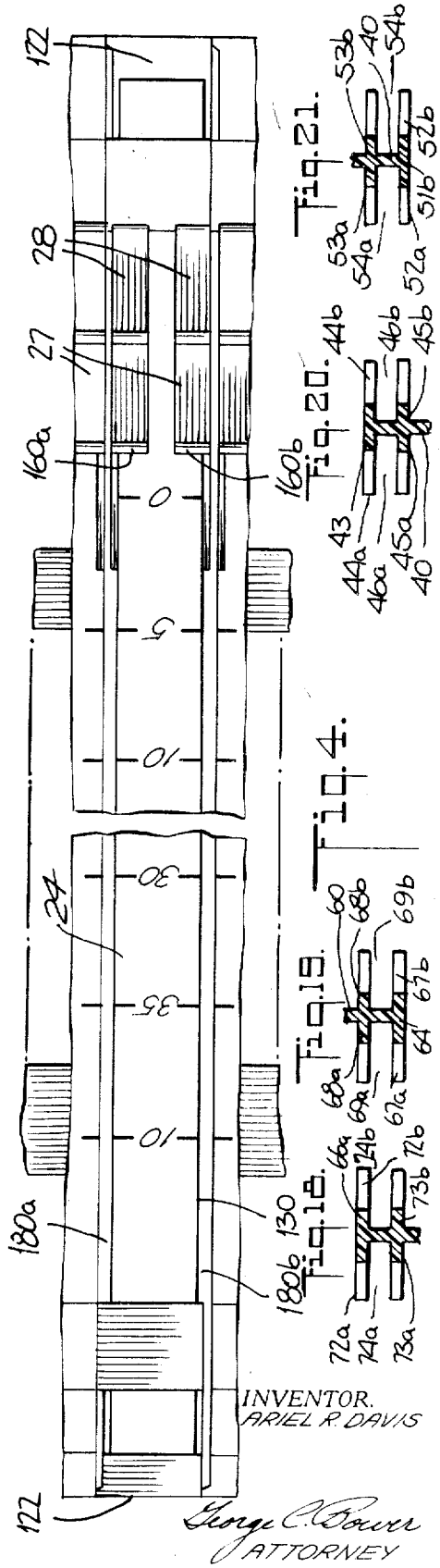


Fig. 4.

Fig. 21.

Fig. 20.

Fig. 19.

Fig. 18.

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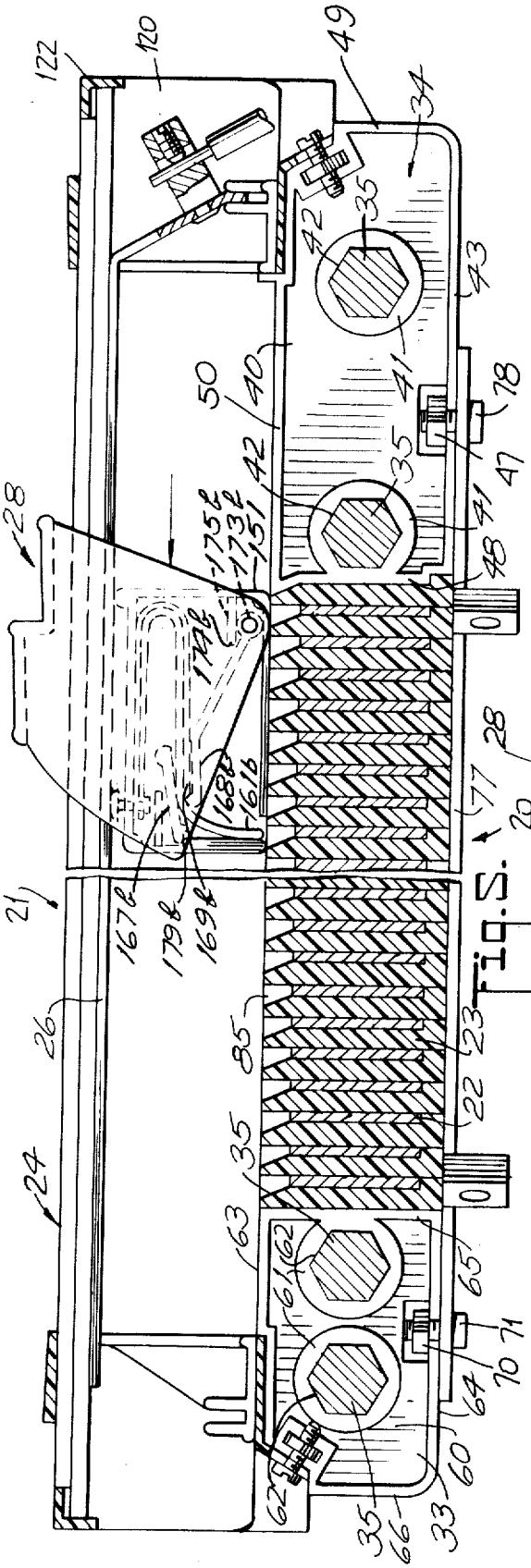


Fig. 5.

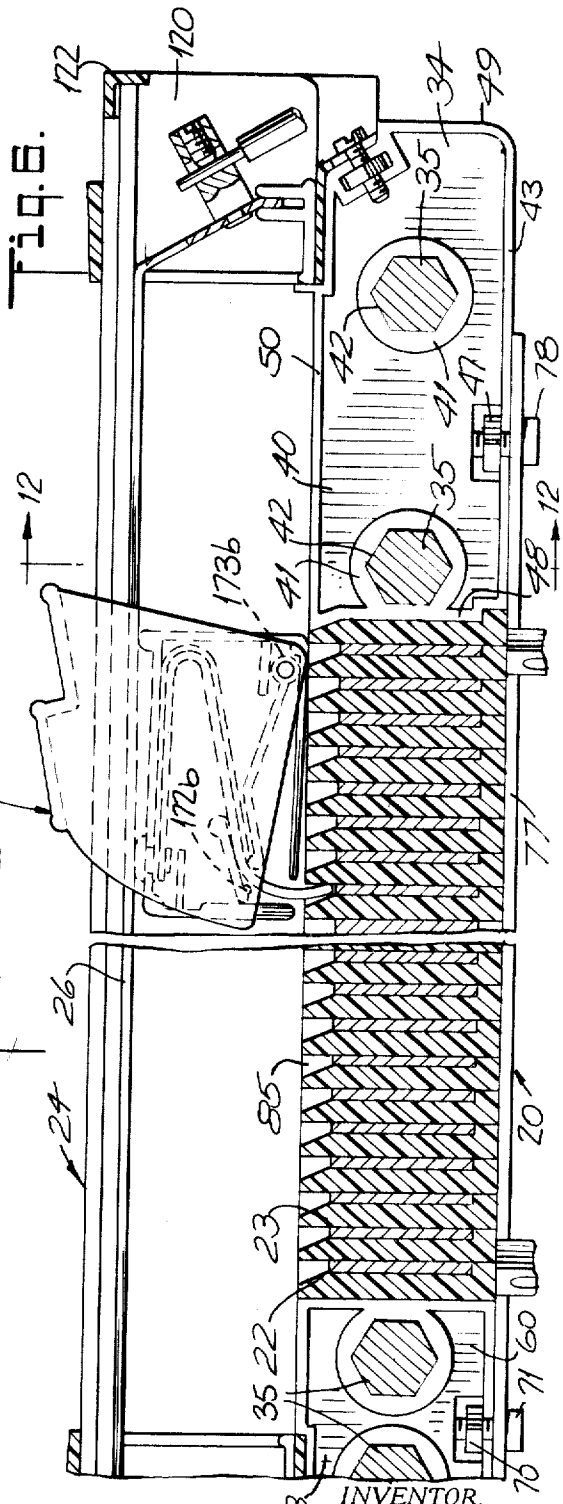


Fig. 6.

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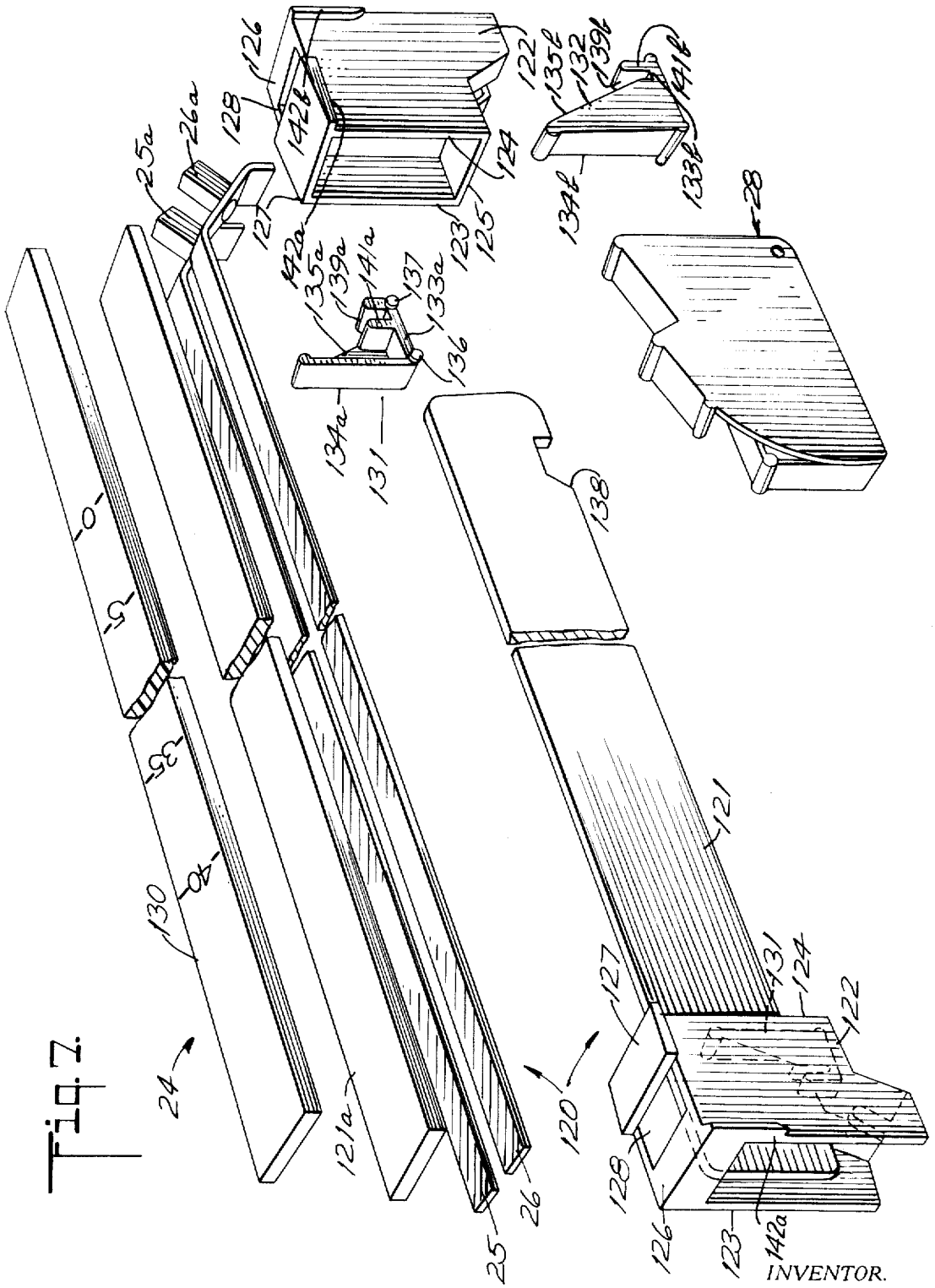
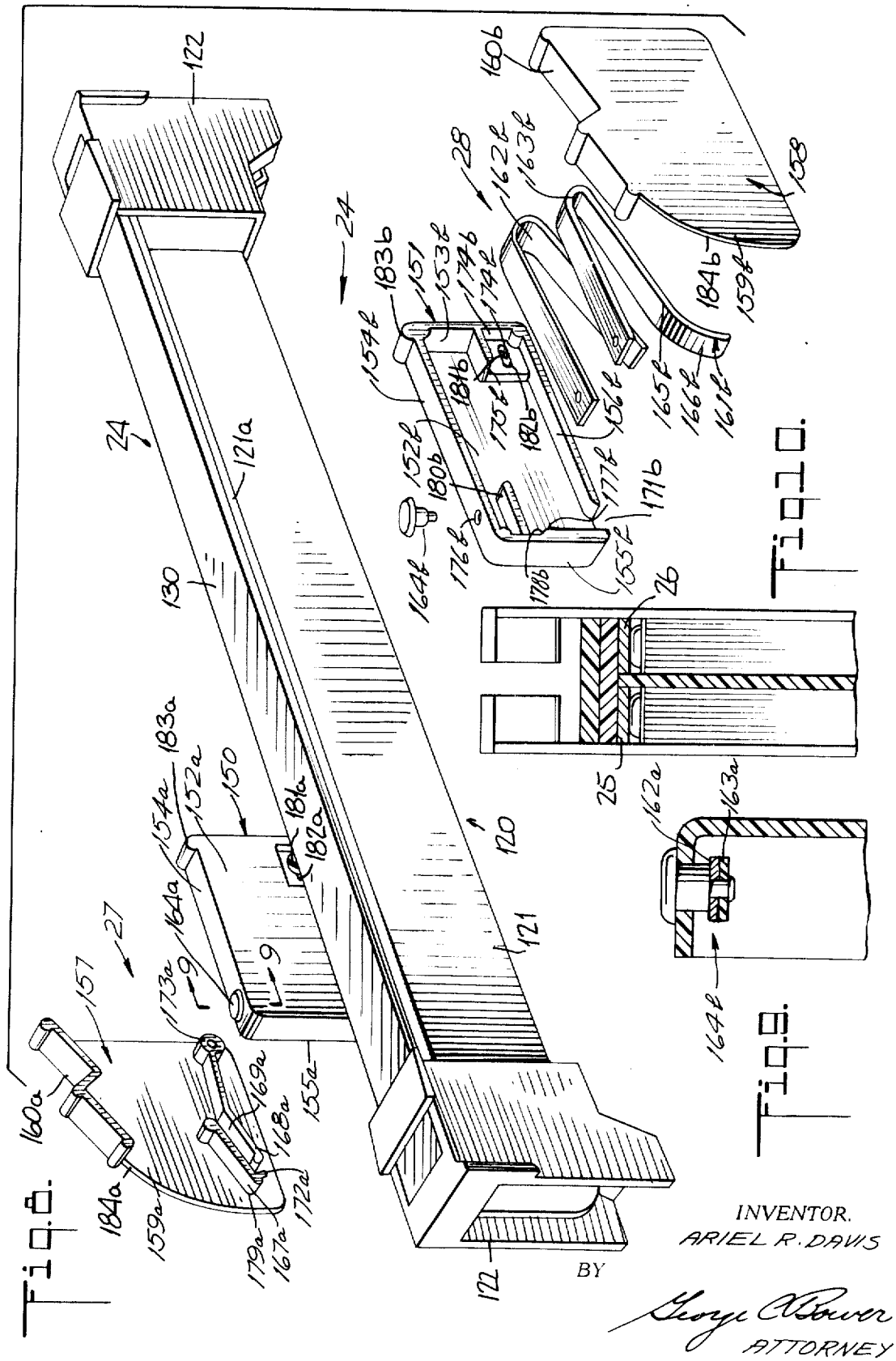

