Sept. 16, 1969 R. A. MOGLE 3,467,891

COMBINATION ELECTRICAL, MECHANICAL, AND THERMAL CONNECTOR ASSEMBLY

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FIG.1

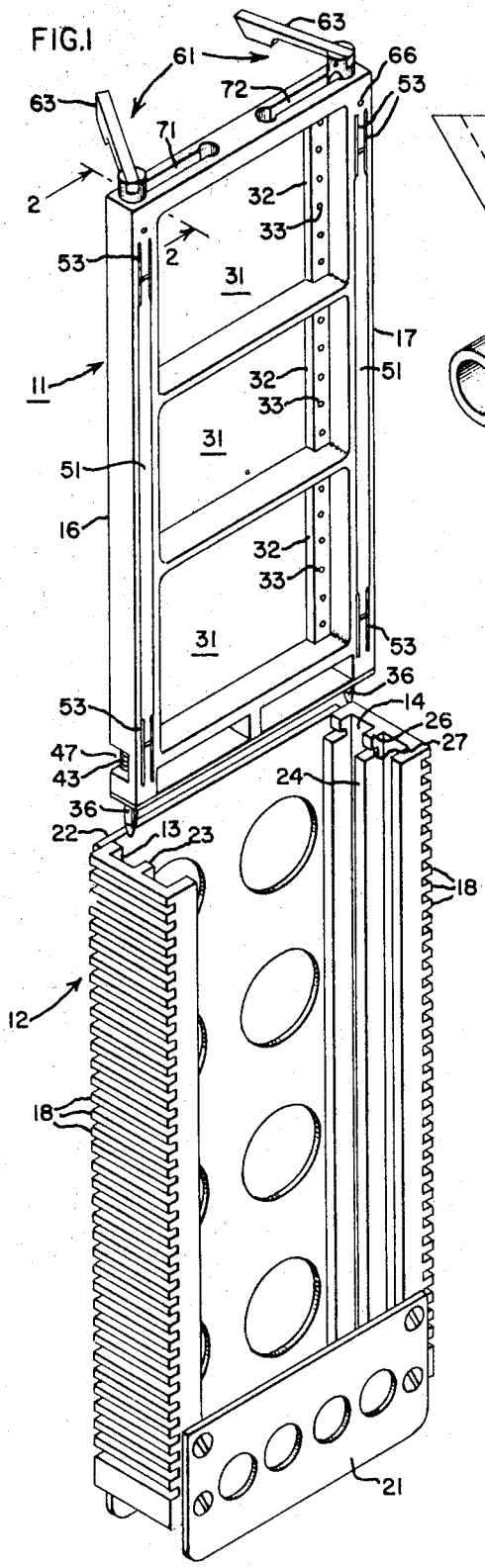

FIG.2

