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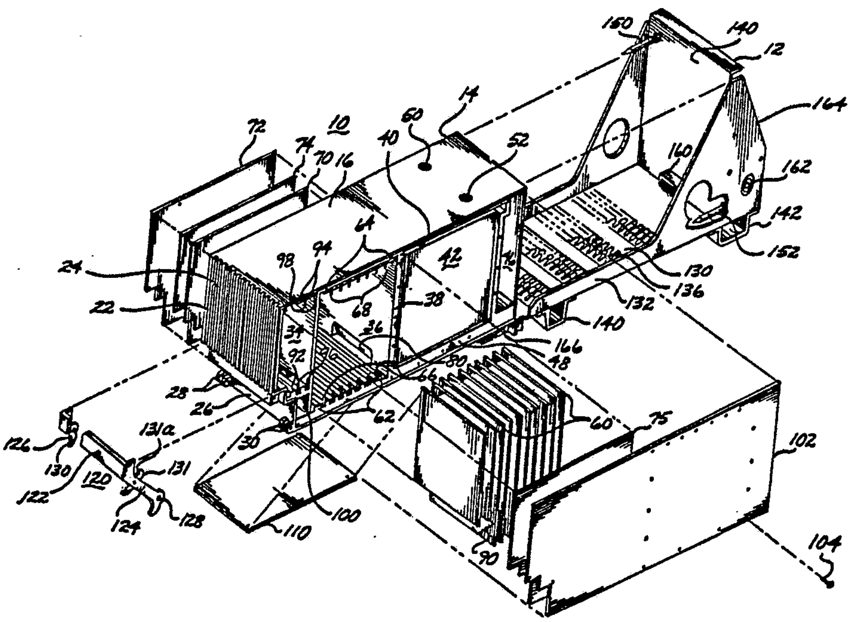

(57) Abstract

An enclosure for an aircraft inertial unit (IRU) includes a dip-brazed chassis (10) having an inertial sensor assembly (ISA) compartment (40) and an electronics module compartment (36). The ISA compartment (40) is rigid with the ISA (42) being mounted therein via diagonally opposed shock isolation mounts (330, 332). The centers of elasticity of the shock isolation mounts (330, 332) are aligned with the center of gravity of the ISA. A caging system (340, 342) prevents excessive movement of the ISA (42) with respect to the ISA compartment (40). The electronics module compartment (36) includes a thermal mass (62, 64) for heat sinking the electronics module (60) by conduction. The surfaces of the walls in the electronics module (60) are heat reflective to prevent heat in the enclosure from being radiated to the electronics module (60). The remaining surfaces of the enclosure are black to promote heat radiation. The IRU enclosure is mounted to the aircraft by means of a mounting tray (12). The tray (12) has diagonally positioned alignment pins (150, 152) that mate with alignment holes in the IRU enclosure (10) to assure proper IRU alignment. Pliant, heat conductive fingers (136) affixed to the tray (12) contact the thermal mass (62, 64) to promote heatflow from the enclosure (10) to the tray. Thermally conductive feet (140, 142) on the tray provide a path for heat flow to the aircraft.

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ENCLOSURE FOR AN AIRCRAFT INERTIAL REFERENCE UNIT

Field of the Invention

The present invention is directed to an enclosure for housing an aircraft inertial reference unit (IRU) and, more particularly, to a dip-brazed IRU enclosure having a rigid compartment with shock isolation mounts for housing an inertial sensor assembly and a compartment including a thermal mass for heat sinking IRU-related electronics.

Background of the Invention

An inertial reference unit (IRU) is an instrument, carried aboard an aircraft or other vehicle, that produces output signals related to aircraft position. The IRU output positional signals may be used by the aircraft's avionics, either to directly fly the aircraft to a given destination, or to provide information to the flight crew related to the aircraft's position.

In practice, the IRU is included within an enclosure, or box, which may be removably mounted to the aircraft. The box houses both the inertial sensors used to sense positional changes, as well as associated electronics for processing the sensor signals and producing output navigation signals. Typically, the inertial sensors include a cluster of three gyroscopes, each positioned with respect to one of three mutually orthogonal axes. The output from each gyroscope is a signal related to angular displacement of the gyroscope about its respective axis. In modern applications, conventional, spinning wheel-type mechanical gyroscopes are being replaced with ring laser gyroscopes. Linear acceleration is sensed by a triad of three accelerometers, each aligned with respect to one of the three coordinate axes. Each accelerometer produces an output signal corresponding to aircraft acceleration along its respective axis.

An IRU enclosure must provide for inertial sensor shock isolation and component cooling. The mounting for the inertial sensors should be designed such that shocks or other vibrations imparted to the IRU enclosure are not transmitted to the sensors, thereby avoiding erroneous sensor outputs and possible sensor damage. The electronics associated with the IRU dissipate heat during operation and must be cooled. For inertial reference units utilizing ring laser gyros, additional cooling must be provided to dissipate heat radiated from the lasers.

The conventional approach to providing an enclosure for aircraft inertial reference systems is to house the inertial sensors and the associated IRU electronics in a standard size box. Currently, the Aeronautical Radio Incorporated (ARINC) standard size enclosure for an IRU is a 10 MCU (modular concept unit). The MCU size standards are virtually identical to the former ATR (Air Transport Radio) standards. One MCU is virtually equivalent to a 1/8 ATR short, so a 10 MCU box corresponds to a 1 1/4 ATR short size enclosure. A standard IRU of 1 1/4 ATR size has the dimensions of: width = 32.23 cm (12.69 inches), height = 194 cm (7.64 inches), and depth = 32.4 cm (12.76 inches). A 1 1/4 ATR size box has proved of sufficient size to include the shock isolation mounting for the inertial sensors as well as suitable spacing for the various electronic circuit cards, to allow convective cooling of the cards by means of ventilation holes in the enclosure and, if necessary, forced cooling air.

Whereas commercial and certain military aircraft have sufficient space dedicated to electronic instrumentation to accommodate a 1 1/4 ATR size IRU enclosure, the space in smaller aircraft is very restrictive and cannot accommodate such a large enclosure. Moreover, whereas commercial aircraft commonly employ blowers to cool electronic instrumentation by means of convection, such cooling blowers are not commonly provided in smaller aircraft.

A requirement for proper IRU performance is that the reference coordinate axes of the inertial sensors be precisely aligned with the corresponding axes of the aircraft. This instrument-to-aircraft alignment has been conventionally provided by mounting the IRU enclosure to a tray that in turn has been affixed to, and aligned with, the aircraft. Such trays have typically included two widely spaced alignment pins that engage alignment holes provided on the back of the IRU enclosure. A third alignment pin is provided at the front of the tray, engaging a provided hole in a flange affixed to the front undersurface of the IRU enclosure. The wide spacing of the two rear pins assures the requisite alignment of the enclosure to the aircraft through the tray alignment. A sealed air passage is provided between the top surface of the tray and the undersurface of the IRU enclosure to allow cooling air to flow through the enclosure vents.

Summary of the Invention

The present invention is directed to an improved enclosure for an aircraft inertial reference unit. The enclosure may be formed in a size substantially smaller than a 1 1/4 ATR standard-size box, yet provides adequate shock isolation for the inertial sensors and sufficient cooling for the associated IRU electronics.

The improved IRU enclosure mounts to an aircraft-mounting tray having uniquely positioned alignment pins to assure rigid alignment of the enclosure. The tray is configured to promote heat flow from the enclosure to the tray, and from the tray to the aircraft frame.

Briefly, according to the invention, an enclosure is provided for housing an aircraft inertial reference unit. The inertial reference unit includes an inertial sensor assembly (ISA) comprised of position sensors, and an electronics circuitry module for processing data from said positional sensors and producing navigation output signals. The enclosure comprises a dip-brazed chassis. The chassis includes a compartment for housing the ISA and a compartment for housing the electronics module. The walls forming the ISA compartment exhibit a predetermined rigidity for maintaining the ISA compartment in a predetermined alignment in response to forces acting on the chassis. Preferably, the ISA compartment provided in the chassis is five-sided, having an open face used to access the ISA. A cover plate mounts over, and covers, the open face and is secured to the chassis by removable fasteners designed to assure a predetermined rigidity of the cover to ISA compartment interface.

The ISA mounts to the walls of the ISA compartment by means of a plurality of shock mounts, each shock mount exhibiting a predetermined compliance such that the ISA is substantially isolated from shocks applied to the chassis. The shock mounts are preferably positioned such that the center of elasticity of each shock mount is aligned with the center of gravity of the ISA. In the preferred construction, the shock mounts are positioned at opposite corners of the ISA.

It is preferred that the displacement of the ISA with respect to the ISA compartment be controlled by a caging device. This caging device comprises a pair of pins, with each pin being secured to, and projecting from, opposite sides of the ISA. Each pin is received within the hole of an elastic grommet secured within a wall of the ISA compartment, with the pins and grommet holes being sized and aligned to form a predetermined clearance between the surface of each pin and grommet hole such that upon a predetermined shock being imparted to the ISA at least one of the pins engages its corresponding grommet, thereby limiting movement of the ISA with respect to the ISA compartment.

It is also preferred that the face of each grommet be predeterminedly spaced from the surface of the ISA compartment sidewall opposite the grommet such that predetermined displacement of the ISA with respect to the ISA compartment along the longitudinal axis of the pin causes the grommet face to engage the ISA-opposing surface, thereby similarly limiting movement of the ISA with respect to the ISA compartment.

The dip-brazed chassis electronics module compartment is preferably comprised of four sidewalls, with at least one of the sidewalls having a heat sink mass formed integrally therein. The electronics module is mounted to the heat sink mass, thereby promoting conductive transfer of heat from the electronics module to the heat sink mass.

For the preferred embodiment wherein the electronics module is comprised of a plurality of individual circuit cards, opposing sidewalls of the electronics module compartment are provided with integral, parallel heat sink flanges. The heat sink flanges are configured such that the circuit cards are supported between opposing heat sink flanges. The circuit cards are mounted to bear against opposing heat sink flanges such that heat from the circuit card is conductively transmitted thereto.

Preferably, the component side of each circuit card is provided with a thermally conductive surface, such as copper metallization, with this thermally conductive surface being mounted to bear against the heat sink flanges.