126
122
128
142a
135a
132
139a
141a
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127
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125
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121
130
24
121a
120
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Fig. 7

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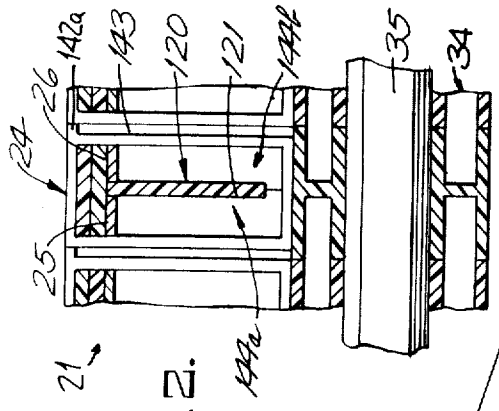


Fig. 12.

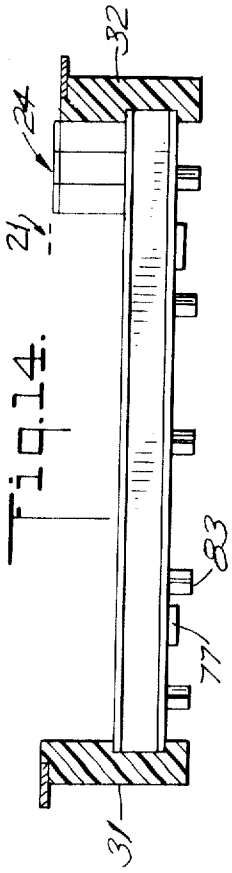


Fig. 14.

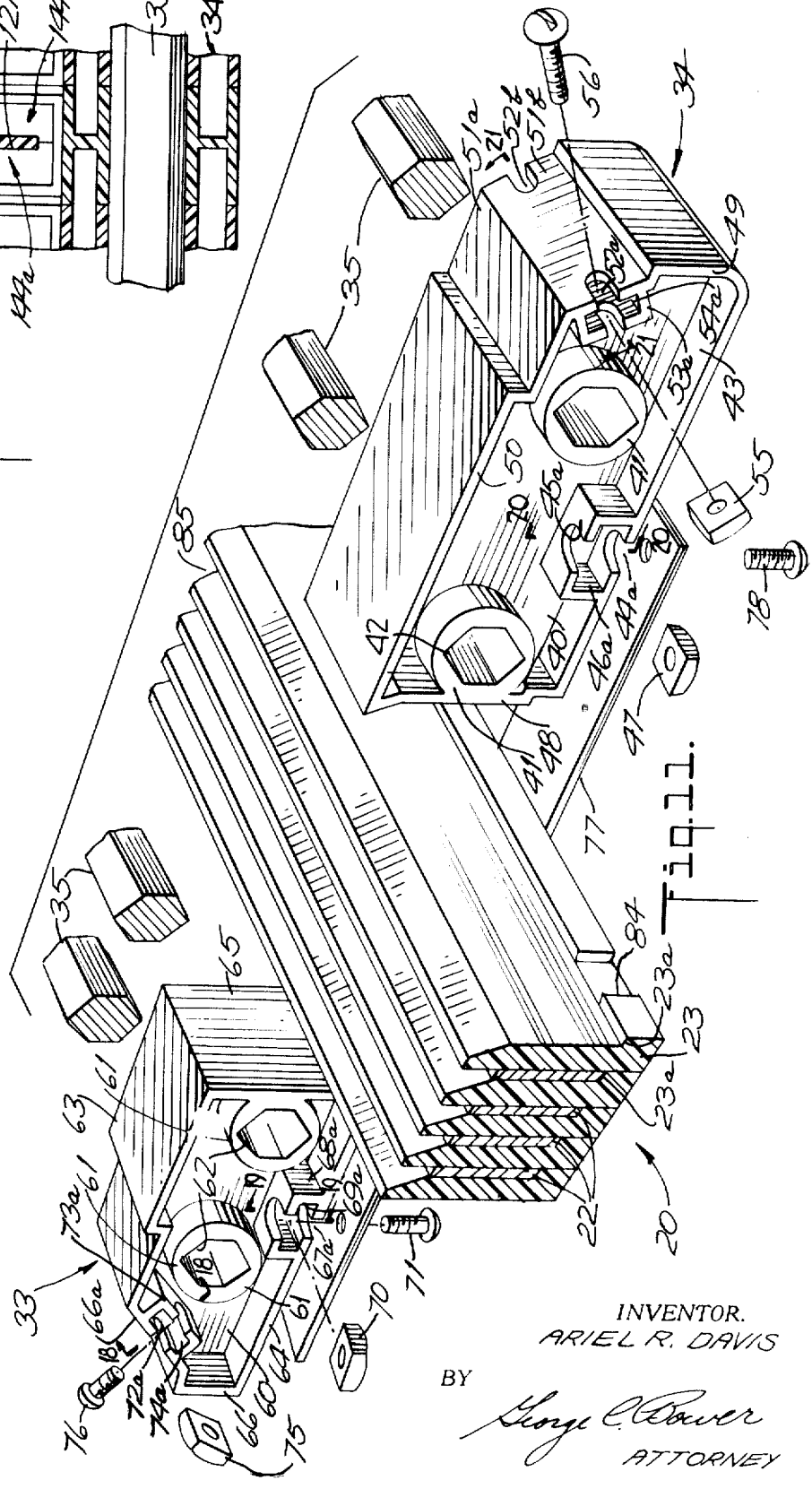
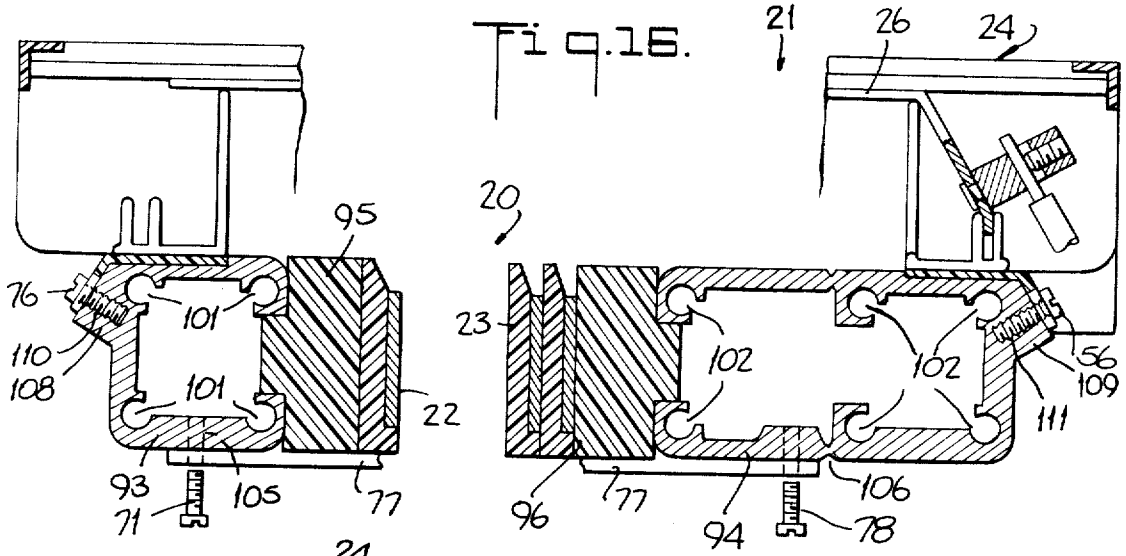


Fig. 11.

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Fig. 16.