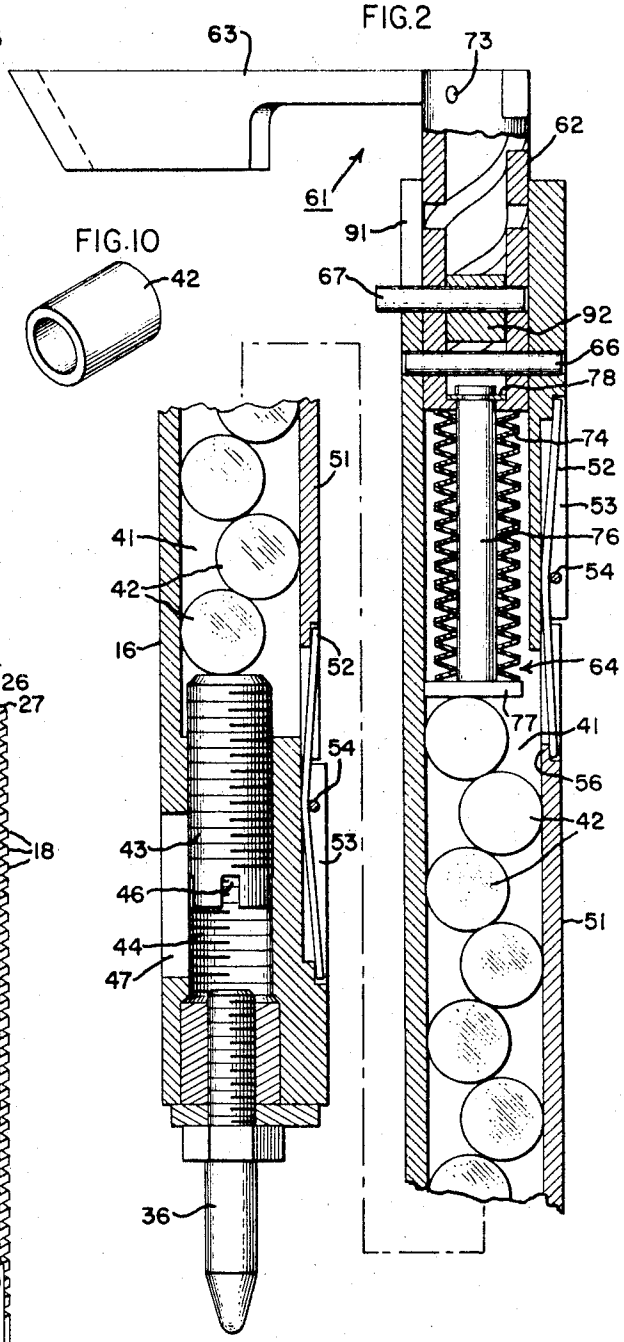

FIG.10

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FIG.3

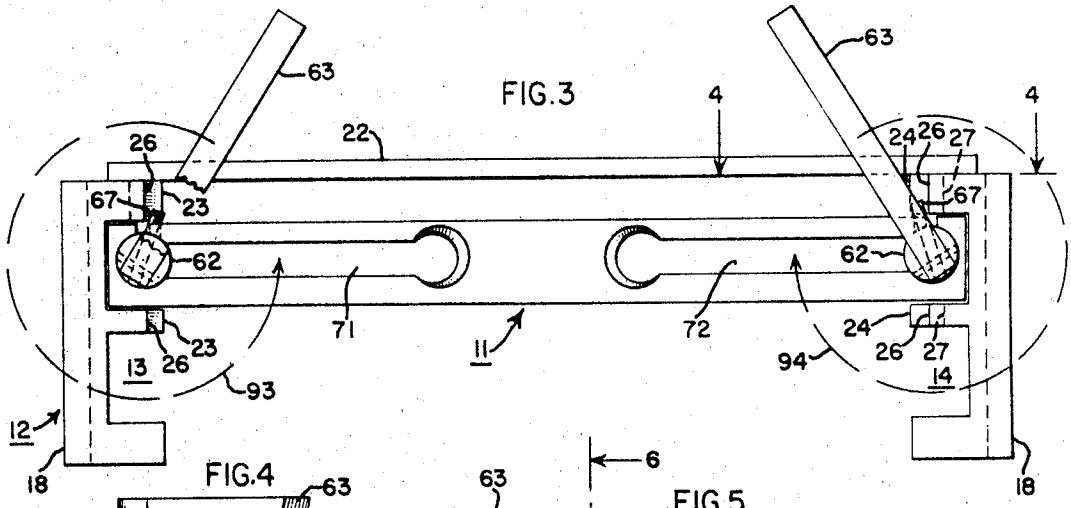

FIG.4

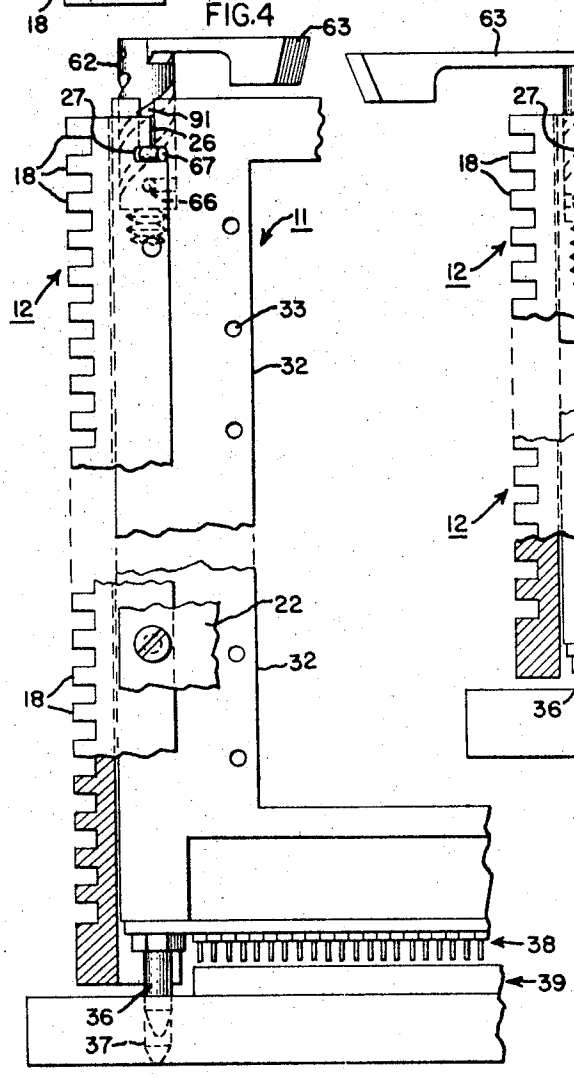

FIG.5

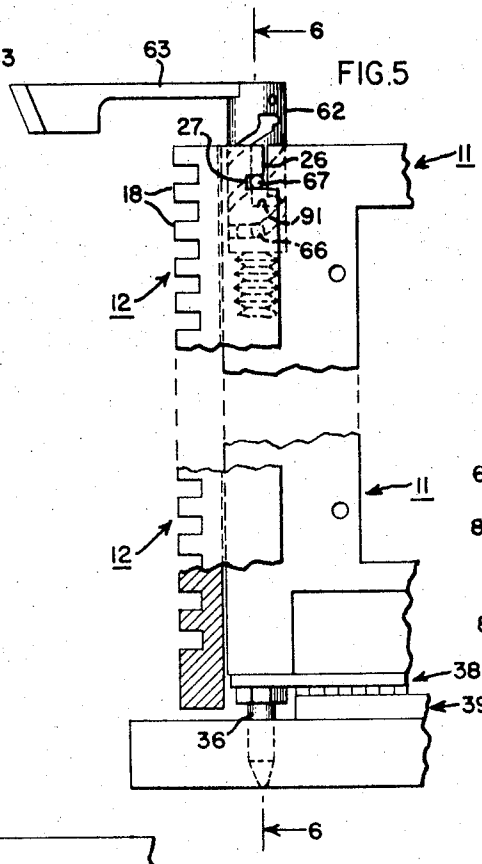

FIG.7