For the preferred embodiment, the electronics module includes a plurality of circuit cards that are electrically interconnected by means of a motherboard or backplane. A backplane is mounted to the enclosure by means of a recessed lip formed integrally in the chassis around an open face thereof. The recessed lip is configured such that the support edges of the backplane bear against the lip. A panel covers the open face of the enclosure, with fasteners securing the panel to the enclosure. A pliant pad, preferably formed of rubber, is configured to be interposed between the panel and the backplane such that upon the panel being fastened to the enclosure, the pliant pad biases the backplane into contact with the connecting ends of the circuit cards. The pliant pad provides isolation to the backplane from shocks on the enclosure.

The enclosure may be combined with a mounting tray, which mounting tray is adapted to be predeterminedly aligned with, and affixed to, an aircraft. The tray is, preferably, L-shaped as viewed from the side, having a horizontally disposed portion and an upright portion projecting from one end of the tray. The upright portion has two alignment pins projecting therefrom over the horizontally disposed portion. The enclosure includes a back end portion with two holes provided therein, the holes positioned and dimensioned to receive the alignment pins when the enclosure is mounted to the tray. The alignment holes are positioned in diagonal corners of the enclosure, to thereby provide rigid alignment of the enclosure with respect to the tray and the aircraft.

The tray preferably includes a plurality of heat-conducting, pliant fingers projecting therefrom such that the fingers bear against predetermined locations on the enclosure when the enclosure is mounted to the tray, thereby promoting heat transfer from the enclosure to the tray. The tray, in turn, is preferably provided with thermally conductive feet for conducting heat from the tray to the aircraft. The walls of the electronics module compartment are preferably provided with heat-reflecting surfaces to minimize the radiation of heat from the walls to the electronics module. All other wall surfaces of the enclosure are provided with heat-radiating surfaces, to thereby promote radiation of heat from the enclosure to ambient.

Brief Description of the Drawings

FIGURE 1 is a perspective view illustrating the assembly of the preferred inertial reference unit (IRU) enclosure and the mating relationship between the enclosure and the aircraft tray;

FIGURE 2 is a perspective, exploded view illustrating the component parts of the IRU chassis prior to dip brazing;

FIGURE 3 is a side elevation view of a partially assembled IRU enclosure;

FIGURE 4 is a side elevation view illustrating the shock mounting and caging system associated with the inertial sensor assembly;

FIGURE 5 is a side, cross-sectional view of the inertial sensor assembly caging system;

FIGURE 6 is a side, cross-sectional exploded view of the IRU enclosure electronics module compartment illustrating the shock isolation mounting of the backplane (motherboard);

FIGURE 7 is a detailed elevation view illustrating the mounting of the electronics module circuit cards;

FIGURE 8 is a front elevation view of the IRU enclosure; and

FIGURE 9 is a back elevation view of the IRU enclosure.

Detailed Description

FIGURE 1 is a perspective view illustrating the assembly of the inertial reference unit (IRU), indicated generally at 10, and the mating relationship between the IRU enclosure and its associated aircraft mounting tray 12.

The principal mounting structure for the IRU is a dip-brazed chassis 14. The dip-brazed chassis 14, the construction of which is described in detail with respect to FIGURE 2, is generally rectangular in shape, having a rectangular, planar top surface 16, a rectangular, planar bottom surface 18, and a rectangular, planar back surface 20. The front surface 22 of chassis 14 includes vertically aligned heat sink fins 24 and a recessed surface 26 with provided pin-receiving bracket pairs 28, 30. FIGURES 8 and 9 are plan views of the front surface 22 and back surface 20, respectively.

Various partition walls define different compartments within the dip-brazed chassis 14. A relatively thin vertical wall 32 separates the power supply compartment, indicated generally at 34, from the signal-processing circuitry compartment, indicated generally at 36. A relatively thick vertically standing wall 38 separates the signal processor circuitry compartment 36 from the inertial sensor assembly compartment 40, which is shown receiving an inertial sensor assembly 42.

A vertically standing, relatively thick wall 44, having an L-shaped top bracket portion 44a, separates the inertial sensor assembly compartment 40 from the pin and socket-receiving compartment, indicated generally at 46.

The chassis 14 bottom surface 18 is formed with a relatively thick, raised floor portion 48 throughout the inertial sensor assembly compartment 40 and pin and socket compartment 46.

As is discussed in greater detail with respect to FIGURE 3, the relatively thick sidewalls 38, 44, and thick raised floor portion 48 form a rigid inertial sensor assembly compartment 40 for housing the inertial sensor assembly 42.

A pair of holes 50, 52 are formed through the top surface 16 of chassis 14 and, as is described in greater detail with respect to FIGURES 3 and 4, provide a means to secure the inertial sensor assembly 42 within the inertial sensor assembly compartment 40. A corresponding pair of mounting holes (not shown) are provided through the bottom surface 18 of the chassis 14.

The signal-processing electronics for the inertial reference system are provided on eight circuit cards, indicated collectively at 60. The circuit cards are conventionally constructed having components on one side and connecting metal traces on the opposite side. To facilitate cooling of the components, the component side is provided with a thermally conductive surface, preferably copper. Integrally formed on the lower surface of the signal-processing circuitry compartment 36 are a plurality of heat sink flanges, collectively indicated at 62. Integrally formed on the upper surface of the signal-processing circuitry compartment 36 are a set of heat sink flanges, collectively indicated at 64. The lower and upper heat sink flanges 62, 64 are aligned perpendicular to the longitudinal axis of the chassis 14, and are vertically aligned with respect to each other such that the circuit cards 60 may be received within the gaps formed between adjacent heat sink flanges 62, 64 to be vertically supported within the signal-processing circuitry compartment 36. A plurality of mechanical card guides 66 associated with the lower heat sink flanges 62 and a corresponding plurality of card guides 68 associated with the upper heat sink flanges 64 secure the circuit cards 60 within the signal-processing circuitry compartment 36, with the thermally conductive surfaces of the circuit cards 60 bearing upon the opposing faces of the heat sink flanges 62, 64. In this way, the heat sink flanges 62, 64 form a thermal mass to allow conduction of heat away from the circuit cards 60.

The discussion with respect to FIGURES 3 and 7 illustrates the manner by which the card guides 66 and 68 force the thermally conductive surfaces of the circuit cards 60 against opposing faces of the heat sink flanges 62 and 64.

Interconnections between the circuit cards 60 are provided by a motherboard or backplane 70. The backplane 70 is secured against the distal open face of the signal-processing circuitry compartment 36 by means of a cover plate 72 that is formed to cover the signal-processing circuitry compartment 36 and the open face of the power supply compartment 34. Screws secure the cover plate 72 in position on the chassis 14. A pliant, shock-absorbing pad 74 is interposed between the cover plate and the backplane 70. In this way, shock and vibration energy imparted to the backplane 70 through the chassis 14 is dissipated in the pad 74. The assembly of the backplane 70, cover plate 72, and pliant pad 74 is shown in greater detail with respect to FIGURE 6.

Similarly, a pliant pad 75 is interposed between cover plate 102 and the exposed ends of circuit cards 60 to provide shock isolation to circuit cards 60. The circuit cards 60 are provided with connecting ends 60a (or connectors as better seen with respect to FIGURES 3 and 7), which mate with corresponding connectors (shown with respect to FIGURES 3 and 7) on the face of the backplane 70. Metallized circuit traces on the backplane 70 form the electrical interconnections between appropriate connector pins.

A slot 80 provided through the wall 38 allows a cable to interconnect between the signal-processing circuitry compartment 36 and the inertial sensor assembly compartment 40, as is better shown with respect to FIGURE 3.

The circuitry for the IRU power supply is provided on a pair of circuit cards, indicated collectively at 90. A pair of lower heat sink flanges 92 are formed integrally with the chassis 14, transverse to the longitudinal axis thereof, on the lower surface of the power supply compartment 34. A pair of aligned heat sink flanges 94 are formed integrally with the chassis 14 on the upper surface of the power supply compartment 34.

The power supply circuit cards 90 are formed in the conventional manner with their components on one side, and metallized circuit traces on the opposite side. As with the circuit cards 60, the component side of the power supply circuit cards 90 include a thermally conductive surface, preferably copper metallization, used to conduct heat away from the components. The lower and upper heat sink flanges 92, 94 are arranged such that the power supply circuit cards 90 may be vertically supported within the power supply compartment 34. A pair of lower card guides 96 associated with the lower heat sink flanges 92, and a pair of upper card guides 98, associated with the upper heat sink flanges 94 are used to secure the circuit cards 90 in position, such that the thermally conductive layer on the component side of the circuit cards 90 bears against opposing faces of the heat sink flanges 92, 94. Thus, the heat sink flanges 92, 94 form a thermally conductive mass used to heatsink the components on the circuit cards 90.

As with the circuit cards 60, interconnections between the power supply circuit cards 90 are provided by the backplane 70.

A transverse channel 100 is provided underneath the power supply compartment 34. The transverse channel 100, as is better shown with respect to FIGURE 3, provides a cavity through which a cable interconnecting the power supply compartment 34 and the signal-processing circuitry compartment 36 may be routed.

The signal-processing circuit cards 60 and power supply circuit cards 90 are held in position by means of a cover plate 102. The cover plate 102 is designed to cover the open face of the power supply compartment 34, the signal-processing circuitry compartment 36, the inertial sensor assembly compartment 40, and the pin and socket compartment 46. The cover plate 102 is held in position by means of a plurality of screws, such as screw 104, which are received within tapped holes (not shown) in the chassis 14. A very close spacing of these screws, such as screw 104, is used around the inertial sensor assembly compartment 40 to assure a rigid connection between the cover plate 102 and the inertial sensor assembly compartment 40 to improve the structural integrity, and rigidity, thereof.

A cover plate 110 mounts over the bottom surface 18 of the chassis 14, as is better shown in FIGURE 3. A gap between the cover plate 110 and the bottom surface 18 allows an interconnecting electrical cable to be routed between the inertial sensor assembly compartment 40, the pin and socket compartment 46, and the signal-processing circuitry compartment 36.

A handle, indicated generally at 120, includes a handgrip 122 and projecting arm portions 124, 126. Holes 128, 130 are provided in the elbow portions of the arms 124, 126. The handle 120 mounts via handle holes 128, 130 and pivot pins (not shown) to the corresponding pin bracket pairs 27, 28, whereby the handle 120 is pivotally mounted to the chassis 14. A pair of locking arms, such as lock arm 131, are pivotally mounted to the arm portions 124, 126 and include catch portions, such as catch portion 131a, which latch to receiving surfaces, formed in front surface 22, to thereby lock the enclosure 10 to the tray 12.