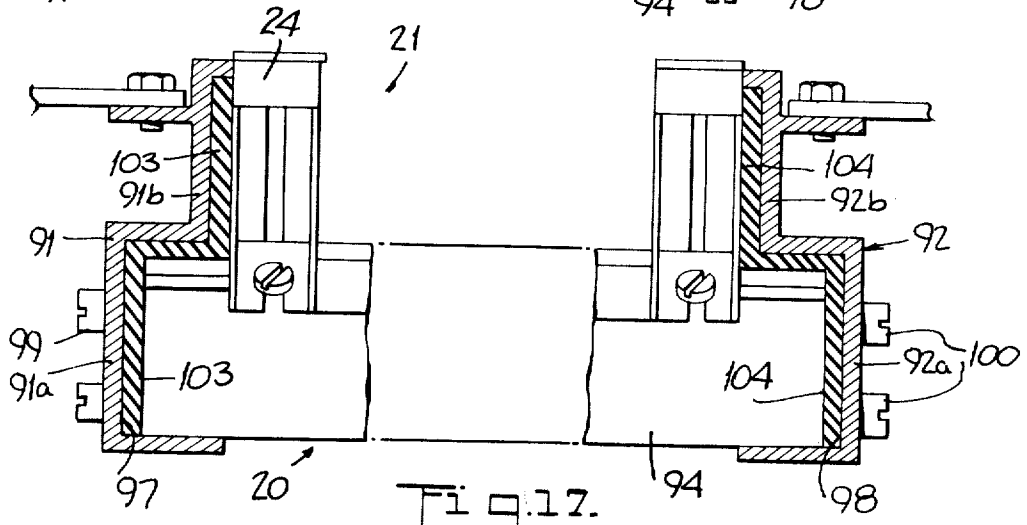
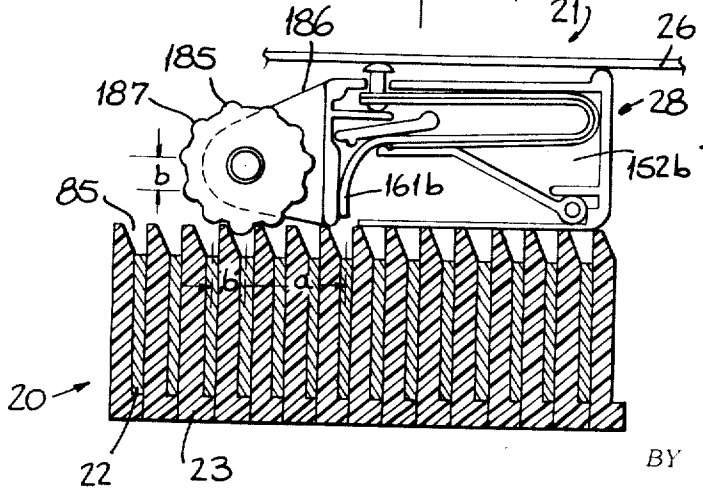


Fig. 17.

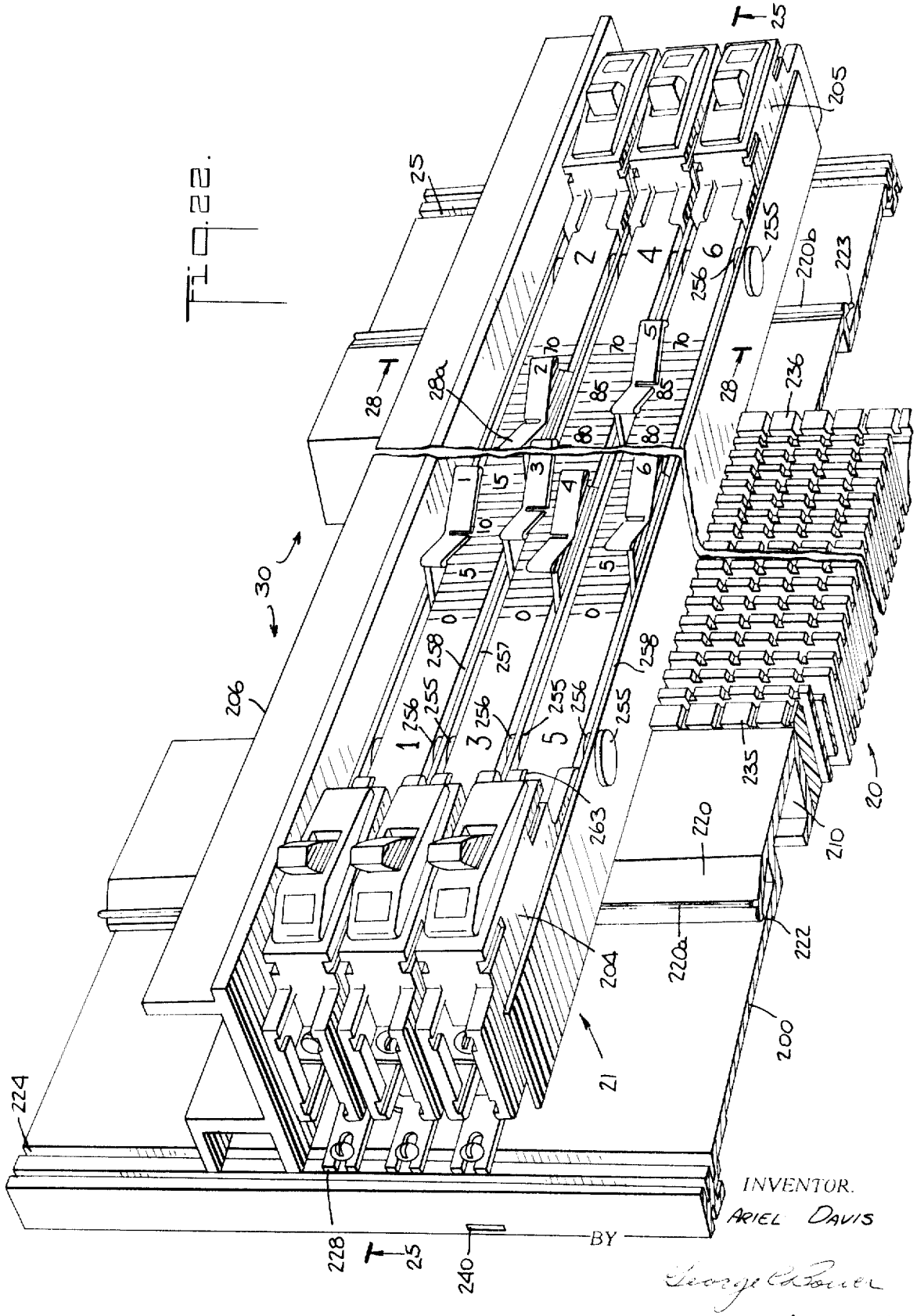
Fig. 15.



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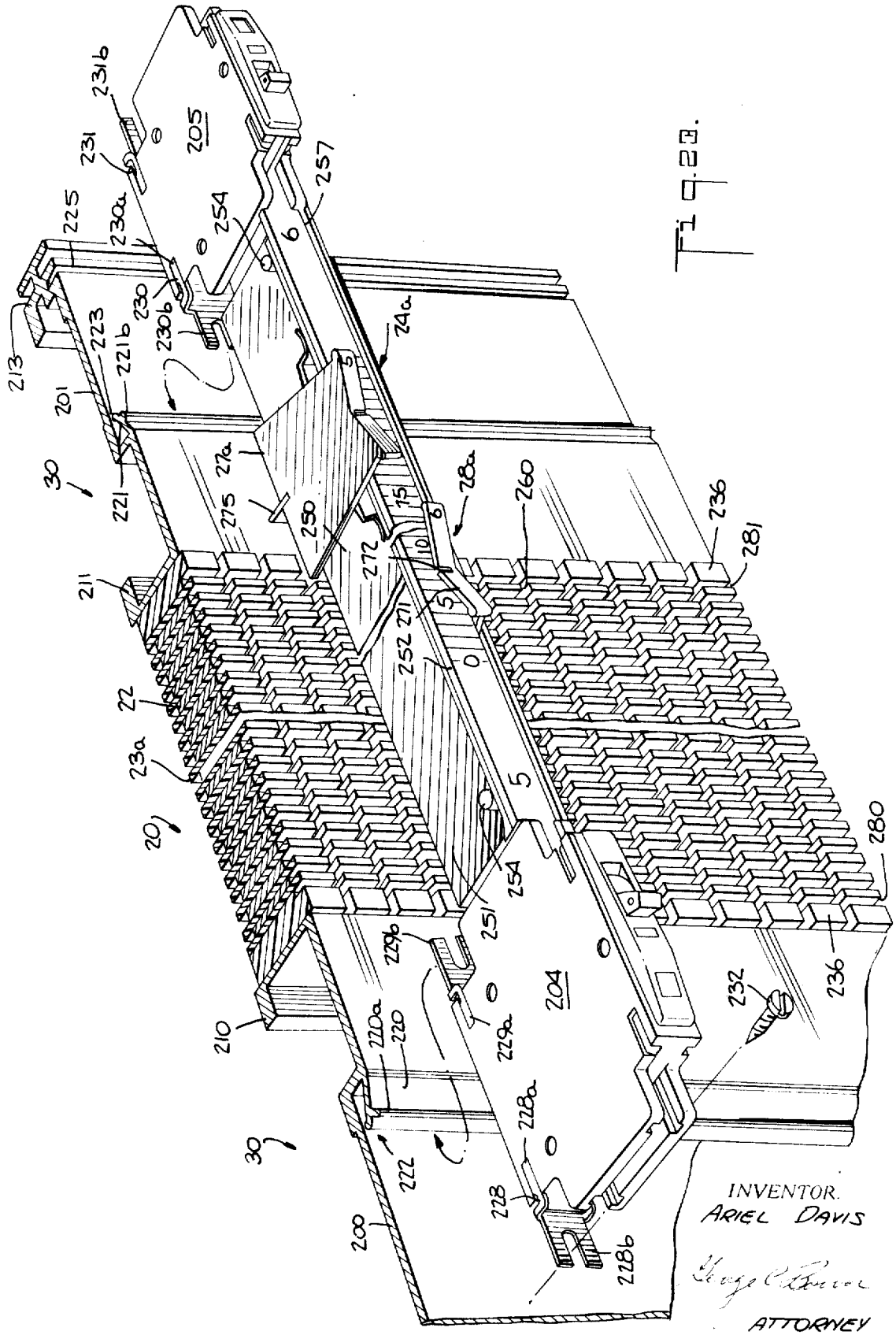
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Fig. 22.



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Fig. 23.