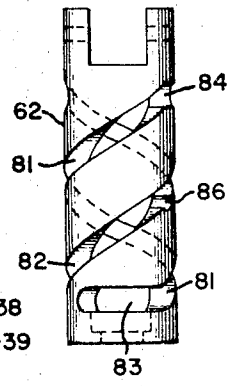

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FIG.6

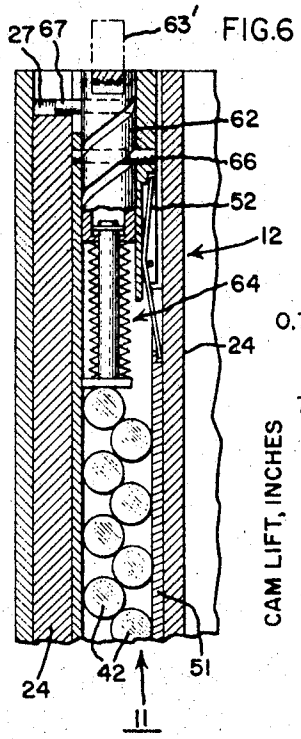


FIG.8

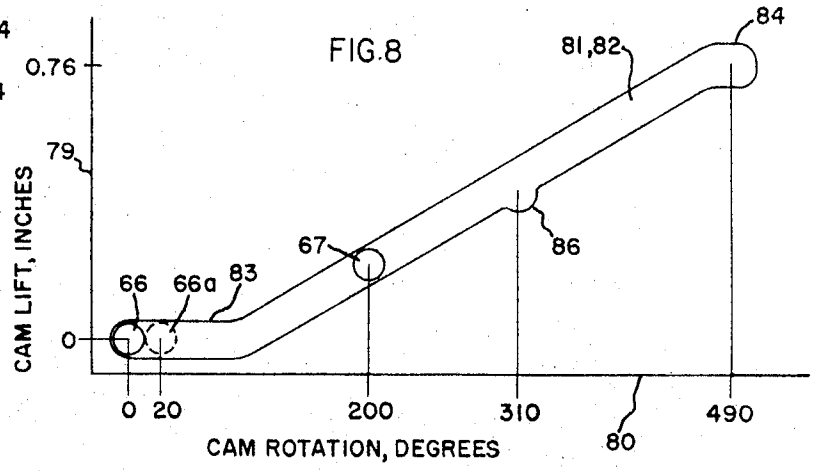
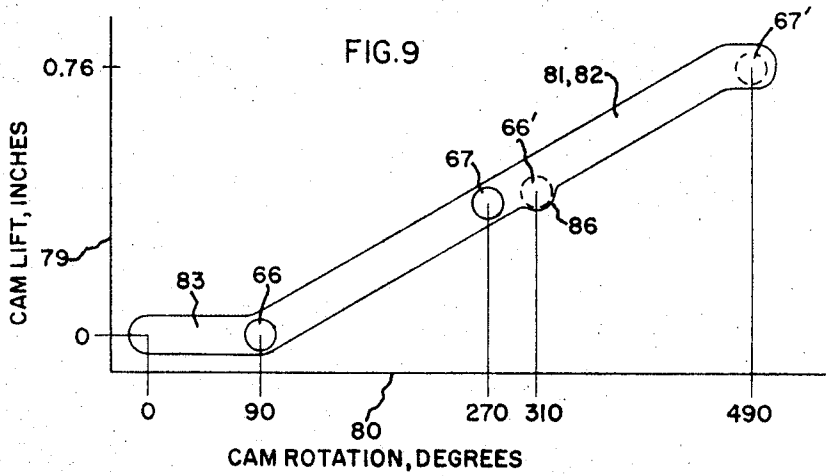