The receiving tray 12 is generally L-shaped as seen in side view, having a generally horizontal support surface 130 and a vertically standing surface 140 projecting from the back end of the tray 12. Adjacent either side of the horizontal support surface 130 are flanges 132, 134 that are spaced to receive the width of the inertial reference system enclosure 10. Projecting upwardly from the horizontal support surface 30 are a plurality of pliant, thermally conductive fingers, such as fingers 136. The fingers, preferably formed from beryllium-copper, are provided in rows normal to the longitudinal axis of the horizontal support surface 130 and are located to contact selected portions of the bottom surface 18 of the enclosure 10, thereby providing a path for heat to flow from the enclosure 10 through the fingers 136 to the tray 12. A pair of U-channel feet 140, 142 mount to the bottom surface of the tray 12. The feet 140, 142 are formed of a thermally conductive material, such as aluminum, and are designed to transfer heat from the mounting tray 12 to the adjacent aircraft surface (not shown).

Projecting from the vertical surface 140 of tray 12 are a pair of alignment pins 150, 152. The alignment pins 150, 152 are aligned in parallel, and project over the horizontal support surface 130. Provided alignment holes (shown in FIGURE 9) in the back surface 20 of the enclosure 10 mate with the alignment pins 150, 152 upon the enclosure 10 being slid into place on the tray 12. To assure that the enclosure 10 is rigidly held in fixed alignment with the tray 12, the alignment pins 150, 152 and the corresponding enclosure alignment holes are positioned at a maximum possible spacing at diagonal corners of the back surface 20.

A female socket 160 is mounted to the vertical surface 140 in alignment with a projecting male plug (not shown) projecting from the lower enclosure back surface 20. Electrical connections between the aircraft and the enclosure are provided through the socket 160.

A grommet 162 is provided through a flange 164 projecting from the side flange 132, and provides a means to route a cable (not shown) from the aircraft to the female socket 160.

A projecting arm 166 from the front surface of the tray 12 includes a cross-pin (not shown) for mating with the handle 120, as is better shown with respect to FIGURE 3.

To further enhance the cooling of inertial reference unit components, and with reference to FIGURE 1, the interior walls of the signal-processing circuitry compartment 36 and power supply compartment 34 are left a shiny metallic color that is heat reflective. In this way, the heat in the walls of the signal-processing circuitry component compartment 36 and power supply compartment 34 is not radiated back to the electronic components on the circuit cards 60, 90, respectively. All other surfaces on the inertial reference unit enclosure are otherwise painted black. These black surfaces promote radiation of heat from the enclosure to ambient.

As is discussed hereinabove, the chassis 14 is an integral unit, formed by dip brazing. FIGURE 2 is an exploded diagram of the chassis 14, illustrating the individual component parts prior to the dip-brazing process.

Referring to FIGURE 2, the individual component parts to the chassis 14 include a top surface portion 16 and a bottom surface portion 18, both of which are essentially rectangular plates. A raised floor 48 projects upwardly from the bottom surface portion 18. Raised floor 48 defines the bottom of the inertial sensor assembly compartment (42 of FIGURE 1). A central cutout 201 through the raised floor 48 allows for the routing of interconnecting cable into, and out of, the inertial sensor assembly compartment.

A pair of provided holes 205, 206 through the raised floor 48 allows the mounting of shock absorbers to support the inertial sensor assembly, as is better shown with respect to FIGURES 3 and 4.

A lower set of parallel heat sink flanges 62 is formed in the signal-processing circuitry compartment portion of the bottom surface 18. Separating the heat sink flanges 62 from the raised floor 48 is a transverse groove 208, designed to receive the lower portion 38a of the wall 38. Lower portion 38a of wall 38 includes a transverse slot, indicated generally by arrow 210, that is used to guide an electrical cable (not shown) through a hole in the signal-processing circuitry compartment portion of the bottom plate 18.

A transverse slot 210 separates the raised floor 48 of the inertial sensor assembly compartment from the raised floor of the pin and socket compartment (46 of FIGURE 1). This slot is designed to receive the bottom edge of wall 44, which separates the inertial sensor assembly compartment from the pin and socket compartment. A cutout 212 in the central, back portion of the bottom surface 18 and raised floor 48 provides clearance for the electrical socket (not shown) that is mounted therein. Clearance for this socket is also provided by a rectangular cutout 214 provided in the sidewall 44.

The back surface portion 20 has a provided cutout 130, along with mounting hole pairs 131, 132, for mounting and securing the electrical socket. A pair of diagonally positioned alignment holes 134, 136 in back surface portion 20 are designed to mate with the alignment pins (150, 152 of FIGURE 1) which project from the mounting tray (12 of FIGURE 1).

Aligned with the alignment hole 136 is a bore (not shown) formed into the opposing face 220 of the raised floor portion 48 of the bottom surface 18. A bore (not shown) is formed in a block 222 which is secured to the undersurface of the top surface portion 16, and is aligned with alignment hole 134.

Projecting downwardly from the top surface 16 is a top wall 230 for the inertial sensor assembly compartment. In addition, parallel heat sink flanges 64 are formed on the undersurface of top surface 16 in alignment with the lower heat sink flanges 62. A slot 234 separates the inertial sensor assembly top wall 230 from the heat sink flanges 64. The width of the transverse slot 234 is designed to receive the top surface 38b of the sidewall 38. Centrally located in the sidewalls 38, 44 are provided holes 240, 242 which, as will be more fully understood with respect to FIGURE 4, receive grommets that constitute a portion of the caging system for the inertial sensor assembly.

The back, or fifth wall of the inertial sensor assembly compartment is formed by a generally rectangular plate 244. Plate 244 also covers the fifth side of the pin and socket compartment (46 of FIGURE 1).

A wall 32 separates the signal-processing circuitry compartment (36 of FIGURE 1) from the power supply compartment (34 of FIGURE 1). Forming the transverse channel (100 of FIGURE 1) is a lower L-shaped bracket 250 having a front face comprising the recessed portion (26 of FIGURE 1) of the front surface 22. Two pin-receiving bracket pairs 28, 30 are formed in the recessed front face 26 of bracket 250 and, as described above, provide a means to mount a handle to the chassis 14. A hole 252 provided through recessed face 26 allows the routing of an external electrical cable into the chassis 14.

Mounting holes, such as mounting hole 253, allow hole 252 to be covered by means of a screw-attached cover (not shown).

The top of the channel (100 of FIGURE 1) is provided by a generally rectangular shaped member 260, having a heat sink flange 92 affixed to the top surface thereof. A provided slot 262 through the heat flange 92 and rectangular member 260 allows the routing of a cable from the power supply compartment (34 of FIGURE 1) into the transverse channel 100.

A generally rectangular member 270 supports the remaining lower heat flange 92 for the power supply compartment. In assembly, the rectangular shaped member 270 separates the bottom of the heat sink finned portion 224 from the recessed front face 26.

A bracket 272 attaches to the bottom surface 18, projecting downwardly therefrom. A provided hole 274 in bracket 272 receives the third alignment pin (not shown) of the mounting tray.

The various components of the chassis 14 as shown in FIGURE 2 are, preferably, formed of aluminum. The molten chemical bath dip-brazing process used to bond together the various component parts of chassis 14 is conventional, and well known, and, as such, specifics of this process are not described in detail herein. In general, the component parts shown in FIGURE 2 are held in the final desired position by means of a suitable tool. The parts are dipped into a flux bath with the filler metal having been preplaced in the joints to be brazed. Upon removal from the flux bath, the unit is cooled, and then removed from the tool.

The dip-brazed IRU chassis 14 of FIGURES 1 and 2 realizes many advantages over other inertial reference system enclosures known to the prior art. Dip-brazing forms rigid connections among the five walls 38, 44, 48, 230, and 244 of the five-sided inertial sensor assembly compartment. This rigidity helps not only to isolate the inertial sensors from shock imparted to the chassis 14, but also to assure constant alignment of the inertial sensor assembly with respect to the mounting tray, and aircraft.

In addition, the various joints in the dip-brazed chassis exhibit low thermal resistance. As such, the entire inertial reference system chassis 14 serves as a thermal mass for purposes of cooling the heat-producing inertial reference system components.

In addition, the application of dip-brazing to an inertial reference system chassis allows relatively thick walls, such as walls 38, 44, 48, and 230 to be formed adjacent relatively thin walls, such as wall 244. If such a construction were attempted by conventional metal casting techniques, fractures would form at the interface of the thin and thick walls. Thus, dip brazing allows the formation of thick walls where rigidity is needed, and thin walls to provide maximum room for enclosing the inertial reference system-related components. This facilitates forming the overall inertial reference system in a smaller package than known heretofore.

FIGURE 3 is a side view illustrating the inertial reference unit enclosure 10 shown mounted to the mounting tray 12. The side cover (102 of FIGURE 1) has been removed to illustrate the positioning of various components within the enclosure 10.

Shown is the power supply compartment 34, formed by the front surface 22, a portion of the top surface 16, the vertical wall 32, and members 260, 270. A pair of lower heat sinks 92 are aligned with a pair of upper heat sinks 302. The power supply circuit cards 90 are secured against the heat sinks 92, 302 by means of lower and upper clips 96, 98. As is shown in greater detail with respect to FIGURE 7, the copperclad component sides of the circuit boards 90 abut the lower and upper heat sinks 92, 302, whereby heat dissipated by the circuit board components is conducted over the copperclad surface and into the heat sinks 92, 302 to provide conductive cooling for the power supply circuit components.

A transverse channel 100 is formed below member 260 and may be used to route interconnecting electrical cables (not shown). A front cover 101 covers an access hole (252 of FIGURE 2) and may be removed via retaining screws (not shown) to route test cables into the enclosure.

The signal-processing circuitry compartment 36 is defined by the sidewall 32, sidewall 38, and portions of the top surface 16 and bottom surface 18. A series of heat sinks 62 projects upwardly from the floor of the signal-processing circuitry compartment 36 and are aligned with downwardly projecting heat sink flanges 64 that extend downwardly from the top surface 16. The heat sinks 62, 64 form slots for receiving circuit cards, such as the circuit cards 60, with lower and upper card guides 66, 68, respectively, being used to secure the circuit cards 60 in position. FIGURE 7 is a detail better illustrating the abutting relationship between the thermally conductive surface of the component side of the circuit cards 60 and the heat sink flanges 62, 64.