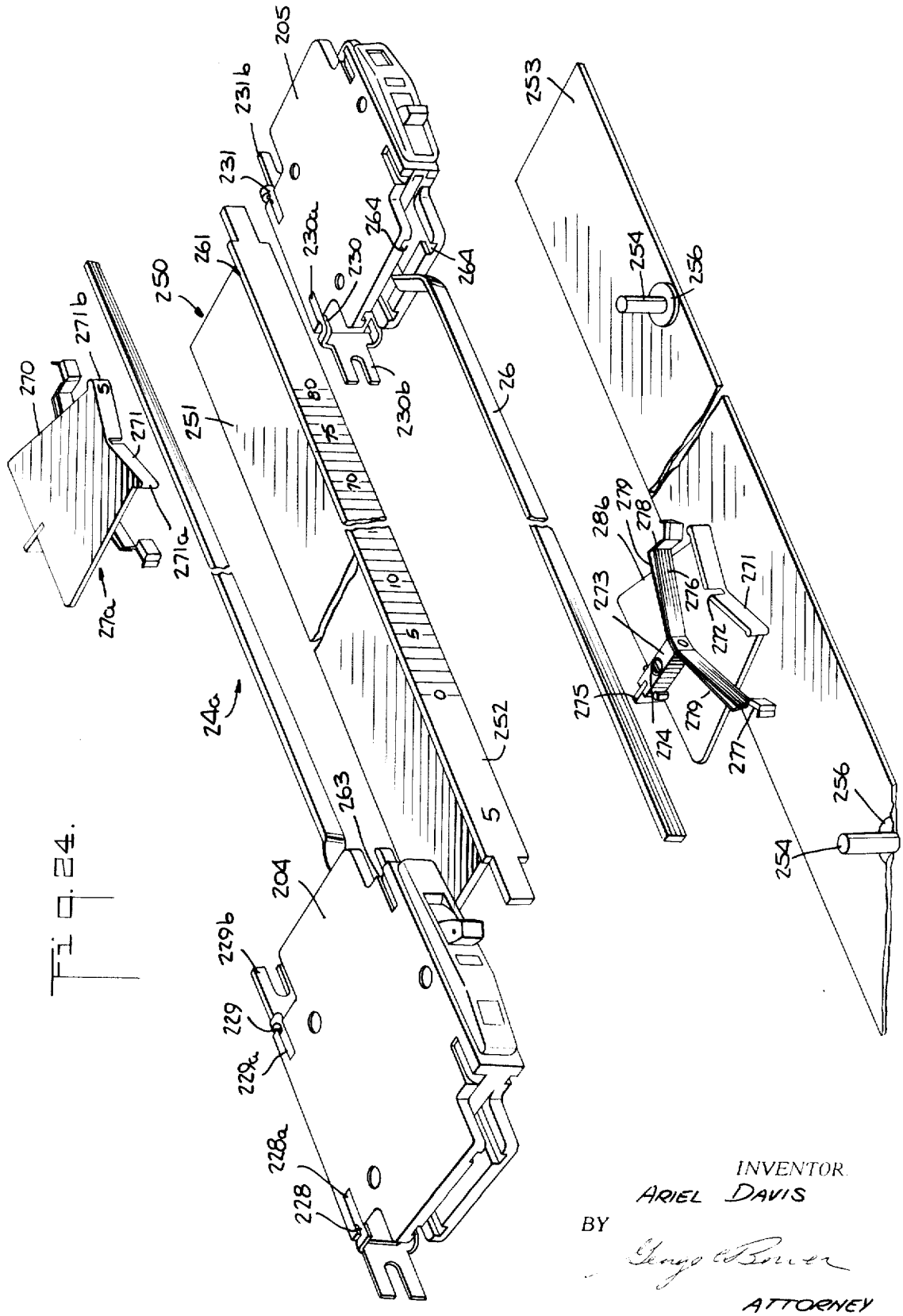


Fig. 24.

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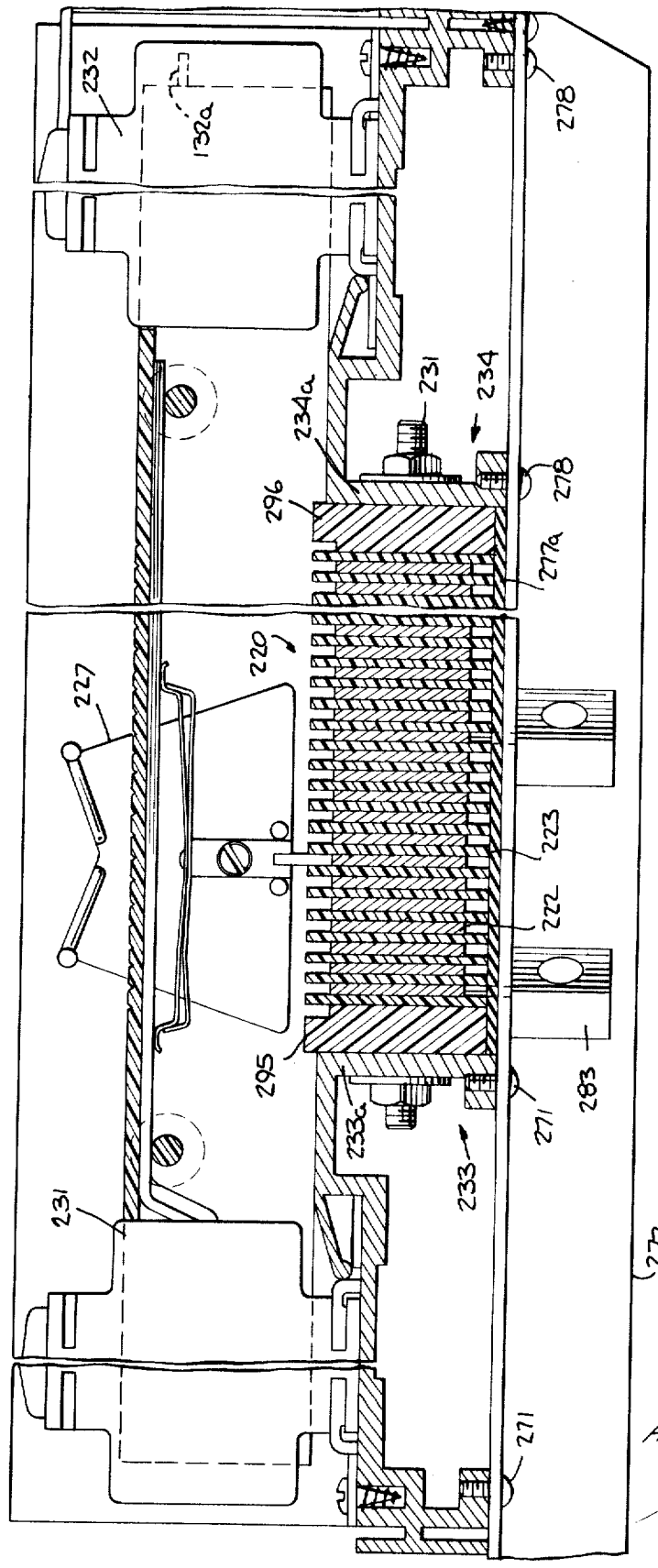


Fig. 28.

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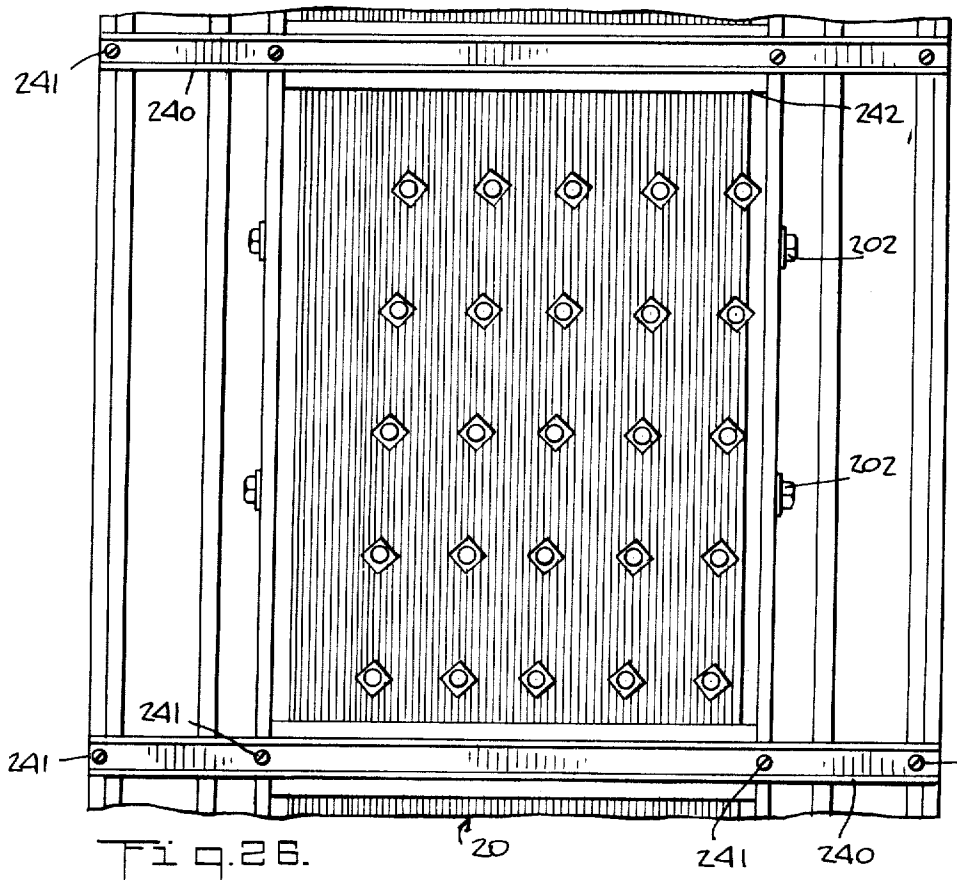
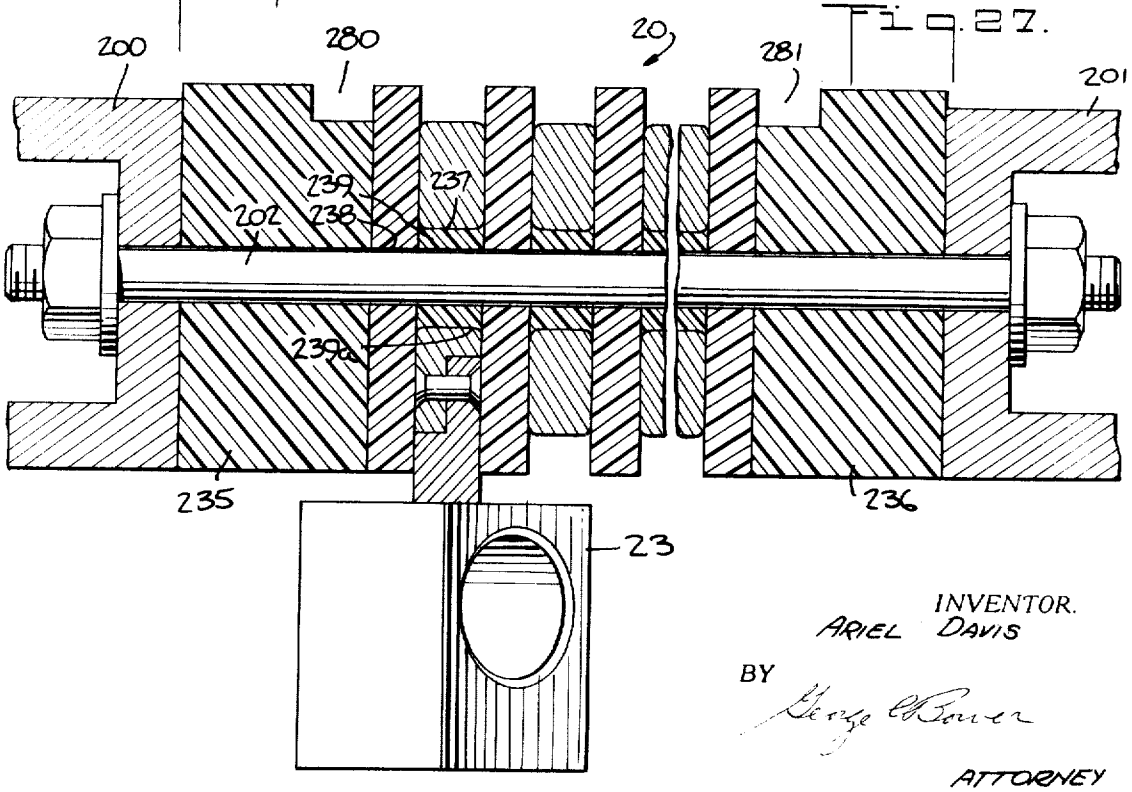


Fig. 26.

Fig. 27.