FIG.9



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3,467,891

COMBINATION ELECTRICAL, MECHANICAL, AND THERMAL CONNECTOR ASSEMBLY

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Int. Cl. H02b *1/04, 9/00;* H01r *13/54*
U.S. Cl. 317—101 10 Claims

ABSTRACT OF THE DISCLOSURE

An improved mechanical arrangement is disclosed for removably attaching a "sub frame" to a "main frame." An edge portion of the sub frame slides into a recess of the main frame, the edge portion being hollow and containing roller members in an elongated staggered arrangement so as to exert force laterally along the edge portion in response to axial motion of a cam or toggle device, thus wedging the sub frame securely in the main frame recess. The cam device is arranged to provide a sequence of motions so that it drives the sub frame into locked seated position prior to wedging it in place.

Background of the invention

There are numerous applications where is it desired to have a movable or removable device which can be quickly secured in place and also quickly released for movement or removal. Such an application is frequent in electronic equipment, computers for example, in which numerous electronic circuits (usually in the form of printed circuits, or microcircuit modules) are carried by sub frames which are removably attached to a main frame. The sub frames must be readily removable for testing, inspection and repair or replacement of the circuits. The sub frames and main frames are usually made of metal so as to provide a good electrical, mechanical, and thermal (heat transfer) connection when assembled.

The desired quick connection and removal of the sub frame to and from the main frame (for repair, replacement, etc.) is generally incompatible with the desired high efficiency of heat transfer. The problem of achieving effective heat transfer has become increasingly severe as the "packaging density" of electronic equipment has increased with advancing technology, whereby circuits having hundreds of heat-producing transistors and resistors are contained in a volume of only a few cubic inches. It is desirable to dissipate this heat by conduction rather than providing air-blowing or other cooling means.

To dissipate the heat by conduction, suitable large areas of the sub frames must be in good thermal heat-flow contact with the main frame. Usually this is achieved by providing numerous bolts or clamps to hold the sub frame in tight contact with the main frame. However, it is difficult to arrange the construction to provide for convenient access to these bolts or clamps, and it is time-consuming to fasten and unfasten them. Also, a single bolt or clamp can be used, but this requires massive frames (for strength), and accurately finished flat surfaces, at the contact areas.

Summary of the invention

Objects of the invention are to provide an improved connector assembly, and to solve the prior-art problems described above.

The improved assembly of the invention comprises, briefly and in a preferred embodiment, first and second members adapted to be removably attached together, the first member having an elongated contact portion and the second member having an elongated recess adapted to receive the contact portion of the first member. The contact portion is provided with an elongated opening along at least a part of the length thereof, and a plurality of roller members are positioned side-by-side for rotation about transverse axes in this opening, the roller members having a diameter less than the depth of the opening and being arranged in a staggered alternately offset manner along the length of the opening. A motion mechanism is adapted to move axially in the elongated opening to urge the rollers mutually together, as a reult of which the rollers exert a lateral force and motion thereby wedging said contact portion of the first member into firm and uniform engagement with the sidewalls of said recess of the second member, thus achieving a good electrical, mechanical, and thermal engagement of the members. The motion mechanism may include a take-up spring means for insuring consistent contact pressure.

As a further feature of the invention, the aforesaid motion mechanism is a cam device comprising a rotatable cylinder provided with a helical slot therein. A pin, fixed to the first member, extends into the helical slot of the cam cylinder, so that when the cam cylinder is rotated it moves axially of said elongated opening as determined by the cam action of the helical opening on the fixed pin. Preferably, the motion mechanism further includes an L-shaped slot in the wall of said first member adjacent to the cam cylinder, and the second member is provided with a notch adjacent the position of the L-shaped slot when the two members are in assembled position. A movable "floating" pin extends through the L-shaped slot and into the helical slot of the cam cylinder at a position above that of the fixed pin. The lower end portion of the helical slot is offset, so as to have no slope, the position of the fixed pin when the assembly is in the released condition, such that, when the cam cylinder is rotated in the direction for tightening the assembly, the movable pin enters said notch of the second member and exerts force axially to cause forceable seating together of the two members thereby insuring proper engagement of multiple-contact electrical connectors carried by the members. Upon further rotation of said cam cylinder in the direction for tightening the assembly, both the fixed and movable pins ride in the sloped portion of the helical slot, whereby the cam cylinder is forced axially of the elongated opening so as to urge the roller members mutually together as has been described. Thus, a single rotational motion of the cam cylinder achieves both a forced locked seating of the members and also a forced wedging of the contact portion of the first member in the recess of the second member. A reversed rotation of the cam cylinder causes a reversed sequence of action, thus mutually releasing the first and second members.