Shown is a face view of the front surface of backplane 70. Backplane 70 is provided with a plurality of female sockets, such as socket 310, which are designed to mate with corresponding male plugs, such as male plug 312, mounted to each circuit card 60, 90. In this way, as the circuit cards 60 are inserted in the signal-processing circuitry compartment 36, and the circuit cards 90 are inserted in the power supply compartment 34, electrical connections from each card 60, 90 are made directly to the backplane 70. On the opposite side (not shown) of backplane 70 are conventional metallized circuit traces used to interconnect the circuit cards 60, 90.

Illustrated is a partial view of a cable 320 that is shown extending toward the backplane 70. This cable, which originates from either the inertial sensor assembly compartment 40 and/or the pin and socket compartment 46, is routed through a hole (210 of FIGURE 2) and slot (80 of FIGURE 2).

The inertial sensor assembly compartment 40 is defined by the top wall 230, raised floor 48, and the sidewalls 38 and 44. Shown mounted in the inertial sensor assembly compartment 40 is the inertial sensor assembly 42. The inertial sensor assembly 42 is essentially rectangular in shape, having recessed opposing corners 42a, 42b. A pair of elastic isolators 330, 332 are shown mounted to the recessed portions 42a, 42b. In fact, two spaced elastic isolators are used at each recessed corner 42a, 42b. The elastic isolators 330, 332, which are described in greater detail with respect to FIGURE 4, help isolate the inertial sensor assembly 42 from vibrations imparted to the enclosure 10.

Projecting from opposite sides of the inertial sensor assembly 42 are a pair of pins 340, 342, which are used in the inertial sensor assembly caging system, as is described in detail with respect to FIGURES 4 and 5.

An electrical cable 320 is routed to the inertial sensor assembly 42 by means of the cutout 201 provided through the raised floor 48.

The pin and socket compartment 46 is defined by the sidewall 44, end surface 20, and portions of the raised floor 48 and a portion of upper wall 230. The pins 150, 152 from the tray 12 are shown projecting into bores provided in the block 222 and through the front surface 220 of the raised floor 48. Also shown is the female socket 160 from the tray 12 being fully engaged by the male plug portion that is affixed in the pin and socket compartment 46.

The tray is shown in partial cross-sectional view to delete the guide rail 132. The tray includes the horizontal support surface 130 and the vertical projecting portion 140, to which the first and second alignment pins 150, 152 are attached. A side bracket 164 includes a grommet 162, which allows the routing of an electrical cable from the aircraft to connection at the socket 160.

A pair of U-channel thermally conductive feet 140, 142 are shown attached, as by rivets, to the bottom of horizontal support surface 130. Projecting upwardly from the top of horizontal support surface 130 are rows of fingers 136. The fingers are made from a pliant, thermally conductive material, such as beryllium-copper, and are configured such that when the enclosure 10 is mounted to the tray 12 the fingers are in contacting arrangement with various portions of the enclosure 10. In this way, heat flow is promoted from the enclosure 10 through the fingers 136 to the tray 12, and then from the tray 12 through the U-bracket feet 140, 142 to the aircraft-mounting surface, indicated generally at 350. The indicated positions of the fingers 136, such as at the central, and right edge portions of the signal-processing circuitry compartment 36 and at the central and right edge of the inertial sensor assembly compartment 40 are carefully selected to maximize heat flow from the enclosure 10 to the tray 12.

A third alignment pin 360 is mounted via block 362 and set nut 364 to an angled lip 365 at the forward portion of the tray horizontal support surface 130. The third alignment pin 360 engages the hole provided in bracket 272 that extends downwardly from the forward portion of the enclosure 10.

Shown attached to a pin-receiving bracket 30 projecting from the recessed portion 26 of the front surface 22 is the front arm 124 of a handle 120. A projecting catch 370 at the end of arm 124 engages a cross-pin 372 that is enclosed within the projecting arm 166 from the tray 12. A locking arm 131, which is pivotally mounted to projecting arm 124, has a catch 131a which engages a lip 271 formed in the undersurface of plate 270. A similar locking arm (not shown) is pivotally mounted to the second projecting arm (126 of FIGURE 1). In this way, the enclosure 10 is locked to the mounting tray 12. Release of the enclosure 10 from the tray 12 is effected by rotating the locking arms (such as arm 131) out of engagement with lip 271 and then rotating the arm 124 by means of the grip 122. This swings the catch 370 out of engagement with the pin 372, allowing removal of the inertial reference system.

FIGURE 4 is a side, plan view illustrating the inertial sensor assembly compartment 40 with the inertial sensor assembly unit 42 mounted therein. The inertial sensor assembly compartment 40, as formed in the dip-brazed chassis 14, is a five-sided enclosure including a back wall 244, sidewalls 38, 44, a top wall 230, and a bottom wall 48. The compartment 40 is designed to provide a very rigid housing for the inertial sensor assembly 42, thereby maintaining inertial sensor assembly 42 in alignment with the inertial sensor assembly enclosure, mounting tray, and the aircraft to assure the proper readings from the sensors.

The inertial sensor assembly 42 is mounted within the compartment 40 by means of elastic isolators, such as isolators 330, 332. Each isolator 330, 332 has a pedestal 333 formed from an elastic material, such as silicone rubber, with a metal baseplate 335 and a threaded metal central bushing 337. The baseplate of each isolator 330, 332 is positioned flush against recesses 42a, 42b, respectively, formed in diagonal corners of the inertial sensor assembly 42. Mounting screws, such as screw 331, secure each isolator 330, 332 to the inertial sensor assembly 42. A cutaway of isolator 330 illustrates a mounting screw 402, the head of which is accessible through a provided opening 52 in upper wall 230 which threads into bushing 337 and is used to secure the isolator 330 in place and adjust the tension applied to isolator 330. Although only two isolators 330, 332 are shown, another pair of isolators are mounted on the distal portions of recesses 42a, 42b.

The natural frequency of the isolators 330, 332 is designed to be much higher than the frequency of shocks that might be applied to the inertial sensor assembly 42. In addition, the natural frequency of the isolators 330, 332 is designed to be much lower than the frequency of the dither motion applied to the laser gyros. Also, the centers of elasticity 330a, 332a, of the isolators 330, 332 are positioned to be on a line with the center of gravity 410 of the inertial sensor assembly. The resulting construction is particularly effective in minimizing vibrations that appear on the chassis 14 from being coupled to the inertial sensor assembly 42 and introducing potential errors in the signals produced by the inertial sensor assembly positional sensors.

Isolators, such as isolators 330, 332, are commercially available from Barry Controls, Inc., Burbank, California.

To protect the delicate sensors contained within the inertial sensor assembly 42, a caging system is employed that limits the movement of the inertial sensor assembly 42 with respect to the compartment 40. The caging system includes two pins 340, 342 that are attached to, and project from, opposite sides of the inertial sensor assembly 42 at the approximate midpoints of the sidewalls such that the longitudinal axes of the pins 340, 342 pass through the center of mass of the inertial sensor assembly 42. The pins 340, 342 are received within the holes in grommets 420, 422, respectively, which are secured in provided holes 240, 242, respectively, in the sidewalls 38, 44.

FIGURE 5 is a detailed cross-sectional diagram illustrating the pin 342 that is received within the hole in grommet 422 secured within hole 242 of sidewall 44. With the inertial sensor assembly 42 in its rest position, the pin 342 is aligned to be centered within the hole provided in grommet 422. The diameter of pin 342 is matched to the diameter of the grommet 422 hole such that a predetermined spacing between the exterior surface of pin 342 and the diameter of the grommet 422 hole is provided. In addition, the spacing between the sidewall of the inertial sensor assembly 42 and the face 440 of the grommet is set to a predetermined value.

For forces acting on the inertial sensor assembly 42 which exceed a predetermined level, the pin 342 engages the grommet 422, or the sidewall of the inertial sensor assembly 42 engages the face 440 of the grommet 422, thereby establishing a limit on the movement of the inertial sensor assembly 42 with respect to the inertial sensor assembly compartment 40. Due to the compliance of grommet 422, the inertial sensor assembly is not abruptly decelerated with respect to the compartment 40, thereby minimizing stress on the inertial sensor assembly sensors.

By positioning the longitudinal axes of the pins 340, 342 through the center of mass of the inertial sensor assembly 42, the pins 340, 342 will engage their corresponding grommets 420, 422, respectively, in a symmetrical manner, ensuring comparable caging forces on both sides of the inertial sensor assembly 42.

In one construction of the invention, the diameter of pin 342 was selected as 0.635 cm (0.25 inches) with the diameter of the hole in the grommet 422 being 1.27 cm (0.5 inches). The spacing between the face of the sidewall of inertial sensor assembly 42 and the face 440 of grommet 422 was selected as 0.3 cm (0.12 inches).

It should be noted that in alternative constructions of the chassis 14, isolators, such as isolators 330, 332 could be positioned in place of the caging pins 340, 342 and grommets 420, 422. However, the above-described caging system was employed in the preferred construction due to space limitations.

FIGURE 6 is a cross-sectional end view of the inertial reference unit enclosure 10 illustrating the backplane-to-circuit card assembly. Shown are the upper and lower chassis surfaces 16, 18. Locked into position, by means of card guides 66, 68, is a circuit card 60 that bears against heat sink flanges 62, 64.

A male connector 312 is attached to the connecting side of circuit card 60. Various electrical circuit nodes on circuit card 60 are connected to pins within connector 312. A cover 102 is secured over the open right side of the enclosure 10 by means of screws, such as screws 602, 604.

Projecting from the backplane 70 in a direction to mate with connector 312 is a female connector socket 310. The backplane 70 includes a corresponding socket, such as socket 310, for each of the various circuit boards 60 with which it mates. Metallized circuit traces (not shown) provided on the surface of the backplane 70 form interconnects between various connectors on the circuit cards 60.

The outer dimensions of the backplane 70 are such that it mates flush against an inner lip 610, 612 integrally formed in the enclosure 10. The backplane 70 is held in place by a cover 72 and a plurality of screws, such as screws 606, 608, that screw into tapped holes (not shown) provided in the enclosure 10. Interposed between the cover 72 and the backplane 70 is a pliant pad 74. Pliant pad 74, which is preferably formed from an electrically insulating material, provides shock mounting to the backplane 70. Similarly, a pliant pad 75 is provided between the cover plate 102 and the edges of the circuit cards 60 for shock isolation to the circuit cards 60.

FIGURE 7 is a side view into the signal-processing circuitry compartment 36. Illustrated is a circuit card 60 in position against a lower heat sink flange 62. The circuit card 60 has a component side 60a from which various electronic components, such as component 702, project. Provided on component side 60a of circuit card 60 is a heat conductive surface, preferably copper. Heat dissipated by the electronic components, such as component 702, is conducted through thermally conductive layer 60a and to the heat sinks, such as heat sink flange 62.