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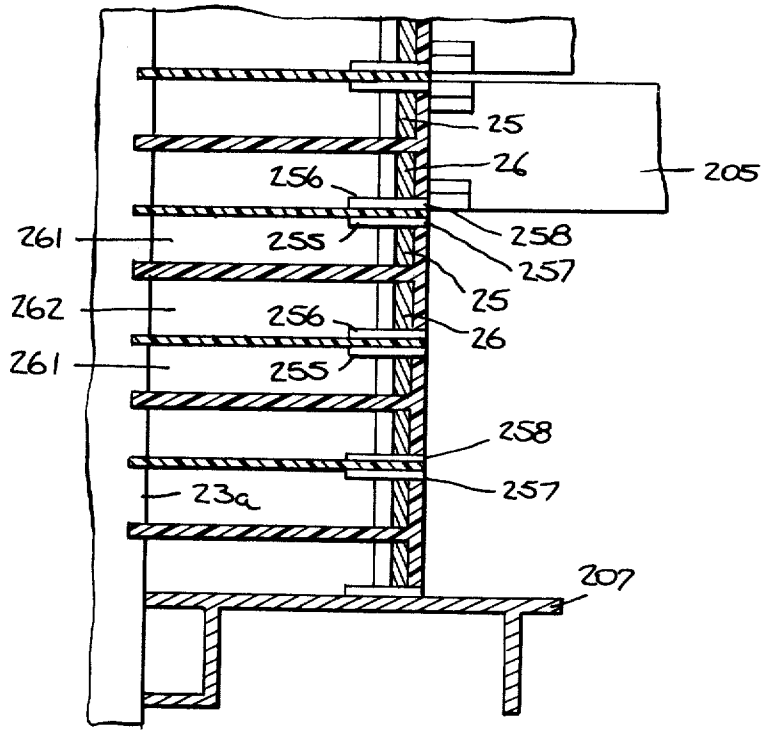


Fig. 28.

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United States Patent Office

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CORDLESS ELECTRIC CROSS-CONNECT PANEL WITH IMPROVED MOVABLE CONTACT ASSEMBLY

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Original No. 3,603,747, dated Sept. 7, 1971, Ser. No. 883,099, Dec. 8, 1969, which is a continuation-in-part of abandoned application Ser. No. 660,988, Aug. 16, 1967. Application for reissue Aug. 7, 1972, Ser. No. 278,437

Int. Cl. H01h *9/00, 15/00;* H02b *1/04*

U.S. Cl. 200—1 R 28 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

A cross-connect or patch panel has a multiplicity of long bus bars interleaved with insulating strips and parallel side support beams. Transverse members hold the bus bars, insulating strips and beams together. Cross-connect modules are mounted on the support beams to span the bus bars and strips and to slidably carry contact assemblies for engagement with a selected bus bar. The contact assemblies are actuatable between bus bar contacting and disengaging positions.

This is a reissue of U.S. Pat. No. 3,603,747 which is a continuation-in-part of abandoned application Ser. No. 660,988, filed Aug. 16, 1967, [This is a continuation-in-part of my application Ser. No. 660,988 filed on Aug. 16, 1967,] and entitled "Cordless Electric Cross Connect Panel." This invention relates to cordless electric cross-connect panels and is directed particularly to the structure of the panel and the current-carrying components.

BACKGROUND OF THE INVENTION

In various electrical distribution fields it is desirable to provide an electrical connecting means for providing a versatility in the connection of a number of load circuits to any one of a number of input supply circuits. The standard method of accomplishing this is by means of a patch panel in which electrical cords connected to the load circuit have plugs for connection to input supply circuits. This is a rather cumbersome method for interconnecting the input supply lines and the load circuits. Also, the panels are too large and occupy too much space. Cross-connect panels have been developed and used in which the individual load circuits are connected to input bus bars by means of brush assemblies moved crosswise to the bus bars for selective engagement with a given bus bar. Although these operate very satisfactorily, the panels were too large. Additional circuits were required to supply more lamp loads and this required more import bus bars. Also the load requirements made it necessary to increase the size and current-carrying capacity of the bus bars. It therefore is desirable to increase the number of output circuits and size of the bus bars with a reduction in size of the overall rearrangement of the components to reduce the wiring and better relate the contact assemblies and the load-circuit breakers contacting the modules to the respective loads.

Also it is desirable to provide brush assembly having a positive engagement and a positive disengagement in relation with the power buses.

OBJECTS AND SUMMARY OF THE INVENTION

An object of the invention is to provide a cross-connect panel of the bar type that substantially reduces the size of the panel with an increase in input bus bars and number of load circuits that can be connected.

Another object is to provide a cross-connect panel that has a greater number of bus bars with greater current-carrying capacity without increasing the size of the panel.

Another object of the invention is to provide a cross-connect panel in which the size and current-carrying capacity of the bus bar is not limited by the cross-connect panel structure.

Another object of the invention is to provide a contact assembly which is readily locked out of engagement and positively forced into engagement with a selected bus bar.

Another object of the invention is to provide a cross-connect panel that may be assembled from plastic molded pieces to minimize the cost of manufacture and assembly.

Another object of the invention is to provide a cross-connect panel with contact assemblies and cross-connect modules and occupy a minimum of space longitudinal to the bus bars.

Another object of the invention is to visually relate the circuit breakers and cross-module contact assemblies.

Another object of the invention is to provide a panel in which the individual load-supply modules are readily and separately removable from the panel.

In summary the invention relates to a cross-connect panel comprising interleaved, striplike bus bars and insulating strips held together by longitudinal supports and transverse tying members and cross-connect modules spanning the bars and strips for transversely guiding brush assemblies engaging a selected bus bar.

Other and further object will be apparent from the following description taken in connection with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the cross-connect panel without the cross-connect modules.

FIG. 2 is a bottom view of the cross-connect panel.

FIG. 3 is a sectional view of the cross-connect panel with a cross-connect module thereon taken along a sectional plane designated by lines **3—3** in FIG. 1.

FIG. 4 is a fragmentary top view of the cross-connect panel.

FIG. 5 is a sectional view of the cross-connect panel with a cross-connect module thereon taken along a sectional plane designated by lines **3—3** in FIG. 1, illustrating the cross-connect assembly in the open or unengaged condition.

FIG. 6 is a sectional view of the cross-connect panel with a cross-connect module thereon taken along a sectional plane designated by lines **3—3** in FIG. 1, illustrating the cross-connect assembly in the closed or energized condition.

FIG. 7 is a perspective exploded view of a cross-connect module. FIG. 8 is a perspective view of a cross-connect module with contact assembly pieces separated.

FIG. 9 is a fragmentary sectional view of the mounting of the brush of the contact assembly taken along lines **9—9** of FIG. 8.

FIG. 10 is a fragmentary sectional view of a cross-connect module taken along lines **10—10** of FIG. 3.

FIG. 11 is a fragmentary perspective exploded view of the support means and rails.

FIG. 12 is a fragmentary sectional view of a cross-connect panel taken along lines **12—12** of FIG. 6.

FIG. 13 is a fragmentary sectional view of the power bus with a connecting lug.

FIG. 14 is a longitudinal sectional view of the cross-connect panel taken along lines **14—14** of FIG. 1 to illustrate the support of the power buses and insulating strips in the end-spacing members.

FIG. 15 illustrates an embodiment of the contact assembly with an indexing wheel.

FIG. 16 is a cross-sectional view of another embodiment of the supporting frame taken along a sectional plane similar to FIG. 3.

FIG. 17 is a side view of the embodiment of the FIG. 16 with the end-spacing members shown in sectional taken in a longitudinal plane.

FIGS. 18–21 are fragmentary sectional views of the nut-retaining means taken along lines **18—18**, **19—19**, **20—20** and **21—21**, respectively, of FIG. 11.

FIG. 22 is a fragmentary perspective view of the third embodiment of the cross-connect panel.

FIG. 23 is a fragmentary perspective view of the bus bars and support members with a cross-connect module in space relation.

FIG. 24 is an exploded perspective view of a cross-connect module.

FIG. 25 is a cross-sectional view of the cross-connect panel taken along lines **25—25** of FIG. 22.

FIG. 26 is a fragmentary rear view of the cross-connect panel.

FIG. 27 is a fragmentary sectional view of the bus bar section taken along lines **27—27** of FIG. 26 illustrating the tying means holding the support members together.

FIG. 28 is a cross-sectional view of the cross-connect load section taken along lines similar to **28—28** of FIG. 22 at the other end of the panel.

DETAILED DESCRIPTION

Introduction

In this specification three basic embodiments of the invention are described and illustrated. One embodiment is shown in FIGS. **1** to **14** and 18 to 21. Another is shown in FIGS. 16 and 17 and a third embodiment is shown in FIGS. 22 to 27. FIG. 15 illustrates an indexing means mounted on the movable contact.

The cordless patch panel comprises a heavy current bus bar supply section **20** and a front cross-connect load section **21**. The bus bar supply section comprises conductive bars or buses **22** and insulating strips **23** between the bars. The cross-connect load section comprises cross-connect modules **24** having two rails **25**, **26** and two movable contact assemblies **27**, **28** for selectively connecting the rails to the same bus or to separate buses. Load circuits connected to the rails may include any power-consuming device such as stage lights. The buses **22** are connected to a power source and the modules **24** are connected to control devices (not shown) such as theater dimmers. The sections **20** and **21** are mounted on a supporting frame **30**.

FIRST EMBODIMENT

Supporting frame

The supporting frame **30** comprises two end-spacing or tying members **31**, **32** and individual supporting blocks **33**, **34** (FIG. 1). A set of supporting blocks **33**, **34** is provided for each cross-connect module **24**. The end-spacing members **31**, **32** and the supporting blocks **33**, **34** are fastened together by four rods **35** extending through the blocks and the end-spacing members. Nuts **36** threaded on the ends of the rods secure the supporting members **31**, **32** are generally rectangular in shape and have grooves **37**, **38** extending longitudinally adjacent the edge of one side. The supporting blocks **33**, **34** are stacked in interfitting relation in two rows between the end members **31**, **32** and are spaced to receive the power bars **22** and the insulating strips **23**. The end-supporting blocks partially fit into the grooves **37**, **38**. The cross-connect modules are in the space above the supporting blocks, power buses and insulating strips.

The supporting blocks **34** are generally rectangular in configuration and symmetrically molded (FIGS. 1, 3, 5, 6 and 11). In the middle is a central wall **40** transverse to the rods and having bosses **41** extending from each side of the wall. The bosses have hexagonal-shaped openings **42** for passing the hexagonal rods and hold the rods from

turning. The bottom wall **43** has two half openings **44**a, b on opposite sides of the central wall **40** (FIG. 20). U-shaped members **45**a, b are around the half openings and form slots **46**a, b for receiving and holding nuts **47**. The inner and outer walls **48**, **49** extend on both sides of the center wall (FIG. 11). The top and outer walls **50**, **49** are stepped at **51**a and sloped at **51**b for interfitting with the cross-connect modules **24**. The sloped portions **51**b of the outer walls have half openings **52**a, b and U-shaped portions **53**a, **53**b forming slots **54**a, b (FIG. 21). The slots **54**a, b receive nuts **55**, one half of the nut extending into a respective member. The supporting blocks **34** are stacked in side-by-side relation with the edges of the inner and outer and top and bottom walls **48**, **49**, **50**, **43** of adjacent blocks and the bosses compressed into contacting relation to form a firm and rigid supporting beam. The surfaces of the walls provide continuous outer surfaces on the stacked blocks.

The supporting blocks **33** are also rectangular in configuration and similar to the supporting blocks **34** except that the supporting blocks **33** are shorter in length (FIGS. 3, 5, 6 and 11). The supporting blocks **33** have an intermediate wall **60** with bosses **61** extending on opposite sides of the intermediate wall **60** are top and bottom walls **63**, **64** and inner and outer walls **65**, **66**. The bottom wall **64** has half openings **67**a, b with U-shaped members **68**a, b with U-shaped members **68**a, b positioned around the openings to form slots **69**a, b (FIG. 18), with U-shaped members **73**a, b forming slots **74**a, b receiving nuts **75** for threading on bolts **76** inserted through the openings **72**a, b of contacting supporting blocks.