Brief description of the drawing

FIGURE 1 is a perspective view of a preferred embodiment of the invention, looking downwardly toward the front and left side thereof, with the main frame and sub frame in separated position,

FIGURE 2 is a cross sectional view of the sub frame taken on the line **2—2** of FIGURE 1,

FIGURE 3 is a top view of the preferred embodiment, with the sub frame and main frame assembled but in unlocked condition;

FIGURE 4 is a partial rear view taken on the line **4—4** of FIGURE 3;

FIGURE 5 is a view the same as FIGURE 4, but with the assembly in partially locked position,

FIGURE 6 is a cross sectional view taken on the line **6—6** of FIGURE 5, and showing the assembly in fully locked position,

FIGURE 7 is a side view of a cam cylinder utilized in the preferred embodiment of the invention,

FIGURES 8 and 9 are development views of cam slots in the cam cylinder of FIGURE 7, showing actuation pins in different operative positions in the cam slots, and

FIGURE 10 is a perspective view of a hollow roller member used in the preferred embodiment.

Description of the preferred embodiment

As shown best in FIGURE 1, the preferred embodiment of the invention comprises one or more sub frames **11** adapted for attachment into a main frame **12** provided with a plurality of pairs of oppositely disposed mutually facing parallel recesses **13, 14** adapted to receive opposite edge portions, **16, 17** of the sub frame **11** when it is slid into the main frame 12. Any desired numbers of pairs of recesses **13, 14** may be provided in the main frame **12**, and numerous main frames **12** may be attached together, in order to accommodate a desired number of sub frames **11**. The main frame **12** is shown as being provided with heat dissipating fins **18** in order to more readily dissipate heat conducted to the main frame from the sub frame **11**. By way of example, the overall size of a sub frame **11** useful for carrying electronic circuitry such as is used in computers, may be approximately 12 inches long, 6 inches wide, and ½ inch thick. The main frame **12** may be manufactured by machining the recesses **13** and **14**, and cooling fins **18**, into pieces of metal flat stock, and assembling pairs of these machined pieces in mutually facing parallel relationship by means of a front piece **21** and rear piece **22** attached by screws or other suitable means, or the unit may be made from one or more castings. The walls **23** between recesses **13**, and the walls **24** between recesses **14**, are provided with an offset shoulder **26** and a notch **27**, as shown, for the purpose of receiving a locking pin as will be described later.

The sub frame **11** is provided with one or more recesses **31** having ledges **32** at the sides thereof containing one or more threaded openings **33**. The recesses **31** are adapted to contain electronic circuits (not shown) carried by one or more metal sheets or strips which are attached to the sub frame **11** by means of screws threaded into the openings **33**, or by other suitable means for transferring heat from the electronic circuits to the metal sub frame **11**.

The sub frame **11** is provided with centering pins **36** adapted to enter centering openings **37** provided in the main frame **12** for the purpose of insuring proper mating of multiple contact electrical connectors **38, 39** carried respectively by the sub frame **11** and main frame **12** (refer to FIGURE 4). Each of the side portions **16** and **17** of the sub frame **11** is provided with an elongated opening **41** therein, extending substantially the entire length of the side portion. A plurality of roller members **42** are positioned in the opening **41**, in a staggered alternately offset manner, as best shown in FIGURE 2. Preferably the roller members **42** have a diameter equal to approximately ⅔ the dimension of the width of the opening **41**. Preferably the roller members **42** comprise hollow metal cylinders, as shown in FIGURE 10, arranged on mutually parallel axes that are mutually perpendicular to the axis of the elongated opening **41** and to the thickness dimension of the sub frame **11**.

The bottom end of the arrangement of roller members **42** is supported by an adjustable screw **43**, threaded into a threaded portion **44** near the lower end of each of the side portions **16** and **17**, and provided with slots **46** to accommodate an adjustment tool, these slots **46** being reached by the adjustment tool via an access cutout **47** provided in each of the side portions **16** and **17**.

The elongated openings **41** are bounded along three sides thereof by the side portions **16** and **17**, the fourth side thereof, which faces a sidewall **23** or **24** between recesses **14** or **13** of the main frame **12** when asssembled, constituting a retainer plate **51** which fits partially into the elongated opening and which is resiliently urged against the assembly of roller devices **42** by means of wire spring **52** carried in slots **53** of the sub frame **11** and retained in place by retainer pins **54**, these retainer springs **52** extending into engagement against shoulders **56** of the retainer plates **51** so as to urge these plates inwardly in the openings **41** and against the assembly of roller members **42**.

A pair of motion mechanisms, which are cam devices **61** in the preferred embodiment of the invention, are respectively positioned at the upper ends of the elongated openings **41** in the side portions **16, 17** of the sub frame **11**.

