Heat pin integrated circuit packaging apparatus for dissipating heat from electronic components into a cooling device. The apparatus comprises: a mounting element, such as a printed circuit board (10), having at least one cavity (40), for mounting the electronic components (1) in an electrical circuit; a heat pin (50), for thermally conducting heat away from the electronic component (1); a thermal planar frame (60) having at least one opening or position (90) for capturing a heat pin (50), the thermal planar frame having an inwardly facing surface (80) exposed to the cooling device; and an arrangement for detachably coupling the electronic component (1) to the heat pin (50) such that the electronic component (1) is electrically coupled to the printed circuit board (10) and thermally coupled to the heat pin (50). Thus heat generated by the electronic component (1), flows into the heat pin (50) and is dissipated into the thermal planar frame (60) for cooling by any of a variety of cooling devices.
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HEAT PIN INTEGRATED CIRCUIT PACKAGING

Field of the Invention

This invention relates generally to packaging assemblies and more specifically to packaging apparatus for dissipating heat from integrated circuit chips and other electronic components.

Background of the Invention

The problem of cooling electronic components has become more difficult with the increasing sophistication of integrated circuits. Power dissipation of more than 5 watts in individual integrated circuit chips and the desire for higher packing densities of such chips on printed circuit boards create a significant cooling problem. Since many semiconductor integrated circuit devices require a controlled temperature range for proper operation, it is necessary that the heat generated by the higher-density forms of chips and chip packaging be dissipated more efficiently and temperature controlled more precisely than in the past.

Cooling an electronic component which is packaged as part of an assembly of other such components can be described in terms of a thermal resistance problem. When the component or chip is packaged with like devices on a printed circuit board, the heat generated must be able to flow through the packaging and into some cooling apparatus if the proper temperature of the device is to be maintained. Thus, the thermal resistance or conductance of the packaging assembly greatly affects heat dissipation into the cooling medium.

A typical integrated circuit device is composed of one or more silicon chips mounted in ceramic or some other suitable material as a carrier. There is a modest thermal resistance to heat flow through the chip itself and the chip carrier.

In some typical packaging schemes for integrated circuit chips, the integrated circuit chip carrier has
been permanently brazed or joined to a heat conducting metal heat sink to reduce thermal resistance. This package as a unit is in turn connected to a printed circuit board. In this form, heat generated by the integrated circuit flows through the brazed material into the metallic heat sink which is then cooled by the ambient air or by a forced air cooling system. This type of assembly often requires special manufacturing of the integrated circuit chip carrier. Another form of heat dissipation for electronic components includes permanently brazing or affixing the electronic component to individual heat sinks immersed in a liquid cooling system.

A significant thermal resistance can be encountered at the interface between a chip carrier and a heat dissipating device, which can be lowered by such permanent eutectic bonds, but for a number of reasons it is advantageous not to have a permanent bond between the chip carrier and the heat pin. First, a permanent bond may require special manufacture of the chip and chip carrier. Second, a permanent bond between the chip carrier and the heat pin makes the assembly, servicing, and replacing of chips difficult. Also, a permanent bond between the chip carrier and the heat dissipating device limits the flexibility of the packaging assembly as part of a larger scale assembly. Lastly, permanent bonding and special manufacturing may, in some cases, substantially lower the number of chips which can be mounted on one printed circuit board.

Thus, in the prior art, the use of some permanent bonding method, makes assembly and disassembly of a large number of components difficult. Also, in the prior art, one form of cooling means is typically chosen and the packaging assembly is often limited to use with one particular cooling method.

Furthermore, most packaging assemblies for heat dissipation and cooling are designed to work most
effectively with one particular type of electronic component. For example, packaging schemes that would work well with small scale integrated circuitry, where a relatively low amount of excess heat is generated by the components, would not work as efficiently with a mixture of small and medium, or small, medium and large scale integrated circuitry in one assembly. This is especially true in those packaging assemblies which require special design of the integrated circuit chip carrier in order for the chip to be attached to a particular heat pin design. Since most assemblies for heat dissipation are designed around one particular type of component there is very little flexibility in assembling a family of such packaging schemes. In designing computer systems, for example, which use a wide variety of electronic components, it is economically and technically desirable to have a common packaging scheme which can work effectively with a variety of component types and a variety of cooling means.