Thus the supporting blocks **33** and **34** may be assembled into supporting beams. Straps **77** (FIGS. 3, 5, 6 and 11) may extend across the back of the insulating strips and secured by the bolts **78**, **71** and threading into nuts **47** and **70** to intermediately support the power buses and insulating strips (FIG. 11).

The end-spacing members **31**, **32** have holes **80**, **81** (FIG. 1) for spacing the rods and the sets of stacked supporting blocks **33**, **34**. The end-supporting blocks partially fit into the grooves **37**, **38** in the end members for interlocking the end members **31**, **32** and the stacked sets.

Power buses

The power buses **22** are nested in the L-shaped insulating strips **23** for stacking between the end-spacing members and the sets of supporting blocks (FIGS. 3, 5, 6 and 11). The ends of the nested power buses and insulating strips fit in the grooves of the end-spacing members. The supports formed by the sets of supporting blocks **33**, **34** are spaced to receive the desired number of power buses. The power buses rest on the ledge **29** (FIG. 11) of the L-shaped insulating strip to support the bus and isolate the buses from the bottom of the assembly. The power buses have connecting lugs **83** (FIGS. 2, 11 and 15) extending through notches **84** in the ledges of the insulating strips and projected rearwardly. The lugs of adjacent buses are spaced longitudinally, as illustrated in FIG. 2. These rectangular-shaped lugs are turned to present the diagonal of the lug to the power bus to increase the contact area with the power bus and to rotate them to a 45° angle so that wiring is simplified and the power cable can be kinked to hold it in place. For larger panels the power buses and insulating strips may be intermediately supported by straps **77** extending cross-wise between the stacked supporting blocks (FIG. 11) and fastened thereto by bolts **78**, **71** threaded into nuts **47**, **70** held in the bottom walls **43**, **64** of the supporting blocks. The insulating strips **23** are made of insulating material, such as plastic, and are thicker than the power buses to electrically isolate the buses. The strips extend beyond the copper buses to form grooves **85** (FIGS. 5, 6, 11 and 15). The projecting ends of the insulating strips are tapered by sloping one of the walls to widen the groove for rotary entry of the contacting blade.

Cross-connect modules

The cross-connect modules **24** are mounted crosswise to and span all of the buses **22** (FIG. 1). Contact or brush assemblies **27, 28** are slideably supported by the cross-connect modules to connect a particular bus to a respective load rail (FIGS. 3, 4 and 8). A T-shaped insulating support **120** extends the length of the cross-connect modules and has a center wall or partition **121** positioned between the two load rails **25, 26** for electrical isolation and a load rail backing member or wall **121a** (FIGS. 7 and 12). The T-shaped support may be a single piece or the center wall and load rail wall may be separate pieces secured together in a suitable manner.

At the ends of the cross-connect modules are cross-connect-mounting members **122** (FIGS. 7 and 8). These members have sidewalls **123, 124** and inner walls **125**. The upper ends of the sidewalls are connected by angular-shaped stop members **126** and partial outer walls **127** spaced from the angular-shaped stop members to form rectangular openings **128**.

The walls of the mounting members form a chamber for receiving the ends of the T-shaped insulating members and the ends of the rails **25, 26**. The inner walls have the same configuration as the outer walls of the supporting blocks. The sloped portions of the inner walls have slots for receiving bolts **56, 76** threading into nuts **55, 75**. This securely fastens the mountings to the frame. The T-shaped insulating member **121** extends to and engages the angular-shaped stop members **126** to longitudinally hold the insulating member against movement and against the supporting blocks and L-shaped insulating strips.

The outer wall portions **127** (FIGS. 7 and 8) extend over the edges of the sidewalls of the cross-connect-mounting member and are spaced from the T-shaped insulating member. The transparent light transmiting scale or index strip **130** fits under the wall portions **127** and is longitudinally held in position by the angular-shaped stop member **126**.

The load rails **25, 26** (FIG. 12) are rectangular in cross section and are held against the inner side of the wall **121a** of the T-shaped insulating member **121** by rail-spacer supports **131, 132** located within the chamber of the cross-connect-mounting members **122** (FIG. 7). The rail-spacer supports **131, 132** are L-shaped and have base members **133a, b** extending parallel and resting on the supporting and support members **134a, b** extending normal to the supporting block and rail. Triangular-shaped web members **135a, b** cooperate with the support members **134a, b** and stiffen the rail-spacer supports. The ends of the base and supporting members **133a, b 134a, b** are rounded and lateral projections **136, 137** (FIG. 12) are provided at the ends of the base members for fitting in notches **138** in the center wall **121** of the T-shaped support **120** to position the spacer and hold it longitudinally. The rail-spacer supports are mirror images and are positioned on opposite sides of the center wall **121**.

The rail-spacer supports **131, 132** hold the load rails **25, 26** against the top wall **121a** of the T-shaped insulating support. At one end of the cross-connect module the rails **25, 26** are bent at an angle and fit in the slots **139a, b** formed by the outwardly extending projections **141a, b** on the base members **133a, b** of the rail-spacer supports to anchor the rails in place. This forms the terminal end of the rail and electrical load-connecting lugs **25a, 26a** extend normal to the angled portions of the rail and slopes the projections toward the end of the cross-connect module. The load lugs are recessed in the cross-connect mounting between the sidewalls **123, 124** and the T-shaped member **120**. Thus the load lugs are easily accessible for inserting and fastening leads.

On one side of the cross-connect-mounting members are longitudinal and lateral side projections **142a, b**. Isolating insulating strips **143** (FIG. 12) of a rectangular shape extend longitudinally between the mountings of a modular unit and recess in the projections **142a, b**. Thus the T-shaped members **120** and the insulating strips **143** (FIG. 12) form enclosed channels **144a, b** extending across and above the power buses **22**. The brush or contact assemblies **27, 28** are located in these channels for movement crosswise to the power buses.

Contact Assemblies

The brush or contact assemblies **27, 28** have rectangular-shaped housing **150, 151** (FIGS. 3–8) with side panels **152a, b** and four walls **153a, b, 154a, b, 156a, b** normal thereto along a respective edge. The housings are greater in length than in height. On the open side of the housings are the actuators **157, 158** formed by flat panel support levers **159a, b** and handles **160a, b** along the exterior edge. The housings and actuators are in the channels and support blade-type contacts **161a, b** U-shaped leaf-type springs **162a, b**, conductive straps **163a, b** and upper brush contacts **164a, b**. The bus-bar-engaging contacts **161a, b** have a generally L-shape with mounting legs **165a, b** and contacting legs **166a, b**. The support levers **159a, b** have two generally parallel fingers **167a, b, 168a, b** extending normal thereto adjacent the edges opposite from the handles **160a, b** and spaced to form slots **169a, b** to receive the mounting legs **165a, b** and springs **162a, b** and straps **163a, b**. The fingers have projections **172a, b** curving the slots **169a, b** for gripping and holding the contacts **161a, b** with the contacting legs **166a, b** extending beyond the edges of the support levers. Spaced from the contact-supporting fingers **167a, b, 168a, b** the support levers **159a, b** have pivot studs **173a, b** formed by the edge walls **156,a b** of the housing and the guide walls **175a, b**. The slots **174a, b** have open ends facing the contact. The edge walls **156a, b** have openings **171a, b** through which the contacting legs extend to engage the power buses. The support levers with the contacting legs are swung in and out of engagement with the buses. The U-shaped leaf springs **162a, b** are resilient means which fit in the slots **169a, b** with the mounting legs and curve to extend along the edge walls **154a, b**. Load rail brush contacts **164a, b** are attached to the conductive straps **163a, b** and springs **162a, b** at the ends thereof and extend through the openings **176a, b** in the edge walls **154a, b** to engage the load rails **25, 26**, respectively. The U shaped leaf springs **62a, b** also press the support levers longitudinally. Catches **177a, b** with rounded edges **178a, b** are positioned on the other side of the contacts from the pivots and catch edges **179a, b** extend from the fingers **167a, b**. The catch edges **179a, b** are forced by the springs bearing against walls **155a, b** to engage the catches **177a, b** and hold a respective support lever with the contacts in the raised or disengaged position.

The housings **150, 151** and support levers **159a, b** are held together by assembly screws **181a, 181b** threaded into pivot studs **173a, b**, respectively, through elongated slots **182a, b**, respectively, in the walls **152a, b**, respectively. The support or actuating levers **159a, b** extend through slots **180a, b** (FIG. 4) between the strips and exteriorly to the scale **130**. Handles **160a, b** normal to the support levers provide means for manual pressing of the support levers to pivot contacts in and out of engagement. The handles extend over the contacts to provide a moment towards the bus bars to disengage the catches and press the contacts into engagement.

The load rail brushes **164a, b** (FIG. 8) project beyond the edge walls **154a, b** and knobs **183a, b** are provided at the other end to restrict rocking movement of the housing on actuation or movement of the brush assemblies. The brush assemblies are movable over the length of the channels.

The conductive load rails **25** and **26** are made of copper and the brush contacts **164a, b** are made of silver. The conductive straps **163a, b** may be made of a plurality of flexible copper strips. The power buses **22** and the contacts **161a, b** may also be made of copper.

The blade is forced and held into engagement by the U-shaped steel springs **162a**, b to force and hold the blade in a current transfer relation. The U-shaped springs **162a**, b force the contact blade into engagement with the power buses and the brushes **164a**, b into engagement with the load rails **25**, **26**. Thus a good transfer of current occurs between the power buses and the load rails.

The handles **160a**, b are positioned on opposite sides of the moment arm through the pivot studs **173a**, b so that on engagement of the handle portions **160a–2**, b–2 by the fingers of an operator the support lever will be rotated in a clockwise direction (FIG. 3) to withdraw the contact blade from engagement of the handle portions **160a–1**, b–1 by the fingers of an operator the support lever is rotated in an opposite direction forcing the fingers **179a**, b to disengage from the rounded-edge catches **177a**, b.

Partition walls **182a**, b are spaced from the walls **154a**, b to provide a space for the brushes **164a**, b and to provide a stop engaged by the fingers **167a**, b on removal of the contact blades **161a**, b. On rotation of the support lever the pivot studs **173a**, b slide in the slots **174a**, b to accommodate the engagement and disengagement of the fingers **179a**, b. Thus the contact assemblies **27** and **28**, which are mirror images of one another, may be moved longitudinally along the cross-connect modules with the contact blade recessed, and may be parked in the space provided by the supporting blocks **34**, as illustrated in FIGS. 3 and 4.

The Index Scale Means

The positions of the contact assemblies are related to the power buses **22** by the index strip **130** on the cross-connect modules. The walls **127** of the mounting members **122** are spaced from the walls **121a** of the T-shaped support **120**. The index strip **130** fits in this space and extends above the wall **121a**. On the undersurface of the strip engaging the wall **121a** a scale may be engraved corresponding to the number of power buses **22**. The ends of the indexing strip **130** engage the angles **126** so as to position the scale in relation to the power buses **22**. The edges **184a**, b of the support levers **159a**, b are shaped or curved as illustrated so that when an edge is at a given indicia on the scale, the contact blade is at the corresponding power bus. On rotation of the actuators **157**, **158** the respective edges maintain relationship with the respective indicia for the respective power bus that the contact blade is at or in engagement within either the engaging or disengaging position.

The walls **126** are spaced from the angle members **127** to form openings or windows. Illumination means may extend laterally through the cross-connect modules to provide light that is carried by the transparent indexing strip to illuminate the engraved indicia. The index strip may be made of methylmethacrylate.