The circuit card 60 is held in place with its component side thermally conductive layer 60a in abutting relationship with the heat sink flange 62 by means of a circuit guide retaining clip. A handle 66a on clip 66 may be pulled outwardly to release each card 60 and, when a card is installed in position, the handle 66a is rotated to its locked position, as shown in FIGURE 7, which forces a leaf spring (not shown) to bear against the back surface of card 60, thereby forcing the abutting relationship of the thermally conductive surface 60a against heat sink flange 62. Card guide retaining clips 66 of the type used in the present enclosure are commercially available from Birtcher Corporation, El Monte, California.

Also shown in FIGURE 7 is the front surface of the connector 312 attached to the circuit card 60 that mates with a corresponding socket on the backplane 70. One such socket is shown at 310.

The power supply circuit cards 90 mate with the backplane 70 in a similar manner.

Preferably, the heat dissipating components (such as component 702) are positioned on the circuit cards 60, 90 such that they are as close as possible to the heat sink flanges (such as flange 62), thereby providing short thermal paths for heat to flow from the circuit cards 60, 90 to the chassis 14. The vertical position of the backplane 70, in the preferred embodiment (rather than a more conventional horizontal placement), facilitates such configuration.

FIGURE 8 is a front elevation view of the enclosure 10. Shown is the front surface 22 including the vertically spaced heat sink fins 24 which radiate heat from the enclosure to ambient.

A recessed portion 26 includes an opening 252 from which electrical cables may be routed to test the enclosed electronics. A cover plate (not shown) is secured over opening 252 by means of screws (not shown) that attach via threaded holes, such as hole 253.

Projecting from the lower left and lower right portions of the front surface 22 are pin-receiving brackets 28, 30, respectively. These brackets, as is described more fully with respect to FIGURE 3, provide a means to mount a handle (not shown).

Projecting downwardly from the enclosure 10 is a bracket 272 with a provided alignment hole 274. The third alignment pin (FIGURE 3) on the mounting tray is received within alignment hole 274 when the enclosure 10 is mounted to the tray.

FIGURE 9 is an end elevation view of the back surface 20. A socket cutout 130 is provided in the lower central portion of back surface 20, with provided mounting holes 131, 132 being used to secure the socket (not shown) in place. The bracket 272 projecting downwardly from the lower surface of the enclosure includes the alignment hole 274, as described above.

Provided in diagonal corners of the back surface 20 are the alignment holes 134, 136. As is described with respect to FIGURE 1, these alignment holes mate with alignment pins (150, 152) that project from the vertical surface of the mounting tray. In prior art constructions, such alignment holes were provided at a predetermined spacing on a horizontal line in the back of the enclosure. Because the present inertial reference system enclosure is considerably smaller than those known to the prior art, a unique feature of the present positioning of the alignment holes 134, 136 is that they are spaced at a maximum possible spacing S, on a diagonal, to thereby provide maximum rigidity to the enclosure 10, maintaining enclosure 10 in proper alignment.

In one construction of the present inertial reference system, the overall length of the top surface 16 (FIGURE 3) is 38.56 cm (15.18 inches). The width of the enclosure, W (FIGURE 9), is 12.42 cm (4.89 inches). The height, H (FIGURE 9), of the enclosure 10 is 19.33 cm (7.61 inches). In this construction, the alignment holes 134, 136 are spaced at a spacing S (FIGURE 9) of 20 cm

(7.886 inches). The horizontal spacing, HS (FIGURE 9), of the alignment holes 134, 136 is 10.16 cm (4.00 inches), whereas the vertical spacing VS (FIGURE 9), is 17.26 cm (6.796 inches).

In the above-described construction of the invention, and referring to FIGURE 4, to provide rigidity to the inertial sensor assembly compartment 40, the sidewalls 38, 44 and top wall 230 are formed with a thickness of 0.635 cm (0.25 inches), whereas the raised floor 48 has a thickness of 1.77 cm (.698 inches).

The described inertial reference system enclosure occupies a volume of less than one-half the size of a standard 1 1/4 ATR box and, as such, is less than one-half the size of aircraft inertial reference system enclosures known to the prior art. This size is accomplished while maintaining rigidity to the inertial sensor assembly compartment through the proper sizing of the inertial sensor assembly walls and the dip-brazed construction. In addition, the inertial sensor assembly is isolated from shocks on the enclosure due to a carefully constructed shock isolation mounting and caging system.

The careful attention paid to conductive heat sinking of the various dissipating components used in the inertial reference system has avoided the need for convection cooling, as required by prior art designs. By careful design of heat flow paths from the heat-dissipating components in the IRU to the IRU enclosure, and then through the mounting tray to the aircraft, no convection holes need be provided in the enclosure, thereby preventing the entrance of foreign matter. Also, in certain mounting configurations, the IRU will operate at high pressure-altitudes, where little or no convective cooling is available.

To further enhance the cooling of inertial reference unit components, and with reference to FIGURE 1, the interior walls of the signal-processing circuitry compartment 36 and power supply compartment 34 are left a shiny metallic color that is heat reflective. In this way, the heat in the walls of the signal-processing circuitry component compartment 36 and power supply compartment 34 is not radiated back to the electronic components on the circuit cards 60, 90, respectively. All other surfaces on the inertial reference unit enclosure are otherwise painted black. These black surfaces promote radiation of heat from the enclosure to ambient.

In summary, an improved aircraft inertial reference unit enclosure has been described. While the preferred embodiment of the invention has been described in detail, it should be apparent that many modifications and variations thereto are possible, all of which fall within the true spirit and scope of the invention.

CLAIMS

1. An enclosure for housing an aircraft inertial reference unit, said inertial reference unit including an inertial sensor assembly (ISA) comprised of position sensors, and an electronic circuitry module for processing data from said position sensors and producing navigation output signals, the enclosure comprising: a dip-brazed chassis, said chassis including a compartment for housing said ISA and a compartment for housing said electronics module, the walls forming said ISA compartment exhibiting a predetermined rigidity for maintaining said ISA compartment in a predetermined alignment in response to forces acting on said chassis.

2. The enclosure of Claim 1, wherein said dip-brazed chassis ISA compartment includes a five sided, open face enclosure, said ISA being accessed through said open face, and a cover plate for mounting over, and covering said open face, said cover plate being secured to said chassis by removable fastener means for assuring a predetermined rigidity of the resultant cover to ISA compartment interface.

3. The enclosure of Claims 1 or 2, wherein said ISA mounts to the walls of said ISA compartment by means of a plurality of isolators, each isolator exhibiting a predetermined compliance such that said ISA is substantially isolated from shocks applied to said chassis.

4. The enclosure of Claim 3, including a first isolator secured to the top surface of said ISA towards a first end thereof and a second isolator secured to the bottom surface of said ISA at an end thereof diagonally opposite said first end.

5. The enclosure of Claim 3 or 4, wherein said isolators are predeterminedly positioned with respect to the center of gravity of said ISA.

6. The enclosure of Claim 5, wherein said isolators are positioned such that the center of elasticity of each isolator is aligned with the center of gravity of said ISA.

7. The enclosure of any preceding claim, including caging means for predeterminedly limiting the displacement of said ISA with respect to said ISA compartment.

8. The enclosure of Claim 7, wherein said caging means comprises a pair of pins, each pin being secured to, and projecting from opposite sides of said ISA, each pin being received within the hole of an elastic grommet secured within a wall of said ISA compartment, said pins and grommet holes being sized and aligned to form a predetermined clearance between the surface of each pin and grommet hole such that upon a predetermined force being imparted to said ISA at least one of said pins engages its corresponding grommet, thereby limiting movement of said ISA with respect to said ISA compartment.

9. The enclosure of Claim 8, wherein the face of each grommet is predeterminedly spaced from the surface of the sidewall opposite said grommet such that a predetermined displacement of said ISA with respect to said ISA compartment along the longitudinal axis of a pin causes said grommet face to engage said ISA opposing surface thereby limiting movement of said ISA with respect to said ISA compartment.

10. The enclosure of Claim 1, wherein said dip-brazed chassis electronics module compartment comprises four sidewalls, at least one of said sidewalls having a heat sink mass formed integrally therein, and wherein mounting means mounts said electronics module to said heat sink mass for the conductive transfer of heat from said electronics module to said heat sink mass.

11. The enclosure of Claim 10, wherein said electronics module is comprised of a plurality of individual circuit cards, and wherein opposing sidewalls of said electronics module compartment are provided with integral, parallel heat sink flanges, said heat sink flanges being configured such that said circuit cards may be supported between opposing heat sink flanges, the enclosure further including circuit card mounting means for mounting each circuit card such that it bears against opposing heat sink flanges such that heat from said circuit card is conductively transmitted to said heat sink flanges.

12. The enclosure of Claim 11, wherein each circuit card includes a component side for mounting electronic components and a connection side for forming electrical connections between said components, with each circuit card component side including a thermally conductive surface; and wherein each circuit card mounts within said electronics module compartment such that said thermally conductive surface bears against said heat sink flanges, whereby heat from said circuit card components is conducted over said thermally conducting surface to said heat sink flanges.

13. The enclosure of Claim 11, wherein said electronics module further includes a backplane for forming electrical connections with connecting ends of said circuit cards; and wherein said heat sink flanges and circuit cards are configured such that the connecting ends of said circuit cards are accessible through an open face of said dip-brazed chassis, said enclosure further including means for mounting said backplane to said enclosure such that said backplane forms said electrical connections to said circuit cards.

14. The enclosure of Claim 13, wherein said means for mounting said backplane to said enclosure includes a recessed lip formed integrally in said chassis around said chassis open face, said recessed lip being configured such that predetermined support surfaces of said backplane bear against said lip, a panel for covering said open face, means for removably fastening said panel to said enclosure, and a pliant pad configured to be interposed between said panel and said backplane such that upon said panel being fastened to said enclosure, said pliant pad biases said backplane into contact with the connecting ends of said circuit cards, said pliant pad providing isolation to said backplane from shocks on said enclosure.

15. The enclosure of Claim 1, 10, or 12, in combination with a mouting tray, said mounting tray being adapted to be predeterminedly aligned with, and affixed to an aircraft, said enclosure and tray being predeterminedly configured such that said enclosure may be mounted to said tray in predetermined alignment with respect thereto.