Consequently, it is an object of this invention to provide a heat dissipation packaging assembly for electronic components which permits components of varying heat intensity to be mixed in one sub-assembly with consistently effective cooling. It is another object of this invention to provide an assembly for packaging components to dissipate heat with high efficiency into any of a number of cooling means. It is a further object of this invention to maintain a controlled junction temperature for the integrated circuit components.

Another object of this invention is to package electronic component devices in a detachable manner, so that needs for special manufacture of chip carriers and for special bonding techniques are eliminated.

Further, it is an object of this invention to provide a common architecture for the packaging of electronic components that can be used with a variety of cooling techniques including ambient air cooling, forced
air cooling, liquid cooling, and other forms of cooling. It is a further object of this invention to provide a packaging assembly for heat dissipation which is cost effective.

It is yet another object of this invention to provide a heat dissipation scheme which permits electronic components to be densely packaged together in a small area while providing uniform cooling for all devices located on one sub-assembly module, thus yielding improved device temperature uniformity. When used for the packaging of computer systems electronic circuitry, it is another object of this invention to facilitate an increase in the systems speed and improvements in computer system reliability.

Summary

This invention comprises an assembly for packaging heat generating electronic components in such a way that the excess heat generated by the components can be dissipated into any one of a plurality of cooling apparatus. The invention comprises: a means for mounting electronic components in an electrical circuit, such as a printed circuit board having a number of cavities extending thorough it; at least one thermally conductive heat pin shaped to fit through the cavity in the printed circuit board; a thermally conductive planar frame which has a number of holes or positions for capturing heat pins and which has one surface exposed to whichever cooling means is chosen; and a means for detachably coupling integrated circuit chips or other electronic components to the printed circuit board and to the heat pins so that each component is attached to a heat pin which protrudes thorough the circuit board and is held in contact with the thermally conductive planar frame. Thus, the heat generated by the electronic component flows through the heat pin and is dispersed
into the common thermal ground of the planar frame for cooling by the selected coolant.

A preferred means for detachably coupling the component to the planar member comprises a molded socket which has a recessed floor and a number of side walls. A spring means is attached to the side walls, so that an integrated circuit chip can be inserted into the socket after a heat pin has been connected to the floor of the socket. The spring means provides pressure to hold the electronic component in electrical contact with the connecting wires to the printed circuit board and in thermal contact with the head of the heat pin. The heat pin in turn is thermally connected to a common thermal ground which is a planar frame having a plurality of positions suitable for capturing heat pins. The use of a threaded heat pin permits easy assembly and disassembly as the heat pin head holds the molded socket against the printed circuit board and the shank of the heat pin can be threaded or screwed into the opening in the thermal planar frame. A number of various methods of attaching the heat pin to the thermal planar frame may also be used without departing from the objects of this invention.

Brief Description of the Drawings

FIG. 1 is a cross-sectional view of one embodiment of the packaging assembly of this invention showing a heat pin threaded into a planar frame.

FIG. 2 is a cross-sectional view of another embodiment of the heat pin packaging assembly showing a heat pin protruding through a planar frame.

FIG. 3 is a perspective view of the elements of this invention as used in one embodiment.

FIG. 4 is a cross-sectional view of another embodiment of this invention showing another form of spring means.
FIG. 5 is a cross-sectional view of still another embodiment of this invention showing a heat pin formed as part of a molded socket.

FIG. 6 is a cross-sectional view of another implementation of the invention in which heat pins protrude from a thermal planar frame.

FIG. 7 is a detailed cross-sectional view taken along the same lines as FIG. 1, showing portions of the invention.

FIG. 8 is a top view of a printed circuit board used in conjunction with this invention.

FIG. 9 is a perspective view of a number of electronic components packaged with the assembly of this invention.

FIG. 10 is a different perspective view of the arrangement shown in FIG. 9.

FIGS. 11, 12 and 13 are additional perspective views of alternative packaging schemes made possible using this invention.