In FIG. 15 the contact assembly **28** is shown with an indexing wheel **185**. The wheel **185** is rotatably mounted on the extension **186** from the **152b** and has knobs or projections **187** circumferentially spaced apart a distance equal to the distance b between groove centers. The center of the wheel is a distance a from blade **161b** which is a multiple of distance b. The base of the projection has a circumferential width greater than the distance b to provide an in and out movement of the contact assembly on moving over a strip. When a projection **187** is seated in a groove **85** the blade **161b** is in position for insertion in a groove **85** and contacting a bus **22**. Thus the inward seating of the projection is detected by the operator for proper positioning of the contact assembly.

SECOND EMBODIMENT

In FIGS. 16 and 17 another embodiment of the supporting frame is illustrated. The supports extending longitudinally to the power buses and mounted in the end-spacing members **91** and **92** comprise aluminum extruded members **93** and **94** and insulating plastic members **95** and **96**. The end-spacing or tying members **91** and **92** are extruded aluminum pieces having U-shaped portions **91a**, **92a** forming grooves **97** and **98** to receive the extruded aluminum members **93** and **94** and the plastic members **95** and **96**. Bolts **99** and **100** extend through the U-shaped portions **91a** and **92a** and thread into the channels **101**, **102** in the aluminum members **93** and **94**. The end spacing members have planar portions **91b** and **92b** extending upwardly from the U-shaped portions to provide end supports for the cross-connected modules. Insulating linings **103**, **104** are provided between the cross-connect modules and the aluminum end spacing members **91** and **92** to electrically isolate the end contact assemblies. The plastic members **95** and **96** electrically isolate the aluminum members **93** and **94** from the power buses 22. Tapped holes **105** and **106** are provided in the bottom portions of the aluminum members to receive bolts **71** and **78** for connecting straps **77**. In the outer wall the aluminum members are provided with bosses **108** and **109** having grooves **110** and **111** for receiving screws **76**, **56** to connect the members **24** to the aluminum members with allowance for sidewise adjustment.

THIRD EMBODIMENT

Introduction

As in the first embodiment the panel comprises a heavy current bus bar supply section **20**, a front cross-connect load section **21** and a supporting frame **30**. The insulating strips **23a** are flat and do not have the ledges **29** of the insulating strips **23**. The supporting frame **30** comprises the supports **200**, **201** and the rods **202** extending through the heavy current bus bar supply section **20** and secured to the supports by nuts **203**. The cross-connect load section **21** comprises the cross-connect modules **24a** with circuit breakers **204**, **205** and the end members **206**, **207**.

Bus bar supply section

The bus bar supply section **21** has longitudinally extending copper bus bars **22** separated by the wider insulating strips **23a**. *The bus bars and the insulating strips are thin and each have a width many times its thickness. The bus bars and insulating strips are in side-by-side interleaved relation. The supply has two opposite sides and a back.* The length and number of the bus bar and insulating strips depend on the size of the panel. The insulating strips extend forwardly and rearwardly of the bus bars to provide electrical isolation of the bus bars and grooves on front for the blades of the movable contacts **27a**, **28a**. On the back the bus bars have square-shaped lugs **83** for connection of the bus bar to the main supply lines. The lugs are offset from one another to provide ample space for leads.

Support frame

The supports **200**, **201** of the support frame extend longitudinally on opposite sides of the bus bar supply section **20** and may be made of any length to accommodate the desired number of cross-connect modules. As distinguished from the first embodiment and similar to the second embodiment the supports are single extruded pieces that are stiff and rigid to provide a firm support for the cross-connect panel and rigid connection to a supporting frame (not shown). The supports have a cross-sectional U-shape configuration transverse to the bus bars **20**. The cross-sectional U-shape is formed by inner L-shaped flanges **210**, **211** and outer L-shaped flanges **212**, **213** extending along opposite edges of the respective outwardly facing walls **214**, **215**. The width A of the inner flanges are the same or about the same as the width B of the insulating members **23a** of the bus bar supply section. The width of the support is several times the width of the width of the inner flanges **210**, **211**. The supports therefore have a shallow configuration.

The two supports have inner portions **216**, **217** and outer portions **218**, **219**. The outer portions are greater in

width than the inner portions and have the circuit breakers **204, 205** fastened thereto. The outer portions are 2.5 times as wide as the inner portions. Deformable flanges **220, 221** extend from the upper edges of the inner portions in the direction of the width of the supports. Longitudinally extending beads **220a, 221a** are provided along the edges of the flange and are engaged by the tool pressing against the flanges to bend them downwardly or rearwardly. Narrow longitudinal slots **222, 223** between the edges of the flange and the outer portions. Grooves **224, 225** extend longitudinally along the respective edges of the outer portions. The circuit breakers have mounting clips **228, 229, 230, 231** with forked portions **228a, 229a, 230a, 231a** fastened to the supports by screws **232, 233**, respectively, threaded into the grooves **224, 225** and by fork portions **229b, 230b**, frictionally sliding into the slots **222, 223**. Along the outer sides of the flanges **212, 213** are T-shaped members **244, 245** forming slots **246, 248** and **247, 249**, respectively. The slots and members extend the length of the respective supports. The screws **241** may be threaded into the slots **246, 247** for fastening the straps **240**. A panel **249** may be fastened by bolts **249a** threading into the slots **246, 247** (FIG. 25).

The supports are fastened to the bus bar section **20** and to one another by rods **202** passing through the bus bars **22**, insulating strips **23a**, insulating members **235, 236** and the flanges **210, 211**. Insulating members **235, 236** having a substantially greater thickness than the insulating strips **23a** are between the flanges **210, 211**, respectively, and the bus bars and insulating strips.

The bus bars **22** and insulating strips **23a** have axially aligned holes **237, 238** forming bores through one supply section **21** for the rods the holes **237** are larger than the holes **238** and grommets **239** are fitted in the holes **237**. The grommets are initially wider than the bus bars and made of a deformable plastic electrically insulating material. On tightening of the nuts the insulating strips press against the grommets and flow the grommet material into bevels **239a** in the holes **237** in the bus bar. These compressed grommets electrically isolate the rods from the copper bus bars **22**.

The supports **200, 201** are also fastened together by U-shaped straps **240** extending transversely across the back of the patch panel and fastened by screws **241** threaded into the inner and outer flanges. Insulating layers **242** of plastic material is recessed between the inner flanges and across the back of the bus bar supply section to electrically isolate the respective straps **240** from the bus bars **22**.

Cross-connect modules

The cross-connect modules **24a** have a main T-shaped member **250** formed by partition **251** tightly fitting in a lengthwise groove in the load rail backing or crossmember **252**. Attached to one side of the T-shaped member is a second partition member **253** parallel to the first. Stubs **254** with flat disc-shaped heads **255** are fastened by flat disc-shaped washers **256** on the other side from the heads. The stubs fit snugly into holes in the first partition member. The fastening washers **256** engage the edge of the load-rail-backing member **252** to space the second partition from first. The free end of the stub passing through the first partition member bears against the head of the adjacent stub of the adjacent module to impart firmness and rigidity to the successive modules. The partitions form channels for the movable contacts **27a, 28a** and the fastening washers **256** form slots **257** between the second partition member and the load-rail-backing member to pass the movable contacts **27a, 28a**.

The edges of the insulating strips **23a** have aligned notches **260** for receiving the inner edges of the vertical partition members **251, 253**. The interlocking of the edges of the partition members and insulating strips holds the inner portions of the partition members in proper space relation. The outer portions are held in position by the end-to-end engagement of the stubs. The partition members are thin flexible pieces. The interfitting of the edges into the grooves and the clamping of the outer edges interlocks the cross-connect modules in a firm fixed relation. Thus, the modules with the load-rail-backing member **252** and two partition members **251, 253** in side-by-side relation form successive parallel movable contact channels **261, 262**.

At opposite ends of the modules are circuit breakers **204, 205** in planar or end-to-end alignment with modules and transverse to the supports. Mounting clips **228, 229, 230, 231** are pressfitted into the opposite lower ends of the circuit breaker with forked portions of the mounting clips extending in the plane of the bottom of circuit breakers. The forked portions **229b, 230b** extending towards the bus bars fits in the slots **222, 223** and under the flanges **221** extending from the inner portions **216, 217**. At the other end forked portions **228b, 231b** of the mounting clips are fastened by screws **232, 233** threading into the grooves **224, 225**.

The rails **25, 26** are attached to the circuit breakers **204, 205**, respectively, and extend in respective channels **261, 262**. The rails are bent at one end and connected to terminals (not shown) in the recesses **263, 264**, respectively. In the contact module the rails fit between the stubs **254**, and the load-rail-backing member **252** to firmly hold the rails in place between the partition members **251, 253** and against the member **252**. The load-rail-backing member has end tabs **265, 266** narrower than the width of the member **252**. The tabs fit in grooves or recesses **263, 264** in the ends of the circuit breakers facing the contact module. The circuit breakers **204, 205** firmly hold the contact module **24** in place on the frame.

Contact assemblies

The contact assemblies **27, 28** are identical and comprise mounting or actuating members **270** extending through the slots **257, 258** in the contact modules **24** with the flanges or handles **271** normal to the respective members **270**. The handles are U-shaped and have grips **271a, b** for grasping by the fingers to lift the assemblies. A slot **272** provides for visual location of the contact assembly in relation to the index on the contact module. The blocks **273** are mounted on the side of the respective actuating members by screws **274** threaded therein. The blocks extend beyond the respective actuating members and have blades **275** mounted respectively therein and extend from edge. The resilient current-conducting strips **276** of beryllium copper are intermediately mounted to the respective ends of the block **273** opposite to the contact blade **275**. The conducting strip bearing end of the block **273** is located in about the center of the respective actuating member. The conducting strip **276** extends along the side of the actuating member beyond the end edges L-shaped tips **277, 278** on the ends engage one of the rails on substantially equal distances from the center of the actuating members. The conducting strips apply equal and opposite torques to the contact assembly. Thus, each assembly will stand perpendicular to the bus bars. Resilient steel strip **279** backs the conducting strip to provide adequate contact pressure. The flanges, block, blade and conducting strips are on the same side of the actuating member.

The contact assembly is picked up by the tips **277, 278** and lifted clear of the insulating strips **23a** and moved along the channel until the slot **272** is at the indicia on the exposed surface of the member **252**. The contact assembly is then released to engage the selected bar. As best seen in FIG. 25 the stubs **254** are adjacent to a respective circuit breaker and also function as stops engaged by a respective tip **277, 278**. When in engagement with a stub the blade **275** is in a position for insertion into the grooves **280, 281** formed by the last insulating strips **23a** along a respective side and respective insulating members **235, 236**. These are neutral positions at each end of the module.

Markings and indicia

The load-rail-backing member is marked on exterior surface to indicate each bus bar. The contact assemblies and associate circuit breakers are correlated by identical members being placed on the handles **271** and the exterior surface of the load-rail-backing members adjacent the associated circuit breaker. The toggles on the circuit breakers are on the opposite side from the supports. The patch panel may be mounted with the bus bars extending vertically as shown in FIG. 23 or may extend horizontally with the modules extending horizontally or the patch panel may be set horizontal with the contact assemblies moving horizontally in the channels. The preferred manner is to position the panel with the bus bars extending vertically and the contact module extending horizontal to indicate each bus bar. The surfaces are also marked at each end to identify or number the associated circuit breaker. The contacted assemblies carry the corresponding number.

In the embodiment of FIGS. 22 to 27 the supports may be made from extruded aluminum and cut to the desired length. The supports are easily fastened together by the rods **202** passing through bus bars and insulating strips. Grommets isolate the copper bars.