16. The enclosure of Claim 15, wherein said tray is generally L-shaped as viewed from the side, having a horizontally disposed portion and an upright portion projecting from one end of said tray, said upright portion having two alignment pins projecting therefrom over said horizontally disposed portion; and said enclosure includes a back end portion with two holes provided therein, said holes being positioned and dimensioned to receive said alignment pins when said enclosure is mounted to said tray.

17. The enclosure of Claim 16, wherein said back end portion is generally rectangular in shape and wherein said holes are located in diagonal corners of said back end portion.

18. The enclosure of Claim 17, wherein said alignment holes are spaced approximately 20 cm (7.9 inches).

19. The enclosure of Claim 16, wherein: said tray includes a third alignment pin, said third alignment pin being parallel to said two alignment pins, said third alignment pin projecting from the opposite end of said horizontally disposed tray portion from said two alignment pins; and said enclosure includes a bracket projecting downwardly from the front end portion of said enclosure, said bracket including an alignment hole for receiving said third alignment pin when said enclosure is mounted to said tray.

20. The enclosure of Claim 15, wherein said tray includes a plurality of heat conductive pliant fingers projecting therefrom such that said fingers bear against

said enclosure when said enclosure is mounted to said tray thereby conducting heat from said enclosure to said tray.

21. The enclosure of Claim 20, wherein said fingers are positioned to contact predetermined portions of said enclosure to maximize the flow of heat from said enclosure.

22. The enclosure and tray combination of Claim 20, wherein said fingers are formed of beryllium-copper.

23. The enclosure of Claim 20, wherein the lower surface of said horizontally disposed tray portion is provided with thermally conductive feet for conducting heat from said tray to said aircraft.

24. The enclosure of any one of Claims 10 to 12, or 20 to 23, wherein the walls of said electronics module compartment are provided with a heat reflecting surface to minimize the radiation of heat from said walls to said electronics module.

25. The enclosure of Claim 24, wherein all wall surfaces other than the walls of said electronics module are provided with a heat radiating surface to promote radiation of heat from said enclosure to ambient.

26. Apparatus for securing and heat sinking an inertial reference unit (IRU) to an aircraft comprising: an enclosure for said IRU, said enclosure including a thermally conductive mass and means for mounting the heat producing portions of said IRU to said thermally conductive mass; a mounting tray, said mounting tray being

adapted to be predeterminedly aligned with, and affixed to said aircraft; means for mounting said enclosure to said tray in predetermined alignment therewith; means for conducting heat from said thermally conductive mass to said tray; and means for conducting heat from said tray to said aircraft.

27. The apparatus of Claim 26, wherein said means for conducting heat from said thermally conductive mass to said tray includes a plurality of heat conductive, pliant fingers projecting therefrom such that said fingers bear upon said thermally conductive mass when said enclosure is mounted to said tray.

28. The apparatus of Claim 27, wherein said fingers are positioned to contact predetermined portions of said thermally conductive mass to maximize the flow of heat from said enclosure to said tray.

29. The apparatus of Claim 27 or 28, wherein said fingers are formed of beryllium-copper.

30. The apparatus any one of Claims 26 to 29, wherein said means for conducting heat from said tray to said aircraft include thermally conductive feet mounted to said tray, said feet being in contact with said aircraft when said tray is affixed to said aircraft.

31. Apparatus for securing an inertial reference unit (IRU) to an aircraft in predetermined alignment therewith comprising: an enclosure for housing said IRU, said enclosure having a generally rectangular back end surface with two alignment holes being predeterminedly

positioned in diagonal corners of said back end surface; and a mounting tray including means for mounting said enclosure to said tray, said tray adapted to be predeterminedly aligned with, and affixed to said aircraft, said tray being generally L-shaped as viewed from the side having a horizontally disposed portion and an upright portion projecting from one end of said tray, said upright portion having two alignment pins projecting therefrom over said horizontally disposed portion, said alignment pins engaging said alignment holes upon said enclosure being mounted to said tray such that said enclosure is secured in predetermined alignment with said tray.

32. The apparatus of Claim 31, wherein said tray includes a third alignment pin, said third alignment pin being parallel to, and projecting from the opposite end of said horizontally disposed portion from said two alignment pins; and said enclosure includes a bracket projecting downwardly from the front end portion of said enclosure, said bracket having a provided alignment hole for receiving said third alignment pin upon said enclosure being mounted to said tray.

33. The apparatus of Claim 31 or 32, wherein said alignment holes are spaced approximately 20 cm (7.9 inches).

34. The apparatus of Claim 31 or 32, wherein said alignment holes are spaced approximately 10 cm (4.0 inches) horizontally and 17.3 cm (6.8 inches) vertically.

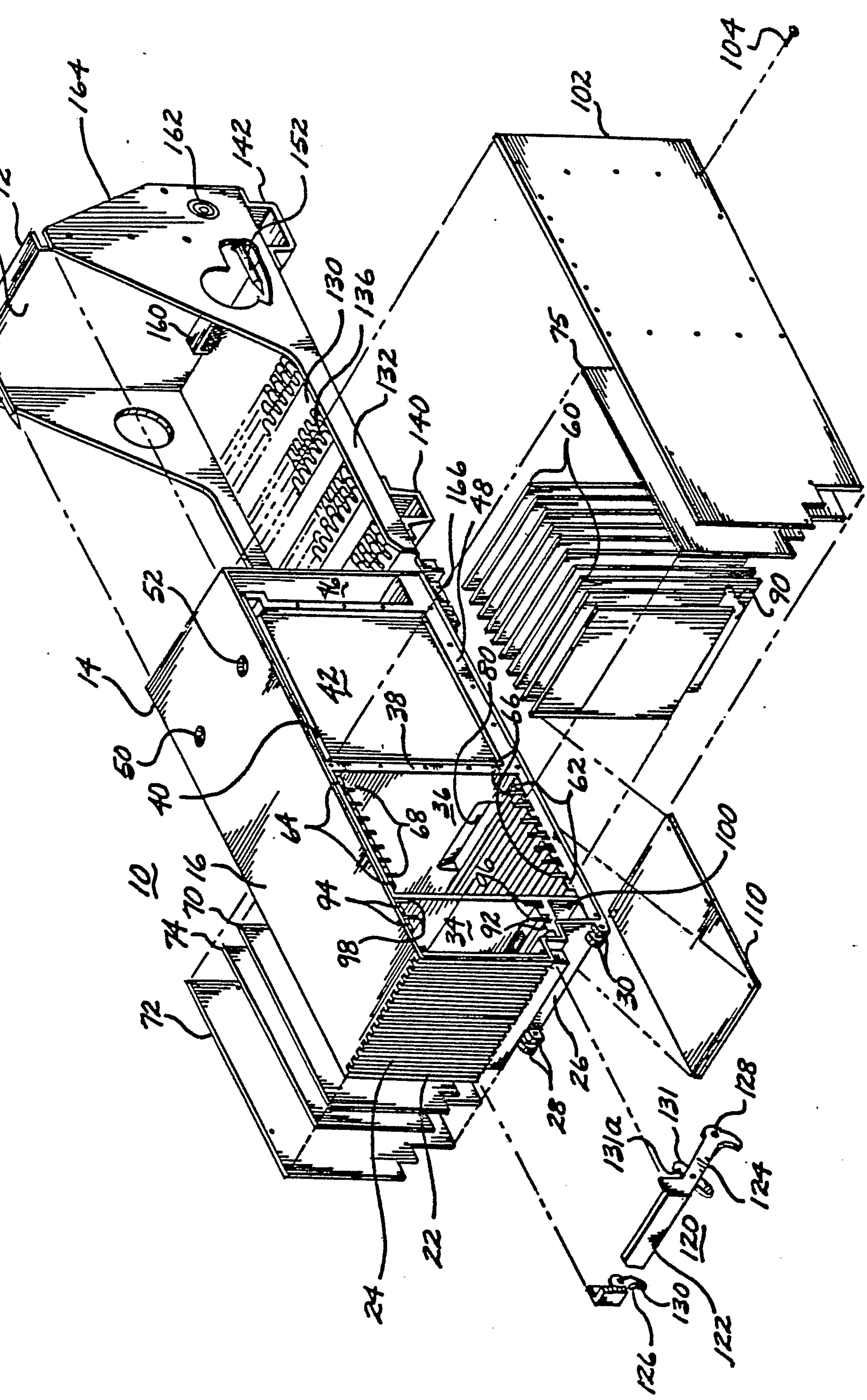

Fig. 1.

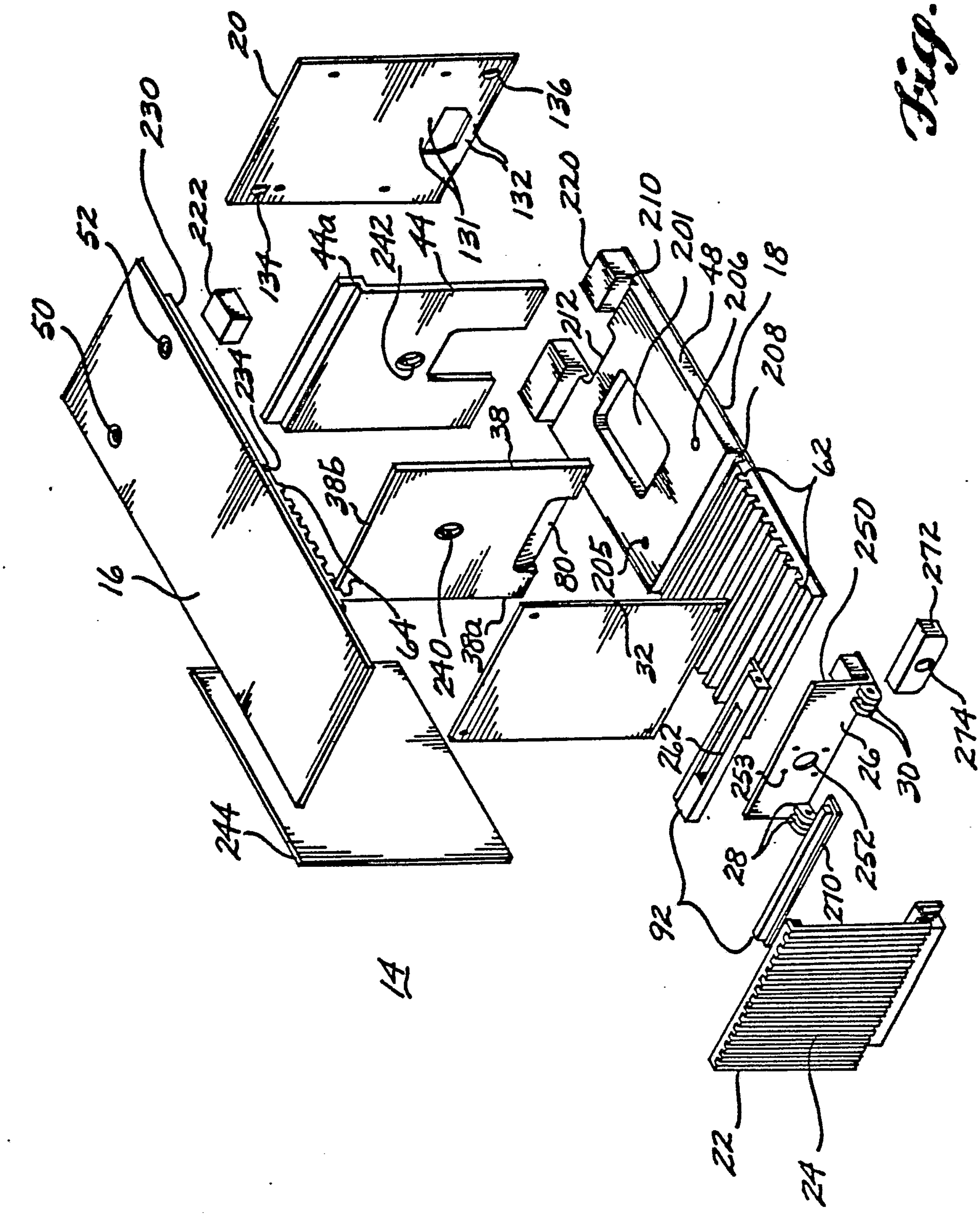
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Fig. 2.