**Best Mode for Carrying Out the Invention**

Referring to FIG. 1, there is shown a typical electronic component 1, which consists of an integrated circuit mounted in a chip carrier with the die cavity facing upward. In one embodiment the electronic component 1 is inserted into a molded socket 110, which has a recessed floor 120, and upwardly extending side walls 140. The molded socket 110 has an aperture 130 located in the recessed floor 120. A metal heat pin 50 is inserted through the aperture 130 in the floor of the molded socket 110. The heat pin is comprised of a shank portion 51 and a head portion 52. Along the upper surface of the head 52 of the heat pin 50 a thermal gasket 100 is affixed to the heat pin 50. This gasket provides a lowered thermal resistance and a smoother interface between the electronic component 1 and the metal heat pin 50.
In the present invention several materials can be used for the thermal gasket 100 on the heat pin 50. A thin impregnated silicone pad can be used, treatment of the interface with a thermally conductive paste can be used, or a metallic gasket material such as an indium alloy can be used. The thermal resistance of these gaskets can be derived from published materials.

As can be seen in FIG. 3, the shank portion 51 of the heat pin 50 protrudes downwardly through a component mounting assembly in an electrical circuit, shown here as printed circuit board 10 which has an upper surface 20 and a lower surface 30. Conventional multi-layer printed circuit boards can be used with the invention. The printed circuit board 10 has at least one hole or cavity 40 of a size to permit the insertion of the heat pin. In the printed circuit board 10 shown, a dielectric layer is on the lower side 30 of the printed circuit board 10, serving to insulate the wiring from the thermal planar means such as frame 60. Thermal planar frame 60 has an upper surface or first surface 70 which faces outwardly towards the dielectric layer 30 of the printed circuit board and a second surface 80 which faces towards the selected cooling means.

In one embodiment of the invention the planar frame 60 has a number of outwardly extending protrusions or fins 160 to provide further heat dissipation. As can be seen in FIG. 1 planar frame 60 has an aperture 90 also sized to permit the insertion of a heat pin 50. In the embodiment shown in FIG. 1 the shank of the heat pin 50 has a threaded portion which permits the heat pin to be threaded into the corresponding threaded aperture portion 90 of planar frame 60.

Thermal resistance of the heat pin 50 is a function of heat pin size and composition. A preferred embodiment uses an aluminum alloy material for the heat pin.

Use of a threaded heat pin 50 permits the total contact area between the threaded pin and the planar
frame 60 to be greater, therefore, thermal resistance is additionally lowered. Finally, the torque or interface pressures arising from the use of a threaded heat pin 50 provide some further reduction in thermal resistance.

Planar frame 60 is comprised of any metallic substance having good thermal conductivity and, correspondingly, low thermal resistance. In one embodiment, extruded aluminum is used. In FIG. 5 it can be seen that the heat pin 50, protruding from the floor of the molded socket 110, holds the socket 110 in thermal contact with the thermal planar frame 60, and contacts 180 provide electrical contact between the electronic component 1 and printed circuit board 10. In addition, the spring means 150 of the molded socket 110 holds the electronic component 1 pressed firmly against the thermal gasket 100 located on top of the heat pin 50 and against the electrical contacts 180. This assembly permits the heat generated in the electronic component 1 to flow through the thermal gasket 100 into the heat conducting heat pin 50 and downwardly through its shank 51 where it is dispersed into the metal planar frame 60.

Turning to FIG. 7, it can be seen that since the second surface 80 of thermal planar frame 60 is exposed to the cooling means, the heat from the electronic component is effectively dispersed in a uniform manner through planar means 60 into whatever cooling medium is chosen.

The conduction/convection resistance in transferring heat from the heat sink or heat pin to the coolant is an important thermal impedance. It depends on the geometry, heat transfer coefficient, and thermal properties of the planar frame 60. Optimal surface configurations for the planar frame's 60 second surface 80 can be derived from published materials. When these optimum geometrical configurations for the second surface 80 are used in conjunction with the preferred embodiment of the invention and the total thermal resistances are
calculated, improved package resistances on the order of five degrees centigrade per Watt (5°C/W) may be obtained using the present invention; an improvement over conventional thermal resistance values of other heat sink methods of twelve degrees to fifteen degrees centigrade per Watt (12°C to 15°C/W).