The third embodiment is the preferred embodiment due to its simplicity in structure and readily adaptable to various sizes and lengths. The horizontal positioning of the contact modules and left-to-right reading of the markings and movement of the contact assemblies make it an easy patch panel to operate. The availability of the lugs at the rear and the terminals of the circuit breakers along the sides makes it very easy to connect to the load and supply lines. Summary of Features and Advantages.

It is thus seen from the foregoing description that the supporting frame may be made from molded plastic pieces or from extruded aluminum. The pieces may be readily assembled and formed into a supporting frame that holds the power buses so that the conductive strips may be used having a considerable length is relation to thickness and contact area. This provides for a considerable amount of copper to carry the current and dissipate heat that may be produced between the engaging surfaces of the power buses and the contact blades.

The contact assemblies may be made of molded plastic pieces that are easily assembled to provide a positive blocking of the contact blade out of engagement and a positive engagement of the contact blade without the contact assembly or the actuator varying the longitudinal position, so that at all times the position of the contact assembly in relation to the power bus being engaged remains fixed. Thus there is no doubt as to the power bus being engaged.

The cross-connect modules also are readily manufactured by standard plastic-molding techniques and are readily assembled and mounted on the supporting frame. Individual modules may be independently removed from the supporting frame. The terminals on the cross-connect modules and the terminals on the power buses are readily accessible for connecting leads thereto. The connection of the leads to the power bus terminals readily permits the rotation of the panel from its seating in a casing for maintenance purposes.

Various modifications and changes may be made in the foregoing embodiments without departing from the invention as set forth in the appended claims.

I claim:

1. A cross-connect panel comprising

a bus bar supply section having

a plurality of thin bus bars and insulating strips, each bus bar and strip having a width many times its thickness, said bus bars and strips being in side-by-side interleaved relation with said strips electrically isolating said buses, and

a support frame having

two supports along said side-by-side interleaved bus bars and strips on opposite sides thereof and means for rigidly fastening and pressing said interleaved bus bars and strips together; and

a cross-connect load-section mounted on said support frame and having

a plurality of cross-connect modules, each module having two end members attached respectively to said supports,

partition means forming channel means, rail means in said channel means and extending transversely across said bus bars, and brush assembly means in said channel means for connecting said rail means to any one of said bus bars.

2. A cross-connect panel as set forth in claim **1** wherein said fastening means are spacing members at opposite ends of said bus bar supply section and said supports are secured thereto in pressing relation with said interleaved bus bars and strips.

3. A cross-connect panel as set forth in claim **2** wherein said supports are each a plurality of supporting blocks in aligned side-by-side relation and rodlike means extending through said supporting blocks of each support and said spacing members for fastening said spacing members and said blocks together.

4. A cross-connect panel as set fortth in claim **3** wherein said support blocks and said modules are the same width.

5. A cross-connect panel as set forth in claim **4** wherein said two end members of each module are mounted on and attached to respective blocks on opposite sides of said bus bar supply section.

6. A cross-connect panel as set forth in claim **3** wherein said spacing members have grooves extending lengthwise of said spacing members and said bus bar supply section fits at opposite ends into said grooves, respectively.

7. A cross-connect panel as set forth in claim **1** wherein said insulating strips extend beyond said bus bars on said cross-connect load section to form grooves for receiving said brush assembly means to engage respective bus bars.

8. A cross-connect panel as set forth in claim **1** wherein said support frame has traps extending laterally across said frame on the side opposite to said cross-connect load section and fastened to said supports.

9. A cross-connect panel as set forth in claim **1** wherein said partition means comprises two partition walls.

10. A cross-connect panel as set forth in claim **9** wherein said each of said modules has one of said partition walls extending between midportions of said module end members and in alignment with said respective module end members, said modules each having a top member extending between said two respective aligned module members and perpendicular to said one partition wall along the opposite edge from said bus bar supply section to form two channel means, and said other partition wall is positioned on the sides of said aligned end members to separate said channel means of adjacent modules.

11. A cross-connect panel as set forth in claim **1** wherein said supports each is a single piece of extruded aluminum having means for fastening said end members of said modules.

12. A cross-connect panel as set forth in claim **11** wherein said supports are U-shaped.

13. A cross-connect panel as set forth in claim **12** wherein said U-shaped support each has two side portions parallel to said bus bar supply section and an end portion connecting said side portions having edges engaging said bus bar supply section for pressing said bars and strips in interleaved relation.

14. A cross-connect panel as set forth in claim **1** wherein each of said supports has a main portion perpendicular to said bars and strips and inner flange perpendicular to

said main portion with said inner flange bearing against said bus bar supply section.

15. A cross-connect panel as set forth in claim 14 wherein said fastening means are rods extending through said bus bars and strips and said inner flanges of said supports on opposite sides of said bus bar supply section and means on said rods for securing said supports and said bus bar supply section together.

16. A cross-connect panel as set forth in claim 15 wherein said main portions have inner and outer portions, respectively, and said end members are attached to respective outer portions.

17. A cross-connect panel as set forth in claim 16 wherein said inner and outer portions of respective supports are at different levels and said inner portions have deformable flanges extending towards said respective outer portions to form narrow slots therewith for attaching said end members.

18. A cross-connect panel as set forth in claim 17 wherein said deformable flanges have beads extending longitudinally therealong for engagement by a tool pressing said deformable flanges toward said respective outer portions.

19. A cross-connect panel as set forth in claim 17 wherein said end members have mounting clips fitting into said slots between said respective deformable flanges and respective outer portions for attaching said end members to said respective supports.

20. A cross-connect panel comprising

a bus bar supply section having

a plurality of thin bus bars and insulating strips, each bus bar and strip having a width many times its thickness, said bus bars and strips being in side-by-side interleaved relation with said strips electrically isolating said buses, and

a support frame having

two supports along said side-by-side interleaved bus bars and strips on opposite sides thereof and means for rigidly fastening and pressing said interleaved bus bars and strips together and

a cross-connect load section mounted on said support frame and having a plurality of cross-connect modules each having two rails and two brush assemblies engaging a respective rail and movable for contacting any one of said bus bars and two circuit breakers at a respective end of each module connected to a respective rail for connecting two loads and for mounting said each module on said supports.

21. A cross-connect module comprising a T-shaped insulating means having a longitudinally extending insulating partition and a longitudinal crossmember on and perpendicular to said partition to form two longitudinal channels, mounting means at each end of said T-shaped insulating means and having parallel sidewalls spaced from said partition, inner walls and outer walls extending between said sidewalls of a respective mounting means, said T-shaped insulating means fitting in said mounting means and engaging said outer walls for imparting a given longitudinal length to the module, two load rails extending longitudinally along said crossmember on opposite sides of said partition, rail spacers positioned in said mounting means for supporting said load rails on said inner walls of said mounting means, brush assemblies in said respective channels and engaging said respective load rails to connect said load rails to power buses extending laterally to said T-shaped insulating means.

22. A brush assembly positioned between a plurality of parallel extending buses and a load rail extending crosswise thereto and spaced therefrom comprising a housing positioned between said load rail and said buses, an actuating lever having a contact member mounted thereon for engaging a given bus, said actuating lever and said housing having means for pivotally attaching said lever to said housing including means permitting relative linear movement of said actuating lever to said housing for moving said actuating lever between a contacting position and a raised position, a contact button for engaging said load rail and having electrically conductive means connected to said contact member for passing current between a respective brush and said load rail, a resilient means connected to said contact member and said contact button for applying contact pressure to said buses and load rail and engaging said housing for providing pressure between said actuating lever and said housing in the direction of the relative linear movement, and catch means on said actuatlever and said housing for holding said actuating lever and contact member in a raised position and disengaging on application of pressure lateral to said linear movement for moving said contact member into the bus-engaging position.

23. A brush assembly comprising a housing, an actuating lever, a contact member, a contact button, a generally U-shaped electrically conductive springlike resilient means having a bend and two spaced ends attached respectively to said contact member and button, said actuating lever having means holding said contact member and said respective end of said springlike resilient means having means for pivotally attaching said actuating lever to said housing at a distance from said contact member in the same direction as said bend of said U-shaped means from said spaced ends, said housing having means with said pivotal attaching means fitting thereon to permit limited movement of said pivotal attaching means longitudinal to said U-shaped means, said actuating lever having a finger, said housing having a catch and having support means spaced from said catch with said U-shaped means between said catch and support means for engaging said support means to press said finger into engagement with said catch for holding said actuating lever and contact member in a raised position and finger disengaging from said catch under pressure transverse to said limited movement to rotate said contact member into engaging position.

24. A cross connect panel comprising:

a bus bar supply section, a back and opposite sides and plurality of thin bus bars and the insulating strips transverse to said back each bus bar and strip having a width many times its thickness, said strips electrically isolating said bus bars normal to said back;

a support frame having two supports along the sides of said bus bar supply section on opposite side thereof and extending through said bus bars and insulating strips and connecting means for securing said supports for rigidly fastening and pressing said interleaved bus bars and strips together; and a cross connect load section mounted on said support frame and having a plurality of separate, individual cross connect modules transverse to said bus bars and having a plurality of side-by-side channels, transversely extending rail means in said respective channels and transversely movable brush assembly means for connecting said respective rail means to any one of said bus bars.

25. A cross connect panel as set forth in claim 24 wherein said strips and said bus bars have aligned openings for passing said connecting means and bevels on said bus bars around the openings therein and insulating means in said bus bar openings, said insulating means initially having a width slightly than the thickness of the respective bus bars, the openings of said adjacent insulating strips being smaller than said bevels and bus bar openings to deform said insulating means on tightening of said connecting means by pressing said insulating means in saia bevels.

26. A cross connect panel as set forth in claim 24 wherein said connecting means are a plurality of conductive rods bolted to said supports and said bus bars and insulating strips have openings for passing said rods, said bus bar openings being larger than said insulating strip openings and having bevels facing the adjacent strip, insulating means in the openings of said bus bars and having an initial width greater than the thickness of the respective

bus bar and of deformable electrically insulating material to flow into said bus bars and strip means on opposite side thereof, connecting rods extending through said openings and insulating means and being fastened to said supports for pressing said interleaved bus bars and strip means together;

a cross connect load section mounted on said support frame and having a plurality of cross connect modules, each module having two rails and two brush assemblies engaging a respective rail and movable for contacting any one of said bus bars and two circuit breakers at a respective end of each module for connection of a respective rail to a load.

27. A cross connect panel comprising:

a bus bar supply section having a plurality of bus bars spaced in side-by-side relation and insulating means therebetween to electrically isolate said bus bars;

frame means for supporting said bus bars and insulating means; and

a cross connect load section mounted on said support frame means and having a plurality of separate cross connect modules, each module having end members attached to said frame means, partition means forming channels, rail means in said channels and extending transversely across said bus bars and movable brush assemblies in said respective channels for connecting said rail means to any one of said bus bars.

28. A cross connect panel comprising a bus bar supply section having a back and two opposite sides and having a plurality of thin bus bars and insulating strip means, each bus bar and strip means having a width many times its thickness, said bus bars and strip means being in side-by-side interleaved relation, said strip means electrically

isolating said buses and, said bus bars and said strip means having openings therethrough for passing connecting rods;

a support frame having two supports on said respective sides and along said side-by-side interleaved bus bars and strip means of said supply section and having connecting rods extending through said openings and bolted to said supports to compress said bars and strip means together, said strips forming grooves over and along said bus bars;

a cross connect load section mounted on said support frame and said bus bar supply section, said load section having a plurality of separate cross connect modules; each module having end members attached to said supports, partition means forming two channels, rail means in said channels and extending transversely across said bus bars and contact assemblies in said respective channels for connecting said rails to any one of said bus bars.

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