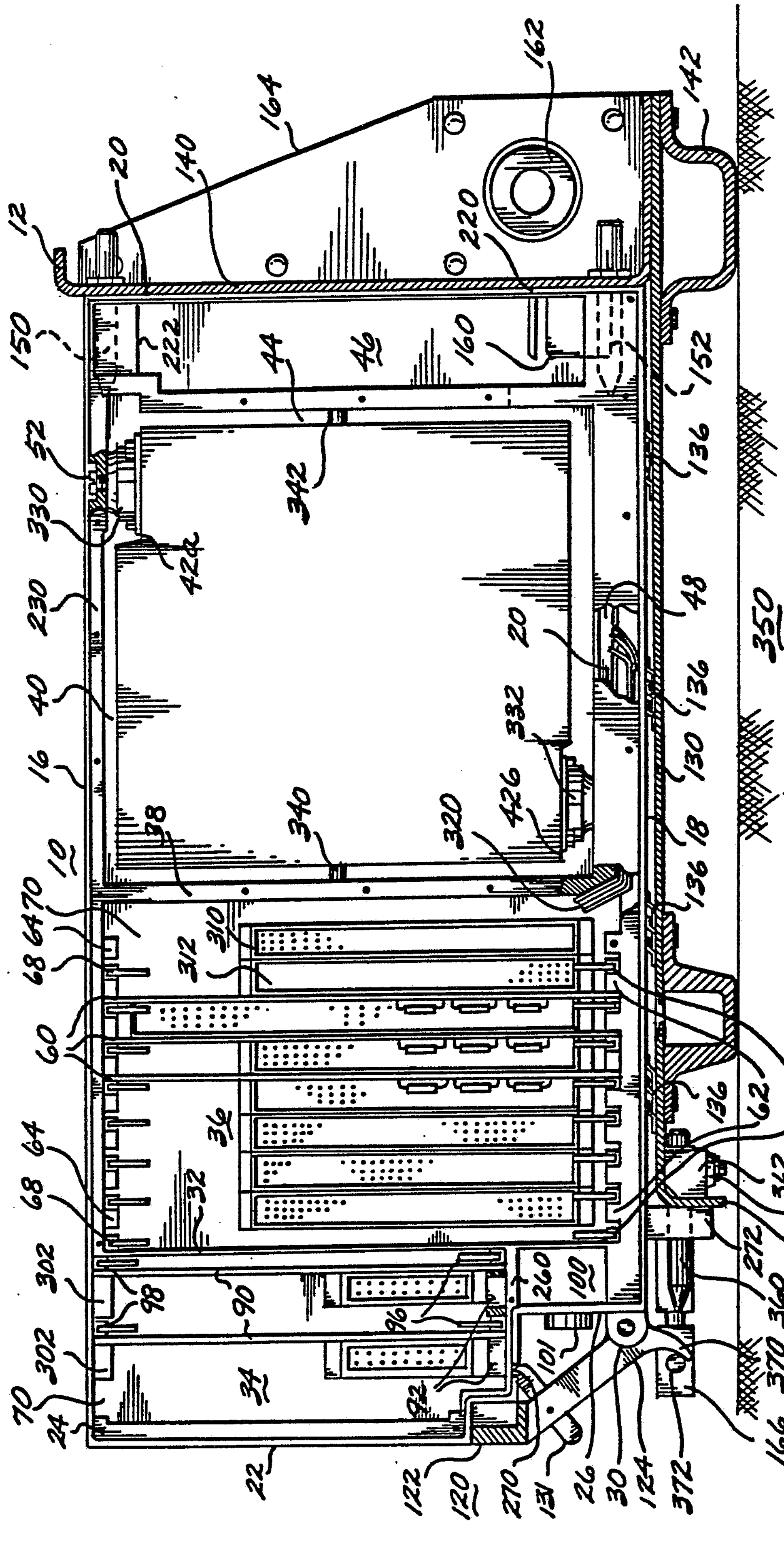
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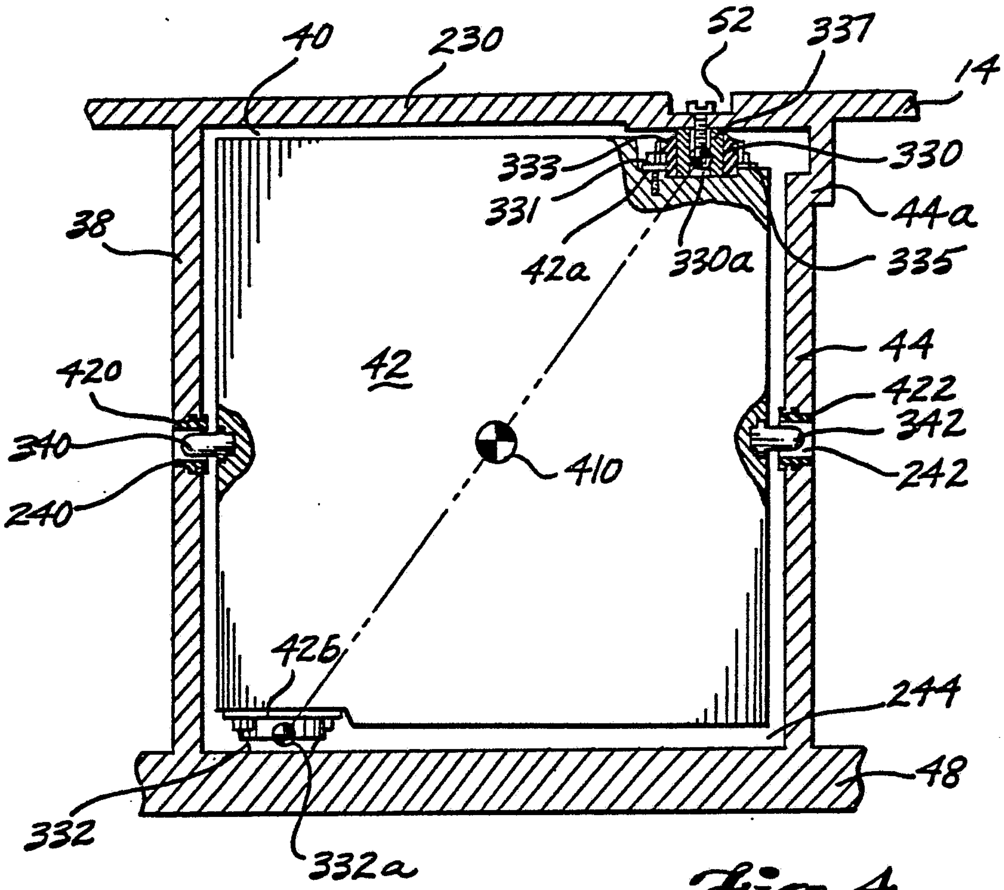
Fig. 3.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332
332a

Fig. 4.

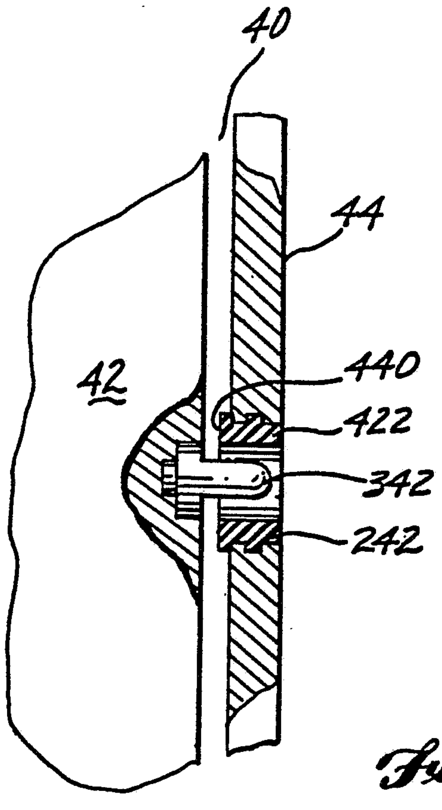
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Fig. 5.