Referring again to FIG. 7, it can be seen that the thermal gasket 100 is affixed to the heat pin 50. But, as is seen in FIG. 7 heat pin 50 itself can be separate and detachable from the molded socket 110 and the electronic component 1.

Referring now to FIG. 8 a mounting means such as a printed circuit board 10 suitable for use with the invention is shown. Printed circuit board 10 contains a number of cavities or holes 40 arranged in a rectilinear pattern. In the preferred embodiment of this invention the heat pin 50 shown in FIG. 1 can be inserted through one of the holes 40 shown in FIG. 8 of the printed circuit board 10.

Referring to FIG. 9 a perspective view of an assembly using the invention is shown. The molded sockets 110 shown in FIG. 9 contain electronic components and heat pins (not visible). Each socket is held by a heat pin against the outer surface 20 of printed circuit board 10 and thermal contact between the electronic component and the thermally conductive planar frame 60 is made by the heat pin. As can be seen in FIG. 9, however, planar frame 60 has a first surface 70 abutting printed circuit board 10 and a second surface 80 extending away from printed circuit board 10. Additionally, in FIG. 9 it can be seen that the second surface 80 of planar member 60 has a number of cooling fins 160 extending away from the electronic circuitry. These cooling fins assist in further dissipating heat.

FIG. 10 shows the assembly depicted in FIG. 9 from a back perspective view. In FIG. 10, it can be seen that
heat pins 50 are captured against planar frame 60 by nuts 54.

Another embodiment of the planar packaging assembly is shown in FIG. 11. In this embodiment molded socket 110 containing an electronic component is held against printed circuit board 10 and against the outer wall 70 of planar frame 60. However, planar frame 60 is now made in a chambered shape such that on its opposing side there is a similar outer surface 70a on which additional printed circuit boards 10 can be mounted with electronic components and the inner surface 80a faces towards the inside of the chambered construction. In the framework shown in FIG. 11 the cooling medium can be forced through the interior of planar frame 60 in the direction of the arrow. This assembly can be adapted for use with forced air cooling, or various combinations of liquid cooling, with the appropriate addition of inlet and outlet chambers for the cooling medium. This also permits a totally enclosed flow path for the cooling medium.

Yet another configuration made possible by the invention is shown in FIG. 12 in which a multiple number of printed circuit boards 10 containing a multiple number of molded sockets 110 are affixed to the planar frame 60 which is of a similar type of chambered construction.

FIG. 13 is a perspective drawing of a cruciform chambered shape which also can be used in conjunction with the invention. Thus, it can be seen that the invention permits wide flexibility in the use of cooling techniques and appropriate planar frames. The size, shape and strength of planar means 60 can be designed to maximize the density of electronic components that can be packaged together in a particular assembly and permit the designer to select the most appropriate cooling medium.

The invention also permits a variety of electrical interconnection means to be used between modules of printed circuit boards. For example, in the embodiment shown in FIG. 9, a conventional printed circuit board 10
having gold finger interconnects 11 can be used. In the embodiments shown in Figs. 11 and 12 cable or other interconnects 11 can be used. The embodiments shown in Figs. 11, 12, and 13 can also be enclosed such that a cooling medium, such as a liquid, can be used and the components affixed to the outer surfaces can be replaced or repaired without disrupting the cooling medium flow.

Turning now to FIG. 2 an alternative embodiment of the invention shows the heat pin 50 extending completely through planar frame 60 and having a threaded portion 53 at the lower end of the shank which is held in place against planar frame 60 by nut 54.

FIG. 4 shows another embodiment of the invention in which the spring means 150 used to maintain contact between the electronic component 1 and the heat pin 50 is supported by protrusions 110a which extend upwardly from the printed circuit board 10. As this shows, various means of applying pressure to maintain thermal contact between the electronic component, the heat pin 50 and the thermal planar means 60 can be used, without deviating from the objects of this invention.