Each cam device **61** comprises an assembly of a cam cylinder **62**, an actuation lever **63** pivotally attached to the cam cylinder **62** at the upper end thereof, a take-up compression spring **64** attached to the cam cylinder **62** at the bottom end thereof, and a fixed positioning pin **66** and a movable floating locking pin **67** arranged in a manner to be described. The sub frame **11** is provided with openings **71** and **72** into which the two pivoted levers **63** are respectively placed when the assembly is in the locked condition. Each lever **63** is pivotally attached to the upper end of the associated cam cylinder **62** by means of a pivot pin **73**, so that the handle **63** is pivotable about an axis lateral to that of the cam cylinder **62**. By turning the lever **63**, the cam cylinder **62** is caused to rotate, as will be described more fully. The compression spring **64** may be what is known in the art as a Belleville washer stacked spring, i.e., a stack of Belleville washers, which are resilient and slightly conical in shape, stacked in alternating orientation on a spring rod **76** having a retaining head **77** and passing through an opening in the lower end of the cam cylinder **62** and captivated thereto by means of a C-ring retaining washer **78**, as best shown in FIGURE 2.

The cam cylinder **62** is provided with a pair of helical slots **81** and **82**, as best shown in FIGURES 7, 8 and 9. In FIGURES 8 and 9, the vertical axis **79** represents cam lift height in inches, and the horizontal axis **80** represents cam rotation in degrees. The helical slots **81** and **82** are identical, and are angularly spaced 180° apart on the cam cylinder **62**, the lower portions (approximately 90° of cam rotation) **83** thereof being offset so as to have no slope. The slots **81** and **82** extend a total angular peripheral distance of 490° in the preferred embodiment of the invention, and the upper portions **84** thereof are offset a short distance so as to have no slope, as shown. A detent **86** is provided in each of the slots at the 310° position, as shown, for a purpose to be described later.

The fixed pin **66** is positioned in openings at opposite sides of the sub frame **11**, and extends through both helical slots **81** and **82** of the cam cylinder **62**. The floating pin **67** extends outwardly of the frame **11** a short distance, and passes through an L-shaped slot **91** in a side-wall of the sub frame **11**, and through both helical slots **81** and **82** of the cam cylinder **62** at a position approximately one-half revolution above the position of the fixed pin **66**. The floating pin **67** is captivated by means of a cylindrical plug **92** positioned within the hollow cam cylinder **62** and provided with an opening through which the pin **67** fits snugly.

The invention functions as follows. When the sub frame **11** and main frame **12** are disassembled, as shown in FIGURE 1, the cam cylinders **62** have been turned, by means of the levers **63**, so as to be in their upmost position, as shown in FIGURES 1, 2 and 4. In this position, the fixed pin **66** is at the zero degree or lower-most point on the cam slots **81** and **82**, and the floating pin **67** is at the 200° point, as shown in FIGURE 8. In this position, the floating pins **67** extend angularly with respect to the sub frame **11**, through the short leg portion of the L-shaped slot **91**, as shown best in FIGURES 3 and 4. The

sub frame **11** is slid into a pair of recesses **13, 14** of the main frame **12**, and the floating pins **67** pass closely by the offset shoulders **26** of the recess sidewalls **23, 24**, and respectively seat against the sidewalls **23** and **24** adjacent the notches **27**. In this position, the multiple contact electrical connectors **38** and **39** have not reached engagement position. With the cylinder **62** in the aforesaid zero degree or raised position, no pressure is exerted on the assembly of roller members **42**, and hence the retainer plate **51** is in its most recessed position in the elongated opening **41** in each of the side portions **16, 17** of the sub frame **11**, and hence the sub frame **11** slides readily in the pair of recesses **13, 14**.

The levers **63** are now rotated, manually, each through an angle of 310° in the directions indicated by the circular arrows **93, 94** (FIGURE 3) and then are placed downwardly into the openings **71** and **72**, respectively, thus completing the assembly procedure in a quick and simple manner. The aforesaid rotation of 310° of the cam cylinder **62** by means of the levers **63** causes the following sequence of actions to occur. During the first twenty degrees of cam cylinder rotation, the floating pin **67** moves sideways into the notch **27** of the main frame **12**, as shown in FIGURE 5, at which point the fixed pin **66** is at the twenty degree point as indicated by numeral **66***a* in FIGURE 8, the floating pin **67** still being at the 200° point. During the remainder of the cam rotation, the fixed pin **66** and floating pin **67** are in vertical alignment, and are 180° apart in each of the cam slots **81** and **82**.