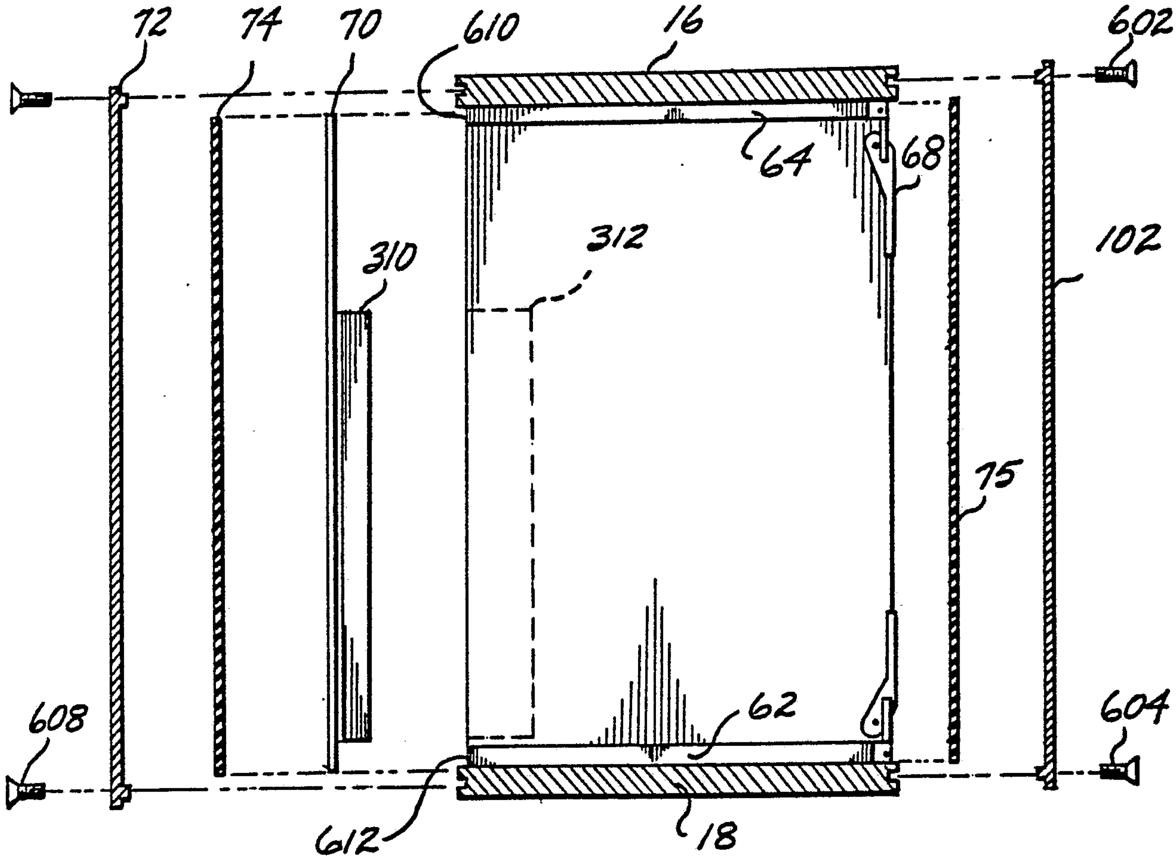
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Fig. 6.

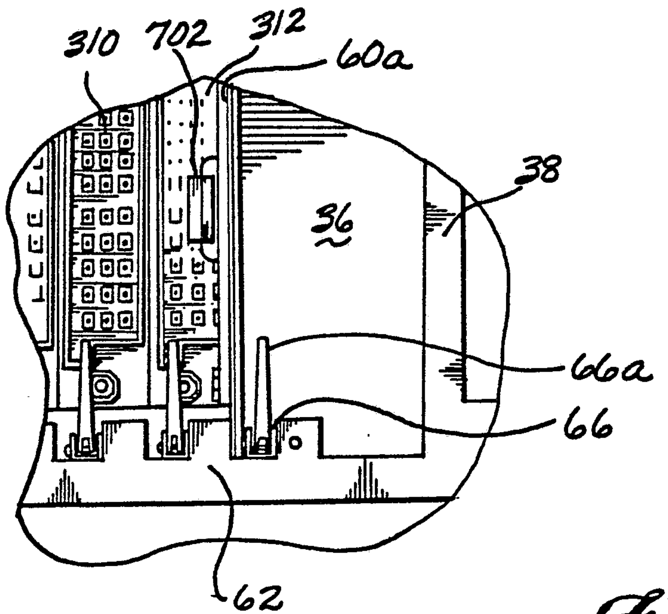
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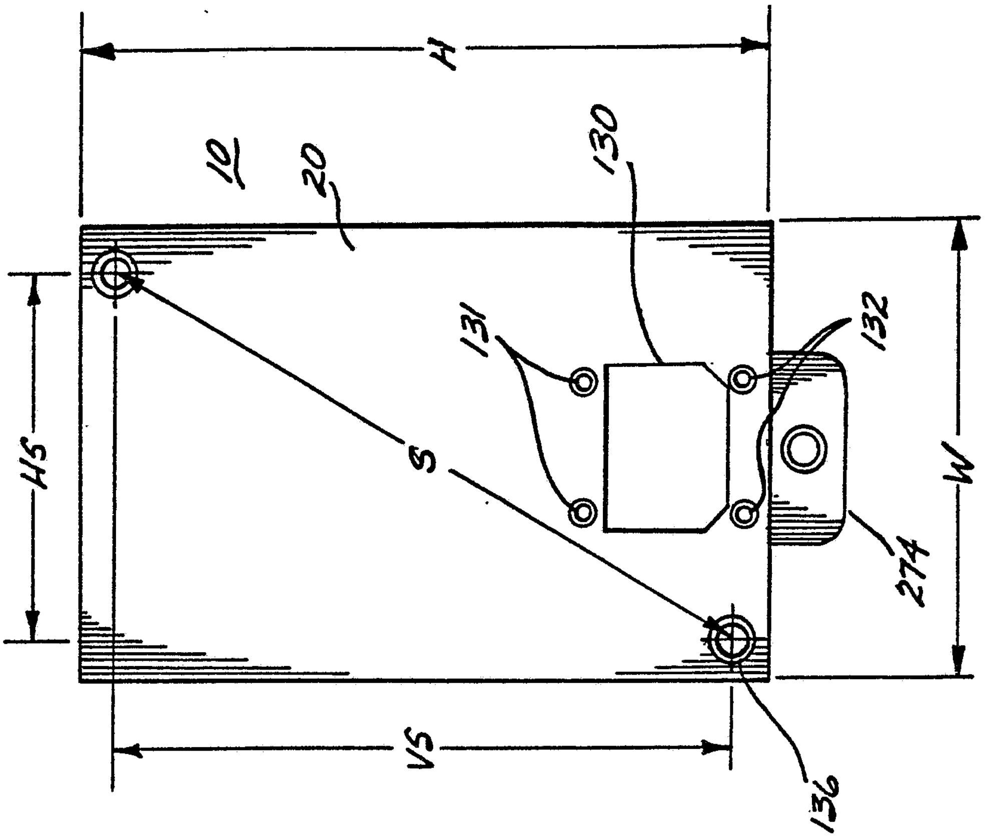
Fig. 7.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HS
S
W
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VS
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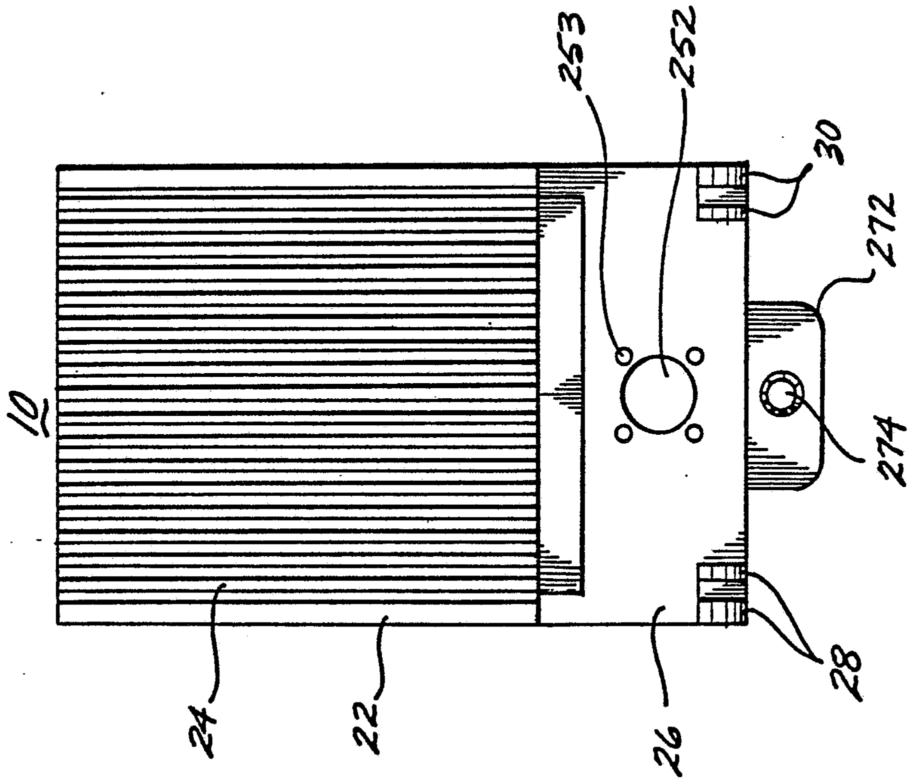
Fig. 9.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272
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24
22
26
28

Fig. 8.

INTERNATIONAL SEARCH REPORT

International Application No PCT/US85/00688

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL.[3] B64D 43/00
U.S. CL. 244/1R 361/386

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	244/1R; 361/386, 415, 931; 165/185; 322/DIG 1; 74/5.34; 228/259; 248/573, 614;

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [6]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y	US, A, 2,470,185 (PIETZ) 17 May 1949	13-17
Y	US, A, 3,139,679 (SAJ) 07 July 1964	1, 18
Y	US, A, 3,140,538 (RUTLEDGE) 14 July 1964	1, 18
Y	US, A, 3,212,564 (PASSMAN) 19 October 1965	28-31, 33-34
Y	US,A, 3,368,117 (POND) 06 February 1968	2,22
Y	US,A, 3,575,335 (BADEN) 20 April 1971	1, 18
Y	US, A, 3,631,325 (WENZ) 28 December 1971	19-21

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
27 June 1985	15 JUL 1985
International Searching Authority [1]	**Signature of Authorized Officer [10]**
ISA/US	Galen L. Barefoot

International Application No. PCT/US85/00688

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No [18]
Y	US,A, 3,997,819 (EGGERT) 14 December 1976	3-4, 6-7, 9-11
Y	US,A, 4,125,017 (DHUYVETTER) 14 November 1978	1, 18
Y	US,A, 4,236,190 (HOLLINGSEAD) 25 November 1980	23-27, 32
Y P	US,A, 4,454,566 (COYNE) 12 June 1984	19-21
Y	GB,A, 543,917 (GOLDSCHMIDT) 19 March 1984	5, 7, 12