Turning now to FIG. 5, another embodiment of the invention is shown for use with a single planar frame 60 is shown. In this embodiment the heat pin 50 is formed as part of the molded socket 110. Thus, molded socket 110 is one element, having a heat pin 50 with a threaded shank portion 53 protruding therefrom. This still permits the heat pin to be inserted through a cavity 40 (not shown) in the printed circuit board 10, and through an aperture 90 in thermal planar frame 60. Since the heat pin 50 extends through the planar frame 60, it can be held in place by means of a nut 54. Forming the heat pin 50 as part of the molded socket 110 reduces the manufacturing cost of the assembly and simplifies test and repair while still permitting the electronic component 1 to be detachably coupled.
A further variation of this invention is depicted in FIG. 6. In this embodiment, the heat pin 50 is formed as a protruding portion of planar frame 60. Heat pin 50 extends upwardly to form a threaded head section 52 which screws into a correspondingly threaded aperture 53 in molded socket 110. Thus it can be seen that a number of varying embodiments of the heat pin integrated circuit packaging concept can be accomplished with this invention.

Use of the packaging assembly of the present invention permits approximately twice the normal density of integrated circuit chip electronic modules to be mounted on a conventional printed circuit board. This, in turn, significantly reduces the cost and size of the overall packaging modules and in computer packaging systems, for example, it also permits improved reliability and speed of the devices so interconnected. Reliability is improved as a result of the lowered junction temperatures attained with this invention. The higher density of chip modules reduces the length of module interconnections, and this, in turn, reduces signal delays, thereby improving the speed of the overall subsystem of modules.

The packaging assemblies shown can be used with a number of cooling mechanisms important for electronic equipment, such as natural convection with air, forced air cooling, liquid cooling, and multi-phase and heat pipe heat transfer. At relatively low dissipation densities of approximately .04 watts per square centimeter, heat pin packaging can be used with natural convection to achieve highly reliable cooling.

Thus, it can be appreciated that the present invention comprises a heat pin integrated circuit packaging apparatus that fully satisfies the objects, aim, and advantages set forth above. While the invention has been described in conjunction with specific embodiments thereof, it is evident that many
alternatives, modifications, and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace all such alternatives, modifications and variations as come within the spirit and broad scope of the appended claims.

What is claimed is:
1. In an assembly for electronic components having a cooling means for dispersing the heat generated by the electronic components, apparatus for packaging the electronic components for conducting heat into the cooling means comprising:

A. mounting means for mounting the electronic components in an electrical circuit, the mounting means having at least one cavity extending therethrough;

B. at least one thermally conductive heat pin means having a protruding surface such that the heat pin means can be inserted through the cavity in the mounting means for thermally contacting the electronic components;

C. thermally conductive planar means having at least one first surface coupled to the heat pin means and having at least one second surface exposed to the cooling means;

D. means for detachably coupling the electronic components to the mounting means such that each electronic component is electrically coupled to the mounting means and each electronic component is thermally coupled to a heat pin means extending through a cavity in the mounting means and coupled to the thermally conductive planar means;

Whereby heat generated by the electronic component is dispersed through the heat pin means and into the thermally conductive planar means for dissipation by the cooling means, thereby cooling the electronic components.

2. The apparatus as recited in Claim 1 wherein each heat pin means is comprised of a shank portion and a head portion with a thermal gasket thereon and wherein the means for detachably coupling the electronic components comprises a means for applying mechanical pressure against an electronic component such that the electronic
component is electrically coupled to the mounting means and is thermally coupled to the thermal gasket on the head of the heat pin.

3. The apparatus as recited in Claim 2 in which the means for detachably coupling an electronic component further comprises:

   at least one molded socket having a recessed floor from which the shank portion of the heat pin means is extended, the molded socket also having a plurality of upwardly extending side walls with a spring means attached thereto;

   Whereby the electronic component can be inserted into the molded socket such that the spring means thermally couples the electronic component to the head portion of the heat pin means.