As the cam cylinder **62** is rotated further, from the 20° point to the 90° point, the floating pin **67**, which now is captivated in fixed position by the notch **27**, causes the cam slots **81** and **82** to force downwardly on the fixed pin **66** thereby forcing the subframe **11** downwardly into seated position in the frame **12**, thus forcing the multiple contact electrical connectors **38** and **39** together. In FIGURE 5, which represents the apparatus with the cam mechanism at the 90° point, with the fixed pin **66** and floating pin **67** at the 90° and 270° points, respectively, as shown in FIGURE 9, the sub frame **11** has been forced downwardly into the main frame **12** as compared with the position shown in FIGURE 4. This cam forcing of the multiple contact electrical connectors **38** and **39** together is important, because, due to the multiplicity of contacts needed to accommodate electrical connections to the numerous circuits carried by the sub frame **11**, it would not be feasible to rely on a person manually forcing the sub frame **11** into seated position in the main frame **12**.

Beginning with the 90° cam rotation point, as shown in FIGURE 9, the fixed pin **66** and floating pin **67** remain relatively fixed in position with respect to each other, and simultaneously ride in the sloped helical slots **81** and **82**. Since these pins are in fixed position with respect to the frames **11** and **12**, further rotation of the cam cylinder **62** causes the cam cylinder to turn downwardly with respect to the elongated opening **41** in each of the side portions **16** and **17** of the sub frame **11**, thus urging the spring assembly **64** downwardly against the arrangement of roller devices **42**, thereby expanding the roller arangement laterally and forcing the pressure retainer plate **51** outwardly against the adjacent sidewalls **23** and **24** in the main frame **12**. Thus, the sub frame becomes tightly wedged into the recesses **13** and **14**, at or prior to the full 310° rotation of the cam cylinders **62**, at which point the fixed pin **66** engages the detent **86** in the slots **81** and **82** as indicated by numeral **66'** in FIGURE 9, and at which point the floating pin is at the upper position **67'** in the slots **81** and **82**. With the fixed pin in the detent **86** as indicated at numeral **66'**, there is a "clicking" positioning of the levers **63** over their respective frame opening **71** and **72**, whereupon these levers are readily placed downwardly into these openings so as to be flush with the top of sub frame **11** and hence out of the way, it being noted that for at least a portion of the rotation of the levers **63** they must be pivoted slightly upwardly in order to properly rotate the cam cylinders **62** into the sub frame **11**. The spring arrangement **64** functions to take up any excess motion in the downward motion of the cam cylinder **62** with respect to the fully wedged position of the sub frame **11** in the main frame **12**.

The aforesaid wedging of the sub frame **11** in the recesses **13** and **14** of the main frame **12**, provides both good electrical (such as electrical ground) connection, and also provides for uniform heat conduction contact between the sub frame **11** and main frame **12**, all along the length of the side portions **16** and **17** of the sub frame **11**, thus effectively conducting heat generated by electrical circuits carried by the sub frame **11**, to the main frame **12** where it is further dissipated into surrounding space with the aid of the heat radiating fins **18**. The adjustment screws **43** are adjusted when necessary so as to assure proper functioning of the assembly of rollers **42** to exert proper outward pressure and motion on the pressure plate **51**. The main heat conducting path, it may be noted, is not through the pressure plates **51**, but rather through the opposite sides of the end portions **16** and **17** to the adjacent sidewalls **23, 24** of the main frame **12**.

It will be readily realized that the invention solves the prior problems that have been described above, and provides an arrangement whereby a first member can be securely attached to a second member quickly and easily by merely sliding them together, and turning one or more levers or actuating other means for turning the cam cylinders, or otherwise exerting force downwardly on the arrangement of rollers **42**. Furthermore, this quick assembly arrangement provides sequential functions of forcing the sub frame member into seated position with respect to the main frame member, and then wedges the members together along one or more elongated portions thereof, thus providing effective electrical, mechanical, and thermal contact therebetween. To disassemble the arrangement, a person simply lifts the levers **63** out of their openings **71** and **72**, and rotates them in the reverse direction as for locking the assembly, whereby in one simple motion of the levers the assembly is released from the wedging action in the recesses **13** and **14**, and is forced upwardly thereby separating the multiple contact electrical connectors **38** and **39**, whereupon the sub frame **11** is easily slid out of the main frame **12**.

As has been described, the roller members **42** preferably comprise hollow metal cylinders as shown in FIGURE 10; however, they may comprise solid cylinders or spherical balls if desired, the cylinders being preferred because of greater contact area mutually between them. As a further feature of the invention, the hollow roller cylinders are made sufficiently resilient so as to provide some or all of the aforesaid motion takeup as an aid to or in lieu of the functioning of the takeup compression spring **64**.

While a preferred embodiment of the invention has been shown and described, various other embodiments and modifications thereof will become apparent to persons skilled in the art, and will fall within the scope of invention as defined in the following claims.