4. The apparatus as recited in Claim 1 wherein each heat pin means is comprised of a threaded shank portion and an outwardly extending head portion with a thermal gasket and wherein the thermally conductive planar means is comprised of a first surface having at least one threaded opening such that the threaded shank portion of the heat pin means can be threaded therein, whereby the heat pin means can be inserted through a cavity in the mounting means and connected to the thermally conductive planar means, such that the heat pin means holds the mounting means against the first surface of the thermally conductive planar means.

5. The apparatus as recited in Claim 1 wherein each heat pin means is comprised of a threaded shank portion, and a nut threaded to fit the shank portion, the threaded shank portion having thereon an outwardly extending head portion with a thermal gasket and wherein the thermally conductive planar means is comprised of a first surface having at least one opening such that the threaded shank
portion of the heat pin means can be extended therethrough, whereby the shank portion of the heat pin means can be inserted through a cavity in the mounting means to protrude through an opening in the thermally conductive planar means such that the detachable nut of the heat pin means can be affixed thereto, so that the heat pin means holds the mounting means against the first surface of the thermally conductive planar means.

6. The apparatus as recited in Claim 1 wherein the thermally conductive planar means is comprised of at least one first surface with a plurality of heat pin means formed as protrusions thereon, the heat pin means each having an extending shank portion having a threaded head portion with a thermal gasket thereon, and the thermally conductive planar means having at least one second surface exposed to the cooling means, whereby the shank portion of the heat pin means can be inserted through a cavity in the mounting means and connected to the means for detachably coupling the electronic components to the mounting means, such that the heat pin means holds the mounting means against the first surface of the thermally conductive planar means.

7. The apparatus as recited in Claim 6 wherein the means for detachably coupling the electronic component to the thermally conductive planar means is comprised of at least one molded socket having a recessed floor with a threaded aperture therethrough such that the heat pin means can be inserted through a cavity in the mounting means and threaded into the threaded aperture of the molded socket, the molded socket also having a plurality of upwardly extending side walls with a spring means attached thereto; whereby the electronic component can be inserted into the molded socket such that the spring means thermally couples the electronic component to the head of the heat pin means.
8. In an assembly for electronic components having a cooling means for dispersing the heat generated by the electronic components, apparatus for packaging the electronic components for conducting heat into the cooling means comprising:

A. mounting means for mounting the electronic components in an electrical circuit, the mounting means having at least one cavity extending therethrough;

B. at least one thermally conductive heat pin means having a threaded shank portion and having an outwardly extending head portion with a thermal gasket thereon, such that the shank of the heat pin means can be inserted through the cavity in the mounting means;

C. at least one thermally conductive metal frame having at least one outwardly facing first surface with a plurality of threaded openings for thermally capturing the heat pin means and having at least one inwardly facing second surface exposed to the cooling means;

D. at least one molded socket having a recessed floor with an aperture therethrough through which the threaded shank portion of the heat pin means can be extended, such that the threaded shank portion of the heat pin means extends through the molded socket and through the cavity in the mounting means, threading into an opening in an outwardly facing first surface of the thermally conductive metal frame, the molded socket also having a plurality of upwardly extending side walls with a spring means attached thereto;

Whereby an electronic component can be inserted into the molded socket such that the spring means of the molded socket electrically couples the electronic component to the mounting means and thermally couples the electronic component to the head of the heat pin means,
thereby dispersing heat from the electronic component into the thermally conductive metal frame for dissipation by the cooling means, thereby cooling the electronic components.

9. In an assembly for electronic components having a cooling means for dispersing the heat generated by the electronic components, apparatus for packaging the electronic components for conducting heat into the cooling means comprising:

A. mounting means for mounting the electronic components in an electrical circuit, the mounting means having at least one cavity extending therethrough;

B. at least one thermally conductive heat pin having a threaded shank portion and having an outwardly extending head portion with a thermal gasket thereon, such that the shank of the heat pin means can be inserted through the cavity in the mounting means;

C. at least one nut threaded to fit the shank portion of the heat pin means;

D. at least one thermally conductive metal frame having at least one outwardly facing first surface and at least one inwardly facing second surface exposed to the cooling means, the thermally conductive metal frame having at least one opening extending therethrough;

E. at least one molded socket having a recessed floor with an aperture therethrough such that the threaded shank portion of the heat pin means can be extended through the aperture in the socket and through a cavity in the mounting means, to protrude through an opening in the thermally conductive metal frame such that the heat pin means can be captured by the nut, the molded socket also having a plurality of upwardly
19 extending side walls with a spring means attached thereto.

Whereby an electronic component can be inserted into the molded socket such that the spring means electrically couples the electronic component to the mounting means and thermally couples the electronic component to the head of the heat pin means, thereby dispersing heat from the electronic component into the thermally conductive metal frame for dissipation by the cooling means, thereby cooling the electronic components.

10. In an assembly for electronic components having a cooling means for dispersing the heat generated by the electronic components, apparatus for packaging the electronic components for conducting heat into the cooling means comprising:

A. mounting means for mounting the electronic components in an electrical circuit, the mounting means having at least one cavity extending therethrough;

B. at least one thermally conductive metal frame having at least one outwardly facing first surface having a plurality of heat pins formed as protrusions thereon, the heat pins each having an extending shank portion having a threaded head portion with a thermal gasket thereon, the thermally conductive metal frame also having at least one inwardly facing second surface exposed to the cooling means;

C. at least one molded socket having a recessed floor with a threaded aperture such that the threaded head portion of a heat pin can be extended through a cavity in the mounting means and be threaded into the threaded aperture in the floor of the molded socket, the molded socket also having a plurality of upwardly extending side walls with a spring means attached thereto;
20

Whereby an electronic component can be inserted into the molded socket such that the spring means electrically couples the electronic component to the mounting means and thermally couples the electronic component to the head of the heat pin means, thereby dispersing heat from the electronic component into the thermally conductive metal frame for dissipation by the cooling means, thereby cooling the electronic component.

10

In an assembly for electronic components having a cooling means for dispersing the heat generated by electronic components, apparatus for packaging the electronic components for conducting heat into the cooling means comprising:

15 A. mounting means for mounting the electronic components in an electrical circuit, the mounting means having at least one cavity extending therethrough;

B. at least one molded socket having a recessed floor, the floor having a thermal gasket on its inner surface and a threaded heat pin means protruding from the outer surface of the recessed floor, such that the threaded heat pin means can be extended through a cavity in the mounting means, the molded socket also having a plurality of upwardly extending side walls with a spring means attached thereto, such that an electronic component can be inserted into the molded socket such that the spring means of the molded socket electrically couples the electronic component to the mounting means and thermally couples the electronic component to the heat pin means;

C. at least one thermally conductive metal frame having at least one outwardly facing first surface with a plurality of threaded openings for thermally capturing the threaded heat pin means.
and having at least one inwardly facing second surface exposed to the cooling means;

Whereby heat generated by the electronic components is dispersed through the heat pin means of the molded socket into the thermally conductive metal frame for dissipation by the cooling means, thereby cooling the electronic components.
**INTERNATIONAL SEARCH REPORT**

**International Application No:** PCT/US81/00826

### I. CLASSIFICATION OF SUBJECT MATTER

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

- Int. Cl. 3 H05K 7/20
- U.S. Cl. 361/385; 174/16HS

### II. FIELDS SEARCHED

**Minimum Documentation Searched**: 174/16HS, 357/79,81; 361/381,382,386,387,388

Documentation Searched other than Minimum Documentation to the extent that such Documents are Included in the Fields Searched:

### III. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>US,A, 3,522,491, Published 4 Aug 1970, Coe</td>
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* Special categories of cited documents: 15
  - "A" document defining the general state of the art
  - "E" earlier document published on or after the international filing date
  - "L" document cited for special reason other than those referred to in the other categories
  - "O" document referring to an oral disclosure, use, exhibition or other means
  - "P" document published prior to the international filing date but on or after the priority date claimed
  - "T" later document published on or 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

### IV. CERTIFICATION

- **Date of the Actual Completion of the International Search**: 1 SEP 1981
- **Complete Int. Search 19 August 1981**
- **International Searching Authority**: ISA/US
- **Signature of Authorized Office**: Gerald R. Tolin
- **Primary Examiner**: Gerald R. Tolin
- **Art Unit**: 213