I claim:

1. An arrangement for pressing first and second members together at elongated contact areas thereof, wherein the improvement comprises a plurality of roller members arranged in an elongated staggered manner alongside said contact areas, and means for applying force axially on said elongated arrangement of roller members thereby to cause said roller members to exert a lateral force for pressing said first and second members together at said elongated contact areas thereof.

2. An arrangement as claimed in claim **1**, in which said first member is provided with an elongated opening alongside said elongated contact areas, said elongated arrange-

ment of roller members being positioned in said elongated opening, and including an elongated pressure plate positioned in said elongated opening and means for urging said pressure plate toward said arrangement of roller members so that the outer surface of said pressure plate normally is substantially flush with the surrounding surface of said first member, whereby said axial force on the roller members causes them to force said pressure plate outwardly with respect to said elongated opening.

3. An arrangement as claimed in claim 1, in which said means for applying force axially includes means for imparting motion over a predetermined distance along the axis of said elongated arrangement of roller members, and further including a compression spring take-up means interposed in said combination of roller members and means for applying force, so as to take up any excess of said motion thus providing consistent pressure over said elongated contact areas.

4. An arrangement as claimed in claim 3, in which said take-up means comprises said roller members, said roller members being in the form of hollow cylinders made from resilient material so as to be compressible for providing said take-up of any excess motion.

5. An arrangement for removably attaching a sub frame to a main frame, said sub frame being adapted to carry electrical circuitry and said main frame being provided with at least one elongated recess adapted to receive an elongated side portion of the sub frame when said sub frame is slid into said main frame, wherein the improvement comprises a plurality of roller members arranged in an elongated staggered manner along said elongated side portion, and means for applying force axially on said elongated arrangement of roller members thereby to cause said roller members to exert a lateral force for bringing said side portion and said recess into mutual contact substantially along the lengths thereof.

6. An arrangement as claimed in claim 5, in which said elongated side portion of the sub frame is provided with an elongated opening extending therealong, an elongated dimension of said opening being exposed along a side of said sub frame adjacent to and alongside said elongated recess of the main frame when said frames are assembled together, said elongated arrangement of roller members being positioned in said elongated opening, and including an elongated pressure plate positioned in said elongated opening and means for urging said pressure plate toward said arrangement of roller members so that the outer surface of said pressure plate is substantially flush with said side of the sub frame, whereby said axial force on the roller members causes them to force said pressure plate outwardly with respect to said elongated opening and against a surface of said elongated recess thereby wedging together said sub frame and said main farme.

7. An assembly as claimed in claim 6, in which said means for applying force axially includes means for imparting motion over a predetermined distance along the axis of said elongated arrangement of roller members, and further including a compression spring take-up means interposed in said combination of roller members and means for applying force, so as to take up any excess of said motion thus providing consistent pressure of said wedging together of the sub frame and main frame.

8. An arrangement as claimed in claim 7, in which said take-up means comprises said roller members, said roller members being in the form of hollow cylinders made from resilient material so as to be compressible for providing said take-up of any excess motion.

9. An arrangement as claimed in claim 6, in which said means for applying force axially on the elongated arrangement of roller members comprises a cam cylinder positioned in said sub frame near an end of and substantially in axial alignment with said elongated opening, said cam cylinder being rotatable between limits defined as the locked and unlocked conditions of said frame assembly and being provided with at least one helical slot having an offset region of zero slope, a fixed pin carried by said sub frame and extending into said helical slot at said offset region thereof when said cam cylinder is at said unlocked limit of rotation, an opening through the wall of said sub frame adjacent said cam cylinder, a floating pin extending into said helical slot and extending through said last-named opening externally of said sub frame, said last-named opening being dimensioned to permit limited rotation of said floating pin with rotation of the cam cylinder, a notch in said main frame adapted to receive said floating pin when said cam cylinder is rotated from the unlocked condition whereby the action of the fixed pin riding in said offset region of the rotating slot and said floating pin riding in the rotating helical slot forces said sub frame to move into seating position with respect to said main frame until the fixed pin reaches an end of said offset region, whereupon with continuing rotation of the cam cylinder said fixed pin and said floating pin ride simultaneously in the helical slot thus causing the cam cylinder to screw toward said assembly of roller members thereby applying said force axially thereto.

10. An assembly as claimed in claim 9, in which said cam cylinder is so dimensioned that the upper portion thereof extends from said sub frame when at said unlocked limit and the top thereof is substantially flush with the surface of said sub frame when at said locked limit, and including an actuation lever pivotally attached to said cam cylinder at the top thereof and oriented to lie over the top surface of said sub frame when the cam cylinder is at said locked limit, a detent in said helical slot to receive one of said pins at said locked limit, and an opening in the top surface of said sub frame adapted to receive said pivoted lever when the assembly is in locked condition.

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P. A. CLIFFORD, Assistant Examiner

U.S. Cl. X.R.

49—415; 312—320; 339—17, 75